Online ISSN : 2249-4626
Print ISSN : 0975-5896
DOI : 10.17406/GJSFR

Global Journal

of Science Frontier Research: A

Physics and Space Science

Origin of Chiral Life

Role of Gauge Particles

Highlights

Buoyancy Explains Flight

Warm Intergalactic Medium

Discovering Thoughts, Inventing Future

VOLUME 17 ISSUE 1 VERSION 1.0

Global Journal of Science Frontier Research: A
Physics & Space Science

Global Journal of Science Frontier Research: A
Physics & Space Science

Volume 17 Issue 1 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*

Sponsors: *Open Association of Research Society*
Open Scientific Standards

Publisher's Headquarters office

Global Journals® Headquarters
945th Concord Streets,
Framingham Massachusetts Pin: 01701,
United States of America
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Global Journals Incorporated
2nd, Lansdowne, Lansdowne Rd., Croydon-Surrey,
Pin: CR9 2ER, United Kingdom

Packaging & Continental Dispatching

Global Journals
E-3130 Sudama Nagar, Near Gopur Square,
Indore, M.P., Pin:452009, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investors@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Including by Air Parcel Charges):

For Authors:
22 USD (B/W) & 50 USD (Color)
Yearly Subscription (Personal & Institutional):
200 USD (B/W) & 250 USD (Color)

Dr. Bondage Devanand Dhondiram

Ph.D.

No. 8, Alley 2, Lane 9, Hongdao station,

Xizhi district, New Taipei city 221, Taiwan (ROC)

Dr. Yaping Ren

School of Statistics and Mathematics

Yunnan University of Finance and Economics

Kunming 650221, China

Contents of the Issue

i. Copyright Notice
ii. Editorial Board Members
iii. Chief Author and Dean
iv. Contents of the Issue

1. Using Gravitational Waves to Put Limits on Primordial Magnetic Fields. *1-6*
2. Biocosmological Role of Gauge Particles in the Origin of Chiral Life and the Inflationary Origin of Matter-Antimatter Asymmetry in Semiclosed Friedman Universe. *7-10*
3. Simulating the Second Moment of NMR Spectral Line in Ammonium Chloride Single Crystal. *11-25*
4. Modulus of Elasticity of Lab_6 – Meb_2 (Me – Ti, Zr, Hf) Composite at High Temperatures based on the Interfacial Interactions. *27-30*
5. Inflationary Origin of Matter-Antimatter Asymmetry in Semiclosed Friedman Universe. *31-33*
6. The Cosmic Web, the Seed of Galaxies- are also Made of Warm Intergalactic Medium(WHIM) and Dark Energy? *35-45*

v. Fellows
vi. Auxiliary Memberships
vii. Process of Submission of Research Paper
viii. Preferred Author Guidelines
ix. Index

Global Journal of Science Frontier Research: A
Physics and Space Science
Volume 17 Issue 1 Version 1.0 Year 2017
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Using Gravitational Waves to Put Limits on Primordial Magnetic Fields

By David Garrison
University of Houston Clear Lake, United States

Abstract- We describe a technique for using simulated tensor perturbations in order to place upper limits on the intensity of magnetic fields in the early universe. As an example, we apply this technique to the beginning of primordial nucleosynthesis. We determined that any magnetic seed fields that existed before that time were still in the process of being amplified. In the future, we plan to apply this technique to a wider range of initial magnetic fields and cosmological epochs.

GJSFR-A Classification: FOR Code: 020105

USINGGRAVITATIONALWAVESTOPUTLIMITSONPRIMORDIALMAGNETICFIELDS

Strictly as per the compliance and regulations of :

Using Gravitational Waves to Put Limits on Primordial Magnetic Fields

David Garrison

Abstract- We describe a technique for using simulated tensor perturbations in order to place upper limits on the intensity of magnetic fields in the early universe. As an example, we apply this technique to the beginning of primordial nucleosynthesis. We determined that any magnetic seed fields that existed before that time were still in the process of being amplified. In the future, we plan to apply this technique to a wider range of initial magnetic fields and cosmological epochs.

I. Introduction

Magnetic fields are believed to have played a large part in the dynamics of the evolution of our universe. However, little is known about the existence of magnetic fields when the universe was very young. There are no direct observations of primordial magnetic fields. Theories also disagree on the amplitude of primordial magnetic fields. There are currently several dozen theories about the origin of cosmic magnetic fields [2, 18]. The main reason that we believe that primordial magnetic fields existed is because they may have been needed to seed the large magnetic fields observed today. Most theories of cosmic magnetic field generation fall into one of three categories [2, 12, 18]: 1) magnetic fields generated by phase transitions; 2) electromagnetic perturbations expanded by inflation; and 3) turbulent magnetofluid resulting in charge and current asymmetries. Once generated, these seed magnetic fields were amplified by a dynamo however, we don't know when or how this dynamo did it's work.

Most models calculate the magnitude of primordial magnetic fields by starting with the observed strength of galactic or intergalactic magnetic fields and calculating how this field should have been amplified or diffused by external effects such as the magnetic dynamo and expansion of the universe [2, 18]. A major problem is that there doesn't appear to be a universal agreement of how efficiently a dynamo could have strengthened seed magnetic fields or when the strengthening occurred. Estimates of the strength of these seed fields can vary by tens of orders of magnitude. In the absence of amplification mechanisms, the frozen-in condition of magnetic field lines tells us that [2, 18].

$$\vec{B}_0 = \vec{B}a^2. \tag{1}$$

Author: Physics Department, University of Houston Clear Lake, Houston, Texas 77058. e-mail: Garrison@UHCL.edu

Here $\vec{B}_0$ is the present magnetic field where the scale factor is unity and $\vec{B}$ is the magnetic field when the scale factor was a. Once amplification and diffusion are taken into account, this relationship can be used to calculate the amplitude of magnetic seed fields. Seed magnetic fields produced during Inflation are predicted to have a current strength somewhere between 10^{-11} G and 10^{-9} G on a scale of a few Mpc [2, 18, 26]. Magnetic seed fields generated by phase transitions are believed to be less than 10^{-23} G at galactic scales [2, 18]. Some turbulence theories imply that magnetic fields were not generated until after the first stars were formed therefore requiring no magnetic seed fields [2].

Given how little is understood about primordial magnetic fields and the general lack of agreement among theoretical predictions, it seems clear that the existence of primordial magnetic fields can neither be confirmed or ruled out. It seems that the best we can do is set an upper limit on the strength of primordial magnetic fields and utilize this limit as a starting point in developing models of cosmic turbulence. Observations of the CMB limit the intensity of the magnetic seed fields to a current upper limit of 10^{-9} G [2, 18, 26, 38].

It is well known that gravitational waves can interact with a magnetofluid in the presence of a magnetic field. Work by Duez et al [15] showed how gravitational waves can induce oscillatory modes in a plasma field if magnetic fields are present. Work by Kahniashvili and others [30, 31, 32, 34, 35, 36] have shown how a turbulent plasma can yield gravitational waves. The result may be a highly nonlinear interaction as energy is transferred from the fluid to the gravitational waves and back resulting in potentially significant density perturbations. Magnetic fields are the glue that bind the gravitational waves to the plasma field. The objective of this work is to utilize the interaction between gravitational waves and the primordial magnetofluid in order to put limits on the strength of magnetic fields that could have existed in the early universe.

II. Primordial Gravitational Wave Amplitudes

According to Boyle, Primordial Gravitational Waves develop primarily from tensor perturbations expanded by the inflation event [3, 4]. The process is similar to that of scalar perturbations and the two are related by a tensor/scalar ratio

Global Journal of Science Frontier Research (A) Volume XVII Issue I Version I Year 2017

$$r = \Delta_t^2/\Delta_s^2. \quad (2)$$

Here the Δ terms refer to the primordial power spectrums. As a function of horizon exit time, τ_{out} and wavenumber, k,

$$\Delta_t^2(k,\tau_{out}) = 64\pi G\frac{k^3}{2\pi^2}|h_k(\tau_{out})|^2 \approx 8(\frac{H_*}{2\pi M_{pl}})^2, \quad (3)$$

$$\Delta_s^2(k,\tau_{out}) \approx \frac{1}{2\epsilon_*}(\frac{H_*}{2\pi M_{pl}})^2, \quad (4)$$

$$r(k) \equiv \Delta_t^2(k,\tau_{out})/\Delta_s^2(k,\tau_{out}) \approx 16\epsilon_*. \quad (5)$$

$M_{pl} = (8\pi G)^{-1/2}$ is the "reduced Planck mass" and ϵ is the slow roll parameter. Also the asterisk (*) terms denote the value of the parameters when the tensor perturbation exits the horizon. The wavenumber is commonly defined as k $= a_* H_*$ at the horizon exit. Once the tensor mode enters the horizon, k≫aH, the strain amplitude of the gravitational waves can be defined as

$$h_k = \frac{1}{a\sqrt{2k}}. \quad (6)$$

Unfortunately, because there is not a consistent dimensionless definition of the Hubble Parameter, this method does not allow for an easy way to calculate the amplitude of gravitational waves in the early universe. We therefore turn to Grishchuk's work [19, 20]. Grishchuk believed that gravitational waves were generated by ination and amplified by a process called parametric amplification. Starting with the idea that the gravitational wave power spectrum is deduced by treating contracted tensor perturbations as eigenvalues of a quantum mechanical operator that works on the vacuum state we see that

$$\langle 0|\,\hat{\Omega}\,|0\rangle = \langle 0|\,h_{ij}(n,\eta)h^{ij}(n,\eta)\,|0\rangle = \frac{\mathcal{C}^2}{2\pi^2}\int_0^\infty n^2\sum_{p=1,2}|h_p(\eta)|^2\frac{dn}{n}. \quad (7)$$

Here, n refers to a dimensionless angular wave number, p refers to the left and right handed polarizations of the gravitational waves and $\eta = \int \frac{dt}{a(t)}$ is the conformal time.

The constant $\mathcal{C}$ should be taken as $\mathcal{C}=\sqrt{16\pi}l_{pl}$. It can be shown that the mean-square amplitude of the gravitational wave is

$$h^2(n,\eta) = [\frac{4l_{pl}}{\sqrt{\pi}}n]^2\sum_{p=1,2}|h_p(\eta)|^2. \quad (8)$$

The square root of the equation above will provide a root-mean squared (RMS) amplitude of a gravitational wave for a specific wave number. To complete the power spectrum, we show that the amplitude of gravitational waves can be expressed as

$$h(n,\eta) = [\frac{4l_{pl}}{\sqrt{\pi}}n]|h(\eta)|. \quad (9)$$

Using the relation $n_H = 4\pi$, which corresponds to the current Hubble radius [19, 20],

$$h(n,\eta) = 16\sqrt{\pi}l_{pl}\frac{n}{n_H}|h(\eta)|. \quad (10)$$

Grischuk shows that this can be expressed in a convenient form as

$$h(n) = 16\sqrt{\pi}l_{pl}\frac{b}{l_0}(\frac{n}{n_H})^{2+\beta}. \quad (11)$$

The variable β is the power-law ination parameter with -2 corresponding to the de Sitter universe and b is a constant defined in terms of β as

$$b = \frac{2^{|2+\beta|}}{|1+\beta|^{|1+\beta|}} \quad (12)$$

l_0 is a constant that denotes an arbitrary Hubble radius during inflation, it is on the order of $10^6 l_{pl}$ according to Grischuk.

$$a(\eta) = l_0|\eta|^{1+\beta} - \infty \leqslant \eta\ ; \quad -2 \leqslant \beta \leqslant -1 \quad (13)$$

Since Grishchuk's solution effectively varies by wavenumber, n_H, to some power between 0 and -1, we can see that Boyle and Grishchuk's solutions may be equivalent for β = -1.5. By setting n_H to reflect a Hubble parameter earlier than the current epoch, we can calculate the spectrum of gravitational waves at any time in the history of the universe post inflation.

III. Overview of the Software

As described in the article, Numerical Relativity as a Tool for Studying the Early Universe [17], the code used here was specifically developed to study relativistic plasma physics in the early universe. This code is based on the Cactus Framework (www.cactuscode.org). Cactus was originally developed to perform numerical relativistic simulations of colliding black holes but it's modular design has since allowed it to be used for a variety of Physics, Engineering and Computer Science applications. It is currently being maintained by the Center for Computation and Technology at Louisiana Sate University. Cactus codes are composed of a esh (which provides the framework) and the thorns (which provide the physics). The code used within this work, SpecCosmo, is a collection of cactus thorns written in a combination of F90, C and C++.

The code uses the relativistic MHD evolution equations proposed by Duez [14]. It is also designed to utilize a variety of different differencing schemes including 2nd order Finite Differencing, 4th order Finite

Differencing and Spectral Methods. This work uses Fourier Spectral Methods and periodic boundary conditions exclusively. These involve treating the functions as generic periodic functions and calculating the derivatives using FFTs and inverse FFTs. The code is capable of solving Einstein's Equations directly (through a modified BSSN formulation) as well as the relativistic MHD equations. The code was thoroughly tested [17] and found to accurately model known GRMHD dynamics. These tests included MHD waves induced by gravitational waves test, the consistency of cosmological expansion test and shock tests.

The initial data used was derived from work done by several projects involving primordial magnetic fields, phase transitions and early universe cosmology in general [16, 28, 34, 36, 37]. This study models a high energy epoch of the universe after inflation and the Electroweak phase transition when the universe was about 3 minutes old. The author chose this as the starting point for our study because it was the beginning of the Primordial Nucleosythesis in the early universe.

IV. Evolution Equations

The MHD equations used here are based on Duez's evolution equations [14].

$$\partial_t \rho_* + \partial_j(\rho_* v^j) = 0, \tag{14}$$

$$\partial_t \tilde{\tau} + \partial_i(\alpha^2 \sqrt{\gamma}\, T^{0i} - \rho_* v^i) = s, \tag{15}$$

$$\partial_t \tilde{S}_i + \partial_j(\alpha \sqrt{\gamma}\, T_i^j) = \frac{1}{2}\alpha \sqrt{\gamma}\, T^{\alpha\beta} g_{\alpha\beta,i}, \tag{16}$$

$$\partial_t \tilde{B}^i + \partial_j(v^j \tilde{B}^i - v^i \tilde{B}^j) = 0. \tag{17}$$

Here ρ_* is conserved density, v^j is velocity, $\tilde{\tau}$ is the energy variable, $\tilde{S}_i$ is the momentum variable, s is the source term, α is the lapse term, γ is the determinate of the three metric and T^{ij} is the stress-energy tensor. The tilde denotes that the term was calculated with respect to the conformal metric. The first equation comes from conservation of baryon number, the second derives from conservation of energy, the third is conservation of momentum and the fourth is the magnetic induction equation. For this simulation we use Geodesic Slicing, $\alpha = 1.0$, $\beta_i = 0.0$.

The code utilizes a first order version of the BSSN equations to simulate the background space-time. For fixed gauge conditions, the modified BSSN equations as defined by Brown [6] are:

$$\bar{\partial}_0 K = \alpha \left(\tilde{A}^{ij} \tilde{A}_{ij} + \frac{1}{3} K^2 \right) + 4\pi\alpha(\rho + S)\ . \tag{18}$$

$$\bar{\partial}_0 \phi = -\frac{\alpha}{6} K\ , \tag{19}$$

$$\bar{\partial}_0 \phi_i = -\frac{1}{6}\alpha \overline{D}_i K - \kappa^{\phi} \mathcal{C}_i\ , \tag{20}$$

$$\bar{\partial}_0 \tilde{\gamma}_{ij} = -2\alpha \tilde{A}_{ij}\ , \tag{21}$$

$$\begin{aligned}\bar{\partial}_0 \tilde{A}_{ij} &= e^{-4\phi}\left[\alpha(\tilde{R}_{ij} - 8\pi S_{ij}) - 2\alpha \overline{D}_{(i}\phi_{j)} + 4\alpha\phi_i\phi_j + \Delta\tilde{\Gamma}^k{}_{ij}(2\alpha\phi_k)\right]^{TF} \\ &\quad + \alpha K \tilde{A}_{ij} - 2\alpha \tilde{A}_{ik}\tilde{A}^k_j\ ,\end{aligned} \tag{22}$$

$$\bar{\partial}_0 \tilde{\gamma}_{kij} = -2\alpha \overline{D}_k \tilde{A}_{ij} - \kappa^{\gamma} \mathcal{D}_{kij}\ , \tag{23}$$

$$\bar{\partial}_0 \tilde{\Lambda}^i = -\frac{4}{3}\alpha \tilde{D}^i K + 2\alpha \left(\Delta\tilde{\Gamma}^i{}_{k\ell} \tilde{A}^{k\ell} + 6\tilde{A}^{ij}\phi_j - 8\pi \tilde{\gamma}^{ij} S_j \right)\ . \tag{24}$$

The bar denotes a derivative taken with respect to the fiducial metric and the tilde again denotes a derivative taken with respect to the conformal metric. Also, $\mathcal{C}_i$ and $\mathcal{D}_{kij}$ are constraint equations and κ^{ϕ} and κ^{γ} are proportionality constants. ρ, S, S_j and S_{ij} are source terms as found in the standard version of the BSSN equations. Brown et al also defined:

$$\begin{aligned}\mathcal{C}_i &= \phi_i - \overline{D}_i \phi = 0, \\ \mathcal{D}_{kij} &= \tilde{\gamma}_{kij} - \overline{D}_k \tilde{\gamma}_{ij} = 0, \\ \Delta\tilde{\Gamma}^i{}_{k\ell} &= \frac{1}{2}\tilde{\gamma}^{ij}\left(\tilde{\gamma}_{k\ell j} + \tilde{\gamma}_{\ell kj} - \tilde{\gamma}_{jk\ell}\right)\ , \\ \tilde{R}_{ij} &= -\frac{1}{2}\tilde{\gamma}^{k\ell}\overline{D}_k \tilde{\gamma}_{\ell ij} + \tilde{\gamma}_{k(i}\overline{D}_{j)}\tilde{\Lambda}^k + \tilde{\gamma}^{\ell m}\Delta\tilde{\Gamma}^k_{\ell m}\Delta\tilde{\Gamma}_{(ij)k}\end{aligned}$$

$$+\tilde{\gamma}^{k\ell}[2\Delta\tilde{\Gamma}^{m}{}_{k(i}\Delta\tilde{\Gamma}_{j)m\ell}+\Delta\tilde{\Gamma}^{m}{}_{ik}\Delta\tilde{\Gamma}_{mj\ell}]\ ,$$

V. Experimental Set-Up and Assumptions

In order to determine the upper limit of primordial magnetic fields that existed at a particular stage in the evolution of our universe, we inject a broad spectrum of gravitational waves into a homogenous relativistic plasma field with a constant magnetic field and study the results. This is similar to what Duez did in the second of two papers [15]. The basic idea of the Duez paper was to calculate the effect that standing gravitational plane waves would have on a homogenous plasma field with a constant magnetic field. The result was to excite magnetosonic and Alfen waves in the plasma based on the polarization of the gravitational waves and other parameters such as the density, temperature and magnetic field of the plasma. This was done as a test of their GRMHD code but we use it here to probe what magnetic fields may have been physically allowable in the early universe. We choose to perform this study 180s after the big bang although such a study could have been performed anytime after electro-weak symmetry breaking. For the results to be relevant, we must assume that magnetogenesis and any dynamo effects had already created and strengthened a primordial magnetic fields

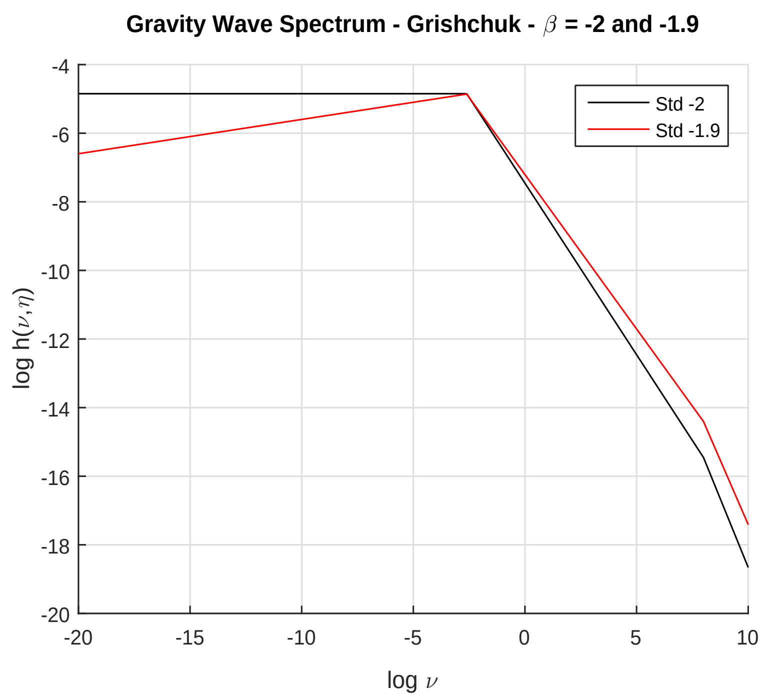


Figure 1: Primordial Gravitational Wave spectrum as calculated by Grishchuk's method for t = 180 s.

that would gradually be weakened by the expansion of the universe. The temperature, density, Hubble parameter, scale factor and mass contribution of the universe at this stage are all well known [28]. We utilized an initial temperature of 1.0×10^{9} K. The scale factor and Hubble Parameter are $a = 2.81 \times 10^{-9}$ and $H =$ 2.46 $\times 10^{-3} s^{-1}$ respectively. The mass/energy density at the time was $1.08 \times 10^{4} \frac{kg}{m^3}$. Our study assumes that 80% of the mass density of the universe was composed of "dark matter". This was chosen to be consistent with our current dark matter to baryonic matter ratio. This "dark matter" was simulated using a pressureless, non-magnetic fluid with no internal energy, in addition to the magnetofluid used to simulation regular matter. This was done to keep us from over estimating the effects of magnetic fields on the matter field. The amplitude of the gravitational waves at this epoch was determined using Grishchuk's solution described in a previous section.

We ran 6 simulations with different values of a fixed magnetic fields along the z-axis, $0\ G$, $10^{2}\ G$, $10^{4}\ G$, $10^{5}\ G$, $10^{6}\ G$ and $10^{8}\ G$. Each run used random tensor perturbations with amplitudes up to 10^{-19}. We utilized a three dimensional computational grid with 64^3 internal grid points corresponding to 4^3 meters with a courant factor of 0.1. The domain size of 4^3 meters was chosen to allow for multiple light crossing times during the course of the simulation. Geodesic slicing conditions and periodic boundary conditions were used for all simulation runs. We also used a 3rd order Iterative Crank Nicolson time scheme for time integration. A spectral differencing method was used and the simulations ran for over 1,000 iterations. There were no shocks or discontinuities in the system so we did not utilize our HRSC routines.

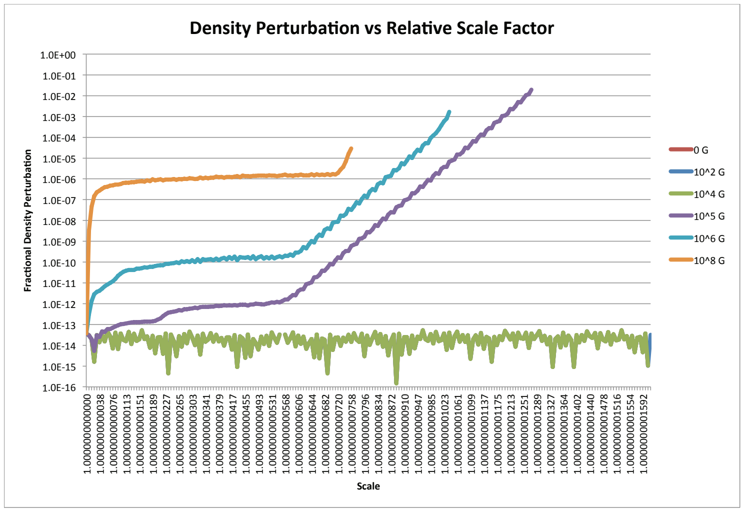


Figure 2: Density perturbations as the result of different initial magnetic fields

VI. Results

As one can see from Figure 2, the density perturbations appear larger as the intensity of the initial magnetic field increases. There appears to be no difference between the 0 G magnetic field and the 10^4 G magnetic field. However, the 10^5 G magnetic field seems to have a much larger effect on the plasma field with density perturbations on the order of a part in 10^{12} result. When the magnetic fields are near or above 10^5 G the perturbations continue to grow until the system becomes unstable. This is clearly an unphysical result. It should be noted that a primordial magnetic field of 10^8 would correspond to a current cosmological magnetic field of 10^{-9} G which is the established upper limit.

VII. Discussion

The goal of this project was to develop a technique for testing the upper limit of cosmological magnetic fields throughout different epochs of universal evolution. We did this using the beginning of Primordial Nucleosythesis as an example. We observed that the relative amplitude of density perturbations varied according to the strength of the initial magnetic fields. Our observed instabilities for magnetic fields greater than 10^4 G imply that such strong magnetic fields should not have been physically possible during the Primordial Nucleosynthesis epoch. We saw that the maximum possible magnetic field as determined by observation, is not physically viable. From this we conclude that the amplification of the seed magnetic fields either did not finish until much later or current cosmological magnetic fields should have amplitudes below 10^{-13} G. Future work will involve applying this technique to later epochs over a wider range of initial magnetic fields in order to more accurately determine upper limits for magnetic field intensities.

VIII. Conflicts of Interests

The author declares that there are no conflict of interests regarding the publication of this article.

IX. Acknowledgement

The author would like to acknowledge the support of the University of Houston Center for Advanced Computing and Data Systems for access to the high performance computing resources used for the completion of this project.

References Références Referencias

1. T. W. Baumgarte and S. L. Shapiro, Phys. Rev. D 59, 024007 (1999).
2. E. Battaner and H. Lesch, (2000) [arXiv:hep-ph/0408289]
3. L. A. Boyle and P. J. Steinhardt, Phys. Rev. D 77, 063504 (2008) doi:10.1103/PhysRevD.77.063504 [astro-ph/0512014].
4. L. A. Boyle, UMI-32-23849.
5. A. Brandenburg, K. Enqvist and P. Olesen, Phys. Rev. D 54, 1291 (1996)
6. J. D. Brown et al., Phys. Rev. D 85, 084004 (2012) doi:10.1103/PhysRevD.85.084004 [arXiv:1202.1038 [gr-qc]].
7. C. Caprini and R. Durrer, Phys. Rev. D 74, 063521 (2006) [arXiv:astro-ph/0603476]
8. C. Caprini, R. Durrer and G. Servant, JCAP 0912, 024 (2009) [arXiv:astro-ph/0909.0622]
9. S. M. Carroll, San Francisco, USA: Addison-Wesley (2004) 513 p
10. J. Cho, Astro. Phys. J. 621, 324-327 (2005)
11. J. Cho, J. of Korean Phys. Soc. 49, 4 (2006)
12. A. D. Dolgov, (2001) [arXiv:hep-ph/0110293
13. A. D. Dolgov, D. Grasso and A. Nicolis, Phys. Rev. D 66, 103505 (2002) [arXiv:astro-ph/0206461

14. M. D. Duez, Y. T. Liu, S. T. Shapiro and B. C. Stephens, Phys. Rev. D 72, 024028 (2005)
15. M. D. Duez, Y. T. Liu, S. T. Shapiro and B. C. Stephens, Phys. Rev. D 72, 024029 (2005)
16. R. Durrer and A. Neronov, Astron. Astrophys. Rev. 21, 62 (2013) [arXiv:1303.7121 [astro-ph.CO]].
17. D. Garrison, J. Grav. 2014, 407197 (2014) [arXiv:1207.7097 [gr-qc]].
18. D. Grasso and H. R. Rubinstein, Phys. Rept. bf 348 163-266 (2001) [arXiv:astro-ph/0009061]
19. L. P. Grishchuk, V. M. Lipunov, K. A. Postnov, M. E. Prokhorov and B. S. Sathyaprakash, Phys. Usp. 44, 1 (2001); Usp. Fiz. Nauk 171, 3 (2001); [arXiv:astro-ph/0008481]
20. L. P. Grishchuk, Phys. Rev. D 74, 083008 (2006), [arXiv:gr-qc/0605100]
21. J. N. Islam, Cambridge, UK: Univ. Pr. (1992) 190 p.
22. G. Gogoberidze, T. Kahniashvili and A. Kosowsky, Phys. Rev. D 76, 083002 (2007) [arXiv:astro-ph/0705.1733]
23. L. M. H. Hall, I. G. Moss, A. Berera, Phys.Rev. D69 (2004) 083525
24. K. M. Hu_enberger, H. K. Eriksen, F. K. Hansen, A. J. Banday, and K. M. Gorski, ApJ, 688 (2008) 1.
25. D. Hobill, A Burb and A Coley, Deterministic Chaos in General Relativity (New York, Plenum Press, 1994)
26. F. Hoyle 1951 IAU Symposium on the Motion of Gaseous Masses of Cosmical Dimensions: Problems of Cosmical Aerodynamics (Central Air Documents Office), p. 195
27. T. Inoue, K. Asano and K. Ioka, Astrophys. J. 734, 77 (2011) [arXiv:astro-ph.HE/1011.6350]
28. J. N. Islam, An Introduction to Mathematical Cosmology (Cambridge, Cambridge University Press, (1992)
29. S. Iso, Strong Coupling Gauge Theories in the LHC Perspective (SCGT12): pp. 238-246. arXiv:1304.0293 [hep-ph]
30. T. Kahniashvili, (2005) [arXiv:astro-ph/0508459]
31. T. Kahniashvili, G. Gogoberidze and B. Ratra, Phys. Rev. Lett. 95 151301 (2005) [arXiv:astro-ph/0505628]
32. T. Kahniashvili and B. Ratra, Phys. Rev. D 75 023002 (2007) [arXiv:astro-ph/0611247]
33. T. Kahniashvili, New Astron. Rev. 50, 1015 (2006) [astro-ph/0605440].
34. T. Kahniashvili, A. Kosowsky, G. Gogoberidze and Y. Maravin, Phys. Rev. D 78, 043003 (2008) [arXiv:astro-ph/0806.0293]
35. T. Kahniashvili, L. Campanelli, G. Gogoberidze, Y. Maravin and B. Ratra, Phys. Rev. D 78, 123006 (2008) [Erratum-ibid. D 79, 109901 (2009)] [arXiv:astro-ph/0809.1899]
36. T. Kahniashvili, L. Kisslinger and T. Stevens, Phys. Rev. D 81, 023004 (2010) [arXiv:astro-ph/0905.0643].
37. L. S. Kisslinger, Mod. Phys. Lett. A19, 1179-1186 (2004) [arXiv:hep-ph/0402001]
38. H. Kodama and M. Sasaki, Prog. Theor. Phys. Suppl. 78, 1 (1984)
39. H. Kurki-Suonio, Cosmological perturbation theory, part 2. Lecture notes for a course of cosmological perturbation theory given at the University of Helsinki 2010, (2010)
40. A. Melatos and C. Peralta, Astrophys. J. 709, 77 (2010) [arXiv:astro-ph.HE/0911.1609]
41. C. J. Moore, R.H. Cole and C. P. L. Berry, http: =www:ast:cam:ac:uk= _ cjm96=noise curve:pdf
42. S. Mukherjee, S. Das, M. Joy and T. Souradeep, JCAP 01 (2015) 043 arXiv:1410.8835 [astro-ph.CO]
43. A. Nicolis, Class. Quant. Grav. 21, L27 (2004) [arXiv:gr-qc/0303084]

Global Journal of Science Frontier Research: A
Physics and Space Science
Volume 17 Issue 1 Version 1.0 Year 2017
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Biocosmological Role of Gauge Particles in the Origin of Chiral Life and the Inflationary Origin of Matter-Antimatter Asymmetry in Semiclosed Friedman Universe

By Noboru Hokkyo
Senjikan Institute

Abstract- The biocosmological role of CP-symmetry-violating chiral Z^0 boson in the origin of the chiral life and the cosmological role of CP-symmetric Higgs boson H^0 in the inflationary origin of the matter-antimatter asymmetry in the semiclosed Friedman universe are discussed.

Keywords: *biology; cosmology; gauge particles; origin of life; matter-antimatter asymmetry.*

GJSFR-A Classification: *FOR Code: 069999*

Biocosmological Role of Gauge Particles in the Origin of Chiral Life and the Inflationary Origin of Matter-Antimatter Asymmetry in Semiclosed Friedman Universe

Noboru Hokkyo

Abstract- The biocosmological role of CP-symmetry-violating chiral Z^0 boson in the origin of the chiral life and the cosmological role of CP-symmetric Higgs boson H^0 in the inflationary origin of the matter-antimatter asymmetry in the semiclosed Friedman universe are discussed.

Keywords: biology; cosmology; gauge particles; origin of life; matter-antimatter asymmetry.

I. Introduction

In 1860 L. Pasteur[1] wrote: "Life as manifested to us is a function of the asymmetry of the Universe. I can even imagine that all living species are primordially in their structure, in their external forms (like left-right chiral asymmetry) of a function of the Universe." A. Salam[2] later wrote that Pasteur was prophetic in the unification of biology and cosmology. We here discuss the biocosmological role of the chiral Z^0 boson predicted in 1968 in the origin of chiral life, and the cosmological role of the Higgs boson H^0 discovered in 2014 in the inflationary origin of matter-antimatter symmetry in the semiclosed Friedman universe.

II. Biocosmology

A. Salam[2] summarized the presently accepted view of the origin of life as occurring in three stages: cosmic, previotic chemical, and biological:

1) The cosmic stage concerns itself with the early history of the universe, where electroweak forces made a phase transition into electromagnetic and weak forces 10^{-12}s after the universe was born. The radius of the universe was then extended from Planck scale ~ 10^{-33}cm to 10^{-2}cm; the temperature was 250Gev ~ $10^{12}\kappa T$; and the carriers of the neutral weak force of Z^0 boson acquired the mass by Higgs mechanism.
2) Chemistry became important after the planets were formed, some 10 billions years later, though it may have played a role in the presolar epochs as well (long after the quarks of the early cosmic era had condenced into protons and neutrons and much after the recombination with electrons, taking place some 10^5 years following Big Bang). Molecules of future life could thus have formed before the origin of the Earth.[3]
3) The biological era concerns itself with the replication of nucleic acid polymers and protein synthesis. The biological era may have started some 4 billlion years ago.

III. Z^0 Boson and Chiral Life

It is known that all amino acids and proteins utilized in living systems are of the L (left-handed) type. Salam emphasized the role of the chiral Z^0 interaction as its weak interaction works as a contact interaction in biochemical process (zwitterionic process).[2] Then, starting from Z^0 interactions,[4] the quantum mechanical cooperative and condensation phenomena[5,6] could give rise to second order phase transitions from D (right-handed) to L type occurring generally at low temperatures bellow a critical point T_C, known as $T_C << T_B = 3K << T_E \sim 300K$, where T_B is the ambient cosmic background radiation temperature at the present epoch of the expanding universe. T_E is the Earth's present surface temperature. There the crucial problem is that of amplification of the electroweak advantage over the course of time so that, fo example, the 20 amino acids convert almost entirely from L to D type.

We are thus led to look for the origin of the chiral life in more distant and cooler parts of the universe,[7,8,9] arriving at the semilosed Friedman model of the extragalactic radio source where the evolutionarilly earlier upper hemisphere of the universe is filled with negative dark energy causing large mass defect.[10,11]

IV. Planckeon-H^0 Boson Composite

In his 1963 paper: Semiclosed Worlds in the General Theory of Relativity Zel'dovich[12] wrote: "A class of Friedman solutions of general relativity equation is found in which, as we approach the matter from infinity, we reach a singularity at the graviational radius. But beyond this point the metric is continued in an unusual way—the radius decreases again and goes to zero only after passing through a maximum" (Novikov's similar work[13] noted in proof). Andreev, Stanyukovich and

Author: Senjikan Institute, Niigata, Japan.
e-mail: noboruhokk@yahoo.co.jp

others[14,15] found related solutions showing the possible existence of a gravitationary closed point particle with Planck mass m_{pl} and radius l_{pl} moving with light vlocity which they called maximon or Planckeon. These particles can emit radiation only if they collide with massive object, but the radiation is unobservable by the Doppler effect.

We here propose a gravitationally bound Planckeon-Higgs boson composite[10,11] creating negative attractive potential and positive rest mass energy:

$$-Gm_Hm_{pl}/l_{pl} = -G(m_H/m_{pl})m_{pl}^2/l_{pl}$$

$$= -10^{-17}Gm_{pl}^2/l_{pl} < 0, \qquad (1)$$

$$10^{-17}m_{pl}c^2 = 10^{-17}(\hbar c/l_{pl}) > 0, \qquad (2)$$

filling the evolutionarilly earlier upper hemisphere as dark energy and evolutionarilly later lower hemisphere as dark matter of the closcd Friedman univese. Here we have used $m_H = 10^{-17}m_{pl} = 10^{-22}$g. On the equator separating the two hemispheres we have

$$10^{-17}(m_{pl}c^2 - Gm_{pl}^2/l_{pl}) = 0, \qquad (3)$$

where the mass energy is absorbed by the attractive potential.

V. Evolutionary History of Friedman Universe

We extend the Friedman metric in Lorentz-Friedman-Reissner-Nordström form[10,11]:

$$ds^2 = c^2g_{tt}dt^2 - g_{rr}dr^2,$$

$$g_{tt} = g_{rr}^{-1} = 1 - r^2/r_g^2 + L_\theta^2 l_{pl}^2/r^2 \qquad (4)$$

Here $r_g = 2GM/c^2$ is the gravitational radius of the universe having Newtonian mass M and radius $R \geq r_g$, and

$$L_\theta = \hbar l_\theta/2\pi,\ l_\theta = \text{integer}. \qquad (5)$$

is the quantized angular momentum.

The evolutionary history of the Lorentz-Friedman black hole is containd in the integral

$$l_{pl} = \int^R g_{rr} r dr$$

$$= \int^R r dr(1 - r^2/r_g^2 + L_\theta^2 l_{pl}^2/r^2)^{-1}. \qquad (6)$$

giving the unitary and holographic information content (entropy)[16] of the black hole acquired by an observer approaching the matter distribution through empty space from infinity:

$$(R/l_{pl})^2 = (10^{28}/10^{-33})^2 = 10^{120}. \qquad (7)$$

VI. Superluminal Inflation and Subluminal Evolution

The light velocity is obtained by solving $ds^2 = 0$ as:

$$dr/dt = c(g_{tt}/g_{rr}) = c\,(1 - r^2/r_g^2 + L_\theta^2 l_{pl}^2/r^2)$$

$$> c \text{ at } r \sim l_{pl} \text{ and } r \sim r_g - l_{pl}$$

$$= c \text{ at } r = r_C = (r_g/l_{pl})^{1/2}$$

$$= c \text{ in between } r_C < r < r_C = c \text{ and } r \sim r_g - l_{pl} \qquad (8)$$

Eqs.(8) show that, starting from quantum fluctuations of preexisting metric for $0 < r < l_{pl}$, the light velocity is superlumnal at $r \sim l_{pl}$ and $r_g - l_{pl}$. After Big Bang at temperature $T_B = 10^{27}$K, dr/dt decreases with the increse of r towards $r = r_C = (r_g/l_{pl})^{1/2} = L_\theta^2 10^{-2}$ cm for $r_g = R = 10^{28}$cm.

During the superluminal and inflationary epoch of electroweak and grand unification of gauge fields by Higgs mechanism, a causaly related small region extends from $r \sim 10^{-25}$cm to $r \sim 10$cm, followed by a brief interlude of reheeting, retuning to the pre-inflatioonary temperature of the universe. Further evolution is described by standard Friedman universe starting the radiation dominated phase of Hubble's evolutional history expanding with subluminal velocity. Hubble constant H relates the velocity v of a massive extragalactic object to its distance d from the Earth:

$$H = v/d \qquad (9)$$

The COBE astronomical observations of the large-scale homogeneity of the distribution of matter and galaxy formation on the scale of 10^{10}cm light years can be explained by the superluminal and bi-directional EPR causal connection between radius $r = l_{pl}$ and $r = r_C$, while stars, clusters of galaxies, voids and other structures larger than 10^8 light years seem to indicate the angular momentum (5) $l_\theta \sim 10^3$ so that $r_C = l_\theta 10^{-2} \sim 10$cm, the high l_θ value indicating the multi-directional inflation.

VII. H^0 Boson and Inflation

H^0 boson has non-vanishing vacuum expectation value which spontaneously breaks electroweak gauge symmetry and which, in turn, gives rise to the Higgs mechanism capable of giving mass to the gauge bosons.

The PC and T symmetric Klein-Gordon equation

$$[\,\partial^2/\partial^2/(ct)^2 - \partial^2/\partial^2 r^2 + (\hbar/mc)^2]\psi = 0 \qquad (10)$$

obeyed by the Higgs boson wave function $\psi(r, t)$ can be decomposed into two-component Dirac form:

$$(\partial/\partial/ct - \partial/\partial r + \hbar/mc)\psi_+ = 0,$$

$$(\partial/\partial/ct + \partial/\partial r + \hbar/mc)\psi_- = 0, \qquad (11)$$

Global Journal of Science Frontier Research (A) Volume XVII Issue I Version I Year 2017

where $\psi_{\pm}$ represent the positive and negative energy states of the Higgs boson going forward and backward in time.

During the inflation, starting at $r = l_{pl}$ and ending at $r = r_C$, the light velocities $(dr/dt)_{\pm}$ are given by

$$\begin{aligned}(dr/dt)_{+} &= c[(1 - r/r_g + L_\theta l_{pl}/r], \\ &> c \ \text{ at } r = l_{pl} \\ &= c \ \text{ for } r = r_C = (L_\theta l_{pl} r_g)^{1/2} \end{aligned} \tag{12}$$

and

$$\begin{aligned}(dr/dt)_{-} &= c[(1 + r/r_g + L_\theta l_{pl} \\ &> c \ \text{ at } r = r_g - l_{pl} \\ &= c \ \text{ for } r = r_C = (L_\theta l_{pl} r_g)^{1/2} . \end{aligned} \tag{13}$$

The CERN high energy proton-proton collision experiment creating H^0 boson, immediately decaying into a counter-propagating pair of photons, seems to tell the preference of H^0 boson, going forward in time, to its antiboson, going backward in time, by the present universe expanding forward in time.

VIII. Matter-Antimatter Asymmetry

Matter-antimatter symmetry required by quantum theory and relativity is largely violated in cosmic scale outside high energy laboratory experiments. As there were equal amount of gauge matter and antimatter, immediately after the moment of the hot Big Bang at $r = r_C$, we here propose to consider that the probability of collision between H^0 boson and the gauge matter, comoving forward in time, dominates over the collision between H^0 boson and antimatter, counter-propagating backward in time during inflation expanding forward in time.

IX. Cosmological Double-Slit Experiment

In his positron theory Feynman extended Jordan-Paulil propagator

$$\begin{aligned} D(r, t) &= t/|t|\delta(c^2t^2 - r^2) \\ &= D_{ret} - D_{adv} \end{aligned} \tag{14}$$

To

$$\begin{aligned} D &= D_{ret} + D_{-} \\ &= D_{adv} + D_{+} . \end{aligned} \tag{15}$$

Here D_{ret} and D_{adv} are the retarded and advanced propagators. $D_{\pm}$ are the Fourier contributions from positive and negative frequency sheets. At the Chicago meeting Pauli criticized Feynman's D_F by applying it to the single electron double-slit experiment. Feynman[17] replied Pauli by showing a delayed-choice double-slit equipped with time-dependent shutters creating $\Lambda + V = N$ shaped electron-positron pairs, zigzagging in time.

A matter-antimatter symmetric cosmology is conceivable by replacing the shutter by the Big Bang and the slit by the 3-diensional Lorentz sphere: $(ct)^2 - r^2 = l_{pl}^2$ filled with point-like Planckeons and joind onto Friedman universe at $r = r_c$, allowing a topological (non-Hausdolff) worm hole where the timelike 3-vectors is undefined.

X. Early Comment on Gauge Theory

After C. N. Yang's keynote address: "Gauge Fields, Electromagnetism and the Bhom-Aharonov Effect" at the 1983 Tokyo symposium on the Foundations of Quantum Mechanics (ISQM),[10,11] Greenberger asked: Why is that we do not have a gauge theory of gravity that works in this simple and beautiful way in the Bohm-Aharonov experiment using electron holography? Yang[18] answered: "All gauge theories are related to connection on fibre bundles. In the case of gravity the bundle is a special one, the tangent bundle. That is why, in the final analysis, gravity is different from other gauge theories."

References Références Referencias

1. L. Pasteur, Researches on the molecular asymmetry of natural organic products, Alembic Club Reprint no.4, London (1980).
2. A. Salam, The Role of Chirality in the Origin of Life. Journal of Molecular Biology. **33**, 105 (dictated and typed) (1991).
3. J. Orò et al. The origin and early evolution of life on Earth, Ann Rev Earth Planet Sci. **18**, 317 (1990).
4. K. Kondepdi and C. Nelson, Weak neutral currents and the origin of biological chirality. Nature.**314**, 438.(1985).
5. A. Leggett, In P. Davis (ed) The New Physics. Cambridge University Press p.276 (1990).
6. A. Salam et al. Chern-Simons Super Conductivity at finte temperatures. Nucl. Phys.**B340**, 403 (1990).
7. J. Orò, Comets and the formation of biochemical compounds on the primitive earth. Nature **190,** 389. in (1961).
8. C. Ponamperma and P. Molten, Prospect of life on Jupiter, Space Life Sciences 4 32 (1973).
9. M. Okamoto et al. Polarized Radio Emission from Extragalactic Source, Phys. Rev. **B6**4. 03303 (2007).
10. N. Hokkyo, Physics and Space Science **15** (6)(2015).
11. N. Hokkyo, Physics and Space Science **16**(5) (2016),
12. Ya. B. Zel'dovich, Sov. Phys. JETP **16**(3) 732.(1963)
13. I. D. Novikov, Delayed Expansion of a Part of the Friedman Universe, and Quasers.Soviet Astronomy **8**(6) 857(1963).

14. A. F. Andreev, Macroscopic Bodies with Zero Rest 。。Mass, Sov. Phys. JETP **38**(6) 648.(1974).
15. Yu. N. Babanenkov et al., Geometric Model of Radiation Plancken, Sov. Phys. Dokl. **26**(9). 856.(1974).
16. S. W. Hawking, Information Loss in Black Holes. Phys. Rev. **D72,** 08401 (2005),
17. R. P. Feynman, The Theory of Fundamental 。。Processes. Fig.18.2. Addison-Wesley, New York (1961).
18. C. N. Yang, Gauge Fields, Electromagnetism and the Bhom-Aharonov Effect, Proc. Int. Symp. Foundations of Quantum Mechanics, Physical Society of Japan (1963) p.9.

Global Journal of Science Frontier Research: A
Physics and Space Science
Volume 17 Issue 1 Version 1.0 Year 2017
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Simulating the Second Moment of NMR Spectral Line in Ammonium Chloride Single Crystal

By F. I. Bashirov & N. K. Gaisin
Kazan Federal University

Abstract- Innovative technique of simulating the second moment of NMR spectral line broadened owing to the magnetic dipole-dipole interaction in crystals with internal molecular motion is suggested. The local hindered molecular motion (HMM) is approximated by the extended angular jump model. The resulting expression of the second moment allows one to evaluate the crystal structure distortion and the dynamical parameters of HMM. The presented theory agrees with the experimental anisotropic second moment of proton NMR spectral line in whole temperature region of the ammonium chloride single crystal investigation.

Keywords: *crystallographic point symmetry; hindered molecular motion; nuclear magnetic resonance; second moment; single crystal; symmetry distortion.*

GJSFR-A Classification: *FOR Code: 020399*

Simulating the Second Moment of NMR Spectral Line in Ammonium Chloride Single Crystal

F. I. Bashirov [α] & N. K. Gaisin [σ]

Abstract- Innovative technique of simulating the second moment of NMR spectral line broadened owing to the magnetic dipole-dipole interaction in crystals with internal molecular motion is suggested. The local hindered molecular motion (HMM) is approximated by the extended angular jump model. The resulting expression of the second moment allows one to evaluate the crystal structure distortion and the dynamical parameters of HMM. The presented theory agrees with the experimental anisotropic second moment of proton NMR spectral line in whole temperature region of the ammonium chloride single crystal investigation.

Keywords: crystallographic point symmetry; hindered molecular motion; nuclear magnetic resonance; second moment; single crystal; symmetry distortion.

I. Introduction

The use of spectroscopy techniques such as neutron, Raman, infrared, dielectric, electron, nuclear magnetic and electric quadrupole resonance spectroscopy to study condensed state physics problems has several advantages. This includes the detailed nature of the information, which can be obtained on structural and dynamical properties, and the definiteness of the interpretation, which can be given to the data. The theoretical studying of hindered molecular motion (HMM) dynamics is normally carried out by examining the time depended auto-correlation function (ACF) of a physical quantity of the molecule. A notable progress has been made in the theory of HMM by using the properties of continuous [1] and point [2, 3] symmetry groups.

The second moment of NMR spectral line broadened owing to the magnetic dipoledipole interaction of nuclear spins is serving as one of main probes of HMM in crystalline substances [4-7]. Measuring the second moment allows one to testing various models of HMM taking place in condensed matter.

The basic statements of the well-known HMM models have been carefully discussed in [2, 8]. The most recent developed model, the so-called extended angular jump model (EAJM), is well appropriate to exploring HMM of symmetrical molecules in single crystals, powders, and liquids. It was successfully applied to examine the rates of nuclear magnetic relaxation [9-11], the relative intensities of Raman light scattering [11, 13], dielectric [14, 15] and infrared [13] absorption, and the incoherent neutron scattering function [7, 8, and 16] in mono- and polycrystalline molecular media.

Recently, EAJM-approach was used by describing the intramolecular contribution to the second moment of NMR line shape [17]. This time, we decided to expand this application up to ability of simulating whole NMR spectral line second moment in molecular crystals without any restriction on the temperature region. So, this paper is devoted to add EAJM-approach to simulating the second moment of NMR absorption line broadened owing to the magnetic dipole-dipole interaction of homo- and hetero-nuclear spins in perfect and symmetry distorted crystals. We shall consider the contributions of both intra- and inter-molecular dipole-dipole interactions to the 2nd moment. The validity of the application will be verified by approximating the known experimental data on the 2nd moment of the proton NMR spectral line measured for two main directions of the external magnetic field in the single crystal of ammonium chloride at large temperature region [18].

II. Basics of the Theory of NMR 2nd Moment M_2 in Molecular Crystals

The second moment of NMR spectral line M_2 broadened owing to magnetic dipoledipole interaction of identical resonant nuclear spins in molecular crystals can be simulated by using the following basic expression [3-6]:

$$M_2 = \frac{1}{N_i}\sum_{i=1}^{N_i}\sum_{j\neq i} \frac{3}{4}\hbar^2\gamma_j{}^2 r_{ji}^{-6} I_j(I_j+1)\left(3\cos^2\theta_{ji}-1\right)^2, \tag{1}$$

where the subscript i labels the resonant nuclear spins of a molecule and the symbol N_i designates the number of such spins, the subscript j labels all resonant nuclear spins of the crystal; the symbols γ and I denote respectively

Author α: Corresponding author, Department of General Physics, Kazan Federal University, 420111, Kazan, Russian Federation.
e-mail: fbashir@mail.ru
Author σ: Department of Physics, Kazan Technological University, 420015, Kazan, Russian Federation.

the gyromagnetic ratio and the quantum number of the nuclei; $\hbar$ = 1.0544·10^{-34} J·s is Planck's constant, θ_{ji} is the polar angle that forms the internuclear vector $\mathbf{r}_{ji} = \mathbf{r}_{ji}$ (r_{ji}, φ_{ji}, θ_{ji}) with respect to the intensity vector vector of stationary magnetic field $\mathbf{B}_0$ allocating the laboratory reference frame (LRF). The azimuthal angle φ_{ji} can be any.

In the case of the direction of intramolecular vector $\mathbf{r}_{ji}$ (r_{ji}, φ_{ji}, θ_{ji}) changes accidentally, its spherical angles (φ_{ji}, θ_{ji}) as well as some intermolecular vectors present random functions of time. As a result, spectral distribution of NMR signal is modified. However, the intramolecular and intermolecular vectors effect on NMR signal by different way. Consequently, simulating the NMR second moment M_2 is to be performed by accounting for two additive contributions – intramolecular $M_2^{(\mathrm{intra})}$ and intermolecular $M_2^{(\mathrm{inter})}$:

$$M_2 = M_2^{(\mathrm{intra})} + M_2^{(\mathrm{inter})}. \tag{2}$$

a) *Intramolecular contribution – $M_2^{(intra)}$*

The intramolecular contribution $M_2^{(intra)}$ to the total second moment M_2 accounting for the hindered motion of intramolecular vectors can be presented in the form [19]:

$$M_2^{(\mathrm{intra})} = \frac{1}{N_i} \sum_{i=1}^{N_i} \sum_{j \neq i} \left[\frac{3}{4} \hbar^2 \gamma_j{}^2 I_j (I_j + 1) \cdot \int_{-\delta\nu_i}^{\delta\nu_i} J_{ji}{}^{(0)}(\omega_i) \mathrm{d}\nu_i \right], \tag{3}$$

where

$$J_{ji}{}^{(0)}(\omega_i) = \int_{-\infty}^{+\infty} K_{ji}{}^{(0)}(t) \exp(\mathrm{i}\,\omega_i t)\, \mathrm{d}t \tag{4}$$

is the no normalized spectral density function (SDF) of the autocorrelation function

$$K_{ji}{}^{(0)}(t) = \left\langle F_{ji}{}^{(0)}(t) F_{ji}{}^{(0)*}(t+\tau) \right\rangle \tag{5}$$

of the lattice part of spin-spin interaction Hamiltonian

$$F_{ji}^{(0)}(t) = r_{ji}^{-3} \left(3\cos^2\theta_{ji}(t) - 1 \right) = \left(\frac{16\pi}{5} \right)^{1/2} r_{ji}^{-3}\, Y_0^{(2)} \left[\varphi_{ji}, \theta_{ji}(t) \right]. \tag{6}$$

The quantity $Y_0^{(2)}[\varphi_{ji}, \theta_{ji}(t)]$ is the zero component of the 2nd rank normalized spherical function. In Equation (3), the integration has to be performed within the limits of the double line width from $-\delta\nu_i$ up to $+\delta\nu_i$, where $\nu_i = \omega_i / 2\pi = \gamma_i B_0$ is the resonance frequency of i-th spins, B_0 – the module of induction vector of the static magnetic field, γ_i – the gyromagnetic ratio of resonant nuclei, $\delta\nu_i = 1/T_{2i}$ (T_{2i}) is the spin-spin relaxation time).

The outcomes of simulating Equation (3) depend on the physical model of molecular motion. With respect to the goal of the present studying, EAJM-approach will be used as the model of HMM [2, 8]. Within the framework of that model, the analytical expression of normalized SDF $J_0^{(2)}(\omega_i)$ of the tensor component $Y_0^{(2)}[\phi(t), \vartheta(t)]$ is presented for a single crystal sample by

$$J_0^{(2)}(\omega) = J_0^{(2)}(q_\alpha, \phi, \vartheta, \omega) = \frac{5}{2\pi} \sum_\alpha \sum_{l=0}^{2} \frac{q_\alpha \tau_\alpha}{1 + (\omega\tau_\alpha)^2} a_{\alpha l 0}(\phi) \cos^{2l}\vartheta. \tag{7}$$

It is noted that the angles φ_{ji} and θ_{ji} of the internuclear vector $\mathbf{r}_{ji}$ do not present explicitly in Equation (7). Instead, there are two spherical angles ϕ and ϑ, by which orientation of the crystallographic reference frame sets up in the axial laboratory one. The subscript α labels irreducible representations (IR) Γ_α of the HMM point symmetry group G.

By accounting for Equation (7), the no normalized SDF $J_{ji}{}^{(0)}(\omega_i)$ takes the form:

$$J_{ji}{}^{(0)}(\omega_i) = J_{ji}{}^{(0)}(q_\alpha, \phi, \vartheta, \omega_i) = \frac{16\pi}{5} r_{ji}^{-6} J_0^{(2)}(q_\alpha, \phi, \vartheta, \omega_i) =$$

$$8\, r_{ji}^{-6} \sum_{\alpha} \sum_{l=0}^{2} \frac{q_\alpha \tau_\alpha}{1+(\omega_i\ \tau_\alpha)^2}\, a_{\alpha l0}(\phi) \cos^{2l} \vartheta. \tag{8}$$

The rated expressions of the factors $a_{\alpha l0}(\phi)$ are tabulated explicitly as functions of azimuthal angle ϕ for all crystallographic point symmetry groups of pure rotation in [2,8]. A quantity q_α, the dynamic weight of IR Γ_α of the group G, is playing a role of adjustable parameter of the theory that has to be experimentally determined. It satisfies the normalization condition: $\sum q_\alpha = 1$. For ideal symmetry of HMM, a dynamic weight q_α reduces its static value value equals to the dimension of IR Γ_α of the group G. The parameter τ_α, the HMM correlation time adapted to Γ_α, relates the expression:

$$\tau_\alpha = (1-\chi_{\alpha \mathrm{E}}^{-1} \textstyle\sum_i p_i \chi_{\alpha i})^{-1} \tau\,, \tag{9}$$

where $\chi_{\alpha i}$ and $\chi_{\alpha E}$ are the characters of *i*-th and identical classes, respectively, p_i– the probability of the fundamental act of motion appropriate to *i*-th class of the group G, and τ – a mean time between two successive steps of motion. The time τ is ordered to Arrhenius low:

$$\tau \ = \ \tau_0 \exp\,(E_a/RT)\,, \tag{10}$$

where E_a is the height of activation energy barrier averaged on the HMM symmetry group, τ_0 is a mean time between two sequential attempts to overlap the barrier.

By substituting Equation (8) in Equation (3), we shall obtain the 2nd moment expression specified by the intramolecular action of resonant spins *j* to target resonant spins i in analytical form by

$$M_2^{(\mathrm{intra})} = \frac{6}{N_i} \sum_{i=1}^{N_i} \sum_{j \neq i} \hbar^2 \gamma_j^2 r_{ji}^{-6} I_j (I_j+1) \int_{-\delta\nu_i}^{\delta\nu_i} \left[\sum_{\alpha} \sum_{l=0}^{2} \frac{q_\alpha \tau_\alpha}{1+(2\pi\nu_i \tau_\alpha)^2} a_{\alpha l0}(\phi) \cos^{2l} \vartheta \right] \mathrm{d}\nu_i\,. \tag{11}$$

By performing the prescribed integration, we are obtaining:

$$M_2^{(\mathrm{intra})} = \frac{6}{\pi N_i} \sum_{i=1}^{N_i} \sum_{j \neq i} \hbar^2 \gamma_j{}^2 r_{ji}^{-6} I_j (I_j+1) \sum_{\alpha} \sum_{l=0}^{2} q_\alpha a_{\alpha l0}(\phi) \cos^{2l} \vartheta \,\mathrm{arctg}(2\pi \cdot \delta\nu_i \cdot \tau_\alpha)\,. \tag{12}$$

For a powder, by averaging over the angles ϕ and ϑ, Equation (12) reduces to:

$$M_2^{(\mathrm{intra|pow})} = \frac{6}{5\pi N_i} \sum_{i=1}^{N_i} \sum_{j \neq i} \hbar^2 \gamma_j{}^2 r_{ji}^{-6} I_j (I_j+1) \sum_{\alpha} q_\alpha \mathrm{arctg}(2\pi \cdot \delta\nu_i \cdot \tau_\alpha)\,. \tag{13}$$

In a regime of a fast molecular motion, the inequality $(2\pi \cdot \delta\nu_i \cdot \tau_\alpha) << 1$ is valid that follows the equality arctg $(2\pi \cdot \nu_i \cdot \tau_\alpha) = 0$. In this case the dipole-dipole contribution to the second moment vanishes, that is, $M_2^{(intra)} = 0$, and so-called phenomenon of "spectral line narrowing" or "bandwidth narrowing" is observed.

Alternatively, in the case of a slow motion regime, inequality $(2\pi \cdot \nu_i \cdot \tau_\alpha) >> 1$ followed by equality arctg $(2\pi \cdot \nu_i \cdot \tau_\alpha) \pi/2$ is valid. Furthermore, taking into account the normalization condition $\sum_\alpha q_\alpha = 1$, Equation (13) reduces down to a permanent value:

$$M_2^{(\mathrm{intra|pow})} = \frac{3}{5N_i} \sum_{i=1}^{N_i} \sum_{j \neq i} \hbar^2 \gamma_j{}^2 r_{ji}^{-6} I_j (I_j+1) \tag{14}$$

presented earlier by Abraham and Lösche [5, 6].

For single crystals, Equation (12) reduces to an expression retaining the angular dependence of the 2nd moment produced by homonuclear dipole-dipole interaction in the slow molecular motion regime:

$$M_{2ji}^{(\text{intra})} = \frac{3}{N_i}\sum_{i=1}^{N_i}\sum_{j\neq i}\hbar^2\gamma_j{}^2 r_{ji}^{-6} I_j(I_j+1)\sum_{\alpha}\sum_{l=0}^{2} q_\alpha a_{\alpha l0}(\phi)\cos^{2l}\vartheta\,. \tag{15}$$

As to the second moment contribution produced by the heteronuclear dipole-dipole interaction, the respective formula differs from that above presented by the factor 4/9 [20]. In this case, Equation (15) has to be replaced by

$$M_{2si}^{(\text{intra})} = \frac{4}{3N_i}\sum_{i=1}^{N_i}\sum_{s}^{N_s}\hbar^2\gamma_s^2 r_{si}^{-6} I_s(I_s+1)\sum_{\alpha}\sum_{l=0}^{2} q_\alpha a_{\alpha l0}(\phi)\cos^{2l}\vartheta\,, \tag{16}$$

where the subscript s labels no resonant nuclear spins of the molecule and N_s is the number of such spins.

b) Intermolecular contribution $-M_2^{(inter)}$

The expression of intermolecular contribution to the 2nd moment $M_2^{(\text{inter})}$ associated with homonuclear interaction will be derived by modifying the basic Equation (1) to a form involving the spherical harmonics. We shall replace the angular dependent multiplier $(3\cos^2\theta_{ji}-1)^2$ by its equivalent doublet $\frac{16\pi}{5}\left|Y_0^{(2)}(\varphi_{ji},\theta_{ji})\right|^2$, where $Y_0^{(2)}(\varphi_{ji},\theta_{ji})$ is a normalized spherical harmonic (function) of the 2nd order, a unit spherical tensor of the 2nd rank. Notice: (2) $Y_0^{(2)}(\varphi_{ji},\theta_{ji})$ has no dependence of the azimuthal angle φ_{ji} in this particular case of the zero component of unit spherical tensor of the 2nd rank. Thus, we are rewriting expression (1) in terms of spherical tensors as:

$$M_2^{(\text{inter})} = \frac{12\pi}{5N_i}\sum_{i=1}^{N_i}\sum_{j=1}^{N_j}\hbar^2\gamma_i{}^2 r_{ji}^{-6} I_i(I_i+1)\left|Y_0^{(2)}(\varphi_{ji},\theta_{ji})\right|^2, \tag{17}$$

where N_i is the number of intramolecular resonant spins and N_j is outer (relative to the target molecule) resonant spins. The angles θ_{ji} and φ_{ji} are determined in the LRF.

Nevertheless, it is helpful to assign the internuclear vectors in the crystallographic reference frame (CRF). To produce this change, we shall transform spherical tensors from CRF to LRF by rotation to the three-dimensional Euler angles (ϕ,ϑ,ξ) according to the rule [21]:

$$Y_0^{(2)}(\varphi',\theta') = \sum_{m=-2}^{2} D_{0m}^{(2)}(\phi,\vartheta,\xi)\, Y_m^{(2)}(\varphi,\theta)\,, \tag{18}$$

where (2) $D_{0m}^{(2)}(\phi,\vartheta,\xi)$ is an element of Wigner matrix. Now, we can rewrite Equation (17) as:

$$M_2^{(\text{inter})} = \frac{12\pi}{5N_i}\sum_{i=1}^{N_i}\sum_{j=1}^{N_j}\hbar^2\gamma_i{}^2 r_{ji}^{-6} I_i(I_i+1)\left[\sum_{m=-2}^{2} D_{0m}^{(2)}(\phi,\vartheta,\xi) Y_m^{(2)}(\varphi_{ji},\theta_{ji})\right]^2. \tag{19}$$

By replacing $D_{0m}^{(2)}(\phi,\vartheta,\xi) = \sqrt{(4\pi/5)}\, Y_m^{(2)}(\vartheta,\phi)$ and renaming $M_2^{(\text{inter})} = M_{2ji}^{(\text{inter})}(\phi,\vartheta)$ we shall transform Equation (19) to

$$M_{2ji}^{(\text{inter})}(\phi,\vartheta) = \frac{48\pi^2}{25N_i}\sum_{i=1}^{N_i}\sum_{j=1}^{N_j}\hbar^2\gamma_i{}^2 r_{ji}^{-6} I_i(I_i+1)\left[\sum_{m=-2}^{2} Y_m^{(2)}(\phi,\vartheta)\, Y_m^{(2)}(\varphi_{ji},\theta_{ji})\right]^2, \tag{20}$$

where ϕ and ϑ are the spherical angles of the vector B_0 assigned in LRF, and φ_{ji} and θ_{ji} are those of the internuclear vector $\mathbf{r}_{ji}$ determined in CRF, the subscripts i and j label the resonant homonuclear spins.

By multiplying Equation (20) by the factor 4/9 and replacing subscript j by υ to label no resonant nuclear spins, we shall get the heteronuclear analog of the intermolecular contribution to the 2nd moment $M_{2\upsilon i}^{(\text{inter})}$

$$M_{2vi}^{(\mathrm{inter})}(\phi,\vartheta)=\frac{64\pi^2}{75N_i}\sum_{i=1}^{N_i}\sum_{v=1}^{N_v}\hbar^2\gamma_v{}^2 r_{vi}^{-6} I_v(I_v+1)\left[\sum_{m=-2}^{2} Y_m^{(2)}(\phi,\vartheta)\, Y_m^{(2)}\left(\varphi_{vi},\theta_{vi}\right)\right]^2 . \quad (21)$$

c) Total expression of the 2nd moment – M_2

Taking into account above presented Equations (2), (12), (15), (16), (20), and (21), we are able to write the total expression of the NMR 2nd moment $M_2^{(T)}(\phi,\vartheta)$:

$$M_2^{(T)}(\phi,\vartheta)=\frac{2\hbar^2}{N_i\pi}\sum_{i=1}^{N_i}\left[3\sum_{j\neq i}^{N_i-1}\gamma_i^2 I_i(I_i+1)r_{ji}^{-6}+\frac{4}{3}\sum_{s=1}^{N_s}\gamma_s^2 I_s(I_s+1)r_{si}^{-6}\right]\cdot$$

$$\sum_{\alpha}\sum_{l=0}^{2} q_\alpha \mathrm{arctg}(2\pi\cdot\delta\nu_i\cdot\tau_\alpha)a_{\alpha l0}(\phi)\cos^{2l}\vartheta+$$

$$\frac{48\pi^2\hbar^2}{25N_i}\sum_{i=1}^{N_i}\sum_{j'=1}^{N_{j'}}\gamma_i{}^2 I_i(I_i+1)r_{j'i}^{-6}\left[\sum_{m=-2}^{2} Y_m^{(2)}(\phi,\vartheta)\, Y_m^{(2)}(\varphi_{j'i},\theta_{j'i})\right]^2+ \quad (22)$$

$$\frac{64\pi^2\hbar^2}{75N_i}\sum_{i=1}^{N_i}\sum_{v=1}^{N_v}\gamma_v{}^2 I_v(I_v+1)r_{vi}^{-6}\left[\sum_{m=-2}^{2} Y_m^{(2)}(\phi,\vartheta)\, Y_m^{(2)}(\varphi_{vi},\theta_{vi})\right]^2.$$

The temperature dependence of Equation (22) takes place implicitly by means of the dynamical variable τ_α included in intramolecular part of the 2nd moment. Besides, owing to the temperature dependence of the components $r_{j'i}$, r_{vi}, $\varphi_{j'i}$, $\theta_{j'i}$, φ_{vi} and θ_{vi} of the internuclear vectors $\mathbf{r}_{j'i}, \mathbf{r}_{vi}$, the intermolecular part of the 2nd moment has to be also temperature depended. Meanwhile, it is reasonable to assume that small fluctuations of angles $\varphi_{j'i}$, $\theta_{j'i}$ and φ_{vi} , θ_{vi} about their equilibrium values can't give notable change of local magnetic field on the sits of target protons. Therefore, by evaluating the 2nd moment in the fast motion regime, we shall take into account only the dependence of internuclear distances $r_{j'I}$ and r_{vi} of temperature.

It is timely to remind the meaning of some quantities and labels displayed in Equation (22):

N_i is the number of identical resonant nuclear spins of a target molecule,
i and j label intramolecular resonant nuclear spins,
j' labels resonant spins outer relative to the target molecule,
s – intramolecular no resonant heteronuclear spins,
v – no resonant heteronuclear spins outer relative to the target molecule,
ϕ and ϑ designate the spherical angles of the axial magnetic field direction with respect to CRF,
$\varphi_{j'i}$ and $\theta_{j'i}$ – the spherical angles of $\mathbf{r}_{j'i}$ - internuclear vector fixed in the CRF,
q_α and $a_{\alpha l0}$ – the quantities of the EAJM-approach theory [2, 8].

III. Application to the Single Crystal of Ammonium Chloride NH_4Cl

a) Overview

Ammonium chloride being one of the most studied substances is frequently used as a touchstone of the validity of various theories on the structure and physical properties of crystals. It is an ionic crystal, which ammonium ions exhibit random reorientation and consequently they have no permanent orientation ordering. Unit cell of NH_4Cl is a body-centered cube of CsCl type. At center of a cubic cell, a tetrahedron of ammonium cation NH_4^+ is placed, and its corners are occupied by chlorine anions Cl^-. The lattice parameter is $r_{\text{Cl-Cl}}=r_{\text{N-N}}=(3.844\pm0.024)\cdot10^{-10}$ m, four nearest protons of NH_4^+ -cation are displaced at the distance $r_{\text{N-H}}=(1.038\pm0.04)\cdot10^{-10}$ m from a nitrogen nucleus, and the neighboring protons are spaced from each other to the distance $r_{\text{H-H}}=(1.695\pm0.04)\cdot10^{-10}$ m [22].

Below 242.9 K, the crystal is in its ordered phase. The equilibrium disposition of atoms is shown in Figure 1. The random local motion of ammonium ions does not change the ordered structure of the crystal. It means that the reorientation symmetry group of any ammonium ion vector is the point symmetry group of tetrahedron T.

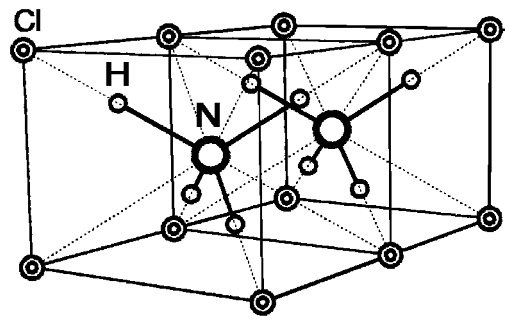


Figure 1: Schematic of the NH_4Cl crystal structure in the ordered phase (T < 242.9 K).

In the single crystal of NH_4Cl, Bersohn and Gutowsky have investigated the proton resonance spectra [18] and we have measured the proton spin-lattice relaxation times [10]. It was found that both the shape of spectral line and the relaxation times are anisotropic and show temperature dependence. To discuss the continuous wave data the quantum mechanical calculation were applied, but no extra knowledge was added about crystal structure [18]. The proton relaxation data were discussed in the framework of classical mechanical EAJM-approach taken as the model of NH_4^+- cation HMM [2, 8]. As a result of such simulation, a phenomenon of the site symmetry distortion was discovered in the ordered phase of NH_4Cl.

In the following description, we shall simulate particular contributions to the proton NMR 2[nd] moment in the single crystal of NH_4Cl for slow and fast motion regimes of NH_4^+- cation (low and high temperature regions) by using Equations (15), (16), (20), and (21), first. Then, we shall approximate the experimental curves of temperature dependence (- 200°C $< T <$ 25°C) of the total 2[nd] moment M_2 [18] by general Equation (22) for two orientations of the NH_4Cl single crystal in the static magnetic field: [1,0,0] $\|\mathbf{B}_0$ and [1,1,0] $\|\mathbf{B}_0$.

We shall calculate the particular contributions to the angular dependent second moment of proton NMR spectral line stimulated by

a) interaction between the inner four proton spins, which gives rise intraionic proton-proton contribution – $M_{2,\mathrm{HH}}^{(\mathrm{intra})}$
b) action of the unique inner nitrogen nuclear spin to 4 proton spins, which produces the intraionic nitrogen-proton contribution – $M_{2,\mathrm{NH}}^{(\mathrm{intra})}$
c) action of 104 nearest adjacent proton spins to 4 proton spins of target NH_4^+ cation giving rise the interionic proton-proton contribution – $M_{2,\mathrm{HH}}^{(\mathrm{inter})}$
d) action of 8 nearest adjacent chlorine spins to 4 proton spins of the target NH_4^+- cation giving rise the interionic chlorine-proton contribution $M_{2,\mathrm{ClH}}^{(\mathrm{inter})}$, and
e) action of 6 nearest adjacent nitrogen spins to 4 proton spins of the target NH_4^+ - cation giving rise the interionic nitrogen-proton contribution– $M_{2,\mathrm{NH}}^{(\mathrm{inter})}$

All actions of other nuclear spins to the target proton spins are neglected here. Due to their remoteness, they give a small effect in the studied 2[nd] moment.

b) *Slow motion regime of NH_4^+ -cation*

i. Intraionic proton-proton contribution – $M_{2,\mathrm{HH}}^{(\mathrm{intra})}(\phi,\vartheta)$

Accounting for the values of proton spin $I_j = I_\mathrm{H}$ = ½ and the number of protons $N_i = N_\mathrm{H}$ = 4 in Equation (15), we shall get the rated expression of $M_{2,\mathrm{HH}}^{(\mathrm{intra})}(\phi,\vartheta)$ by:

$$M_{2,\mathrm{HH}}^{(\mathrm{intra})}(\phi,\vartheta) = \frac{27}{4}\gamma_\mathrm{H}^2\hbar^2 r_\mathrm{HH}^{-6}\sum_{\alpha=1,2}\left(\sum_{l=0}^{2} q_\alpha a_{\alpha l0}(\phi)\cos^{2l}\vartheta\right). \quad (23)$$

Substituting in Equation (23) 1) table data: γ_H = 26753 $s^{-1}Gs^{-1}$ and $\hbar$ =1.0544·10-27 erg·s; 2) experimental values: q_1 = 0.25, q_2 = 0.73 [10, 11], r_{HH} = 1.695·10^{-8} cm [22], and 3) expressions of the factors $a_{\alpha/0}(\phi)$ [2, 8]: $a_{100}(\phi)$ = (1/8)(1+3$\cos^2 2\phi$), $a_{110}(\phi)$ = – (3/4)(1+$\cos^2 2\phi$), $a_{120}(\phi)$ = (3/8)(3+$\cos^2 2\phi$), $a_{200}(\phi)$ = (1/4)(1–$\cos^2 2\phi$), $a_{210}(\phi)$ = (1/2)(1+$\cos^2 2\phi$), and $a_{200}(\phi)$ = –(1/4)(3+$\cos^2 2\phi$) allows us to obtain the explicit expression of $M_{2,HH}^{(intra)}(\phi,\vartheta)$ by

$$M_{2,HH}^{(intra)}(\phi,\vartheta) = 48.39 - 20.09[\cos^2 2\phi + 2(1+\cos^2 2\phi)\cos^2\vartheta - (3+\cos^2 2\phi)\cos^4\vartheta]. \quad (24)$$

The surface-plot graph of $M_{2,HH}^{(intra)}(\emptyset,\vartheta)$, the HH-intraionic part of the proton NMR 2nd moment, drawn according to Equation (24) as a function of spherical angles ϕ and ϑ of the crystal orientation in the static magnetic field for a slow motion regime of NH_4^+- cation in NH_4Cl single crystal is presented in Figure 2a. The graph of $M_{2,HH}^{(intra)}(\vartheta)$, abridged dependence $M_{2,HH}^{(intra)}$ of the polar angle ϑ, while the azimuthal angle ϕ is fixed by $\pi/4$, is shown in Figure 2b.

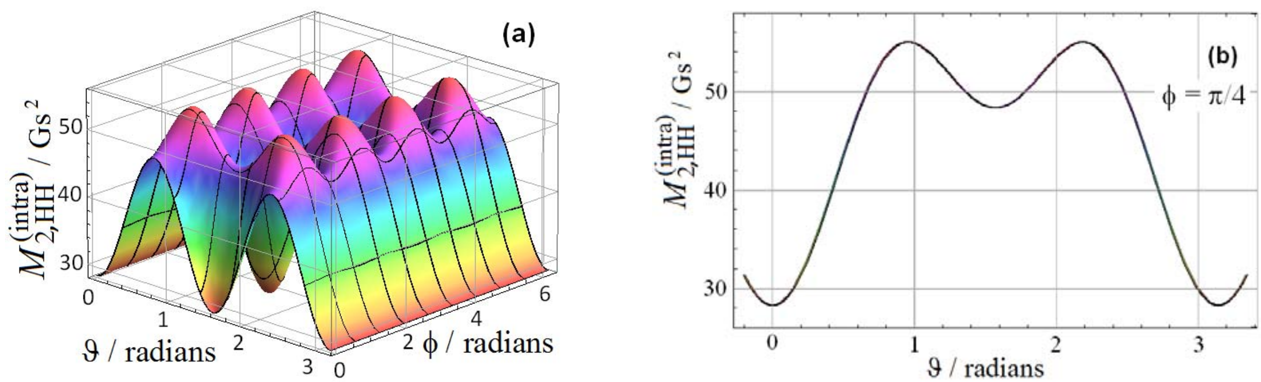


Figure 2: The graphs of the theoretical angular dependence of HH-intraionic contribution $M_{2,HH}^{(intra)}$ to the proton NMR 2nd moment in NH_4Cl single crystal drawn for a slow motion regime of NH_4^+-cation according to Equation (24) as a function: a) of spherical angles ϕ and ϑ, b) of polar angle ϑ for $\phi = \pi/4$.

ii. *Intraionic nitrogen-proton contribution –* $M_{2,NH}^{(intra)}(\phi,\vartheta)$

By substituting the number of protons N_i = 4, the number of nitrogen spins N_s = 1, Plank constant $\hbar$ =1.054.10^{-27}erg·s, the nitrogen spin value $I_s = I_N$ = 1 and gyromagnetic ratio γ_N = 1933.3 $s^{-1}Gs^{-1}$, and experimental values of dynamic weights: q_1 = 0.25, q_2 = 0.73 [10, 11], r_{NH} = 1.038·10^{-8} cm [22], and expressions of the factors $a_{\alpha/0}(\phi)$: $a_{100}(\phi)$ = (1/8)(1+3$\cos^2 2\phi$), $a_{110}(\phi)$ = –(3/4)(1+$\cos^2 2\phi$), $a_{120}(\phi)$ = (3/8)(3+$\cos^2 2\phi$), $a_{200}(\phi)$ = (1/4)(1–$\cos^2 2\phi$), $a_{210}(\phi)$ = (1/2)(1+$\cos^2 2\phi$), and $a_{200}(\phi)$ = (1/4)(3+$\cos^2 2\phi$) [2, 8] in Equation (16), we are obtaining the expression of $M_{2,NH}^{(intra)}(\emptyset,\vartheta)$ in the explicit form by

$$M_{2,NH}^{(intra)}(\phi,\vartheta) = 0.786263 [\cos^2 2\phi + 2 (1+\cos^2 2\phi)\cos^2\vartheta - (3+\cos^2 2\phi)\cos^4\vartheta]. \quad (25)$$

The surface-plot graph $M_{2,NH}^{(intra)}(\phi,\vartheta)$, the intraionic NH-contribution to the proton NMR 2nd moment, drawn according to Equation (25) as a function of spherical angles ϕ and ϑ of the crystal orientation in the static magnetic field for a slow motion regime of NH_4^+ -cation in NH_4Cl single crystal is presented in Figure 3a. The plane graph $M_{2,NH}^{(intra)}(\vartheta)$ drawn according to Equation (25) as a function of solely polar angle ϑ is presented in Figure 3b, whereas azimuth angle is fixed by $\phi = \pi/4$.

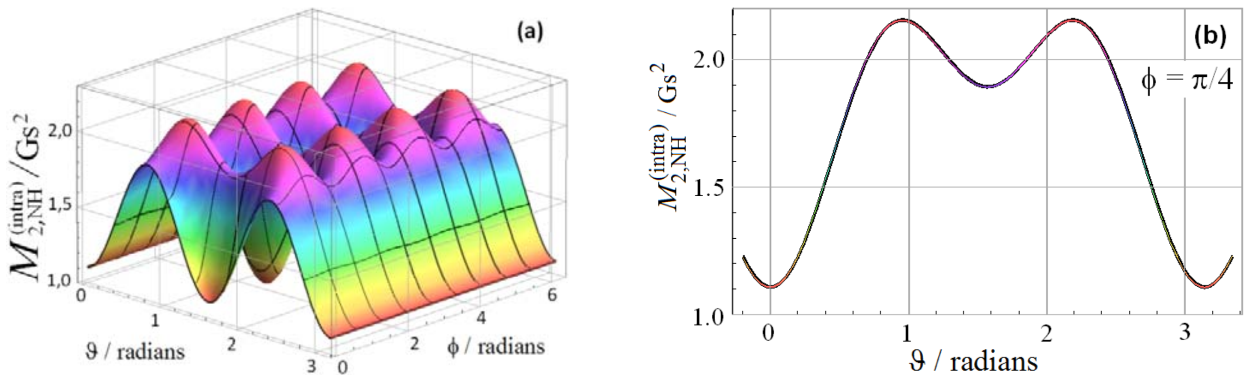


Figure 3: The graphs $M_{2,\mathrm{NH}}^{(\mathrm{intra})}(\phi,\ \vartheta)$ and $M_{2,\mathrm{NH}}^{(\mathrm{intra})}(\vartheta)$ of NH-intraionic contribution to the proton NMR second moment in NH_4Cl single crystal drawn according to Equation (25) for a slow motion regime of NH_4^+-cation as functions of: a) spherical angles ϕ and ϑ and b) polar angle ϑ for $\phi = \pi/4$, respectively.

iii. *Interionic proton-proton contribution* – $M_{2,\mathrm{HH}}^{(\mathrm{inter})}(\phi,\ \vartheta)$

The schematic of target NH_4^+-ion with inner protons numerated by 1, 2, 3, and 4 is shown in Figure 4. Besides, 26 neighboring NH_4^+-ions are presented therein. During this simulation, we shall assume that all protons are immobile and confine ourselves to 104 nearest outer protons, from which only four protons numerated by 5, 6, 7, and 8 are shown in Figure 4. Now, we shall write an expression describing interionic HH-contribution of only 104 nearest protons to inner 4 protons $M_{2,\mathrm{HH}}^{(\mathrm{inter})}(\phi,\ \vartheta)$:

$$M_{2ji}^{(\mathrm{inter})}(\phi,\vartheta) = \frac{48\pi^2}{25N_i}\sum_{i=1}^{N_i}\sum_{j'=5}^{108}\hbar^2\gamma_i{}^2 r_{j'i}^{-6} I_i(I_i+1)\left[\sum_{m=-2}^{2} Y_m^{(2)}(\phi,\vartheta)\, Y_m^{(2)}\left(\varphi_{j'i},\theta_{j'i}\right)\right]^2, \qquad (26)$$

where for commodity the outer protons are labeled by $j'(5 \le j' \le 108)$. By substituting the numbering values of constants γ_{HH} and $\hbar$, just presented, $I_i = I_{\mathrm{H}} = ½,\ N_i = 4$, Equation (26) takes the following semi explicit form:

$$M_{2,\mathrm{HH}}^{(\mathrm{inter})}(\phi,\vartheta) = 2.82721\cdot 10^{-45}\sum_{j'=5}^{108}\sum_{i=1}^{4}\left|\sum_{m=-2}^{2} Y_m^{(2)}(\phi,\vartheta)\, Y_m^{(2)}\left(\varphi_{j'i},\theta_{j'i}\right)\right|^2 r_{j'i}^{-6}\,, \qquad (27)$$

where the values of proton-proton distances $r_{j'i}$ and angles $\varphi_{j'i}$ and $\theta_{j'i}$ are to be estimated by using the structure data [22]: $r_{\mathrm{ClCl}} = r_{\mathrm{NN}} = 3.844\cdot 10^{-10}$ m, $r_{\mathrm{NH}} = 1.038\cdot 10^{-10}$ m, $r_{\mathrm{HH}} = 1.695\cdot 10^{-10}$ m.

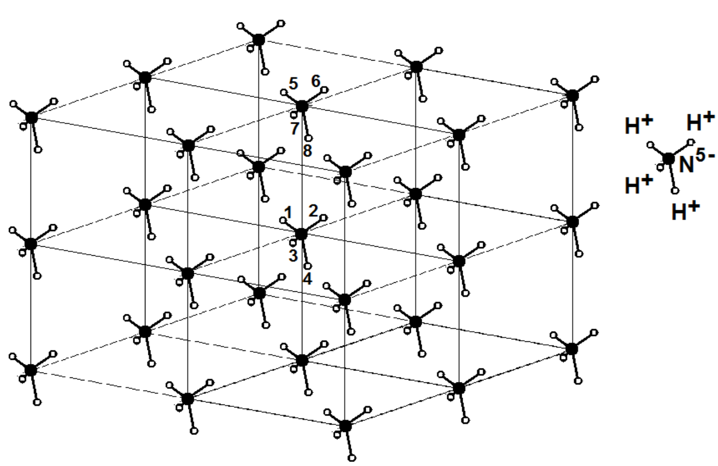


Figure 4: The disposition of hydrogen and nitrogen nuclei in NH_4Cl single crystal taken into account by evaluating the interionic contributions to the 2nd moment of proton NMR spectral line. The numbers counted from 1 to 4 numerates the target protons and the numbers from 5 to 8 label the protons of an adjacent arbitrary chosen NH_4^+-cation. The chlorine ions are not displayed in Figure 4. They are presented in Figure 1

The surface plot graph of $M_{2,\mathrm{HH}}^{(\mathrm{inter})}(\phi,\vartheta)$, the HH-interionic contribution to the proton NMR 2nd moment of ammonium chloride single crystal drawn according to Equation (27) as a function of spherical angles ϕ and ϑ of the crystal orientation in the static magnetic field for a slow motion regime of NH_4^+-cations is shown in Figure 5a. The plan graph of $M_{2,\mathrm{HH}}^{(\mathrm{inter})}(\vartheta)$, the graph $M_{2,\mathrm{HH}}^{(\mathrm{inter})}(\phi,\vartheta)$ for $\phi = \pi/4$, is shown in Figure 5b.

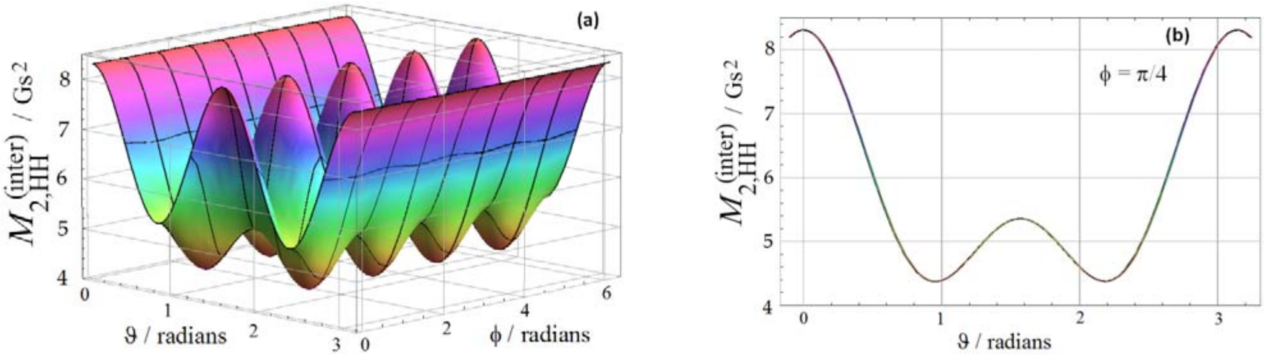


Figure 5: The graphs of $M_{2,\mathrm{HH}}^{(\mathrm{inter})}(\phi,\ \vartheta)$ and, $M_{2,\mathrm{HH}}^{(\mathrm{inter})}(\vartheta)$, the HH-interionic contribution to the proton NMR 2nd moment in ammonium chloride single crystal, drawn according to Equation (27) as functions of spherical angles ϕ and ϑ (Figure 5a) and polar angle ϑ for $\phi = \pi/4$ (Figure 5b) of the crystal orientation in the static magnetic field for a slow motion regime of NH_4^+-cations.

iv. *Interionic nitrogen-proton contribution –* $M_{2,\mathrm{NH}}^{(\mathrm{inter})}(\phi,\ \vartheta)$

By substituting constant values $\hbar = 1.0544.10^{-27}$ erg.s, $\gamma_v = \gamma_{\mathrm{N}} = 1933.3$ s^{-1}Gs^{-1}, $I_v = I_{\mathrm{N}} = 1$, the numbers of protons $N_i = 4$ and nitrogen nuclei $N_v = N_{\mathrm{N}} = 6$ in Equation (21), we are getting the rated expression of interionic contribution created by 6 nearest nitrogen nuclear spins for a slow motion regime of NH_4^+-cations:

$$M_{2,\mathrm{NH}}^{(\mathrm{inter})}(\phi,\vartheta) = 1.75\cdot10^{-47}\sum_{v=1}^{6}\sum_{i=1}^{4}\left|\sum_{n=-2}^{2} Y_n^{(2)}(\phi,\vartheta)\, Y_n^{(2)}(\varphi_{vi},\theta_{vi})\right|^2 r_{vi}^{-6}\,. \tag{28}$$

The graphs of $M_{2,\mathrm{NH}}^{(\mathrm{inter})}(\phi,\ \vartheta)$ and $M_{2,\mathrm{NH}}^{(\mathrm{inter})}(\vartheta)$ similar to those of $M_{2,\mathrm{HH}}^{(\mathrm{inter})}(\phi,\ \vartheta)$ and $M_{2,\mathrm{HH}}^{(\mathrm{inter})}(\vartheta)$ displayed in Figure 5 are shown in Figure 6:

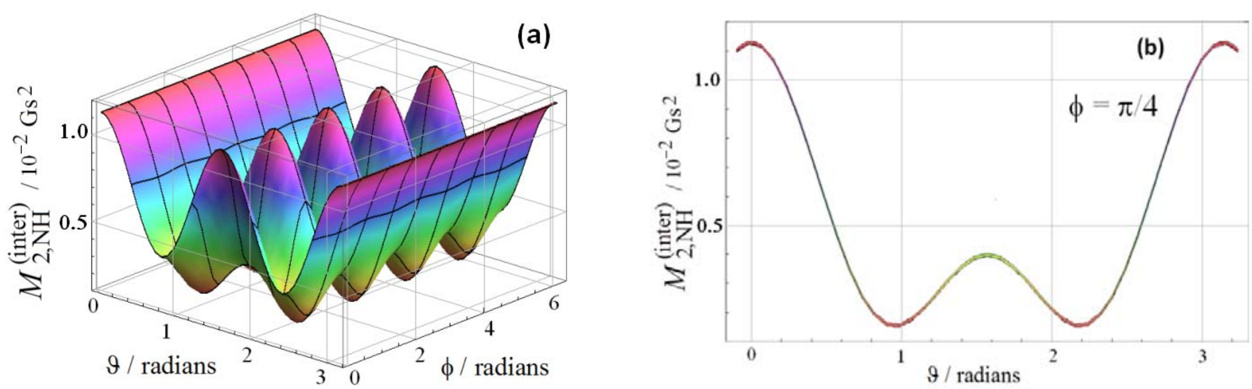


Figure 6: The graphs of $M_{2,\mathrm{NH}}^{(\mathrm{inter})}(\phi,\ \vartheta)$ and $M_{2,\mathrm{NH}}^{(\mathrm{inter})}(\vartheta)$, the interionic NH-contribution to the proton NMR 2nd moment in ammonium chloride single crystal drawn according to Equation (28) as functions of spherical angles ϕ and ϑ (Figure 6a) and ϑ for $\phi = \pi/4$ (Figure 6b) of the crystal orientation in the static magnetic field for a slow motion regime of NH_4^+-cations.

v. *Interionic chlorine-proton contribution –* $M_{2,\mathrm{ClH}}^{(\mathrm{inter})}(\phi,\ \vartheta)$

By substituting constant values $\hbar = 1.0544.10^{-27}$ erg.s, $\gamma_v = \gamma_{\mathrm{Cl}} = 2557.3$ s^{-1}Gs^{-1}, $I_v = I_{\mathrm{Cl}} = 3/2$, the number of protons $N_i = N_{\mathrm{H}} = 4$ and the number of chlorine spins $N_v = N_{\mathrm{Cl}} = 8$, the rated expression of the heteronuclear interionic ClH-contribution $M_{2,\mathrm{ClH}}^{(\mathrm{inter})}(\phi,\ \vartheta)$ follows from Equation (21):

$$M_{2,\mathrm{ClH}}^{(\mathrm{inter})}(\phi,\vartheta)=5.42*10^{-47}\sum_{v=1}^{8}\sum_{i=1}^{4}\left|\sum_{n=-2}^{2}Y_n^{(2)}(\phi,\vartheta)Y_n^{(2)}(\varphi_{vi},\theta_{vi})\right|^2 r_{vi}^{-6}. \tag{29}$$

The graphs of $M_{2,\mathrm{ClH}}^{(\mathrm{inter})}(\phi,\vartheta)$ and $M_{2,\mathrm{ClH}}^{(\mathrm{inter})}(\vartheta)$, similar to those of $M_{2,\mathrm{HH}}^{(\mathrm{inter})}(\phi,\vartheta)$ and $M_{2,\mathrm{HH}}^{(\mathrm{inter})}(\vartheta)$ presented in Figure 5, are shown in Figure 7.

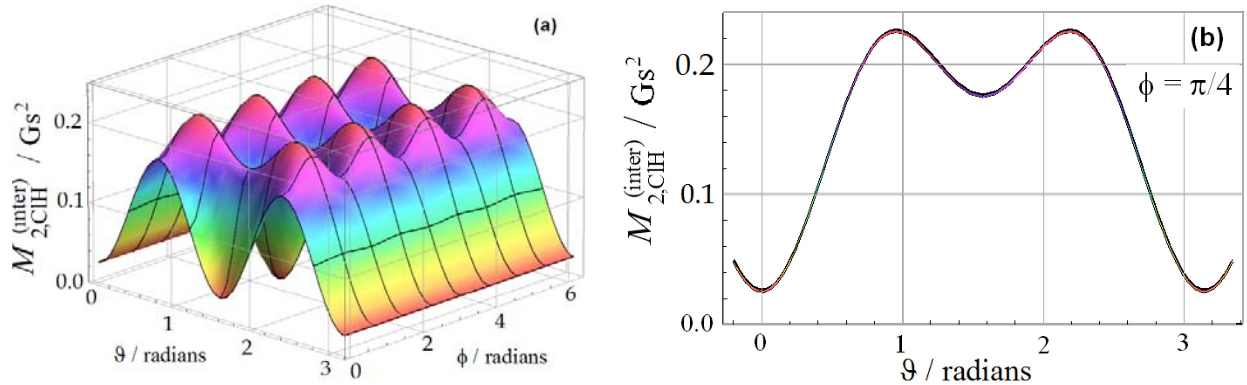


Figure 7: The graphs of $M_{2,\mathrm{ClH}}^{(\mathrm{inter})}(\phi,\vartheta)$ and $M_{2,\mathrm{ClH}}^{(\mathrm{inter})}(\vartheta)$, the interionic ClH-contribution to the proton NMR 2nd moment in ammonium chloride single crystal, drawn according to Equation (29) as functions of a) spherical angles ϕ and ϑ and b) polar angle ϑ ($\phi = \pi/4$) of the crystal orientation in the static magnetic field for a slow motion regime of NH_4^+-cations.

vi. *Total proton 2nd moment for the slow motion regime of NH_4^+-cation – $M(\phi,\vartheta)$*

Summing the partial contributions to M_2 given by Equations (24), (25), (27), (28), and (29), we are getting the expression of the total proton 2nd moment $M_2(\phi,\vartheta)$ in the semiexplicit form as a function of polar ϑ and azimuthal ϕ angles of the NH_4Cl crystal orientation in the static magnetic field for the slow motion regime of NH_4^+-cation:

$$M_2(\phi,\vartheta)= 50.28 - 20.88 \cdot\cos^2 2\phi + 41.76 \cdot(1+\cos^2 2\phi)\cdot\cos^2\vartheta - 20.88 \cdot(3+\cos^2 2\phi)\cdot\cos^4\vartheta$$

$$+2.83\cdot 10^{-45}\cdot\sum_{i=1}^{4}\sum_{j'=5}^{108}\left|\sum_{m=-2}^{2}Y_m^{(2)}(\phi,\vartheta)Y_m^{(2)}Y_n^{(2)}(\varphi_{vi},\theta_{vi})\right|^2 r_{j'i}^{-6}+$$

$$1.75\cdot 10^{-47}\sum_{v=1}^{6}\sum_{i=1}^{4}\left|\sum_{n=-2}^{2}Y_n^{(2)}(\phi,\vartheta)\,Y_n^{(2)}(\varphi_{vi},\theta_{vi})\right|^2 r_{vi}^{-6}$$

$$5.42\cdot 10^{-47}\sum_{v=1}^{8}\sum_{i=1}^{4}\left|\sum_{n=-2}^{2}Y_n^{(2)}(\phi,\vartheta)\,Y_n^{(2)}(\varphi_{vi},\theta_{vi})\right|^2 r_{vi}^{-6}+, \tag{30}$$

where the distances $r_{j'i}$ and r_{vi} are indicated in cm (1cm = 10^{-2} m) and the 2nd moment – in Gs^2 (1 Gs = 10^{-4} T). The spherical harmonics $Y^{(2)}(\phi,\vartheta)$, $Y_m^{(2)}(\varphi_{j'i},\theta_{j'i})$ and $Y_m^{(2)}(\varphi_{vi},\theta_{vi})$ are defined as built-in functions of the software Wolfram Mathematica™. The graph of the theoretical angular dependence of the total proton 2nd moment $M_2(\phi,\vartheta)$ drawn by Equation (30) are presented in Figure 8a.

In Figure 8b, the graph of the theoretical dependence of the total proton 2nd moment is shown as a function of polar angle ϑ for the azimuthal angle fixed by $\phi = \pi/4$. At that orientation of the crystal, the values of the 2nd moment can be determined along all principal axes of the cubic unit cell. The experimental values of the second moment at low temperature (-195°C), that is in the ordered phase, has been found equal to 36.5 Gs^2 ± 0.7 Gs^2 for the direction of static magnetic field vector oriented alongside the fourfold symmetry axis B_0|| [1,0,0], and 54.6 Gs^2± 0.6 Gs^2 – alongside the twofold symmetry axis B_0|| [1,1,0] [18]. These values calculated by using our theoretical formula given by Equation (30) are equal to 37.75 Gs^2 ± 1.5 Gs^2 and 55.82 Gs^2 ± 2.5 Gs^2, respectively, which agree satisfactorily with those experimentally determined.

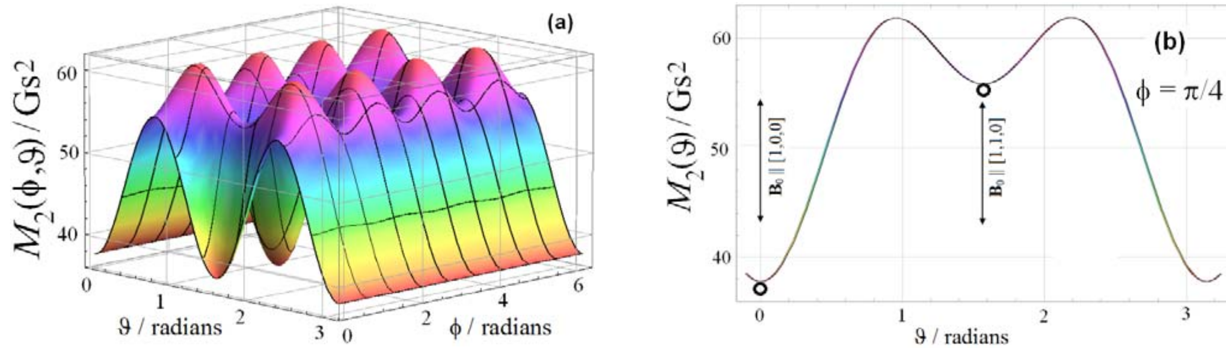


Figure 8: The graphs of the theoretical angular dependence of the proton NMR total 2nd moment in ammonium chloride single crystal for a slow motion regime of NH_4^+ cation:

a) $M_2(\phi,\vartheta)$ and b) $M_2(\vartheta)$. The graph of $M_2(\vartheta)$ is drawn for $\phi = \pi/4$. Experimental values of $M_2(\vartheta)$ mapped by open circles are given for two directions of the static magnetic field in the unit cell of NH_4Cl [18]: $\mathbf{B}_0||[1,0,0]$ and $\mathbf{B}_0||[1,1,0]$.

c) Fast motion regime of NH_4^+-cation

i. *Overview*

Fast motion of ammoniums taking place at high temperatures follows decreasing the intraionic contributions down to zero:, $M_{2,\mathrm{HH}}^{(\mathrm{intra})}(\phi,\vartheta)=0$ and $M_{2,\mathrm{NH}}^{(\mathrm{intra})}(\phi,\vartheta)=0$, whereas interionic ones decrease partially. Therefore, the residual proton 2nd moment in the fast motion regime of NH_4Cl reduces down to 3 additive residual interionic contributions: $M_{2,\mathrm{HH}}^{(\mathrm{inter-res})}(\phi,\vartheta)$, $M_{2,\mathrm{NH}}^{(\mathrm{inter-res})}(\phi,\vartheta)$, and $M_{2,\mathrm{ClH}}^{(\mathrm{inter-res})}(\phi,\vartheta)$.

Hindered rotation of ammoniums averages the internuclear vectors of relevant dipole-dipole interactions. Hence, in order to compute the terms $M_{2,\mathrm{HH}}^{(\mathrm{inter-res})}(\phi,\vartheta)$, $M_{2,\mathrm{NH}}^{(\mathrm{inter-res})}(\phi,\vartheta)$and $M_{2,\mathrm{ClH}}^{(\mathrm{inter-res})}(\phi,\vartheta)$ in the fast motion regime of NH_4^+-cations, the spin-spin distances have to be replaced by those dynamically averaged, in the formulae (27), (28), and (29). We shall assume that the average proton-proton distances $\langle r_{\mathrm{HH}}\rangle$ between the protons of adjacent NH_4^+ -cations in the first coordinate sphere will be taken equal to the lattice parameter $\langle r_{\mathrm{HH}}\rangle_1 = r_{\mathrm{NN}} = 3.844\cdot10^{-8}$ cm. Relative distances in the second and third coordinate spheres will respectively equal to $\langle r_{\mathrm{HH}}\rangle_2 = \sqrt{2}\cdot r_{\mathrm{NN}}$ and $\langle r_{\mathrm{HH}}\rangle_3 = \sqrt{3}\cdot r_{\mathrm{NN}}$. In agreement with crystal structure, the distances $r_{vi} = \langle r_{\mathrm{NH}}\rangle$ and $r_{vi} = \langle r_{\mathrm{ClH}}\rangle$ cited in Equations (28) and (29) have to be replaced by relative average values $\langle r_{\mathrm{NH}}\rangle = r_{\mathrm{NN}}$ and $\langle r_{\mathrm{ClH}}\rangle = \sqrt{3}/2\cdot r_{\mathrm{NN}}$.

The three- and two-dimensional theoretical graphs of the partial interionic 2nd moment $M_{2,\mathrm{HH}}^{(\mathrm{inter-res})}(\phi,\vartheta)$ $M_{2,\mathrm{NH}}^{(\mathrm{inter-res})}(\phi,\vartheta)$, and $M_{2,\mathrm{ClH}}^{(\mathrm{inter-res})}(\phi,\vartheta)$ are presented for the NH_4^+- cation fast motion regime as functions of polar angle ϑ and azimuth angle ϕ in Figures 9-11 (a) and as a function of polar angle ϑ, whereas the azimuth angle ϕ is fixed by $\phi = \pi/4$, in Figures 9-11 (b). The graphs of Figures 12 display the total 2nd moment in the fast motion regime.

ii. *Interionic proton-proton contribution –* $M_{2,\mathrm{HH}}^{(\mathrm{inter\text{-}res})}(\phi,\vartheta)$

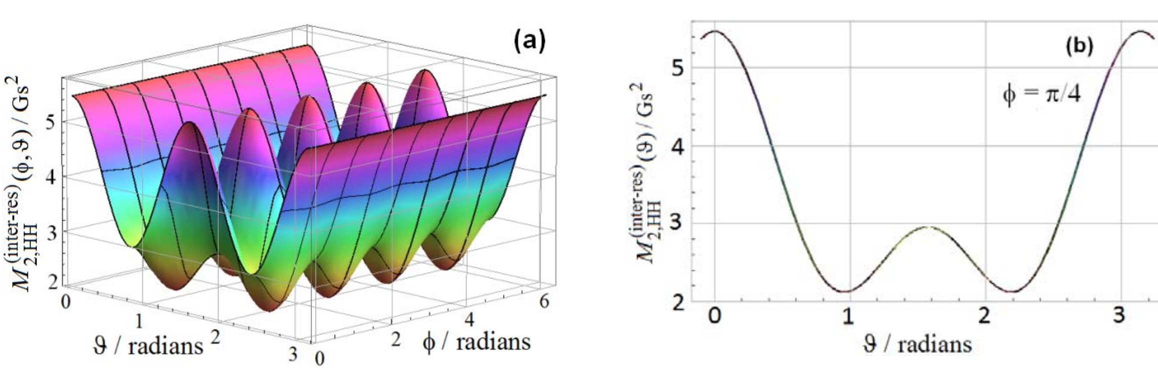


Figure 9: The graphs of $M_{2,\mathrm{HH}}^{(\mathrm{inter-res})}(\emptyset,\ \vartheta)$and $M_{2,\mathrm{HH}}^{(\mathrm{inter-res})}(\vartheta)$, the HH-interionic contribution to the proton NMR 2nd moment in ammonium chloride single crystal, drawn according to Equation (27) as functions of spherical angles ϕ and ϑ (Figure 9a) and polar angle ϑ for $\phi = \pi/4$ (Figure 9b) of the crystal orientation in the static magnetic field for a fast motion regime of NH_4^+ -cations. The HH-distances were taken as average values by $\langle r_{\mathrm{HH}}\rangle_1 = r_{\mathrm{NN}}$, $\langle r_{\mathrm{HH}}\rangle_2 = \sqrt{2}\cdot r_{\mathrm{NN}}$, and $\langle r_{\mathrm{HH}}\rangle 3 = 3\cdot r_{\mathrm{NN}}$ ($r_{\mathrm{NN}} = 3.844\cdot10^{-8}$ cm).

iii. *Interionic nitrogen-proton contribution* – $M_{2,\mathrm{NH}}^{(\text{inter-res})}(\phi,\vartheta)$

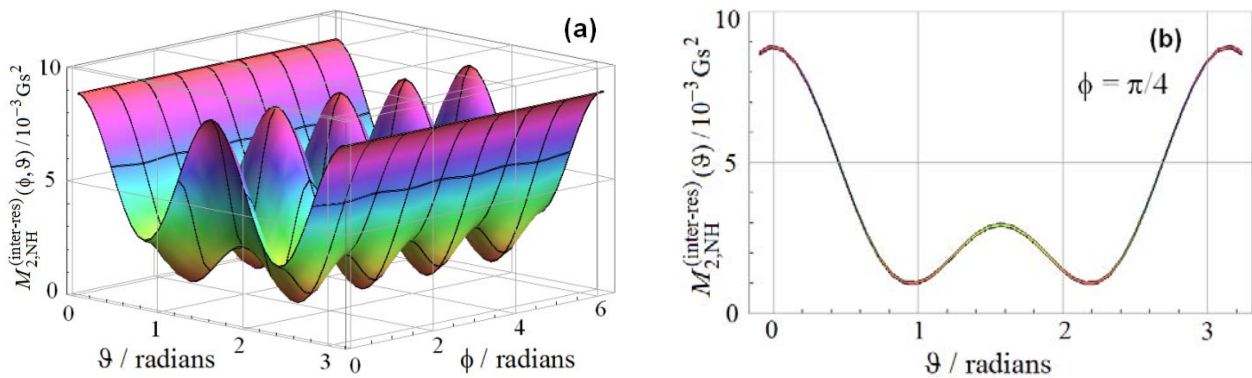


Figure 10: The graphs of $M_{2,\mathrm{NH}}^{(\text{inter-res})}(\phi,\vartheta)$ and $M_{2,\mathrm{NH}}^{(\text{inter-res})}(\vartheta)$, the NH-interionic contribution to the proton NMR 2nd moment in ammonium chloride single crystal, drawn according to Equation (28) as functions of spherical angles ϕ and ϑ (Figure 10a) and polar angle ϑ for $\phi = \pi/4$ (Figure 10b) of the crystal orientation in the static magnetic field for a fast motion regime of NH_4^+-cations. The NH-distances were taken as average values by $\langle r_{NH}\rangle = r_{NN}$ ($r_{NN} = 3.844\cdot10^{-8}$ cm).

iv. *Interionic chlorine-proton contribution* – $M_{2,\mathrm{ClH}}^{(\text{inter-res})}(\phi,\vartheta)$

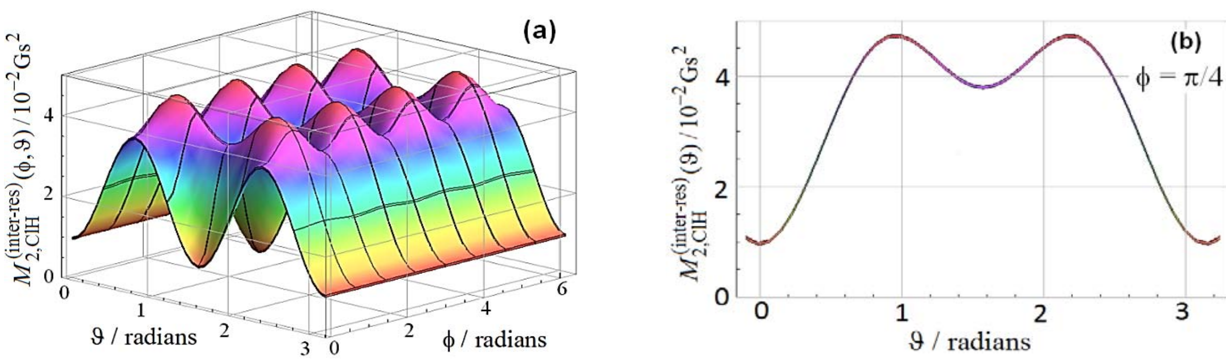


Figure 11: The graphs of $M_{2,\mathrm{ClH}}^{(\text{inter-res})}(\emptyset,\vartheta)$ and $M_{2,\mathrm{ClH}}^{(\text{inter-res})}(\vartheta)$, the ClH-interionic contribution to the proton NMR 2nd moment in ammonium chloride single crystal, drawn according to Equation (29) as functions of spherical angles ϕ and ϑ (Figure 11a) and polar angle ϑ for $\phi = \pi/4$ (Figure 11b) of the crystal orientation in the static magnetic field for a fast motion regime of NH_4^+-cations. The ClH-distances were taken as average values by $\langle r_{ClH}\rangle = 3/2 \cdot r_{NN}$ ($r_{NN} = 3.844\cdot10^{-8}$ cm).

v. *Total proton 2nd moment for the fast motion regime of NH_4^+ -cation* – $M_2^{(\mathrm{res})}(\phi, \vartheta)$

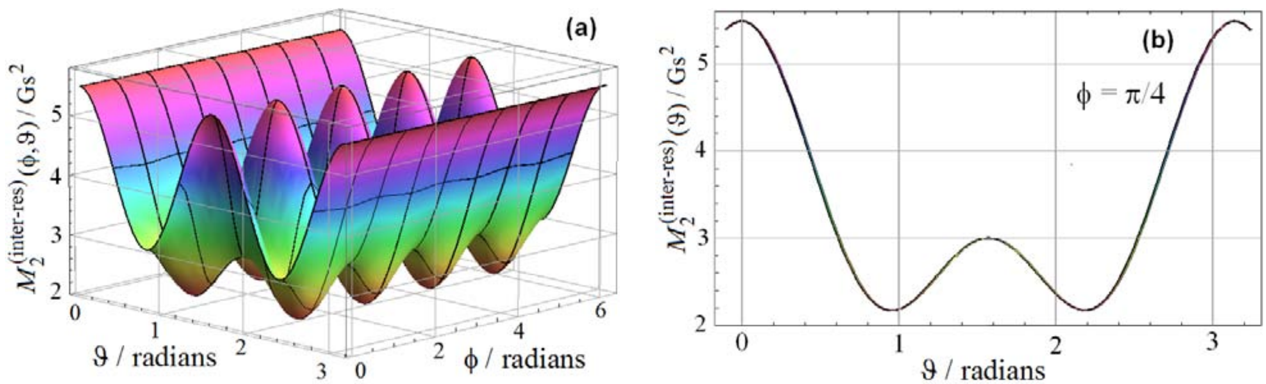


Figure 12: The graphs of $M_2^{(\mathrm{inter-res})}(\phi, \vartheta)$ and $M_2^{(\mathrm{inter-res})}(\vartheta)$, the total residual proton NMR 2nd moment in ammonium chloride single crystal, drawn according to Equation (30) as functions of spherical angles ϕ and ϑ (Figure 12a) and polar angle ϑ for $\phi = \pi/4$ (Figure 12b) of the crystal orientation in the static magnetic field for a fast motion regime of NH_4^+-cations.

vi. *Temperature dependence of the total proton 2nd moment $M_2(\phi,\vartheta)$ for 2 selected directions in NH_4Cl*

To describe $M_2^{(T)}(0,0)$ and $M_2^{(T)}(\pi/4,\pi/2)$, the experimental temperature dependences of the total proton NMR 2nd moment for 2 directions of NH_4Cl in the external magnetic field: [1,0,0]↑↑B_0 (e.g. $\phi = 0$, $\vartheta = 0$) and [1,1,0]↑↑B_0 (e.g. $\phi = \pi/4$, $\vartheta = \pi/2$) [21], we shall use Equations (9)-(10) reduced to $\tau_a = \tau = \tau_0 \exp(E_a/RT)$ and Equations (24, 25, 27-29). Performing necessary calculations, we are obtaining the rated expression of $M_2^{(T)}(0,0)$ by

$$M_2^{(T)}(0,0) = 5.50 + 32.25 \cdot \frac{2}{\pi} \cdot \mathrm{arctg}[4257 \cdot \delta B_{\mathrm{H}}(0,0) \cdot \tau_0 \cdot \exp\left(\frac{E_{\mathrm{a}}}{RT}\right)] \tag{31}$$

and the rated expression of $M_2^{(T)}(\pi/4,\pi/2)$ by

$$M_2^{(T)}(\pi/4,\pi/2) = 3.00 + 52.8 \cdot \frac{2}{\pi} \cdot \mathrm{arctg}[4257 \cdot \delta B_{\mathrm{H}}(\pi/4,\pi/2) \cdot \tau_0 \cdot \exp\left(\frac{E_{\mathrm{a}}}{RT}\right)]\,. \tag{32}$$

Here, $\delta B_{\mathrm{H}}(0,0)$ and $\delta B_{\mathrm{H}}(\pi/4,\pi/2)$ are the proton NMR line widths expressed in Gausses for directions [1,0,0]↑↑B_0 and [1,1,0]↑↑B_0 in the slow motion regime, τ_0 is the time interval between two successive attempts to overlap the reorientation barrier, and E_a is the HMM activation energy. By using Equations (31) and (32) and the constant values $\delta B_{\mathrm{H}}(0,0) = 19.5$ Gs, $\delta B_{\mathrm{H}}(\pi/4,\pi/2) = 23.3$ Gs [21] and $E_a = 4.83$ kcal/mol [2], we approximated the proton NMR experimental data of M_2[1,0,0] and M_2[1,1,0] with the help of computer program "Origin Lab-Origin 2016™". The corresponding graphical results are shown in Figure 13. The present approximation allowed us to determine the time constant τ_0 to be equal to $6.09 \cdot 10^{-14}$ s and $5.01 \cdot 10^{-14}$ s for crystal orientations [1,0,0]↑↑B_0 and [1,1,0]↑↑B_0, respectively. From relaxation measurements performed in rotating reference frame, the corresponding values of τ_0 were extrapolated to $8.4 \cdot 10^{-14}$ s and $9.4 \cdot 10^{-14}$ s [2]. For the reason that the quantity τ_0 has a meaning of adjustable parameters in NMR-spectroscopy, we are concluding that the agreement found under the order of greatness amongst the experimental data of τ_0 is satisfactorily.

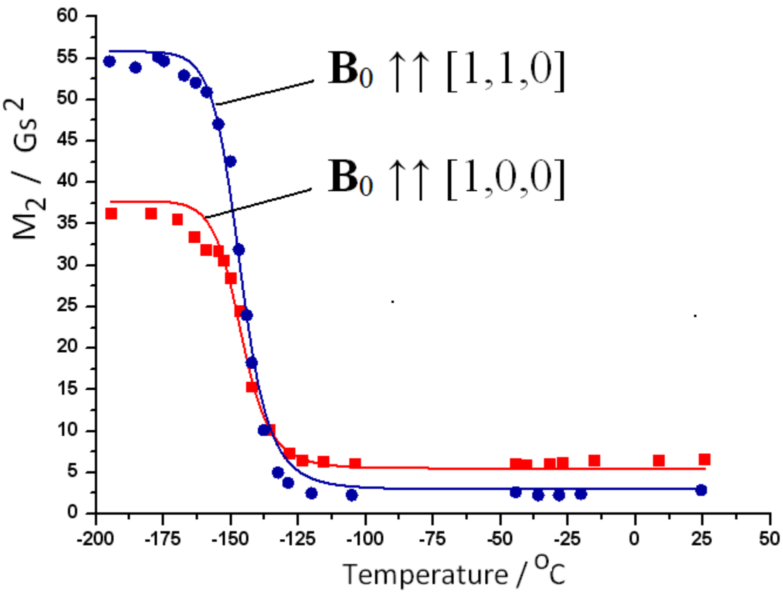


Figure 13: Temperature dependence of the 2nd moment of proton NMR absorption spectral line in the single crystal of ammonium chloride. Experimental data mapped for direction [1,0,0]↑↑B_0 are shown by square symbols "■" and for direction [1,1,0]↑↑B_0 – by round symbols "●" [21]. Theoretical lines are drawn by using Equations (31) and (32), constant values $\delta B_H(0,0)$ = 19.5 Gs ([1,0,0]↑↑B_0) and $\delta B_H(\pi/4,\pi/2)$ = 23.3 Gs([1,1,0] ↑↑B_0) [21] and E_a = 4.83 kcal/mol [2].

IV. Discussion

The presented approach to simulating the NMR 2nd moment in molecular crystals, in general, and, particularly, the angular and temperature dependence of the proton NMR 2nd moment in ammonium chloride allowed us to take new quantitative knowledge on the structure and molecular dynamics herein. In the Table, the theoretical values of different contributions to the 2nd moment are exposed for main orientations of the NH_4C1 crystal at slow and fast hindered motion regimes. NH_4^+-cation slow motion regime is observed at low temperatures, lower 175^{0}C (98 K), and dominant contribution to *M*2 is $M_{2,HH}^{(intra)}$, which is due to intraionic proton-proton interaction. At high temperatures, higher 100^{0}C(173 K), NH_4^+ -cation fast motion regime is observed and major contribution to M_2 is also defined by proton-proton interaction, but, this time, it is due to interionic one, $M_{2,HH}^{(inter)}$.

Table 1: The theoretical values of the 2nd moment contributions to the proton magnetic resonance spectral line in the single crystal of NH_4C1 at different orientation and motion regimes of NH_4^+-cation

ORIENTATION	B_0 ↑↑ [100]	B_0 ↑↑ [111]	B_0 ↑↑ [110]
Slow motion regime ($\omega_0\tau_\alpha >> 0$)			
$M_{2,HH}^{(intra)}$, Gs^2	28.30	55.09	48.39
$M_{2,NH}^{(intra)}$, Gs^2	1.11	2.16	1.89
$M_{2,HH}^{(inter)}$, Gs^2	8.31	4.38	5.35
$M_{2,ClH}^{(inter)}$, 10^{-2} Gs^2	2.56	22.66	17.56
$M_{2,NH}^{(inter)}$, 10^{-2} Gs^2	1.13	0.16	0.40
Fast motion regime ($\omega_0\tau_\alpha << 0$)			
$M_{2,HH}^{(inter)}$, Gs^2	5.47	2.12	2.96
$M_{2,ClH}^{(inter)}$, 10^{-2} Gs^2	0.97	4.73	3.79
$M_{2,NH}^{(inter)}$, 10^{-2} Gs^2	0.88	0.10	0.29

V. Conclusions

NMR investigation of structure and motion in single-crystals is one of the most powerful analytical methods. While simple approach for understanding of non-standard structures did not exist, this article describes and demonstrates a technique that can be used to cope with the challenges of crystallography. Together with the relaxation measurements, simulating the second moment of spectral lines allows one to perform an accurate analysis of dynamics and geometry of internal motion as well as crystal structure.

In this article, the analytical expressions describing overall angular dependence of the NMR 2nd moment were derived in a simplest and smart way. The theoretical results are expressed in comprehensible analytical form, easy to use. Application to the model crystal of NH_4Cl allowed us to prove the evidence of the tetragonal distortion of crystal structure that takes place in the ordered phase of ammonium chloride. Analyses of the 2nd moment temperature data for two orientations have shown that all parameters associated with the motion can be obtained. These parameters are in satisfactory agreement with those taken from NMR-relaxation and other spectroscopic studies.

References Références Referencias

1. Valiev, K.A., Ivanov, E.N., (1973), *Uspehi Fiz. Nauk*, (Moscow, Nauka), *109*, 31.
2. Bashirov F., Gaisin N., (2010), *Crystallography Reviews*, *16*, 3
3. Rigny P., (1972), *Physica*, *59*, 707.
4. Van Vleck, J.H., (1948), *Phys. Rev*., *74*, 1168.
5. Abragam, A., (1961), *The Principles of Nuclear Magnetism* (Oxf. Univ. Press: N.Y.).
6. Lösche, A., (1962), Kerninduktion (Veb Deutsher Verlag der Vissensch.: Berlin)
7. Goc, R.Z., (2002), *Naturforsch*., *57a*, 29.
8. Bashirov, F., (2012), Spectroscopic Techniques and Hindered Molecular Motion (CRC Press: London–New York).
9. Bashirov, F.I., (1994), *Extended abstracts of XXVIIth Congress AMPERE, Magnetic Resonance and Related Phenomena*, Kazan: KFTI-Kazan, *1*, 282.
10. Bashirov, F.I., (1996) *J. Magn. Res*. *A 222*, 1.
11. Bashirov, F.I., (1997), *Mol. Phys*., *91*, 281.
12. Bashirov, F.I., (2001), *Crystallography Reports*, *46*, 494.
13. Bashirov, F.I., Gaisin, N.K., (1998), *J. Ram. Spectroscopy*, *29*, 131.
14. Bashirov, F.I., (1999), *Eur. Phys. J*. AP, *8*, 99.
15. Bashirov, F.I., Gaisin, N.K., (2009), *CEJP, 7*, 79.
16. Bashirov, F.I., (2001), *Mol. Phys*., *99*, 25.
17. Bashirov, F., Gaisin, N., (2015), *International Journal of Spectroscopy*, Volume 2015, Article ID 701386, http://dx.doi.org/10.1155/2015/701386.
18. Bersohn, R., Gutowsky, H.S., (1954), *J. Chem. Phys*., *22*, 651.
19. Powles, J.G., Gutowsky, H.S., (1955), *J. Chem. Phys*., *23*, 1692.
20. Slichter, Ch.P., (1965), Principles of Magnetic Resonance (New York: Harper and Row).
21. Wigner, E., (1931), Gruppentheorie (Braunschweig Ed.: Berlin).
22. Gutowsky, H.S., Pake, G.E., Bersohn, R.J., (1954), *Chem. Phys*. *22*, 643.

This page is intentionally left blank

Global Journal of Science Frontier Research: A
Physics and Space Science
Volume 17 Issue 1 Version 1.0 Year 2017
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Modulus of Elasticity of Lab_6 - Meb_2 (Me - Ti, Zr, Hf) Composite at High Temperatures based on the Interfacial Interactions

By D. Zakarian & A. Khachatrian
IPMS National Academy of Science

Abstract- Mechanical properties of a composite have been calculated within the pseudopotential method. At calculating the system energy we have taken into account non-harmonic effects, connected with thermal vibrations of atoms, using the quasi-harmonic approximation. For equally deformed states we have obtained a stress-strain dependence. We have calculated elastic modulus, maximum strain and the corresponding maximum strength for LaB_6 - MeB_2 composite with eutectic composition with regard to the influence of the components' boundaries, as well as their temperature dependence. There is an exponential dependence of elastic modulus on the composite temperature and in the dependence of elastic modulus - maximum strength ratio on the temperature there is a section where the composite hardening at high temperatures is observed. Different changes in strength and modulus of elasticity depend on the ratio of elastic and total strain of the composite at high temperatures. Accounting of interfacial interaction leads to an increase in the maximum strength of the composite in the whole temperature range, and that provides an increase in the modulus of elasticity.

Keywords: *eutectic, interconnect borders, strength composites, elastic modulus, deformation.*

GJSFR-A Classification: *FOR Code: 240599p*

MODULUSOFELASTICITYOFLAB6MEB2METIZRHFCOMPOSITEATHIGHTEMPERATURESBASEDONTHEINTERFACIALINTERACTIONS

Strictly as per the compliance and regulations of :

Modulus of Elasticity of Lab_6 – Meb_2 (Me – Ti, Zr, Hf) Composite at High Temperatures based on the Interfacial Interactions

D. Zakarian[α] & A. Khachatrian[σ]

Abstract- Mechanical properties of a composite have been calculated within the pseudopotential method. At calculating the system energy we have taken into account non-harmonic effects, connected with thermal vibrations of atoms, using the quasi-harmonic approximation. For equally deformed states we have obtained a stress-strain dependence. We have calculated elastic modulus, maximum strain and the corresponding maximum strength for LaB_6 - MeB_2 composite with eutectic composition with regard to the influence of the components' boundaries, as well as their temperature dependence. There is an exponential dependence of elastic modulus on the composite temperature and in the dependence of elastic modulus - maximum strength ratio on the temperature there is a section where the composite hardening at high temperatures is observed. Different changes in strength and modulus of elasticity depend on the ratio of elastic and total strain of the composite at high temperatures. Accounting of interfacial interaction leads to an increase in the maximum strength of the composite in the whole temperature range, and that provides an increase in the modulus of elasticity.

Keywords: eutectic, interconnect borders, strength composites, elastic modulus, deformation.

I. Introduction

A quasi-binary eutectic composite is a system of two components in the absence of their mutual solubility. In eutectic systems, the boundary contact between the components may be coherent, semicoherent or amorphous depending on the types and structures ratio parameters of their crystal lattices.

If you know the general principle of calculating of the theoretical strength under uniaxial tension through the energy of pure components, the problem of the same calculation for composite is rather ambiguous and complex, which is associated with the influence of the boundaries of the components.

This paper discusses the mechanical properties such as strength, elastic modulus, maximum strain, as well as the surface energy of components contacts in composite as a function of temperature. All of these characteristics are determined by the energy of interaction between the elements in composite. The object of study is Quasi-binary eutectic composites LaB_6 –MeB_2 (Me - Ti, Zr, Hf). Mutual insolubility components of these systems is confirmed by quantum-mechanical calculations and is presented in [1].

Author α σ: IPMS National Academy of Science of Ukraine, Frantzevich Institute for Problems of Materials Science.
e-mail: zakarian.d.a@gmail.com

II. Research Methods, Numerical Simulation and Discussion of Results

The method of determining the total energy of the alloy per molecule within the pseudopotential method is based on the summation of the potentials of paired intermolecular interactions [2]. If the concentration of component A is denoted C, the energy of system from two components can be written

$$U = U_{AA}C^2 + U_{BB}(1-C)^2 + 2C(1-C)U_{AB}. \quad (1)$$

Here

$$U_{AA}C^2 = \frac{1}{2N}\sum_{i\neq j}\Phi_{AA}(R_{ij}), \quad (2)$$

$$U_{BB}(1-C)^2 = \frac{1}{2N}\sum_{i\neq j}\Phi_{BB}(R_{ij}), \quad (3)$$

$$U_{AB}\cdot 2C(1-C) = \frac{1}{2N}\sum_{i\neq j}\Phi_{AB}(R_{ij}), \quad (4)$$

where Φ_{AA}, Φ_{BB}, Φ_{AB} - potentials of interactions between these components [2], and U_{AA}, U_{BB}, U_{AB} - the energy of interaction between the components A- A, B – B and A -B.

The first component has a connection of A - A type, and the second component connection B - B, at the interface - only A - B connection. Equation (1) can be written as

$$U = U_{AA}C^2 + U_{BB}(1-C)^2 + 2C(1-C)U_{AB} = C^2U^*_{AA} + (1-C)^2U^*_{BB}, \quad (5)$$

where

$$U^*_{AA} = U_{AA} + U_{AB}\frac{1-C}{C}, \quad U^*_{BB} = +U_{BB} + U_{AB}\frac{C}{1-C}. \quad (6)$$

Tension along the z axis is determined from the relation [3]

$$\sigma_z = \frac{1}{S_i \cdot d} \cdot \frac{\partial U_{ii}(d)}{\cdot \partial e_z}, \qquad (7)$$

where e_z - relative deformation, and U_{ii} is a U_{AA} or U_{BB}, d - lattice parameter in the direction of the axis of deformation, S_i - atomic plane area in a crystal lattice that is perpendicular to the axis of strain. For calculating the formulas based on strength (6, 7) there is the following relationship:

$$\sigma_A^* = \left[\frac{1}{d_A \cdot S_A} \frac{\partial U_{AA}(d_A)}{\partial e_z} + \frac{1-C}{C} \frac{1}{d_V \cdot S_V} \frac{\partial U_{AB}(d_V)}{\partial e_z} \right] = \sigma_A + \frac{1-C}{C} \sigma_{AB}, \qquad (8)$$

$$\sigma_B^* = \left[\frac{1}{d_B \cdot S_B} \frac{\partial U_{BB}(d_B)}{\partial e_z} + \frac{C}{1-C} \frac{1}{d_V \cdot S_V} \frac{\partial U_{AB}(d_V)}{\partial e_z} \right] = \sigma_B + \frac{C}{1-C} \sigma_{AB} \qquad (9)$$

The paper considers in equal deformed state condition in which the permissible deformation of the composite in tension coincides with the maximum deformation of the reinforcing fibers. In equal deformed state, according to the rule of mixtures, excluding the impact of joining the borders of the two components, the maximum strength of the quasi-binary system will be

$$(\sigma_C)_{\max} = \delta\Omega_A \cdot \sigma_A + \delta\Omega_B \cdot \sigma_B^{\max}. \qquad (10)$$

Here, $\delta\Omega_A$, $\delta\Omega_B$ the volume fractions of LaB_6 and MeB_2, $\sigma_B^{\max}$ - maximum strength of MeB_2 and σ_A – strength of LaB_6 or resistance of the matrix at the maximum deformation of hardener (i.e. when $\varepsilon = \varepsilon_{\max}$), which is called "temporary resistance."

With the impact of borders joining have

$$(\sigma_C^*)_{\max} = \delta\Omega_A \cdot \sigma_A^* + \delta\Omega_B \cdot \sigma_B^{*(\max)}. \qquad (11)$$

With a very small strain the curve stress - strain is close to a linear law, and then:

$$\sigma_c = \delta\Omega_A\sigma_A + \delta\Omega_B\sigma_B = E_A\,\varepsilon_A\,\delta\Omega_A + E_B\,\varepsilon_B\delta\Omega_B, \qquad (12)$$

and taking into account the phase of interaction (Figure I.)

$$\sigma_c^* = \delta\Omega_A\sigma_A^* + \delta\Omega_B\sigma_B^* = E_A^*\,\varepsilon_A\,\delta\Omega_A + E_B^*\,\varepsilon_B\delta\Omega_B, \qquad (13)$$

where σ_c; σ_A; σ_B stresses in composite and in components A and B,

E_i, E_i^*, $\varepsilon_{i\,i}$ - elastic modulus and the strain of the components (and without taking into account the interfacial interaction).

In equal deformed state ($\varepsilon_c = \varepsilon_A = \varepsilon_B$)

$$E_c = \sigma_c / \varepsilon_c : \quad E_c^* = \sigma_c^* / \varepsilon_c \qquad (14)$$

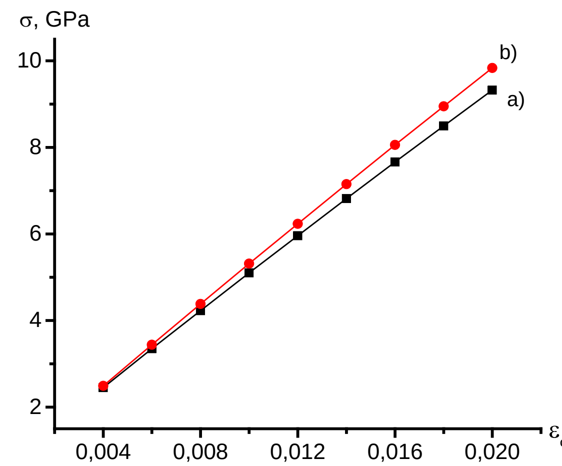


Fig. I: The linear dependence of the composite stress from small strain ε_c: $a)\ \sigma = \sigma_c$, $b)\ \sigma = \sigma_c^*$.

For small values of deformation the calculated values of the stress and the elastic modulus of LaB_6 - TiB_2 composite (at zero temperature) are shown (Table I.).

Table I: The calculated values of the stress and the average value of elastic modulus (in GPa) of LaB_6 - TiB_2 composite with and without interfacial interaction

ε_c	σ_c	σ_c^*	$\overline{E}_c$	$\overline{E}_c^*$
0,004	2,041	2,121	510	530
0,006	3,063	3,185		
0,008	4,081	4,252		
0,010	5,101	5,312		

To identify the mechanical characteristics depending on the temperature, it is necessary to be able to calculate the energy of the electron-ion system of the materials at different temperatures. In the method of pseudopotentials, it means to find a change in the volume of the unit cells, at temperatures different from zero, ie, obtain the explicit dependence of the total energy of the lattice parameters and volume at nonzero temperature.

Note that the calculation of the energy of the electron - ion system in the second-order of perturbation theory in the pseudopotential means using the harmonic approximation. But application of this approach in the lattice dynamics enough to calculate certain physical characteristics that are associated with a change in crystal lattice volume with increasing temperature. This problem can be avoided if use [5] "quasi-harmonic model" (developed by the authors), which allows to identify the temperature dependence of the unit cell volume in the harmonic approximation. The result is a dependence of the energy of the electron-ion system on temperature through the unit cell volume

$$U_{i,j}(T)=U_{i,j}(\Omega_{i,j}(T)) \quad (15)$$

The final formula for calculating the theoretical strength at uniaxial tensile versus temperature are presented in the form:

$$\sigma_A^*(T)=\sigma_A(T)+\frac{1-C}{C}\sigma_{AB}(T); \quad \sigma_B^*(T)=\sigma_B(T)+\frac{1-C}{C}\sigma_{AB}(T)\ . \quad (16)$$

In borides with a high content of boron, the boron atoms form stable complexes structuras (B_6), their influence on the physico-mechanical characteristics of the material occurs at high temperatures, which leads to the appearance of peaks or abrupt changes in the physical and mechanical characteristics [6].

It was found that for uniaxial deformation in the temperature range from 0 to 2750 K the characteristic exponential dependence of strength on temperature disrupted in a temperature range (1300 - 2200K) in the case of LaB_6. In this interval an increase in temperature leads to higher theoretical strength. The same dependence is observed for eutectic systems LaB_6 – MeB_2 (Me - Ti, Zr, Hf), which constitutes mainly from the LaB_6 [1].

Accounting for the interaction energy between heterogeneous elements A and B at the interface of the two phases results in a change of its value and the maximum deformation and hence the maximum strength in the composite. Note that at T = 0K for MeB_2 maximum deformation (Me -Ti, Zr, Hf) is approximately $\varepsilon_{\max} \approx 0,099$ [6]. In the calculation of the effective strength the extension member results in an increase of maximum deformation (at T = 0 K $\varepsilon^*_{B\max}=0.11$, and $\varepsilon^*_{B\max}=0.1161$ for in case of TiB2 and ZrB2, for HfB2 $\varepsilon^*_{B\max}=0.1158$. The increase in the maximum deformation of hardener - the result of interactions of the components (phases), which entails an increase in the temporary matrix resistance, tending to its maximum value, and, in general, increases the strength of the composite.

Results of computational experiment on the calculation of the elastic modulus for composite and components, as well as their temperature dependence are presented in Table. II-III.

Table. II: The elastic moduli of composite materials and components in the system LaB_6 – MeB_2 and experimental value in Gpa

Phase	*E* (Calculation)	*E* (Experiment)	
LaB_6	495,05	478,73 [7]	320 [9]
TiB_2	600,06	540,53 [7]	545[9]
HfB_2	523,97	479,71 [7]	
ZrB_2	534,67	495,80 [8]	430[9]
LaB_6 - TiB_2	506,28	-	
LaB_6 - HfB_2	507,63	-	
LaB_6 - ZrB_2	507,46	-	430-450[9]

The values obtained for the Young's modulus are close to their experimental values within acceptable limits (the maximum relative error of ~ 7%), given that the calculations considered only perfect single crystals, real crystals always have a lower value.

Table III: Dependence of the Young's modulus (GPa) of components LaB_6, TiB_2 and composite LaB_6 – TiB_2 on temperature

T, K	E_A	E_B	E_c
0	495,05	600,06	506,28
300	487,50	593,35	498,86
500	478,19	580,28	489,11
750	466,25	571,09	477,41
1000	450,76	548,67	461.24
1500	430,09	530,29	440,81
2000	400,15	500,07	410,84
2500	360,23	476,13	372,63
2750	330,18	440,06	341,94

If a crystal is subjected to deformation and simultaneously the temperature rises, then in parallel with deformation thermal expansion will operate. Quantum-mechanical calculations show that the interaction between the boron atoms is much stronger than between metal and boron, and even more than metal-metal bond [2]; i.e. B_6 complex expansion requires higher temperatures. This is confirmed by results of calculating the dependence of deformation on the temperature.

At temperatures T> 1300 K expansion of B_6 complex on the plane [200] counteracts the uniaxial strain (stretch) of the complex in the perpendicular direction, as a result of which there appear anomalies in the graph of the strength – temperature dependence. At relatively small deformations, in which the elastic modulus is determined, this effect is not observed (Figure II). Figure III shows the dependence of the modulus of elasticity- maximum strength ratio of the composite on the temperature. In the temperature range of 1000-2500 K, an area of the characteristic hardening of a composite is marked out.

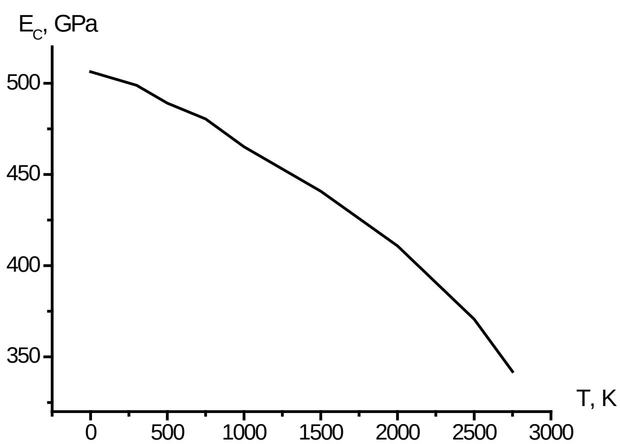


Fig. II: The dependence of the elastic modulus on temperature of the $LaB_6 - MeB_2$ composite

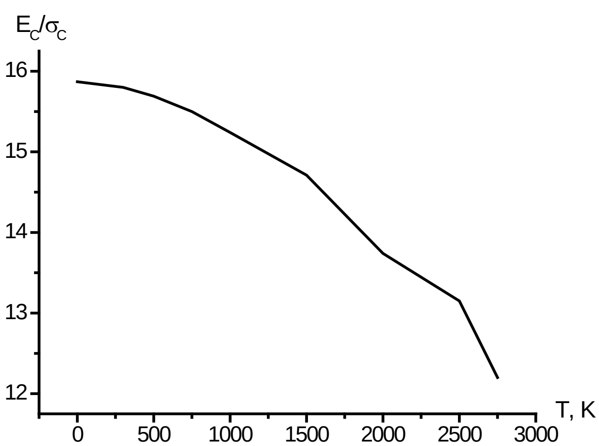


Fig. III: Temperature dependence of the ratio of the modulus of elasticity and ultimate strength of the $LaB_6 - MeB_2$ composite

Accounting components interaction in composites at the interface connections increases the value of composite modulus of elasticity.

The boundary of the two phases in the composite serves as a redistribution of property area: increasing the plasticity of refractory component and the theoretical strength and elastic modules of the composite as a whole. Up to the melting temperature composites $LaB_6 - MeB_2$ have high strength and elastic modulus.

References Références Referencias

1. Zakaryan D., Kartuzov V., Khhachatrian A., Sair A.(2011) Calculation of composition in LaB_6 - TiB_2, LaB_6 - ZrB_2 eutectics by means of pseudopotential method, Journal of the European Ceramic Society V.31.- №7: 1305-1308.
2. Zakarian D., Khachatrian A. (2013) Modeling of intermolecular interactions in the system LaB_6 - MeB_2 within the pseudopotential method, Reports of the National Academy of Science of Ukraine№ 1: 77-82.
3. Zakarian D., Kartuzov V., Khachatrian A.(2016) Prediction of the Mechanical Properties of LaB6–ZrB2 Materials in View of the Effect of Their Intercomponent Boundaries, Strength of Materials 48(2): 290-293.
4. Zakarian D. (2014) Calculation of the surface contact of components in quasibinary eutectic systems, Reports of the National Academy of Science of Ukraine № 11: 82-87.
5. Zakarian D., Kartuzov V., Khachatrian A. (2016) Quasi-harmonic approximation model in the theory of pseudopotentials, Reports of the National Academy of Sciences of Ukraine №4: 106 -110.
6. Zakarian D., Kartuzov V., Khachatrian A. (2015) Therotical Strength of Borides and Quasibinary Borid Eutectics at High Temperatures, Powder Metallurgy and Metal Ceramics 54 (3): 210-214.
7. Serebryakova T.I., Neronov V.A., Pekhov A.D.(1991) High borides. Metallurgy, Moscow.
8. Franzevich I.N., Voronov F.F., Bakuto S.A. (1982) Elastic Constants and modules of elasticity of metal and nonmetal. Naukova Dumka, Kiev.
9. A.B. Lyashenko A.B. Experimental determination of the modulus of elasticity - Private message (unpublished work) - Private message, Kiev- IPMS National Academy of Science of Ukraine, Frantzevich Institute for Problems of Materials Science, - Laboratory V. Filippov.

Global Journal of Science Frontier Research: A
Physics and Space Science
Volume 17 Issue 1 Version 1.0 Year 2017
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Inflationary Origin of Matter-Antimatter Asymmetry in Semiclosed Friedman Universe

By Noboru Hokkyo
Senjikan Institute

Abstract- The cosmological role of the Higgs boson in the inflationary origin of the matter-antimatter asymmetry in the semiclosed Friedman universe is discussed.

Keywords: *general relativity; cosmology; gauge particle; matter-antimatter asymmetry.*

GJSFR-A Classification: *FOR Code: 240000*

INFLATIONARYORIGINOFMATTERANTIMATTERASYMMETRYINSEMICLOSEDFRIEDMANUNIVERSE

Inflationary Origin of Matter-Antimatter Asymmetry in Semiclosed Friedman Universe

Noboru Hokkyo

Abstract- The cosmological role of the Higgs boson in the inflationary origin of the matter-antimatter asymmetry in the semiclosed Friedman universe is discussed.

Keywords: general relativity; cosmology; gauge particle; matter-antimatter asymmetry.

I. Introduction

In 2014 the CERN high energy proton-proton collision experiment detected the Higgs boson with mass m_H of about 100 proton mass:

$$m_H \sim 10^2 m_P \sim 10^{-17} m_{pl}, \qquad (1)$$

where $m_{pl} \sim 10^{-0.5}$g is the Planck mass. Being a scalar the Higgs boson has no electric and color charge. It has its own antiparticle and CP-symmetry.

The cosmological implication of the graviton-Higgs boson composite was discussed[1] in curved spacetime as it may generate huge complogical constant Λ in negative sense, while its anti-boson composite may flatten the curve in positive sence.

II. Planckeon Origin of Dark Energy

In 1963 paper: Semiclosed Worlds in the General Thory of Relativity Zel'dovich[1] wrote: "A class of Friedman solutions of general relativity equation is found in which, as we approach the matter from infinity, we reach a singularity at the graviational radius. But beyond this point the metric is continued in an unusual way—the radius decreases again and goes to zero only after passing through a maximum" (Novikov's similar work[2] noted in proof). Andreev, Stanyukovich and others[3,4] found related solutions showing the possible existence of a gravitationary closed point particle with Planck mass m_{pl} and radius l_{pl} moving with light vlocity which they called maximon or Planckeon. These particles can emit radiation only if they collide with massive object, but the radiation is unobservable by the Doppler effect.

We here propose a gravitationally bound Planckeon-Higgs boson composite[10,11] creating negative attractive potential and positive rest mass energy:

$$-Gm_H m_{pl}/l_{pl} = -\,G(m_H/m_{pl})m_{pl}^2/l_{pl}$$
$$= -\,10^{-17}\,Gm_{pl}^2/l_{pl} < 0, \qquad (2)$$
$$10^{-17} m_{pl}c^2 = 10^{-17}(\hbar c/l_{pl})$$
$$\sim 10^{15}\kappa T > 0, \qquad (3)$$

filling the evolutionarilly earlier upper hemisphere as dark energy and evolutionarilly later hemisphere as dark matter of the closcd Friedman universe. On the equator separating the two hemispheres we have

$$10^{-17}(m_{pl}c^2 - Gm_{pl}^2/l_{pl}) = 0, \qquad (4)$$

where the rest mass energy is absorbed by the attractive potential.

III. H^{0}Boson and Friedman Universe

We extend the Friedman metric to Lorentz-Friedman-Reissner-Nordström form:

$$ds^2 = c^2 g_{tt}dt^2 - g_{rr}dr^2,$$
$$g_{tt} = g_{rr}^{-1} = 1 - r^2/r_g^{\,2} + L_\theta^2 l_{pl}^{\,2}/r^2, \qquad (5)$$

Here $r_g = 2GM/c^2$ is the gravitational radius of the universe having Newtonian mass M and radius $R \geq r_g$, and

$$L_\theta = \hbar l_\theta/2\pi,\ l_\theta = \text{integer}. \qquad (6)$$

is the quantized angular momentum.

The evolutionary history of the Lorentz-Friedman black hole is containd in the integral

$$I_{pl} = \int^R g_{rr}rdr$$
$$= \int^R rdr(1 - r^2/r_g^{\,2} + L_\theta^2 l_{pl}^{\,2}/r^2)^{-1}. \qquad (7)$$

giving the unitary and holographic information content (entropy)[5] of the black hole acquired by an observer approaching the matter distribution through empty space from infinity:

$$(R/l_{pl})^2 = (10^{28}/10^{-33})^2 = 10^{120}. \qquad (8)$$

IV. Superluminal Inflation and Subluminal Evolution

The light velocity is obtained by solving $ds^2 = 0$ as:

$$dr/dt = c(g_{tt}/g_{rr}) = c\,(1 - r^2/r_g^{\,2} + L_\theta^2 l_{pl}^{\,2}/r^2)$$
$$> c \text{ at } r \sim l_{pl} \text{ and } r \sim r_g - l_{pl}$$
$$= c \text{ at } r = r_C = (r_g/l_{pl})^{1/2}$$
$$= c \text{ in between } r_C < r < r_C = c \text{ and } r \sim r_g - l_{pl} \qquad (9)$$

Eqs.(9) show that, starting from quantum fluctuations of preexisting metric for $0 < r < l_{pl}$, the light

Author: Senjikan Institute, Niigata, Japan.
e-mail: noboruhokk@yahoo.co.jp

velocity is superluminal at $r \sim l_{pl}$ and $r_g - l_{pl}$. After Big Bang at temperature $T_B = 10^{27}$K, dr/dt decreases with the increse of r towards $r = r_C = (r_g/l_{pl})^{1/2} = L_\theta^2 10^{-2}$cm for $r_g = R = 10^{28}$cm.

During the superluminal and inflationary epoch of electroweak and grand unification of gauge fields by Higgs mechanism, a causaly related small region extends from $r \sim 10^{-25}$cm to $r \sim 10$cm, followed by a brief interlude of reheeting, returning to the pre-inflatioonary temperature of the universe. Further evolution is described by standard Friedman universe starting the radiation dominated phase of Hubble's evolutional history expanding with subluminal velocity. Hubble contant H relates the the velocity v of a massive extragalactic object to its distance d from the Earth:

$$H = v/d \qquad (10)$$

The COBE astronomical observations of the large-scale homogeneity of the distribution of matter and galaxy formation on the scale of 10^{10}cm light years can be explained by the superluminal and bi-directional EPR causal connection between radius $r = l_{pl}$ and $r = r_C$, while stars, clusters of galaxies, voids and other structures larger than 10^8 light years seem to indicate the angular momentum (5) $l_\theta \sim 10^3$ so that $r_C = l_\theta 10^{-2} \sim 10$cm, the high l_θ value indicating the multi-directional inflation.

V. Inflation as Ultraviolet Anomaly

The Klein-Gordon amplitude of transition (propagator) $D(s^2)$ for the Higgs boson between two points separated by a 4-dimensional squared distance $s^2 = (ct)^2 - r^2$, is given by[6]

$$D(s^2) = -\delta(s^2)/4\pi + (\lambda/4\pi s)H_1^{(2)}(s/\lambda), \qquad (11)$$

where $H_1^{(2)}$ is the Hankel functuion of the second kind and $\lambda = \hbar/mc$ is the particle wavelength. We find:

$$D(s^2) \sim \delta(s^2) \text{ on the light cone } ds^2 = 0, \qquad (12)$$

$$\sim (1/s^{3/2}) \exp(-is/\lambda) \text{ within the light cone } ds^2 > 0, \qquad (13)$$

$$\sim (1/|s|^{3/2}) \exp(\pm|s|/\lambda) \text{ outside the light cone } ds^2 < 0, \qquad (14)$$

The $\pm$ sign in eq.(14) allows the ultraviolet anomaly of the Higgs boson:

$$(1/|s|^{3/2})\exp(|s|/\lambda) \rightarrow \exp(l_{pl}/\lambda)/l_{pl}^{3/2} \rightarrow 1/l_{pl}^{3/2}, \qquad (15)$$

to be copmpared to De-Sitter solution of general relativity equation:

$$r(t) \sim \exp(\pm\sqrt{\Lambda}ct) \rightarrow \exp(ct/l_{pl}), \qquad (16)$$

where $\Lambda = 1/l_{pl}^{/}$.

VI. Higgs Boson in Gravitational Field

The PC and T symmetric Klein-Gordon equation

$$[\partial^2/\partial^2/(ct)^2 - \partial^2/\partial^2 r^2 + (\hbar/mc)^2]\psi = 0 \qquad (17)$$

obeyed by the Higgs boson wave function $\psi(r, t)$ can be decomposed into two-component Dirac form:

$$(\partial/\partial/ct - \partial/\partial r + \hbar/mc)\psi_+ = 0,$$

$$(\partial/\partial/ct + \partial/\partial r + \hbar/mc)\psi_- = 0, \qquad (18)$$

where $\psi_\pm$ represent the positive and negative energy states of the Higgs boson going forward and backward in time.

During the inflation, starting at $r = l_{pl}$ and ending at $r = r_C$, the light velocities $(dr/dt)_\pm$ are given by

$$\begin{aligned}(dr/dt)_+ &= c[(1 - r/r_g + L_\theta l_{pl}/r],\\ &> c \text{ at } r = l_{pl}\\ &= c \text{ for } r = r_C = (L_\theta l_{pl} r_g)^{1/2} \qquad (19)\end{aligned}$$

and

$$\begin{aligned}(dr/dt)_- &= c[(1 + r/r_g + L_\theta l_{pl}/r]\\ &> c \text{ at } r = r_g - l_{pl}\\ &= c \text{ for } r = r_C = (L_\theta l_{pl} r_g)^{1/2}. \qquad (20)\end{aligned}$$

The CERN high energy proton-proton collision experiment creating H^0 boson, immediately decaying into a counter-propagating pair of photons, seems to tell the preference of H^0 boson, going forward in time, to its antiboson, going backard in time, by the present universe expanding forward in time.

VII. Matter-Antimatter Asymmetry

Matter-antimatter symmetry required by quantum theory and relativity is largely violated in cosmic scale outside high energy laboratory experiments. As there were equal amount of gauge matter and antimatter, immediately after the moment of the hot Big Bang at $r = r_C$, we here propose to consider that the probability of collision between H^0 boson and the gauge matter, comoving forward in time, dominates over the collision between H^0 boson and antimatter, counter-propagating backward in time during inflation expanding forward in time.

VIII. Cosmological Double-Slit Experiment

In his positron theory Feynman[6] extended Jordan-Paulil propagator

$$\begin{aligned}D(r, t) &= t/|t|\delta(c^2t^2 - r^2)\\ &= D_{ret} - D_{adv} \qquad (21)\end{aligned}$$

to

$$\begin{aligned}D_F &= D_{ret} + D_-\\ &= D_{adv} + D_+ . \qquad (22)\end{aligned}$$

Here D_{ret} and D_{adv} are the retarded and advanced propagators. $D_\pm$ are the Fourier contributions from positive and negative frequency sheets. At the

Chicago meeting Pauli criticized Feynman's D_F by applying it to the single electron double-slit experiment. Feynman[17] replied Pauli by showing a delayed-choice double-slit equipped with time-dependent shutters creating $\Lambda + V = N$ shaped electron-positron pairs, zigzagging in time.

A matter-antimatter symmetric cosmology is conceivable by replacing the shutter by the Big Bang and the slit by the 3-diensional Lorentz sphere: $(ct)^2 - r^2 = l_{pl}^2$ filled with point-like Planckeons and joind onto Friedman universe at $r = r_C$, allowing a topological (non-Hausdolff) worm hole where the timelike 3-vectors is undefined.

IX. EPR Correlation on Insect

In 1903 Oudemans[8] discovered a phenomenon of pattern integration on the wings of the insect. When a moth or butterfly settles to assume its natural resting posture fragmental patterns apperaring on the exposed but not necessarily visible surface of forewings, hindwings, head, throx, abdomen, and some of legs are integrated to form a composite but unified and scale invariant spatial pattern. Since the phenomenon is observable for both diurnal and nocturnal insects, and since a single mutation seems to be able to transform as a correlated whole, not aquired by adaptation and selection in which independent biochemical processes occurring in spatially distant parts of organisms are organized to form a predetermined patterns at the final stage of development. O. Costa de Beauregard[8] took the phenomenon as a manifestation of the Leibnizian notion "Preharmony" or the Lamarckian slogan "The function creates the organ." We here propose to call it as the biological EPR correlation between sptially separated pattern elements, zigzagging in time.

References Références Referencias

1. M. J. B. Veltman Scientific American, November 88 (1986).
2. Ya. B. Zel'dovich, Sov. Phys. JETP **16**(3) 732.(1963)
3. I.D.Novikov, Delayed Expansion of a Part of the … …..Friedman Universe, and Quasars.Soviet Astroromy …..**8**(6) 857(1963).
4. A. F. Andreev, Macroscopic Bodies with Zero Rest Mass, Sov. Phys. JETP **38**(6) 648(1974).
5. Yu. N. Babanenkov et al., Geometric Model of Radiation Planckeon, Sov. Phys. Dokl. **26**(9). 856.(1974).
6. S. W. Hawking, Information Loss in Black Holes. Phys. Rev. **D72,** 08401 (2005).
   Here the formation and evaporation of ……..Schwartzschild black holes is regarded as a ……..scattering problem with all measurements being
   ……..made at infinity. There only the path integral over
   ……..metrics with trivial topologies is seen to be unitary
   ……..and information preserving.
7. R. P. Feynman, The Theory of Fundamental Processes. Fig.18.2. Addison-Wesley, New York? (1961).
8. J. T. Oudemans, "Etudes sur position de repos chez …….les Lepidopterea," Verh. Akad.Wett. 10,1(1903).
9. O. Costa de Beauregard, Found. Phys.**17**,775 (1987).

This page is intentionally left blank

Global Journal of Science Frontier Research: A
Physics and Space Science
Volume 17 Issue 1 Version 1.0 Year 2017
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

The Cosmic Web, the Seed of Galaxies- Are Also Made of Warm Intergalactic Medium(WHIM) and Dark Energy?

By Mr. Rupak Bhattacharya, Dr. Pranab kumar Bhattacharya, Miss Upasana Bhattacharya, Mr. Ritwik Bhattacharya, Mr. Soumyak Bhattacharya, Miss Rupsa Bhattacharya, Mrs. Dalia Mukherjee, Miss Oindrila Mukherjee, Miss Ayeshi Mukherjee, Mr. Debasis Mukherjee, Mr. Hindole Banerjee & Runa Mitra

Calcutta University

Abstract- Universe consisted of mysterious Dark energy (70%), Dark matter(25%) and that make up now 95% of matter in the universe which revel it self as gravity. Enormous filaments and blobs of dark matter in early universe condensed as universe condensed. Within the cosmic webs, all galaxies, stars, planets were next created. Galaxies are not dotted randomly throughout universe but are generally either concentrated in groups or in clusters, which are connected again by multitude of filaments and voids. These filamentary distributions of galaxies explained by vast quantities of dark matter enveloping galaxies and filamentary cold gas flowing within them, responsible for star formation within them and the dark matter ISM is the dominant mass in the universe. Galaxies over passing time, clumped itself in a filamentary networks.

Keywords: large scale structure of universe; galaxies: clusters, cosmic webs WIMPs.

GJSFR-A Classification: FOR Code: 029999

THECOSMICWEBTHESEEDOFGALAXIESAREALSOMADEOFWARMINTERGALACTICMEDIUMWHIMANDDARKENERGY?

Strictly as per the compliance and regulations of :

The Cosmic Web, the Seed of Galaxies- are also Made of Warm Intergalactic Medium(WHIM) and Dark Energy?

Mr. Rupak Bhattacharya [α], Dr. Pranab kumar Bhattacharya [σ], Miss Upasana Bhattacharya [ρ], Mr. Ritwik Bhattacharya [ω], Mr. Soumyak Bhattacharya [¥], Miss Rupsa Bhattacharya [§], Mrs. Dalia Mukherjee[χ], Miss Oindrila Mukherjee [ν], Miss Ayeshi Mukherjee [ϴ], Mr. Debasis Mukherjee [ζ], Mr. Hindole Banerjee [£] & Runa Mitra [€]

Abstract- Universe consisted of mysterious Dark energy (70%), Dark matter(25%) and that make up now 95% of matter in the universe which revel it self as gravity. Enormous filaments and blobs of dark matter in early universe condensed as universe condensed. Within the cosmic webs, all galaxies, stars, planets were next created. Galaxies are not dotted randomly throughout universe but are generally either concentrated in groups or in clusters, which are connected again by multitude of filaments and voids. These filamentary distributions of galaxies explained by vast quantities of dark matter enveloping galaxies and filamentary cold gas flowing within them ,responsible for star formation within them and the dark matter ISM is the dominant mass in the universe. Galaxies over passing time , clumped itself in a filamentary networks . In the cosmic web hypothesis, all spherical structures appeared probably first within filaments, growing in between them, followed by the great walls [planar structures] connecting the filaments of cosmic Web. Massive filamentary structures observed at relatively small distances from us. These filaments located about 6.7 billion light-years away from us and extends over at least 60 million light-years even. 'Superclusters' are also filamentary cluster–cluster bridges. Computerized numerical simulations shows balance between dark matter and dark energy, determines both how universe expands and how regions of unusually high or low matter density evolved with time. Most of baryons in the local universe are also missing in that they are not in galaxies or in the previously detected gaseous phases. Rupak Bhattacharya and Pranab Bhattacharya [here are authors] suggest that these missing baryons are so predicted may be in a moderately hot phase, 1E5 to 1E7 K, largely in form of giant cosmic filaments that connect the denser virialized clusters and groups of galaxies. These filaments can be detected through absorption lines they produce in the spectra of background Active Galactic Nucleus. Models show that the highest covering fraction of such filaments occurs in super clusters and the archive has two AGNs projected behind super clusters, both of which show absorption systems (in Lyalpha LybetaOVI) at the super cluster red shift

The universe is so permeated by a network of filaments, sheets, and knots collectively forming a “cosmic web.” The discovery of the cosmic web, especially through its signature of absorption of light from distant sources by neutral hydrogen in the intervening intergalactic medium, exemplifies the interplay between theory and experiment that drives science and is one of the great examples in which numerical simulations have played a key and decisive role. We authors in this article recount the milestones in our understanding of cosmic structures; summarizing its impact on astronomy, cosmology, and physics; and look ahead by outlining the challenges faced as we prepare to probe the cosmic web at new wavelengths.

Keywords: large scale structure of universe; galaxies: clusters, cosmic webs WIMPs.

Author α: BSc(Calcutta Univ), MSc (Jadavpur Univ), of residence 7/51 Purbapalli, Sodepur, Dist 24 Parganas(north), Kol-110,West Bengal, India. Free lancer Theoretical Physicist.
Author σ: Professor, MD(Calcutta Univ) Honors ; FIC Path(India), Professor of department of Pathology(detailment), Calcutta School of Tropical Medicine,108, C.R Avenue; Kolkata-73, West Bengal, India.
Author ρ: Student, Mahamayatala, Garia, kol-84, only daughter of Prof.PK Bhattacharya.
Author ω: B.com(Calcutta Univ).
Author ¥: MSc (PUSHA New. Delhi, India) of residence7/51 Purbapalli, Sodepur, Dist 24 parganas(north), Kolkata-110, West Bengal, India,
Author χ: BA(hons), Calcutta Univ, Swamiji Road, South Habra, 24 Parganas(north) West Bengal, India.
Author ν: BHM(IGNOU).
Author ϴ: Student.
Author ζ: Bsc(Calcutta Univ) of Residence Swamiji Road, South Habra, 24 Parganas(north), West Bengal, India.
Author £: of residence7/51 Purbapalli, Sodepur, Dist 24 parganas(north), Kolkata-110,West Bengal, India.
Author €: MA (Calcutta University) BK Mitra Palliative care unit Barrackpore North 24 parganas West Bengal India.

Global Journal of Science Frontier Research (A) Volume XVII Issue I Version I Year 2017

Global Journal of Science Frontier Research (A) Volume XVII Issue I Version I Year 2017

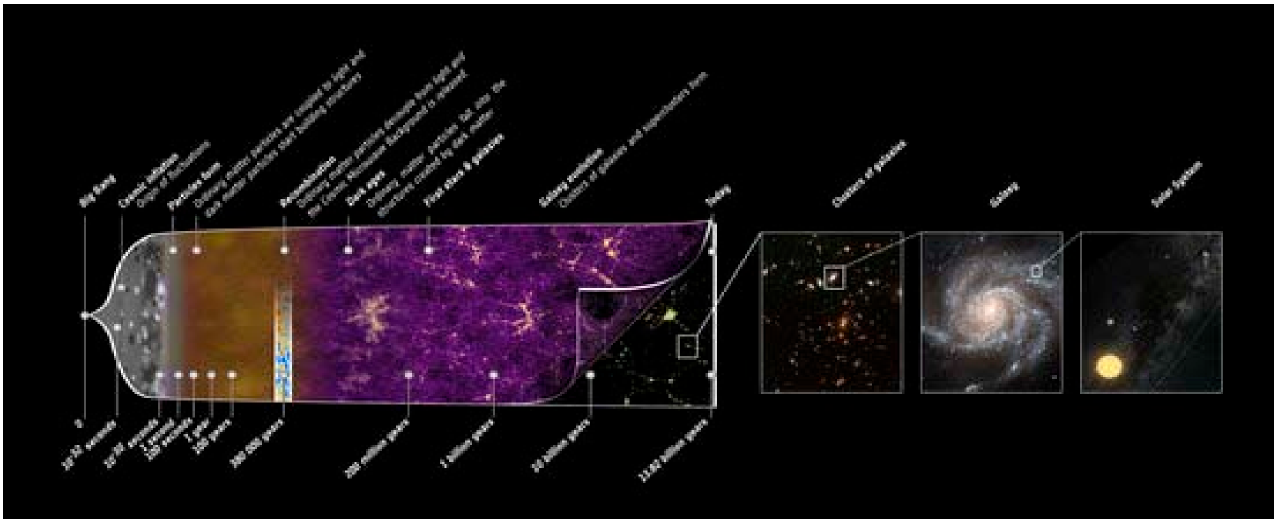


Figure 1

I. The Cosmic Web

The web is the frame work on which our universe was built, if at all it was once created. It consisted primarily of "dark matter," a mysterious stuff that makes up 85% of the matter in observable universe but has revealed itself only through its gravity. Enormous amount of filaments and blobs of the stuff was condensed as the universe gradually matured and expanded. Within them seeds of galaxies and their stars, planets creating streams of light stretching between inky large voids. Voids are empty spaces filled with dark energies. Dark energy pervades everything, stretching space time and affecting the evolution of the cosmic webs.

So our universe is made of voids, filaments, knots and sheets known as cosmic webs. Each point in space time may be classified in one of four possible cosmic web types: voids, sheets, filaments and knots. Voids co-exist with a net of interconnected filaments. The entire observable universe is tangled in a web like structure, the frame work, on which universe was once built up. We all today know it also that universe consisted of mysterious *Dark energy* (70%), *Dark matter*(25%) and that make up now 95% of the matter in universe and which revel it self as gravity. Enormous filaments and blobs of dark matter in early universe condensed as universe condensed. Within these cosmic webs, all galaxies, stars, planets, planetismals, asteroids were actually created. Our universe consists of billons and billions numbers of galaxies, some are larger, some smaller, some are spiral disc shaped, like our Milky way, some non spiral, elliptical, some dwarf galaxies, some dark galaxies, some as say ferst galaxies some are in clusters. More than 700,000 galaxies, whose observed Doppler colors indicated a significant red shift and are therefore presumed to be at large cosmological distances. Galaxies are however not dotted randomly through out universe but are generally either concentrated in groups or in clusters, which are connected again by multitude of filaments. These filamentary distributions of galaxies can be explained by vast quantities of dark matter enveloping galaxies and filamentary cold gas flowing within them, responsible for stars formation within them and the dark matter ISM is the dominant mass in universe.

The observed large scale structure of universe is thought to be due to gravitational growth of density fluctuations in post-inflation era. In this model, the evolving cosmic web is governed by non-linear gravitational growth of the initially by weak density fluctuations in the dark energy dominated cosmology. The cosmic web can be now traced by a tiny fraction of luminous baryonic matter.

[Red shift - what is red shift? What is its relation with expansion of our universe? The red shift *termed as z*, of any kind of luminous sources is increase of measured radiations wavelength with respect to emitted one. It can be defined with mathematical equation as $z \equiv \lambda o - \lambda e \,/\, \lambda e$ where λe is wavelength of the radiation emitted by the luminous source and λo is the observed person one's position in the earth measuring red shift of distant luminous objects. The physical explanation of the red shift, of course, is a direct consequence of expansion of our universe from Big Bang. In fact, one can demonstrate that expansion of space time caused also an increase of wavelength of emitted photons from the luminous source towards the observer person in the earth. One can demonstrate that the expansion of space time causes also an increase of the wavelength of the emitted photons from the source towards the observer. Using equation when applied to light rays in space time that travels along a geodesic of the space-time, which may be defined by $ds^2 = 0$, if one can fix te and t_0 as times when the radiation was emitted and observed, respectively, we have equations like $\int_{te}^{t0} cdt \,/\, a(t) = \int_0^r dr' / \; (1-Kr'^2)^{1/2} = fK(r)$. The light emitted from the source at the time $te + \delta te$ is then seen by the observer at $t_0+\delta t_0$ and since the two objects are following the cosmological expansion we have equation that $fK(r) = \int^{t_0+\delta t_0}_{te+\delta te} cdt/\ a(t)$, we obtain then $\delta t_0 / a_0 = \delta te/\ a(te)$ or when $a_0 = a(t_0)$, or equivalently $a(te)\ /\lambda e = a_0/\lambda_0$. From this relation it is also clear that the red shift and the expansion parameter of our universe are always interconnected. For a generic instant t we have, in fact, $1+ z = a_0 /a_{(t)}$ shows that the objects at the present time in observable universe have red shift $z = 0$ and that the red shift (z) grows at lower expansion factors]

At very high red shifts ($z > 1100$) the pre-galactic medium was very hot, was relatively dense, ionised, with a substantial pressure of radiations. The cosmic microwave background (CMB) observations constrain the amplitudes of density in homogeneities to be very small at the last scattering red shift $z \sim 1000$. The universe then expanded, the matter cooled, and eventually recombined, being mostly in neutral phase during the "Dark ages" of the universe. At some red shift, $6 < z < 14$, hydrogen in the universe was re-ionised, likely due to UV radiation from the first luminous objects, leaving the intergalactic medium (IGM) highly re-ionised state. The re-ionisation indicated the formation of the first luminous objects at the end of the "Dark ages", either by star forming galaxies or as Active Galactic Nuclei (AGN). At the same evolution stage, formation of strong density in homogeneities in the cosmic structure occurs. Since then the non-linear dynamical flows in the vicinity of density in homogeneities would have created large scale cosmic structure shocks of modest strength, thus heating up the baryonic matter and simultaneously producing highly non-equilibrium energetic particle distributions, magnetic fields and electromagnetic emission.

The most current theory of structures formation in the observable universe aims to explain, the structures were mostly homogeneous but slightly inhomogeneous too, Universe that we observe around us, 13.7 Gyr after the Big bang, as the outcome of the growth of the primordial density fluctuations of quark gluon plasma that are observed as the temperature variations in the CMB. The formations of galaxies were possibly the most prominent visual aspect of the formation of cosmic structures that were shaped by the interplay next between the pull of the gravity and the expansion of space under influence of Dark energy. Baryonic gas condensed in the gravitational wells that had already been established by the gravitational contraction of dark matter density perturbations. This condensation was followed by the formation of stars as filamentary cold gas flowed within them ,responsible for star formation within galaxies and thus the emission of photons. All galactic structures [galaxies over passing time , clumped itself in a filamentary network] through the gravitational instability, eventually formed a cosmic net work of voids, filaments, knots and sheets, because gravity was purely then attractive force, and regions of slightly higher density in the early universe accreted matter from their surroundings and grew more over dense, with time. In the cosmic web hypothesis, spherical structures appeared probably first within filaments, growing in between them, followed by the great walls [planar structures] connecting the filaments of cosmic Web. These filaments were spreded millions of light years long and did constitute the skeleton of the early Universe: Galaxies gathered around them, and immense galaxy clusters were formed at their intersections, lurking like giant spiders waiting for more matter to accreted. Scientists and physicists are today struggling to determine how they swirl into existence. Although massive filamentary structures have been often observed at relatively small distances from us. The filament is located about 6.7 billion light-years away from us and extends over at least 60 million light-years even. As our early universe evolved, the cosmic web gradually sharpened more & more, under dense regions known as voids, empty material known as filaments and these materials subsequently flowed into over dense knots.[In the cosmic web, under dense, almost empty regions of the universe, the voids, are delimited by great wall-like sheets and very elongated filaments of matter, which sporadically intersected each other, gave rise to very high-density regions, the clusters. Galaxies, including the most massive ones, are found in large concentrations at such 'nodes' of the web, the clusters; less massive galaxies are prominent in filaments; only very few galaxies inhabit the voids. Large scale structures in the distribution of galaxies were thought to have evolved through gravitational instabilities from small density fluctuations in the (largely homogeneous) early Universe. These structure of galaxies consisted of rich and poor clusters, were connected by filaments and sheets, with regions largely devoid of galaxies (voids) in between. Numerical simulations of the growth of initial density fluctuations through a nonlinear regime, motivated by the likely physics of the early Universe, also show a network of filaments and voids, but the origin of this picture of filaments as the dominant structure was not well understood. J. Richard Bond, Lev Kofman & Dmitry Pogosyan[1] showed in 1996 that the 'web' of filaments that defined the final state in these simulations was present also in the initial density fluctuations; the pattern of the web was defined largely by the rare density peaks in the initial fluctuations, with the subsequent nonlinear evolution of the structure bringing the filamentary network into sharper relief. Applying these results to the observed galaxy distribution, they suggested that 'superclusters' were filamentary cluster–cluster bridges, and we predict that the most pronounced filaments will be found between clusters of galaxies that are aligned with each other and close together.

Global Journal of Science Frontier Research (A) Volume XVII Issue I Version I Year 2017

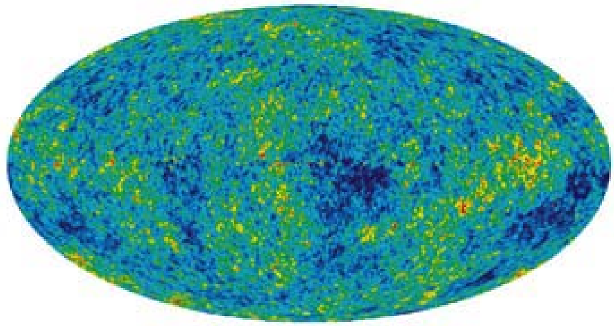


Figure 2

[All sky high resolution map of the microwave light emitted only380'000 years after the big bang and detected by the WMAP satellite. Colors correspond to temperature variations with amplitude of 10−5 around the2.7K black body spectrum. (Image courtesy of the NASA / WMAP Science Team]

a) *Between inflation and the release of the cosmic microwave background (t <1 sec to t =380,000 years)*

After the end of inflation, the universe so consisted of more or less uniform bath of fundamental particles, like zero rest mass particles(as it was told by Rupak Bhattacharya), Higgs particles(many kinds of Higgs particles are there), quarks, electrons and their all their anti-particles. There were also neutrinos, photons, dark energies, gravitons and dark matter particles- an unknown type of massive particle that did not interacted with photons and is therefore called as dark (as it does not emit light). At this time there was slightly more matter than anti-matter, but as the particles collided with their anti-particles they were annihilated, leaving the universe dominated by particles, and by some unsown mechanisms all anti-matter disappeared. Where and why all antimatters disappeared not known to us very well. Quarks then teamed up in trios, forming protons or neutrons – the constituents of atomic nuclei as we know them today. This all happened within the first second after the Big Bang epoch. About three minutes after the Big Bang, protons and neutrons had combined to form the nuclei of hydrogen and helium.

The density and temperature of particles in early universe were so extremely high, and collisions between the particles were then very frequent. Cosmologists refer to this by saying that ordinary matter (such as electrons, protons, neutrons and the few atomic nuclei that had formed by then) was tightly coupled to the photons. Because of these frequent interactions, photons could not travel freely: the universe was then opaque. Besides, ordinary matter is subject to gravity(by a particle called Gravitons) and ideally any denser region – such as the seed fluctuations that were present at the end of inflation – would draw more matter from their surroundings, growing denser and more massive. However, ordinary matter at this epoch was coupled to photons, and radiation pressure of photons pushed away any concentration of matter that may be created under the effect of gravity. This phenomenon prevented any fluctuations in the distribution of ordinary matter to grow denser as long as matter is coupled to the photons. At the same time, dark matter particles were not bound to the photons, since the two species do not interact with one another. This type of dark matter particle is also referred to as cold dark matter (CDM) because the velocity of these particles is much lower than the speed of light. Hence, fluctuations in the distribution of cold dark matter can grew denser and more massive even before the release of the cosmic microwave background. Astronomers also refer to hot dark matter (HDM), or they are neutrinos – particles with a very small mass and no electric charge that travel almost nearly at the speed of light. In the first second of the universe, neutrinos were coupled to photons, but these two types of particles decoupled immediately after. Since they do not interact with light during most of the universe's history, neutrinos considered as a type of dark matter, and since their velocity is close to the speed of light, they are regarded also as hot dark matter. Fluctuations in the distribution of hot dark matter grew denser and more massive, but due to their high velocity, these particles tend to dissipate and their fluctuations are damped on small scales so, effectively, only fluctuations on intermediate and large scales can grow. The growth of primordial fluctuations in hot and cold dark matter give rise to two completely different distributions of cosmic structure. In hot dark matter models, the first structures to form are the most massive, that subsequently fragmented into smaller and smaller structures. This has been discarded on the basis of observations of galaxies in the early universe: since the first objects that are seen to emerge in cosmic history had low mass, and they gradually evolved into more massive structures, cosmologists have established that the bulk of dark matter in the universe was enough cold. However, a small fraction of hot dark matter is present in the universe as neutrinos. Depending on the mass of neutrinos (which has not been determined yet but has mass) the effect of hot dark matter could be more or less evident in distribution of cosmic structure on different scales, since neutrinos tend to smooth out the formation of small-scale structures.

b) *Between the release of the cosmic microwave background and the formation of the first stars and galaxies (t = 380,000 years to t = a few hundred million years)*

About 380,000 years after the Big Bang epoch, the universe had expanded enough so that its density was much lower than at earlier epochs. Likewise, the temperature of the universe had also cooled down from the billions of Kelvin of the first few minutes and had reached about 3000 Kelvin. Protons and electrons could finally combine to form atoms of neutral hydrogen. Electrons disappeared from the view of photons and these two species decoupled from one another. This marked the beginning of the period known as the Dark Ages – a name arising from the fact that there were no individual sources of light, like stars, only clouds of neutral hydrogen was there.

The decoupling had two effects: photons became free to propagate across the universe, which was then largely transparent, and which we now can observe as the cosmic microwave background (CMB); on the other hand, ordinary matter particles were free to assemble under the effect of gravity. From this moment on, ordinary and dark matter could both react to gravity: denser concentrations of matter (both ordinary and dark) grew denser and more massive. Since dark matter particles was already created a network of dense and empty structures (voids), ordinary matter particles could feel the gravitational attraction from the densest concentrations of dark matter and fall toward them. But ordinary matter could also get rid of energy quite effectively by heating up and emitting radiation, which caused it to sink even further into the already existing regions of high matter density. These processes gave rise to a highly sub-structured network of sheets and filaments of ordinary and dark matter known as the cosmic web, which constitutes the skeleton supporting the later emergence of stars and galaxies. Eventually the densest concentrations gave rise to the first stars, leading to the end of the Dark Ages. The Light appeared from the first stars

c) *After the formation of the first stars and galaxies (t = a few hundred million years to t = now)*

A few hundred million years after the Big Bang, distribution of matter in the universe produced very dense knots at the intersections of the sheets and filaments that made up the cosmic webs. In these knots, the density of ordinary matter was so high that the formation of stars and galaxies became possible. Eventually the first stars and galaxies sparked into existence and light could escape from them, revealing the distant universe to telescopes today. The first stars were formed almost exclusively out of hydrogen and helium and are believed to have been extremely massive (about 100 times the mass of the Sun or more) and to have lived very short lives, exploding soon after their formation as supernovae and releasing their material in the surroundings, triggering the birth of new stellar generations. Later generations included other elements formed in the nuclear furnace of previous stars, and their masses were typically smaller. The first generation of stars formed in relatively low-mass galaxies. Massive galaxies, and even more massive structures such as galaxy clusters, formed later.

d) *How did the formation of structure affect the cosmic microwave background?*

The birth of first stars and galaxies had an interesting effect on the cosmic microwave background (CMB) photons. Ultraviolet radiation released by these objects ionised hydrogen atoms, turning them back into protons and electrons. This created a series of expanding bubbles of ionised gas – a bit like the holes in Swiss cheese – and within a few hundred million years these bubbles had merged and the entire Universe was ionised again, a period of time termed re-ionisation according to late Prof Meghnad Saha.

The CMB photons were affected by the re-ionisation; they were scattered off the free electrons in the re-ionised universe, washing out some of the primordial fluctuations in the CMB as we observe it today. Since this happened when the universe was already matured and had reached a substantial size, the effect of re-ionisation can be detected in the fluctuations of the CMB on large scales. This effect is expressed in terms of the 'opacity', which describes the average density of free electrons that are present along the line of sight between an observer (in this case, the telescope on board Planck) and the CMB. This parameter also provides a tool to estimate when the first stars formed.

e) *How is the history of cosmic structure encoded in the cosmic microwave background and power spectrum?*

The variations in the density of matter at the time when the cosmic microwave background (CMB) formed derive from the seed fluctuations that were produced at the end of inflation and can be deciphered by looking at the power spectrum for cosmic structure in the universe at a range of scales. At scales smaller than about one degree – or twice the size of the full Moon on the sky – the graph shows the imprint and oscillation pattern of sound waves that were present in the fluid of ordinary matter and radiation in the very early universe, before the CMB was released. The sound is like Hissss and ever fantastic rythmical musical one of finest tunes. At this epoch, ordinary matter was tightly coupled to the photons, and the radiation pressure of photons pushed away any concentration of matter that might have been created under the effect of gravity. The interplay between gravity, which pulled together the fluid of matter and radiation, and the radiation pressure, which pushed it away, caused a series of rhythmical compressions and rarefactions everywhere in the fluid. This results in the pattern of fantastic sound waves that

Global Journal of Science Frontier Research (A) Volume XVII Issue I Version I Year 2017

is visible in the central part of the power spectrum graph. Since gravity is caused by both dark and ordinary matter particles, but the radiation pressure of photons is only experienced by ordinary matter (because dark matter particles are not coupled to photons), the shape of these oscillations contains information about the amount of ordinary matter relative to the amount of dark matter. As dark matter was not bound to the photons, any concentration of dark matter could grow denser and denser even before the release of the CMB. The relative contribution of ordinary matter particles (also referred to as baryons) to the overall cosmic budget is expressed in terms of the 'Omega_b' parameter, where b stands for baryons, and the relative contribution of cold dark matter particles is expressed in terms of the 'Omega_c' parameter, where c stands for cold. The 'cold' in cold dark matter refers to the low speed of these particles ('warm' dark matter particles move at higher speed and 'hot' dark matter particles move at the speed of light).

While gravity pulls matter together to form structures, the expansion of the universe may counteract this effect and hamper the formation of cosmic structure. For this reason, the amount of fluctuations in the universe depended also on the speed of cosmic expansion, and that quantity can be extracted from the shape of the oscillations in the power spectrum of the CMB. The speed of the universe expansion is expressed in terms of the Hubble constant, H_0, which quantifies the expansion of the Universe at present time.

f) *What does the cosmic microwave background tell us about the overall 'shape' of the Universe?*

The CMB holds clues to the nature and distribution of structure in the universe, and the average density of this matter played a key role in determining the geometry of the universe. The geometry of the universe could take on one of three shapes: it can be curved like the surface of a ball and finite in extent (positively curved); ii) curved like a saddle and infinite in extent (negatively curved), or iii) it can be flat and infinite. The geometry and density of the universe are related in such a way that, if the average density of matter in universe is found to be less than the so-called critical density (roughly equal to 6 hydrogen atoms per cubic metre) the universe will be open and infinite. If the density is greater than the critical density the universe will be closed and finite. If the density just equals the critical density, the universe is flat.

Cosmologists studied the relative sizes of the oscillations of the fluid of matter and radiation at the time the CMB was released to learn more about the shape of the universe. The oscillations translated into regions of higher and lower temperature on the CMB map, and contain information about the amount of particles present. More specifically, the shape of the universe can be determined by looking at where the first of these oscillations appears in the power spectrum. The location of the first oscillation corresponded to a specific size in the early universe called the sound horizon – the maximum distance that a sound wave could have crossed from the Big Bang until the time of the CMB release. To cosmologists, the sound horizon works like a standard measure of known length. By measuring its length in the temperature fluctuations of the CMB, it is possible to determine if the universe is flat or curved. This is expressed in terms of the parameter 'Omega_K' and is equal to zero for exactly flat space

II. The Formation of Structures in the Universe

One of the main goal of todays cosmology is understanding of formation of the structures that we observe in the universe nowadays as various types of galaxies, super clusters, all stars and planets ,satellites asteroids . The Jeans theory of *gravitational instability*, is able to explain mechanism of formation of stars from a quasi homogeneous gas/or fluid, can also be used in the framework of the expanding universe in order to describe, at first order, the formation of galaxies. The standard model predicts the existence of small fluctuations in density field, originated in first instants after the Big Bang by quantum oscillations of the scalar field driving the expansion in the inflationary epoch. The CMB observations measured the amplitude of fluctuations of the primordial universe and it is possible to show how their gravitational amplification could explain formation of large scale structures of universe. As and according to the standard model the scenario of formation predicted that galaxies which were first objects to form, while the structures on larger scale (e.g. clusters and super clusters) were generated via merging of smaller objects: therefore, this picture is called hierarchical clustering. We authors of this article let now describe the basis of the Jeans theory that is able to explain the growth of small density fluctuations: the basic concept is that the perturbations of a uniform fluid are able to grow if self-gravity is able to dominate the stabilizing effect of pressure. The basic laws that describe the dynamics of a self-gravitating fluid are the continuity, the Euler and the Poisson equations

$$\partial\rho/\,\partial t + \nabla^{\rightarrow}\cdot\,(\rho u^{\rightarrow}) = 0$$

$$\partial u^{\rightarrow}/\,\partial t + (u^{\rightarrow}\cdot\nabla^{\rightarrow}){\sim}u = -1/\rho\nabla^{\rightarrow}p - \nabla^{\rightarrow}\Phi$$

$$\nabla 2\Phi = 4\pi G\rho$$

where ρ, $u^{\rightarrow}$ and p are the density, the velocity and the pressure of the fluid element and Φ is the gravitational potential. In this analysis we neglected the effects of thermal conduction and viscosity. This means that we are assuming the conservation of entropy per unit of mass S, described by the following equation

$$\partial S^{\rightarrow}/\partial t + u^{\rightarrow} \cdot \nabla^{\rightarrow} S = 0$$

The system composed by the last 4 equations admits a static solution of the kind $\rho = \rho 0$, $u^{\rightarrow} = 0$, $S = S0$, $p = p0$, $\nabla^{\rightarrow}\Phi = 0$. However this is not compatible with the cosmological principle, because from the Poisson equation a uniform density implies that Φ varies spatially. In other words this means that a fluid with homogeneous density distribution cannot be stationary and must be globally expanding or contracting. For what concerns cosmology, we must consider the solution corresponding to the expansion (or contraction) of a homogeneous and isotropic distribution of matter:

$$\rho(t) = [\alpha 0/\alpha(t)]^{3} \rho(t0)$$

$$u^{\rightarrow} = \alpha^{\cdot}(t)/\alpha(t) r^{\rightarrow}$$

$$\Phi = 2\pi G/3 \rho r^{2}$$

$$p = p(\rho, S)$$

$$S = const$$

This solution also has the problem that both u and Φ diverge for $r \rightarrow \infty$ that can be solved adopting the more accurate relativistic solution, If now we introduce small perturbations δ, $v^{\rightarrow}$, φ, dp and dS to all the physical variables, so that

$$\rho = \rho 0 + \delta\rho 0 = \rho 0(1+\delta)$$

$$u^{\rightarrow} = u^{\rightarrow}_{0} +, v^{\rightarrow}, \Phi = \Phi 0 + \varphi, p = p0 + dp, S = S0 + dS$$

where the index '0' represents the zeroth-order solutions, and put these new values into the system, neglecting the second-order terms, we obtain the new system of equations:

$$\delta. + 3a/ax\delta + {}^{\cdot}a/a(r^{\rightarrow} \cdot \nabla^{\rightarrow})\delta + (\nabla^{\rightarrow} v^{\rightarrow}) = 0$$

$${}^{\cdot}v^{\rightarrow} + {}^{\cdot}a/a\, v^{\rightarrow} + {}^{\cdot}a/a(r^{\rightarrow} \cdot \nabla^{\rightarrow})v^{\rightarrow} = -1/\rho\, \nabla dp - \nabla\varphi$$

$$\nabla 2\varphi - 4\pi G\rho 0\delta = 0$$

$$.dS + {}^{\cdot}a/a\,(r^{\rightarrow} \cdot \nabla^{\rightarrow})dS = 0$$

perturbations in the form of small plane-wave departures by the unperturbed one:

$$du_{i} = u_{i}(t)e^{i\rightarrow k\rightarrow \cdot r\rightarrow},$$

where the variables ui (i=1, 2, 3, 4, 5) correspond to the small perturbations in the different variables and the wave vector $k^{\rightarrow}$ corresponds to a wavelength λ that varies with time following the Hubble expansion:

$$k = 2\pi/\lambda = 2\pi/\lambda 0 \times a_{0}/a = k_{0} x a_{0}/a.$$

These primordial perturbations are considered that constituted the "seeds" for the formation of the structures in the early universe But The Jeans theory is valid only for $|\delta| \ll 1$, while the structures observed nowadays correspond to over densities $|\delta| \gg 1$, for example a cluster of galaxies correspond to a value of δ of several hundred.

III. Current Results on Cosmology The CDM Model

Current observational data suggest as a favourite scenario the so-called *"concordance" Cold Dark Matter* (ΛCDM) model. In this picture the Universe remains flat with the energy density at the present epoch dominated by a cosmological constant and the remaining fraction mainly due to non-baryonic, non-collisional dark matter (DM) with low primordial velocity dispersion. The fraction of density due to standard baryonic matter $\boldsymbol{\Omega}_{b}$ is only of few percent. After the radiation epoch ($z \sim > 104$), the DM component starts to dominates driving the growth of the density fluctuations up to the epoch of recombination when they become observable as gas temperature fluctuations imprinted in the CMB anisotropies. Since the CDM particles have a low velocity dispersion, the typical perturbations that survive to the effect of free-streaming correspond to masses of the order of $M \approx MJ(z_{rec}) \approx 10^{5} M\Theta$, thus to the typical scales of proto galaxies.

Therefore, in this scenario galaxies form first while clusters are created via merging of smaller objects: this picture is called *hierarchical clustering* of structure formation. The dark energy component starts to dominate the expansion at $z \leq 0.5$ and, it has the effect of accelerating the expansion of the Universe. The main problem with the existence of this energy component, its physical origin is still unknown: the most natural explanation is the vacuum energy but the energydensity $\varrho\Lambda$ currently estimated is of the order of

a) Cosmic web even in dwarf and local group galaxies

The near by filaments of the cosmic web connected also our local group of galaxies to large scale cosmic web and computer simulation model reveal that these filaments should channel a steady rain of pristine dwarf galaxies which are too composed of dark matter into the local environment. Because filaments fall into them, also in firm large distances and accrete over a large fraction of the age of universe. These dwarf galaxies that are in process of arriving today can be expected to exhibit very large speed gas is also conveyed into galaxies along the filaments but because of presence of gravitational forces this is rapidly slowed down, first shock heating and then condensing into clouds that fall into the center of gravitational well and contribute to build up gaseous disk component of galaxies. Cloud of active hydrogen known as high velocity cloud surround so our milky way and andromeda galaxies. Hence both large galaxies within local group appear to be continuously accreting gas fed to them from the cosmic web. The question still to be solved as per authors, is how the large-scale cosmic environment of a CDM universe affected the internal properties of dark matter haloes and of the baryonic galaxies, they hosted during their formation and the subsequent billion years of cosmic evolution in 2003, NASA's Wilkinson Microwave Anisotropy Probe (WMAP) spacecraft mapped the afterglow of the big bang, the cosmic microwave background (CMB), to produce, in essence, the universe's baby picture. The universe supposedly sprang into existence infinitely dense and hot and immediately doubled its size 100 times over. After about 10–32 seconds of such "inflation," the expansion slowed, and 400,000 years later, the universe cooled enough to allow free-flying protons and electrons to form hydrogen atoms. That transformation freed light trapped by the particles, which has since stretched into microwaves and cooled to 2.725 kelvin. The CMB is not exactly uniform. Inflation magnified infinitesimal quantum fluctuations in the newborn universe, which eventually seeded the filaments in the cosmic web. The fluctuations also caused the temperature of the CMB to vary across the sky by about 0.001%.

The COBE (Cosmic Background Explorer Study) could detect small anisotropy, subsequently mapped in sharp detailed by WMAP (Wilkinson Microwave Anisotropy Probe) imprinted on the cosmic Microwave Back Ground (CMB) when universe was 3, 80,000 years old. COBE study fueled the model of growth structure universe and mini scale fluctuations in very early universe. The fact, very little is known about the energy and Mass of the Universe, within the frame work of Standard cosmological model. 95% of the universe (Ω the mass density of the universe divided by the Critical density for closed universe) is corporated primarily of Dark energy (72%) and Dark Matter(23%) and only 5% is the detectable matter. As baryons [most of which is hydrogen and helium], - the protons, atomic nuclei that constitute of ordinary matter, galaxies, Stars, planets, Planetismals, all comets, all planets, all living and dead trees, all animals and ourselves and all the materials we see, The remaining 95% matter is mysterious in nature. The dark energy is assumed to be uniform, but the normal and dark matter are not. The balance between dark matter and dark energy determines both how the universe expands and how regions of unusually high or low matter density evolved with time. We can, should detect and measure it in physical state. From studies of Quasars we know that clouds of baryons were present in the early universe about 4 billion years ago(red shift $Z > 2$) in the form of Photo Ionized diffuse high speed intergalactic gas as told just in previous paragraph and that accounted 3/4th of total baryonic mass in the universe. When nucleon synthesis happened with observed light elements at $Z>2$, $\Omega b>3.5\%$, 75% estimated baryons mass were involved. These clouds of Photo ionized intergalactic gas became more and more sparse as time moved towards present and structures like galaxies, galaxy groups, galaxy clusters started to be assembled, only a small fraction of the baryons that were present in Intergalactic medium(ISM) at red shift $Z>2$ are found in stars, cold or warm ISM hot inter cluster gas and residual photo ionized inter galactic medium and it is estimated that 50% of baryon mass is still missing. Most of the baryons in the local universe are also missing in that they are not in galaxies or in the previously detected gaseous phases. Rupak Bhattacharya and Pranab Bhattacharya suggested that these missing baryons are so predicted may be in a moderately hot phase, 1E5 to 1E7 K, largely in the form of giant cosmic filaments that connect the denser virialized clusters and groups of galaxies. These filaments can be detected through absorption lines they produce in the spectra of background AGNs. Models show that the highest covering fraction of such filaments occurs in super clusters and the archive has two AGNs projected behind superclusters, both of which show absorption systems (in LyalphaLybetaOVI) at the super cluster red shift.

b) Question to be solved yet

The question still to be solved as per authors are what are the properties of dark matter and dark energy? Precisely how is the web organized? Exactly how do galaxies form in it? The web spans size scales from individual galaxies to the breadth of the observable universe. In its evolution, it traces the complexity we see today back through time to the big bang how the large-scale cosmic environment of a CDM universe affected the internal properties of dark matter haloes and of the baryonic galaxies, they hosted during their formation and the subsequent billion years of cosmic evolution?.

Unlike the ''baryonic' matter (neglecting the real fact that there are also leptons that, however, contributed very negligible mass of universe), dark matter does not interact appreciably in any other way than through gravity —the weakest but only real long-range force among the four fundamental forces that govern the laws of universe. The best candidates for dark matter is probably till date so far is Cold Dark Matter(CDM), a kind of dark matter that has non-relativistic energies already at very early times and thus led to a bottom-up theory of galaxy structures formation in the early universe in COBE. Dark energy is on the other hand required to explain the observed accelerated expansion of space time (or in other way, equivalently, the weakening of gravity on very large scales and responsible for the expansion of the universe). Baryonic matter thus appeared to be a subdominant component that, while making up all the visible objects in the Universe, is not the most important ingredient in the attempt to understand the structure of the Universe.

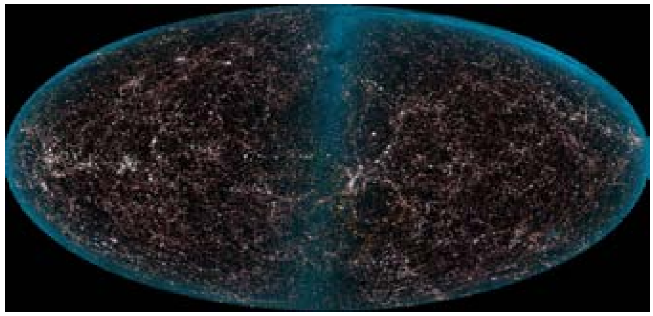


Figure 3

[The highly inhomogeneous universe in 13.7 Gyr, all sky distribution of infrared sources (mostly galaxies) from the Two Micron All Sky Survey (2MASS) in the nearby Universe. The filamentary nature of the cosmic web is clearly visible. (Atlas Image courtesy of 2MASS/UMass/IPAC-Caltech/NASA/NSF).]

c) N body Simulations study of Cosmic Web

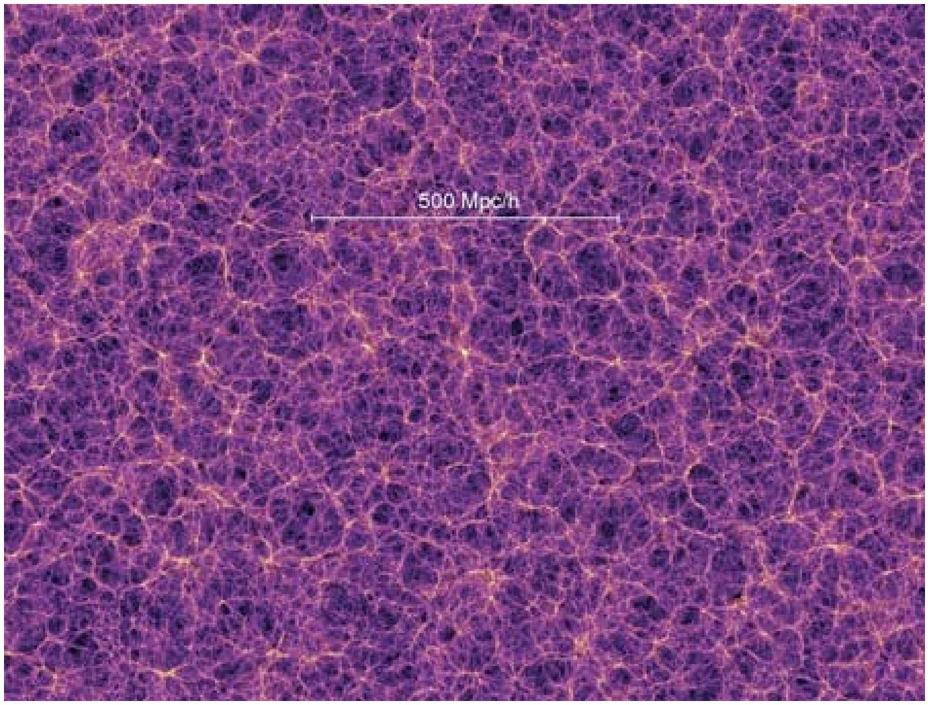
This cosmic web is the large-scale environment, in which galaxies formed and evolved and its existence had been established in large red shift surveys($z > 2$)of many hundred thousand galaxies over the last decades. Since dark matter interacts only gravitationally, it is thus relatively easy to model and computationally affordable. For many years, the numerical study of cosmic structures formation had therefore been focused on the realm of N-body simulations [Simulations that use a particle discretisation of the phase-space are known as N-body simulations. In these simulations, the phase-space density $f(x, p, t)$ is discretized with massive particles and evolved according to the collision less limit of the Boltzmann equation, Thus, in the N-body method, the initial phase space is sampled with particles representing a small sub volume of the full 6-dimensional phase space. Each one of these particles is then evolved in a self-consistent way, fulfilling Liouville's theorem (cf. e.g. Hockney & Eastwood, 1981). The numerical evolution thus requires two steps: (1) a gravity solver, to compute the particle accelerations, and (2) a time integrator, to update particle positions and momentum.]i.e. the Vlasov equation, under self-gravity]: which have had a huge success in showing that the spatial distribution of gravitationally collapsed structures — the dark matter haloes — is highly compatible with the observed distribution of galaxies. Dark matter haloes are connected to each other by large-scale filamentary structures. Cold gas flowing within this 'cosmic web' is believed to be an important source of fuel for galaxy and star formation at high red shift. These simulations are still giving important insights into the detailed aspects of spatial clustering, mass distribution and even internal properties of galaxies through additional semi-analytic models that attempt to relate the properties of galaxies to those of the dark matter haloes in which they are embedded. The physics of baryonic matter is in contrast very complex and computationally expensive. However, it is baryonic galaxies that we see and use to constrain our cosmological theories to reproduce the one Universe in which we live. Including baryonic matter in our simulations of the universe is a challenging necessity to bring our understanding of structure formation to the next level. Only rather recently, the huge growth in available computer power has opened the spectacular possibility to study the condensation of the baryonic gas component into galaxies in cosmological simulations. Gas is able to radioactively cool and thus settles in the centers of the dark matter haloes. 'Sub-grid' models capture the collapse of gas clumps below the resolution limit, making it possible to simulate the formation of stars. The simulated disk galaxies thus consist of a dark matter halo filled with hot gas, a cold gaseous disk and a stellar disk. The quest has indeed started to use such hydrodynamic cosmological simulations to further our detailed understanding of the formation and evolution of galaxies and structure in the universe.

From the point of view of cosmology, the vacuum or voids appears to have an energy density, which may be called "dark energy" or the "cosmological constant" From a particle physics viewpoint, the vacuum is also permeated by a "Higgs Field" - named after physicist Peter Higgs,

Since 2010 , many important studies across the world, showed that the main constituents of the universe, across 90 percent of its history, from the formation and evolution of structures such as galaxies, clusters of galaxies, and the "cosmic web" of intergalactic matter, to the stars, gas, dust, super massive black holes, and dark matter of which they are composed. These elements are coupled in a complicated evolutionary progression as matter accreted into galaxies, stars form and evolve, black holes grew, supernovae and active galactic nuclei expelled matter and energy into the intergalactic medium (IGM), and galaxies collide and merge. There remained four questions to be solved yet ,form the focus for research in the coming decade. The questions are: (1) How do cosmic structures form and evolve? (2) How do baryons cycle in and out of galaxies, and what do they do while they are there? (3) How do black holes grow, radiate, and influence their surroundings? (4)

Global Journal of Science Frontier Research (A) Volume XVII Issue I Version I Year 2017

What were the first objects to light up the universe and when did they do it?



[Caption -: Simulations based on the standard cosmological model, as shown here, indicate that on very large distance scales, galaxies should be uniformly distributed. But observations show a clumpier distribution than expected,(The length bar represents about 2.3 billion light years)

Figure 4

[Caption -: Simulations based on the standard cosmological model, as shown here, indicate that on very large distance scales, galaxies should be uniformly distributed. But observations show a clumpier distribution than expected. (The length bar represents about 2.3 billion light years.]

In the modern hierarchical theories of galaxies structure formation, It is considered that rich clusters of galaxies formed at the vertices of a web like distribution of matter, with filaments emanating from them to large distances and with smaller objects forming and draining in along these filaments. The amount of mass contained in structures near the clusters can be comparable to the collapsed mass of the cluster itself. As the lensing kernel is quite broad along the line of sight around cluster lenses with typical red shifts z_l=0.5, structures many mega parsecs away from the cluster are essentially at the same location as the cluster itself, when considering their effect on the cluster's weak lensing signal. When large-scale numerical simulations of structure formation in a Λ-dominated cold dark matter model was used to quantify the effect that large-scale structure near clusters has upon the cluster masses deduced from weak lensing analysis. A correction for the scatter in possible observed lensing masses should be included when interpreting mass functions from weak lensing surveys.

It was in fact Jerome Drexler, an applied armature physicist who hypothesized and discovered the relativistic-baryon dark matter in early part of 2002 and the dark matters was considered to be engaged in galaxy formation. But Drexler's hypothesis of relativistic dark baryons, would imply that the Dark matter cannot clump on galaxy scales since they are relativistic. The alternate hypothesis might be that Relativistic-baryons entered the universe at the time of the Big bang as a radial outward dispersion of very high energy relativistic charged particles, having low entropy. Because of their very low entropy, the big bang could satisfy the Second Law of Thermodynamics. The initial very high energies of the big-bang relativistic baryons would correspond to the estimated initial temperatures in the current big bang theories. Actually, relativistic-baryon dark matter forms into long large filaments that can create galaxy clusters, galaxies, and stars, but only after those dark matter filaments collide with other similar long large dark matter filaments (http://www.nature.com/nature/journal/v435/n7042/fig_tab/435572a_F1.html what drexler recenly told[2]] New Releases from website from NASA/Harvard, entitled "Motions in nearby galaxy cluster reveal presence of hidden superstructure," regarding Chandra x-ray images of the Fornax cluster makes the significant statement: "Astronomers think that most of the matter in the universe is concentrated in long large filaments of dark matter [now called the "cosmic web"] and galaxy clusters are formed where these filaments intersect[/collide]." [2]

http://www.nasa.gov/centers/marshall/news/news/relea ses/2004/04-231.html) according to the 2004 NASA/Harvard/Columbia University team, relativistic-baryon dark matter does not form galaxy clusters or galaxies until after the dark matter filaments intersect/collide. These collisions slow the relativistic protons and helium nuclei and also create pions and muons, which decay into electrons. The created electrons then transform the slowed protons and helium nuclei into hydrogen and helium atoms, the basic ingredients of galaxies and stars. Thus, these remnants of the dark-matter-filament collisions are ideal for forming galaxies, galaxy clusters, and stars.

d) Warm matter in formation of galaxies and cosmic Web?

The most accepted model of cosmology structure formation is so till date CDM model including the dark energy, or from that particle universe evolved as baryons in diffuse intergalactic medium accelerated towards the site of formation of such structures under influence of gravity and shocks and that heats trillions of Kelvin temperature. The question then remains What is that Dark energy? If from dark matter, What is dark matter? It is distinct from Dark energy? How that matter organized and how is cosmic web organized? How galaxies formed in it? Are the dark energy the zero rest mass particles in Higgs fields and photon that was emitted later with formation of stars is condensation of zero mass (mass less particles), Rupak Bhattacharya and Professor Pranab kumar Bhattacharya suggested? Are they missing baryons? Is it possible that the missing baryons may be concentrated into those filamentary cosmic web structures and they are hot intergalactic medium(WHIM)?The distribution of baryons beyond galaxies thus may be described. The majority of the baryons, which represent 4% of the cosmic mass and energy budget, lie far from individual galaxies in the diffuse intergalactic medium (IGM). Many of these baryons may be in a warm phase that can be probed by quasar absorption in the Lyman-α line of hydrogen. The mature field of quasar spectroscopy can diagnose the location, physical state, metallicity, and general geometry of this gas, which is called the "cosmic web." The remainder of the gas is kept very hot by in fall and shocks and is mostly in higher density regions such as filaments, groups and clusters. The hot gas is only detectable via X-rays and the absorption of highly ionized species of heavy elements. The baryons in low density regions of space are excellent tracers of underlying dark matter. The evolution of the cosmic web indicates where to look for the baryons in collapsed objects but the overall inefficiency of galaxy formation has conspired to keep most baryons dark.

Scientists think dark energy is a form of repulsive gravity that now dominates the universe, although they have no clear picture of what it actually is. Understanding the nature of dark energy is one of the biggest problems in science. Possibilities include the cosmological constant, which is equivalent to the energy of empty space. Other possibilities include a modification in general relativity on the largest scales, or a more general physical field. Vikhlinin and his colleagues used Chandra to observe the hot gas in dozens of galaxy clusters, which are the largest collapsed objects in the universe. Some of these clusters are relatively close and others are more than halfway across the universe. increase in mass of the galaxy clusters over time aligns with a universe dominated by dark energy The study strengthens the evidence that dark energy is the cosmological constant. Although it is the leading candidate to explain dark energy, theoretical work suggests it should be about 10 raised to the power of 120 times larger than observed. Therefore, alternatives to general relativity, such as theories involving hidden dimensions, are being explored. These results have consequences for predicting the ultimate fate of the universe. If dark energy is explained by the cosmological constant, the expansion of the universe will continue to accelerate, and the Milky Way and its neighbor galaxy, Andromeda, never will merge with the Virgo cluster. In that case, about a hundred billion years from now, all other galaxies ultimately would disappear from the Milky Way's view and, eventually, the local super clusters of galaxies also would disintegrate.

References Références Referencias

1. J. Richard Bond*, Lev Kofman† & Dmitry Pogosyan How filaments of galaxies are woven into the cosmic web *Nature* 380, 603 - 606 (18 April 1996); doi:10.1038/380603a0; 1996.
2. Jerome Drexler "Relativistic-Baryon Dark Matter Utilizes Cosmic Web Collisions to Create Hydrogen and Helium Atoms Discovering Dark matter Cosmology" in website Jerome Drexler Discovering Dark matter cosmology (http://www.nature.com/nature/journal/v435/n7042/fig_tab/435572a_F1.html

Global Journals Inc. (US) Guidelines Handbook 2017

www.GlobalJournals.org

Fellows

FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN SCIENCE (FARSS)

Global Journals Incorporate (USA) is accredited by Open Association of Research Society (OARS), U.S.A and in turn, awards "FARSS" title to individuals. The 'FARSS' title is accorded to a selected professional after the approval of the Editor-in-Chief/Editorial Board Members/Dean.

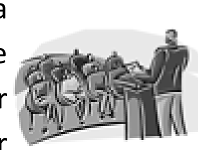
- The "FARSS" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSS or William Walldroff, M.S., FARSS.

FARSS accrediting is an honor. It authenticates your research activities. After recognition as FARSB, you can add 'FARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

The following benefits can be availed by you only for next three years from the date of certification:

FARSS designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

Once FARSB title is accorded, the Fellow is authorized to organize a symposium/seminar/conference on behalf of Global Journal Incorporation (USA). The Fellow can also participate in conference/seminar/symposium organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent.

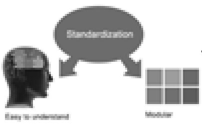


You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The FARSS can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.

As FARSS, you will be given a renowned, secure and free professional email address with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.



The FARSS will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.

The FARSS member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A. Once you are designated as FARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

The FARSS members can avail the benefits of free research podcasting in Global Research Radio with their research documents. After publishing the work, (including published elsewhere worldwide with proper authorization) you can upload your research paper with your recorded voice or you can utilize chargeable services of our professional RJs to record your paper in their voice on request.

The FARSS member also entitled to get the benefits of free research podcasting of their research documents through video clips. We can also streamline your conference videos and display your slides/ online slides and online research video clips at reasonable charges, on request.

The FARSS is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSS can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSS member can decide its price and we can help in making the right decision.

The FARSS member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN SCIENCE (MARSS)

The ' MARSS ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

The “MARSS” is a dignified ornament which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., MARSS or William Walldroff, M.S., MARSS.

MARSS accrediting is an honor. It authenticates your research activities. After becoming MARSS, you can add 'MARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

The following benefitscan be availed by you only for next three years from the date of certification.

MARSS designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

As MARSS, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSS member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

Auxiliary Memberships

Institutional Fellow of Global Journals Incorporation (USA)-OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

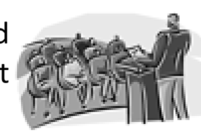
The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

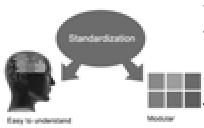


The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.



After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

"

- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone. "

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.

(II) Choose corresponding Journal.

(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not conveninet , and then email the paper directly to dean@globaljournals.org.

Offline Submission: Author can send the typed form of paper by Post. However, online submission should be preferred.

MANUSCRIPT STYLE INSTRUCTION (Must be strictly followed)

Page Size: 8.27" X 11'"

- Left Margin: 0.65
- Right Margin: 0.65
- Top Margin: 0.75
- Bottom Margin: 0.75
- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, "Abstract" word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

2. ETHICAL GUIDELINES

Authors should follow the ethical guidelines as mentioned below for publication of research paper and research activities.

Papers are accepted on strict understanding that the material in whole or in part has not been, nor is being, considered for publication elsewhere. If the paper once accepted by Global Journals Inc. (US) and Editorial Board, will become the copyright of the Global Journals Inc. (US).

Authorship: The authors and coauthors should have active contribution to conception design, analysis and interpretation of findings. They should critically review the contents and drafting of the paper. All should approve the final version of the paper before submission

The Global Journals Inc. (US) follows the definition of authorship set up by the Global Academy of Research and Development. According to the Global Academy of R&D authorship, criteria must be based on:

1) Substantial contributions to conception and acquisition of data, analysis and interpretation of the findings.

2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

Appeal of Decision: The Editorial Board's decision on publication of the paper is final and cannot be appealed elsewhere.

Permissions: It is the author's responsibility to have prior permission if all or parts of earlier published illustrations are used in this paper.

Please mention proper reference and appropriate acknowledgements wherever expected.

If all or parts of previously published illustrations are used, permission must be taken from the copyright holder concerned. It is the author's responsibility to take these in writing.

Approval for reproduction/modification of any information (including figures and tables) published elsewhere must be obtained by the authors/copyright holders before submission of the manuscript. Contributors (Authors) are responsible for any copyright fee involved.

3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Color Charges: It is the rule of the Global Journals Inc. (US) for authors to pay the full cost for the reproduction of their color artwork. Hence, please note that, if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a color work agreement form before your paper can be published.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

6.1 Proof Corrections

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

6.2 Early View of Global Journals Inc. (US) (Publication Prior to Print)

The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

6.3 Author Services

Online production tracking is available for your article through Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The authors will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript.

6.4 Author Material Archive Policy

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

6.5 Offprint and Extra Copies

A PDF offprint of the online-published article will be provided free of charge to the related author, and may be distributed according to the Publisher's terms and conditions. Additional paper offprint may be ordered by emailing us at: editor@globaljournals.org .

Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.
- Do not give permission to anyone else to "PROOFREAD" your manuscript.
- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

B

Baryonic · 4, 62, 67, 68, 69

D

Densest · 64

E

Enormous · 60, 61, 62
Eutectic · 26, 29, 31

H

Haloes · 67, 68, 69

I

Intergalactic · 1, 61, 62, 68, 69, 71

M

Mysterious · 60, 61, 62, 68

P

Pervades · 61
Planetismals · 68
Primordial · 1, 3, 4, 5

S

Sporadically · 63

T

Tilde · 3

save our planet

Global Journal of Science Frontier Research

Visit us on the Web at www.GlobalJournals.org | www.JournalofScience.org
or email us at helpdesk@globaljournals.org

ISSN 9755896