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Density of Physical Space

Gravitational Inverse Square Law

Highlights

Tachyon Plasma Field

Platonic Transfinite Set Theory

Discovering Thoughts, Inventing Future

VOLUME 20 ISSUE 11 VERSION 1.0

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The Quantum Entanglement Roots of Newton's Gravitational Inverse Square Law Via E-Infinity Platonic Transfinite Set Theory

By Mohamed S. El Naschie
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Abstract- Using the E-infinity Cantorian spacetime formalism, i.e. transfinite platonic set theory, we show that Newton's gravitational inverse square law strictly implies quantum entanglement and visa versa to the extent that they are derivable from each other. Noting that the same inverse square law is quasi generic for electrical and magnetic field the unifying role of the Cantorian spacetime of E-infinity becomes evident. The implication and generalization of the above will be explored but its ramifications within physics and beyond is not easily assessed at this early stage of what may amount to a paradigm shift prompted by the simple but very effective golden mean number system, which was suspected recently of being the rationale behind the fine tuning of the universe and the standard model of high energy elementary particle physics.

Keywords: hardy's quantum entanglement, e-infinity, cantorian spacetime, newton's inverse square law, fine tuning, golden mean number system, connes noncommutative geometry, penrose fractal tiling, platonic golden network, transfinite platonic set theory.

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The Quantum Entanglement Roots of Newton's Gravitational Inverse Square Law Via E-Infinity Platonic Transfinite Set Theory

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I. Introduction

Newton's famous inverse square law has a long history associated not only with classical mechanics and astronomy [1-2] but also with electricity and magnetism [1-6] and more recently in connection with the issue of hidden large extra dimensions and modified gravity [2-3] which we assume the reader is familiar with for the purpose of a smooth reading of the present relatively short note [1-27]. It is in this larger context of Newton's formula stating that the force of attraction between two planets with m_1 and m_2 masses is proportional to the product (m_1) times (m_2) divided by the square of the distance between the two planets R^2 [1], [6] that we conduct the present investigation and analysis [10-27].

In modern times this formula was stretched to account for even the forces between the atomic constituents of matter [12] and was the basic inspiration for N. Bohr's famous model of the hydrogen atom [4]. Never the less the author must admit that he did not notice for a long time that for natural units where G = 1 it turns out that Newton's square law may be transformed via the noncommutative E-infinity methodology to Hardy's famous quantum probability of entanglement [2-3],[9],[11],[26-27]. It is this result which will first be derived and then further examined to see if there are even more surprizing connections lurking behind this unexpected result [5-12],[27].

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II. E-Infinity Analysis of Newton's Inverse Square Law Leading to Quantum Entanglement

The reader familiar with E-infinity theory will recall that a pre-quantum particle is fully determined by the bi-dimension [13-14],[22]

$$D(O)=\left(o,\phi\right) \qquad (1)$$

where $\phi=\left(\sqrt{5}-1\right)/2$ is the golden mean, i.e. the zero set while the pre-quantum wave is fixed in an analogous way by [13-14],[22]

$$D(W)\equiv\left(-1,\phi^2\right) \qquad (2)$$

i.e. the empty set by a simple extrapolation of A. Connes' noncommutative geometry to bear on R. Penrose fractal tiling universe [2-3],[13-14]. Thus while m_1 and m_2 planets are characterized exactly via their mass m_i, the counterpart of m_1 and m_2 in Penrose universe according to equations (1) and (2) must clearly be ϕ_1 and ϕ_2 where we have

$$\phi_1=\phi_2=\phi \qquad (3)$$

This is our first analogical correspondence revealed by E-infinity theory. The second correspondence must relate the distance between the planets which is analogous to R [1], [12-14], [22]. In a Penrose fractal tiling universe there is a natural distance which is the isomorphic length [10-11], [13-14]. This isomorphic length is well known to be equal to

$$L=\left(4+\phi^3\right)/2 \qquad (4)$$

However in a five dimensional spacetime entanglement is intersectional and rather than taking the arithmetic mean of Penrose Hausdorff dimension of E-infinity Cantorian spacetime as given by equation (4) [10-15], we should use instead of that the geometrical mean corresponding to the following equation [1], [14-15]

$$R=\sqrt{4+\phi^3} \tag{5}$$

Simple computation shows then that the force of attraction of Newton translates via equations (3) and (5) to [7-15],[22-27]

$$\begin{aligned} F(\phi,R) &= \frac{\phi_1 \otimes \phi_2}{R^2} \\ &= \frac{\phi \otimes \phi}{\left(\sqrt{4+\phi^3}\right)^2} \\ &= (\phi^2)/(\phi^3) \\ &= \phi^5 \\ &= \text{Hardy's probability of quantum entanglement} \end{aligned} \tag{6}$$

By any standard to any open minded thinker this is a marvellous result that made us embrace an interpretation even for the author who likes to think of himself as open minded would have been inclined before deriving equation (6) that such uttering is heresy even for a theoretical physicist let alone a mathematical physicist. The uttering is that Hardy's quantum entanglement is the quantum counterpart analogous to Newton's inverse square law. The next section will try to say more on this and speculate on further generalization of what we considered not long ago to be heresy [7-15].

III. I "Speculate" and thus I "Am" a Theoretical Physicist

The above title of this section is meant to join in an informal way to where Descartes cogito left us [16]. Thus in a spiritual version of Descartes-like cogito, let us have a second look at quantum vacuum fluctuation in conjunction with our newly gained 'Theory of Knowledge' exemplified by our finding of the previous section [16].

We established the fact that two pre-quantum particles represented by ϕ and ϕ would produce in intersection an empty set $(\phi)\otimes(\phi)=\phi^2$ pre-quantum wave [13-15]. However the reverse process could be $\phi^2=(\phi)\otimes(\phi)$ as well as the antiparticle analogue $\phi^2=(-\phi)(-\phi)$. In addition, following our fundamental convection that we would like to elevate to an axiom dictating that anything that is mathematically consistent will find the corresponding physical reality [17-27] so that we could have the intersection $(+\phi)(-\phi)=-\phi^2$ which corresponds to a negative empty set that could evade the annihilation on the union side, namely $(+\phi)+(-\phi)=O$. On the other hand the o is the topological part of the zero set pre-quantum particle given by O,ϕ. It would therefore seem that we need to first do some pretty sophisticated real experiments based on equally sophisticated thoughts experiments before we can understand quantum vacuum fluctuation down to the very nitty gritty minute detail. Going on further in the same direction we could replace ϕ with $\sqrt{\phi}$ and apply the same picture of Newton's inverse square law to find out that [7-14]

$$\begin{aligned} F &= \frac{\left(\sqrt{\phi}\right)\left(\sqrt{\phi}\right)}{4+\phi^3} \\ &= \phi^4 \end{aligned} \tag{7}$$

which we recognize as the E-infinity topological Unruh temperature [13-15]. Similarly we could look at the following mixed F, namely [7-15]

$$\begin{aligned} F &= \frac{(\phi)(\phi^2)}{4+\phi^3} \\ &= \phi^4 \end{aligned} \tag{8}$$

which is the Barbero-Immirzi parameter [7-15]. This parameter plays a pivotal role, as is well known, in making superstring theory and loop quantum gravity compatible [7-14]. We can go on and on but we do not want to overwhelm the reader with too much unconventional interpretations and suffice today that we established the incredible analogy between gravitational attractors [1-14] and Hardy's quantum entanglement [10-15]. Needless to mention here, the additional bonus of Newton's non-local attraction is just like quantum entanglement in being non-local [1],[7],[27].

IV. A Brief Outline of E-Infinity Road from Schrödinger to Connes

To discover E-infinity Cantorian spacetime is not an intellectual effort only but a considerable portion of good fortune and luck is definitely instrumental in the processes [1-27]. It is a natural urge to try to look back with great satisfaction and attempt to pinpoint the most important road marks on the way from E = mc² to $E=mc^2/22$ where dividing the iconic equation by 22 causes a stir and even restrained mild anger in some quarters to say the least [2-4],[7-11], [13-15],[17-26]. We mention in the title of this section two names that definitely were the most immediate sources of the main

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ideas, namely E. Schrödinger and A. Connes. From Schrödinger we have his enormously important insight that quantization may be seen as an Eigenvalue problem [1]. From Connes we have the indispensible golden mean dimensional function [2-4],[7-27]. However that is only the skeleton of the theory. To give even the caricature of this theory we must add the fractal tiling universe of R. Penrose and adorn it with M. Feignbaum's golden mean renormalization groups and then after, filling in numerous gaps with numerous great, pure and applied mathematicians like K. Menger, P. Urysohn, J. von Neumann, E. Witten, L. Smolin, G. Ord, L. Nottale, D. Gross and G. 'tHooft [17-27] then we start to realize that we have found a theory which may explain all what we thought to be unreasonable fine tuning which is just another name of what some call Spinoza's God [25].

V. Conclusion

Newton's inverse square law seems to be far more fundamental to nature than we personally ever suspected although it is gained from piercing observation of the large scale structure of a classical non-quantum universe. As incredible as it may seem, gravitational attraction and quantum entanglement happens to share the same local topological origin implied by E-infinity, Penrose fractal tiling universe and A. Connes' noncommutative geometry as well as von Neumann's pointless geometry. It is quite conceivable therefore that the golden mean number system is the true universal language of nature to translate classical mechanics to quantum mechanics and visa versa. Only future intensive theoretical and very accurate experimental investigation can show if our theory and predictions are correct and precise in all its details and ramifications.

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Gold Nanoparticles as Source of Heat for Medical Treatment: A Review

By Ayushi Tyagi & SS Verma

S.L.I.E.T. Longowal

Abstract- Noble metal nanoparticles with homogeneity in size, shape, and surface properties have potential applications for bioimaging, biomedical diagnosis, and therapy. Gold nanoparticles being the most efficient among all other known noble metal nano particles. Here we illuminate that due to plasmonic resonance, a metal nanoparticle features enhanced light absorption, turning it into an ideal nano-source of heat. Hence forming basis of thermo plasmonics. The recent progress of this emerging and fast-growing field is reviewed and some of its most recent applications based on the heat generated by gold nanoparticles are discussed, namely photothermal cancer therapy, nano surgery, drug delivery, photothermal imaging, protein denaturation, photoacoustic imaging, nano-chemistry, heat-assisted magnetic recording and single living cell experiments.

Keywords: *gold nanoparticles, surface plasmon resonance, plasmonic photothermal therapy.*

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GOLDNANOPARTICLESASSOURCEOFHEATFORMEDICALTREATMENTAREVIEW

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Ayushi Tyagi [α] & SS Verma [σ]

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Keywords: gold nanoparticles, surface plasmon resonance, plasmonic photothermal therapy.

I. Introduction

New properties emerge when the size of a matter is reduced from bulk to the nanometer scale [1,2]. These new properties, including optical, magnetic, electronic, and structural properties, make nano-sized particles (generally 1–100 nm) very promising for a wide range of biomedical applications such as cellular imaging, molecular diagnosis and target therapy depending on the structure, composite and shape of the nanomaterials [3]. The enchantment of Au NPs is reflected in their intense colour, originates from the basic photophysical response that does not exist to non-metallic particles. Noble metals and gold in particular lend themselves well to the synthesis nanoscale materials, thanks to their resistance to aging (oxidation), even in a divided form. Gold nanoparticles, can be obtained in colloidal form by chemical synthesis.

a) Predominance of gold over other noble metals

The predominance of gold over other noble metals is justified by its unique combination of advantages: (i) They exhibit varying colors, ranging from red to violet as their size decreases. Other colors like green and blue can be obtained by also playing on their shape. Gold leads to resonances that can be tuned from the visible to the (near infrared region) NIR, by adjusting the size and the shape of the NPs(since this alters their photothermal and photoacoustic properties, allowing for the utilization of different wavelengths of light, such as light in the near-infrared spectrum)(near-infrared (NIR) light has much greater body transparency making it preferable for PTT.); (ii) gold offers rich and simple surface chemistry that allows functionalization of gold NPs with a variety of chemical compounds; (iii) It has been recognized for its bacteriostatic, anticorrosive, and antioxidative properties i.e., resistance to corrosion and oxidation. their resistance to aging (oxidation), oxidation of gold remains very weak and (iv) gold is not cytotoxic (safely excreted through the urinary system) [4–5]. Colloidal gold exhibits localized plasmon surface resonance (LPSR), meaning that gold nanoparticles can absorb light at specific wavelengths, resulting in photoacoustic and photothermal properties, making them potentially useful for hyperthermic cancer treatments and medical imaging applications. They exhibit varying colors, ranging from red to violet as their size decreases. Other colors like green and blue can be obtained by also playing on their shape. Absorbed light is converted to heat via the nonradiative properties.

b) Nano sources of heat

For a long time, the absorption and the subsequent NP temperature increase have been considered as side effects in plasmonics applications, which focused on the optical properties of metal NPs. Only recently have scientists realized that this enhanced light absorption, turning metal NPs into ideal nano-sources of heat remotely controllable using light, provides an unprecedented way to control thermal-induced phenomena at the nanoscale [10]. The heat generation is directly proportional to the square of the electric field inside the metal. This is an important aspect to consider when designing efficient plasmonic nano-sources of heat. This heat generation in metal nanoparticles is described, under both continuous and pulsed illumination. The corresponding energy can escape in the environment via three processes: (i) diffusion, (ii) convection and (iii) radiation, although the main kind of energy transfer in plasmonics remains diffusion.

c) Localized surface plasmons (LSPs)

Localized surface plasmons (LSPs), are responsible for both enhanced light scattering and enhanced light absorption. The interaction of the electromagnetic field with nanostructure at resonance

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conditions is characterized by a significant enhancement of the scattering and absorption cross sections that may be orders of magnitude higher compared to these at out of resonance conditions [7,8]. On this basis technology of nanoparticle photothermal cancer cell therapy and biological object imaging is developed [9].

d) Surface Plasmons and Surface Plasmon Resonance Sensing (SPR)

Unique phenomenon to plasmonic (noble metal) nanoparticles leads to strong electromagnetic fields on the particle surface and consequently enhances all the radiative properties such as absorption and scattering [11]. These optical properties are a consequence of the dielectric confinement in these objects whose size is less than the wavelength of the excitatory light and which is at the origin of the well-known phenomenon of surface plasmon resonance (SPR), which dominates the extinction spectrum in the visible domain [6].SPR of metallic nanoparticles has significant applications in optics, communications and biosensors. These are the changes caused by increasing influence of certain electromagnetic surface modes—coherent fluctuations of electron charges on metal boundary called surface plasma oscillations or plasmons. Excitation of surface plasmons takes place, when the surface of the metal is exposed to incoming electrons or photons. Plasmons are strongly bound to the incident surface with their maximum intensity at the surface and disappear quickly with increasing distance from the surface. Therefore, they are very sensitive to the surface properties.

e) Plasmonic resonance

Plasmonic resonance occurs when conduction band electrons on metal nanoparticle surface collectively oscillates with same frequency as that irradiated light. This plasmonic resonance has attracted great attention because of large electromagnetic field enhancements near metal nanoparticle and the regulating resonance wavelength with change in material, size, shape and surrounding medium of metallic nanoparticle. Incorporation of liquid metal nanoparticles in plasmonic provides unique properties towards sensing (heart rate monitors etc.)

i. *Surface plasmon resonance*

When a metal particle is exposed to light, the oscillating electromagnetic field of the light induces a collective coherent oscillation of the free electrons (conduction band electrons) of the metal. This electron oscillation around the particle surface causes a charge separation with respect to the ionic lattice, forming a dipole oscillation along the direction of the electric field of the light. The amplitude of the oscillation reaches maximum at a specific frequency, called surface plasmon resonance (SPR) [12–13]. The SPR induces a strong absorption of the incident light and thus can be measured using a UV–Vis absorption spectrometer. The SPR band is much stronger for plasmon nanoparticles (noble metal, especially Au and Ag) than other metals. The SPR band intensity and wavelength depends on the factors affecting the electron charge density on the particle surface such as the metal type, particle size, shape, structure, composition and the dielectric constant of the surrounding medium, as theoretically described by Mie theory [14] Surface-plasmon resonance-enhanced optical properties of colloidal gold nanoparticles directed towards recent biomedical applications with an emphasis on cancer diagnostics and therapeutics.

ii. *Surface plasmon absorption and scattering*

The energy loss of electromagnetic wave (total light extinction) after passing through a matter results from two contributions: absorption and scattering processes. Light absorption results when the photon energy is dissipated due to inelastic processes. Light scattering occurs when the photon energy causes electron oscillations in the matter which emit photons in the form of scattered light either at the same frequency as the incident light (Rayleigh scattering) or at a shifted frequency (Raman scattering). The frequency shift corresponds to the energy difference created molecular motion within the matter (molecular bond rotations, stretching or vibrations). Due to the SPR oscillation, the light absorption and scattering are strongly enhanced, 5–6 orders of magnitude stronger than most strongly absorbing organic dye molecules and then the emission of most strongly fluorescent molecules, respectively [15]

II. Objectives

a) To study the Applications of gold nanoparticles as nano sources of heat

- Nanoparticles applications as nano sources of heat,
  - photothermal cancer therapy
  - drug and gene delivery
  - photoacoustic imaging
  - plasmonic-induced nanochemistry
  - photothermal imaging
  - Nano-surgery
- For each application, particular attention will be paid to

(i) the pioneering works,

(ii) the subsequent pivotal works that introduced the variants and new concepts and (iii) the current state of the art and remaining challenges.

- Brief idea about other applications like protein denaturation, heat-assisted magnetic recording, thermo-plasmonics for Cell Biology.

III. Applications

a) Plasmonic Photothermal Therapy (PPTT)

i. *Hyperthermia for Cancer Therapy (initial approach)*

- Killing cells by heating them above a certain temperature threshold has long been considered a means to cure cancer, since as early as the late 1800s [16, 17, 18], sometimes applied as an adjunctive therapy with various established cancer treatments such as radiotherapy and chemotherapy [19].
- A temperature rises at around 41–48◦C is in principle sufficient to induce cell death. This process is called *hyperthermia*.
- The application of even higher temperatures (48–60◦C) is termed *ablation*. In any case, an efficient photothermal treatment relies on a subtle interplay between temperature and exposure time [20].

ii. *Hyperthermia using Plasmonic Nanoparticles*

Photothermal therapy uses photothermal nano-agents to treat disease by local hyperthermia [21]. The idea of using gold nanoparticles as nanosources of heat for photothermal cancer therapy is one of the most ancient and the most promoted application of thermoplasmonics (Plasmonic Photothermal Therapy (PPTT)). PTT using spherical gold nanoparticles [22] can be achieved with pulsed or cw visible lasers due to the SPR absorption in the visible region and thus such treatment is suitable for shallow cancer (e.g. skin cancer). The cell death is attributed mainly to the cavitation damage induced by the generated micro-scale bubbles around the nanoparticles. The use of nanosecond pulsed laser for PTT is highly selective and localized damage controllable from few nanometers to tens of micrometers depending on the laser pulse duration and particle size [23]. This makes the method useful for single metastatic cell killing and small tumor eradication. Plasmonic nanoparticles can be advantageously used to artificially enhance the optical absorption contrast between cancerous and healthy cells and to use moderate laser intensities. This way cancer cells can be heated and destroyed using a (laser) light illumination at the tumor location, at least in theory. A suitable illumination enables specific photo-damage of cancer tissues without affecting the healthy surrounding. Among available photothermal agents, plasmonic NPs are very good candidates to achieve photo-damage using moderate laser intensity. For an efficient cancer treatment following this approach, several requirements have to be fulfilled. First, gold nanoparticles have to be specifically delivered and located in cancer cells and not elsewhere in order to limit the heat generation to the malignant tissues and not to the surrounding healthy tissues. For this purpose, two approaches are usually considered to achieve specific targeting of the nanoparticles [24]

a. *Active and passive targeting*

In *passive targeting*, the nanoparticles are injected intravenously and the specific localization of the nanoparticles inside the tumor due to their rapid growth, cancer cells are endowed with vasculatures (up to 2 μm in size) that facilitate nanoparticle uptake by the cancer cells. Additionally, the lymphatic drainage of tumors is reduced compared with healthy tissues, making it harder for nanoparticles to leave the tumor once they get into it. This aspect is often referred to as the enhanced permeability and retention (EPR) effect [25]. A consequence of the EPR effect is that macromolecules or nanoparticles can accumulate in tumors at concentrations five to ten times higher than in normal tissue. In *active targeting*, the nanoparticles are also injected intravenously, but the targeting of cancer cells are achieved by coating the NP surface with antibodies, proteins or other ligands like cell surface receptors (*e.g.*, epidermal growth factor receptors, EGFRs), peptides or antibodies that have a specific binding affinity with receptors overexpressed at the membrane of cancer cells. Nanoparticle internalization can then occur by receptor-mediated endocytosis.[26]

The second aspect that has to be considered is the wavelength of the incident light used to heat the NPs. Indeed, light absorption of human tissues is minimum in the so-called transparency window (between 700 and 900 nm). Working in this region of the spectrum allows reaching tumors that can be up to several centimetres deep, along with minimum absorption and thus less heat is being delivered to the rest of the exposed tissues that are not targeted with NPs. While light absorption of spherical gold NPs peaks in the green, LSP resonances can be shifted to the infrared by using non spherical NPs. This explains why hyperthermia experiments are mainly based on the use of gold nano shells (formed by a dielectric core surrounded by a thin gold layer) [27], gold nanorods or gold nanocages, which allow accurate tuning of LSPs to the NIR spectral region. The use of spherical gold NPs can also be efficient due to agglomeration of NPs that tends to red-shift the NP absorption spectrum [28].

b. *Typical preclinical trial procedure*

First experiments on plasmonic photothermal therapy (PPTT) of cancer were made in living cells in culture. Subcutaneous tumors were grown in mice up to a certain size, typically one centimetre big. Half the mice population subsequently received gold nanoparticles via in situ deposition or via tail injection, while the remaining mice only received an injection of a saline solution, as a reference. After a few hours, most of the nanoparticles were supposed to have reached the tumor. Laser illumination was thus performed right at the tumor location for a few minutes, at a given laser intensity, sometimes upon controlling the temperature (see Figure (b)). This process was repeated several days and at the end of the treatment, comparison was made between the mice with and without nanoparticle injection. Figure (c) shows a mouse before and after effective treatment.

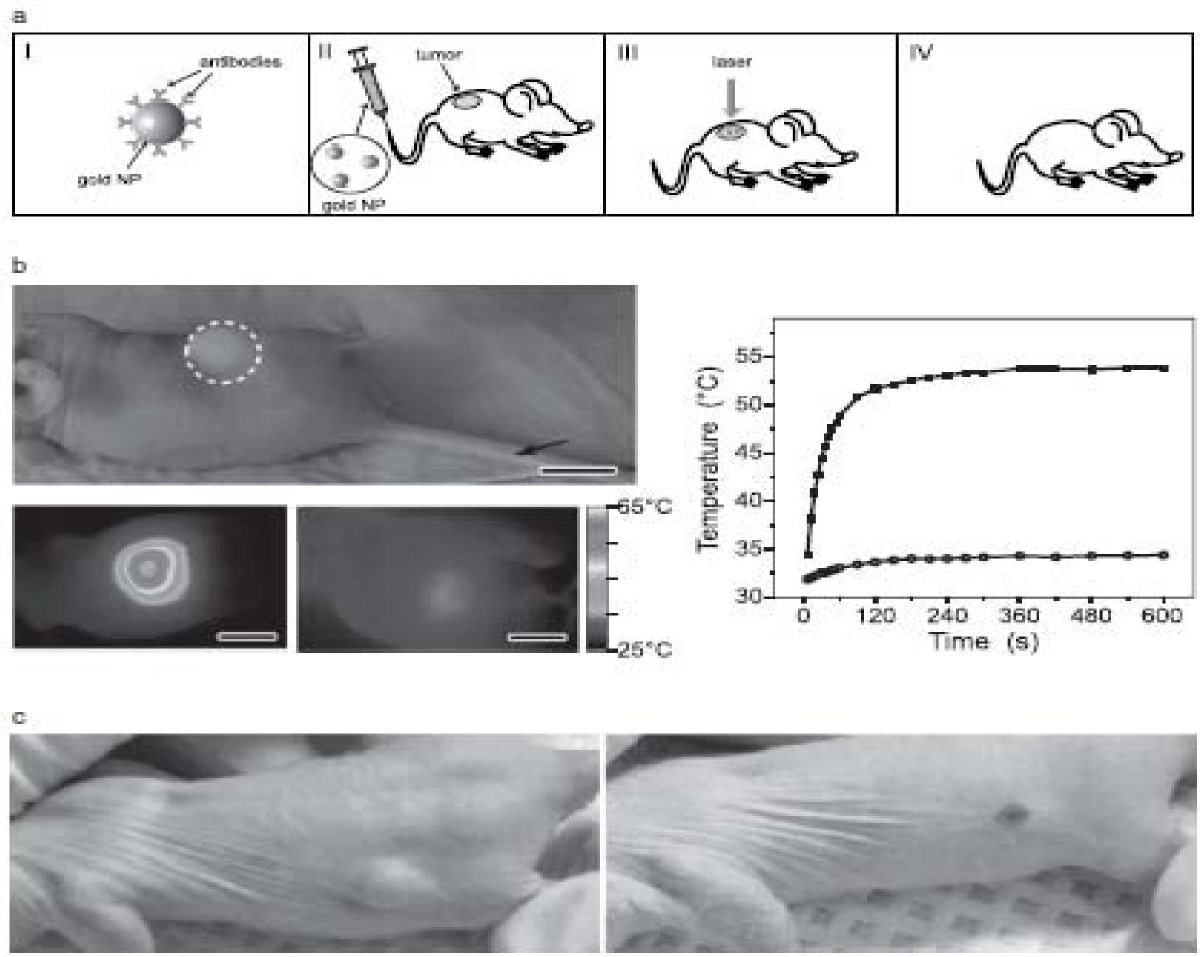

Figure (a): Schematic illustrating the usual approach in plasmonic photothermal therapy (PPTT). First, gold nanoparticles are functionalized with small molecules or antibodies that specifically target cancer cells. Then, a nanoparticle solution is directly injected into the tumor location or via tail vein injection. After a given period of incubation, the tumor is illuminated to heat the nanoparticles and generate hyperthermia. This procedure is repeated until healing is complete. Reproduced with permission from Reference [29]. Copyright 2012, WILEY–VCH Verlag GmbH & Co. KGaA, Weinheim

(b) (Top-left) Photograph of a tumor-bearing mouse. The arrow indicates the location of injection of the nanocage or saline solutions. The dash circle indicates the size of the laser beam. (Bottom left) Thermographic images of nanocage-injected and saline-injected tumor-bearing mice. (Bottom right) Control. (Right) Plots of average temperature within the tumors (dashed circle) as a function of irradiation time. All scale bars are 1 cm. Reproduced with permission from Reference [30]. Copyright 2010, Wiley–VCH Verlag GmbH & Co. KGaA,Weinheim.

(c) Photothermal tumor ablation: (left) Mouse before treatment. (right) Mouse after treatment. Reproduced with permission from Reference [31]. Copyright 2008, American Urological Association.

b) Cell death uing photothermal mechanisms

- A simple temperature increases up to 45◦C. However, reaching a uniform temperature increase of 45◦C in all cancer cells and no deleterious temperature increase in neighbouring healthy cells may seem unrealistic. First, the precise value of 45˚C is difficult to control. Then, the temperature increase cannot be restricted to the tumor volume because of heat diffusion.
- A more promising method consists in using a (nanosecond- to femtosecond-) pulsed laser illumination [31]. The sudden temperature bursts following each pulse of light remain confined at the vicinity of each nanoparticles and can reach huge values, close to 280˚C, with no bubble formation. The direct consequence is the local perforation of cell membrane and destruction of organelles, leading to cell death.

- Still under pulsed illumination, a further increase of the laser power can lead to the formation of transient nanobubbles. The sudden formation and collapse of a bubble generate a shock wave that propagates through the medium and can disrupt cell membranes and lysosomes, leading to cell death [32]

c) Plasmonic Photothermal Therapy of Atheroma

Atheroma consists of an abnormal local accumulation of cells, lipids, and calcium in artery walls, leading to a restriction of blood flow. In most cases, atheroma most commonly results in heart attack and ensuing debility. PPTT using silica-gold nanoparticles led to significant regression of coronary atherosclerosis.

d) Plasmonic Photothermal Therapy of Acne Vulgaris

Used gold-coated silica nanoparticles and delivered them into sebaceous glands. By illuminating the glands using millisecond pulses of light, a local injury to sebaceous follicles and glands were performed resulting in a reduction in inflammatory lesion burden on the cheeks of patients as shown in figure.

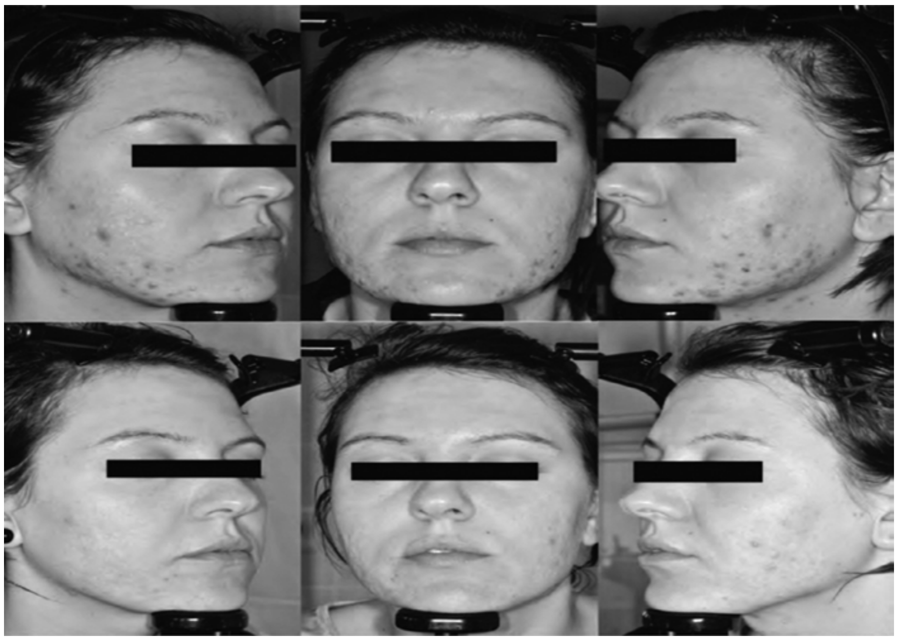

Figure: Baseline (top row) and 24-week post-baseline (bottom row) photographs of a subject showing a reduction in inflammatory lesion burden on the cheeks. Reproduced from Reference [33]. Copyright 2015, The Society for Investigative Dermatology, Inc.

e) Drug and Gene Delivery (DGD)

Transport and release of drugs or genes to specific location in vivo is a crucial challenge for the improvement of therapies for human diseases [34]. It focuses on targeted delivery of drugs or genes for therapeutic purposes. The principle of *plasmonic-assisted* delivery of drug or genes is that the therapeutic compounds, functionalized to the surface of metal nanoparticles, are supposed to be released only under illumination due to a temperature increase inducing a bond breakage. Investigation mainly consisted in improving this basic scheme by proposing different variants, such as the drug release from capsule-like vehicles (nanocages, liposomes, micelles). The therapeutic agents are attached to gold NPs that act as nano-carriers through the human body. Once they are at the desired location, the active agents can be detached and released by remotely heating the NPs using laser illumination [35,36]. Hence, in this kind of application, plasmonic NPs have two roles: they act as both nano-carriers and nano- sources of heat. A delivery of drugs or genes remotely triggered by an external stimulus offers strong advantages over a passive release or an internally triggered release (*e.g.*, by a chemical stimulus). The possible remote stimuli are light (ideally in the near-infrared), ultrasounds and magnetic fields. This approach allows unprecedented control of the location, the timing, the duration and the magnitude of drug release. Sufficient incident light intensity must be used to release drugs or nucleotides, but must remain below the intensity threshold causing photothermal damage of cells and tissues [37]. In particular, the timing of drug delivery could be finely adjusted. For example, insulin is most effective when delivered to a diabetic in short bursts whereas an anaesthetic should be delivered in a steady, continuous fashion [38]. Plasmonic photothermal delivery (PPTD) has been demonstrated using various geometries of plasmonic systems, such as nanospheres, nanorods, nanoshells, nanocages and liposomes. In any case, an efficient delivery system must fulfill several requirements. First, the active compounds must be protected against the surrounding biochemical conditions during transport. Second, it must remain inactive (mute) outside the target. Third, the delivery system must be nontoxic and biodegradable if it is given parenterally.

f) Photoacoustic Imaging (PAI)

Photoacoustic imaging (optoacoustic imaging) refers to a biomedical imaging modality based on the photoacoustic effect (optoacoustic *effect*), which consists of the generation of acoustic waves produced by the absorption of pulses of light (or of radio-frequency waves in some cases). Photoacoustic (PA) (or optoacoustic) tomography combines the advantages of light and ultrasound to achieve the detection of deep tumors with high resolution (<1 mm). Photoacoustic imaging (PAI) uses optical illumination and ultrasonic detection to produce deep tissue images based on their light absorption, and uses endogenous or exogenous contrast agents. The basis of PA tomography is the generation of acoustic signals using short laser pulses. Working with NIR light ensures a maximal light penetration in tissues. The absorption of a focused pulsed laser generates a rapid and localized temperature increase (<1 °C). The subsequent thermal-induced expansion of the tissue triggers the formation and propagation of an acoustic wave (or stress wave) that can be detected at the surface of the body by using an array of ultrabroad-band acoustic transducers. Finally, a deconvolution algorithm is used to render a three-dimensional image of the absorbing tissues. This technique enables imaging in real time, with a high-spatial resolution (~ 5 μm), deep inside tissues (5–6 cm), on the anatomical functional and molecular content of biological tissues in the absence of ionizing radiation. Two main imaging modalities exist: photoacoustic microscopy and photoacoustic tomography [39]. "photoacoustic microscopy employs a coupled, focused ultrasonic detector–confocal optical illumination system to generate multidimensional tomographic images without the need for reconstruction algorithms, whereas the detectors in photoacoustic tomography scan the laser-illuminated object in a circular path and use inverse algorithms to construct three-dimensional images." Gold nanoparticles are naturally very good candidates because of their strong light absorption properties in the infrared and their biocompatibility. The use of nanoparticle-based contrast agents greatly extended PAI applications [40].

The benefit is three-fold:

(i) It allows deeper imaging within tissue with enhanced contrast. Metal nanoparticles are highly absorbing and their absorption properties can be tuned in biological transparency windows.
(ii) It allows active targeting of specific locations in living organisms using metal nanoparticles conjugated with antibodies. This way, systems endowed with weak endogenous photoacoustic contrast can be made highly visible using PAI.
(iii) PAI can be coupled with photothermal therapy using gold nanoparticles acting both as photoacoustic and photothermal agents in tumors.

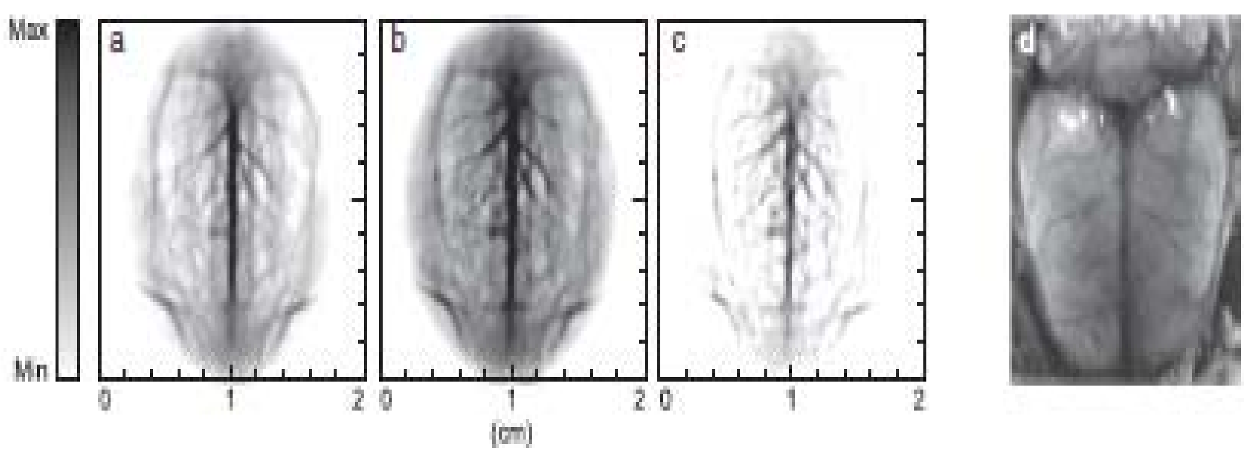

Figure: Noninvasive PAT of a rat brain in vivo employing the nanoshell contrast agent and NIR light at a wavelength of 800 nm. (a) Open-skull photograph of the rat brain cortex obtained after the data acquisition for photoacoustic tomography. (a) Photoacoustic image acquired before the administrations of nanoshells. (b) Photoacoustic image obtained 20 min after the third administration of nanoshells. (c) Differential image that was obtained by subtracting the pre-injection image (a) from the post-injection image (b). Reproduced with permission from Reference [41]. Copyright 2004, American Chemical Society.

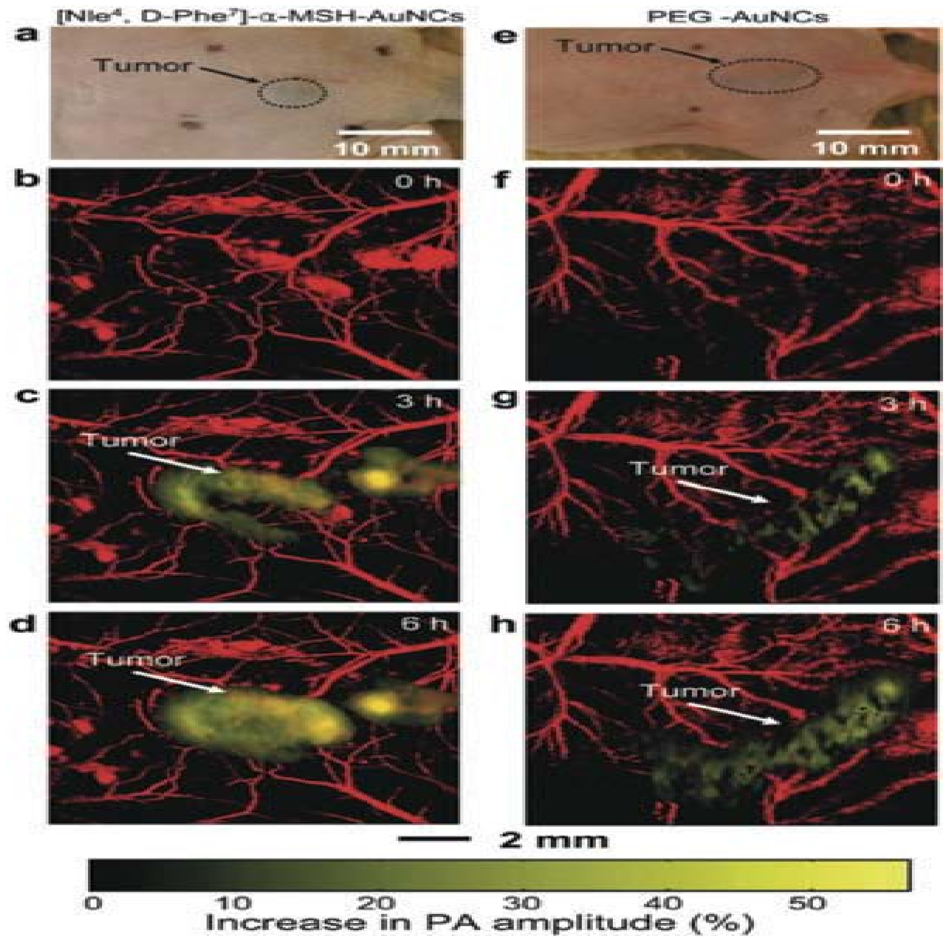

Figure: (online color at: www.lpr-journal.org) *In vivo* non-invasive PA images of B16 melanomas using gold nanocages [42]. Photographs of nude mice transplanted with B16 melanomas before injection of a) bioconjugated and e) PEGylated nanocages. PA images of the B16 melanomas after intravenous injection with 100 μl of 10 nM b–d) bioconjuated and f–h) PEGylated nanocages through the tail vein. Color scheme: red, blood vessels; yellow, increase in PA amplitude. (Reprinted with permission of ACS.)

g) Plasmonics induced nanochemistry (PINC)

Chemical reactions are influenced by various parameters such as temperature, pH and pressure. Usually, a temperature increase is accompanied by an increase in the reaction rate described by the empirical Arrhenius law that expresses the dependence on temperature *T* of the reaction rate constant *K*: $K = Ae^{-E_a/k_BT}$ where *A* is a constant, E_a the activation energy and k_B the Boltzmann constant. The ability of plasmonic NPs to control heat over time and space with an unprecedented level of accuracy appears naturally as a means to efficiently control chemical reactions at the nanoscale. When gold nanoparticles are dispersed in a chemical reaction medium and illuminated at their plasmonic resonance, an increase of the chemical yield of the reaction can be observed. There are at least four mechanisms leading to the enhancement of chemical reaction yields in plasmonics [43]

1. The *optical near-field* enhancement in the case of photochemical reactions.
2. The local *temperature increase* due to light absorption and subsequent heat generation (named TPINC, the subject that will be developed in this section).
3. *Hot electron transfer* to surrounding oxidizing chemical species
4. A *catalytic activity* of the nanoparticle due to its nanometric size and which is not observed with its bulk counterpart [44]. Unlike the three other mechanisms, this one is not related to plasmonic properties.

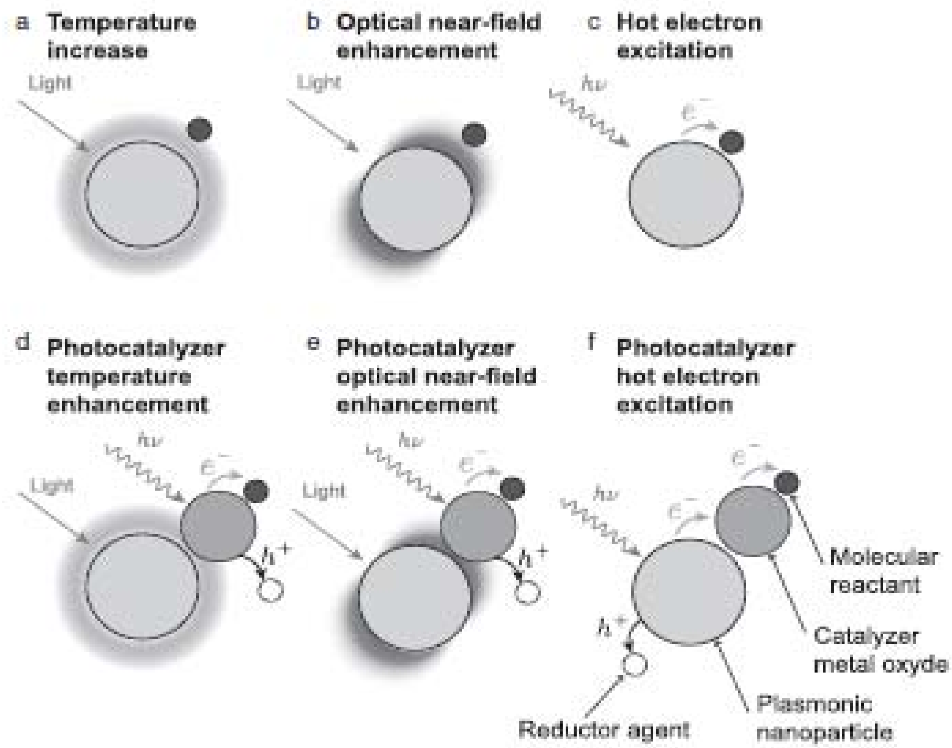

Figure: Different mechanisms proposed for enhancing a chemical reaction around plasmonic nanoparticles. Reproduced with permission from Reference [45]. Copyright 2014, Royal Society of Chemistry

The benefits of using plasmonic nanoparticles compared with the use of a regular hot plate are a priori as follows:

- Heating a small region makes it possible to make the thermal dynamics faster due to a reduced thermal inertia (typically below the microsecond timescale; In other words, it is much faster to heat (or let cool) a small volume than a large volume.
- Heating a micrometric area makes it possible to easily superheat the fluid above its boiling point (up to around 240◦C for water), with possible applications in solvothermal chemistry without using an autoclave [46].
- Heating on the nanoscale enables the formation of products with a nanometric spatial resolution.

h) Photothermal Imaging (PTI)

Photothermal microscopy enables detection of nano-objects solely based on their absorption, notably gold nanoparticles [47]. The principle is that in Photothermal Imaging (PTI) gold nanoparticles of a few nanometer big were randomly deposited on a glass substrate and immersed in surrounding medium. When these gold nanoparticles were heated by a few kelvins using a focused laser beam, which resulted in a decay of the refractive index of the surrounding medium i.e. when NP is illuminated, the temperature increase experienced by the surrounding medium induces a local variation of refractive index. This local variation of the refractive index, also known as the nanolens effect. Such a refractive index variation spreads over a distance from the particle much larger than the particle size itself, according to the thermal diffusion law. This larger volume of liquid undergoing a refractive index variation was sufficiently big to scatter an incident probe beam and make the presence of the nano-object detectable using any phase imaging technique. The good sensitivity of the technique and the stability of the signal enabled advances in nano-object spectroscopy (absorption spectroscopy and correlation spectroscopy), optical microscopy technique aimed at detecting metal NPs (10 nm) that are normally too small to be detected using any conventional optical microscopy and optical detection in living cells (localization and tracking of biomolecules and organelles).

The main interest of detecting nano-objects via absorption (and not via fluorescence, for instance) is that they behave as ideal labels: they are small enough to remain non-invasive and, more importantly, they do not suffer from photobleaching, or blinking like common fluorescent probes. Because of the absence of photobleaching, the proteins can be visualized for arbitrarily long times, offering new opportunities for efficient protein tracking in three dimensions. This is a great advantage compared with regular fluorescent markers, which tend to photo bleach very rapidly in tracking experiments. PTI is based on the detection of phase objects. All the experimental setups are based on the use of phase imaging techniques. In any case, two laser illuminations were implemented:

- A laser beam (usually at $\lambda = 532$ nm, a few mW or less) intended to heat the nanoparticle. This laser was mechanically or acousto-optically modulated to enable a synchronous detection of the signal.
- A low-intensity laser beam (in the near-infrared) to build a phase contrast image [48].

i) Nano-surgery

Laser surgery, consists of using laser light to cut tissues, has become a reliable alternative to the conventional scalpel in fields such as ophthalmology and dermatology [49, 50]. It offers bloodless and more accurate cutting along with reduced risks of infection. At a smaller scale, laser light can be used as a tool to assist transfection of individual cells by forming a transient pore in the cell membrane [51] that permits the introduction of either therapeutic agents (proteins, DNA, RNA) or imaging agents (fluorophores, quantum dots, nanoparticles) through the cell membrane and as a tool to cut individual neurons [52].Optical transient portion in cell membranes has been demonstrated using a variety of illumination conditions, involving different mechanisms depending on the laser–cell interaction [53]. While CW illumination mainly induces a local heating at the cell membrane, femtosecond pulsed illumination with high repetition rate induces membrane permeability that is mainly the result of a low-density plasma originating from the generation of free electrons. Interestingly, this technique permits the study of one cell at a time. However, it suffers from potential photo-damage originating from the high laser power that is required. In this context, the use of plasmonic NPs makes it possible to locally increase the absorption and thus reduce the intensity requirements. Also, the possibility of controlling heating near few to single particles is expected to significantly reduce the dimension of the pore.

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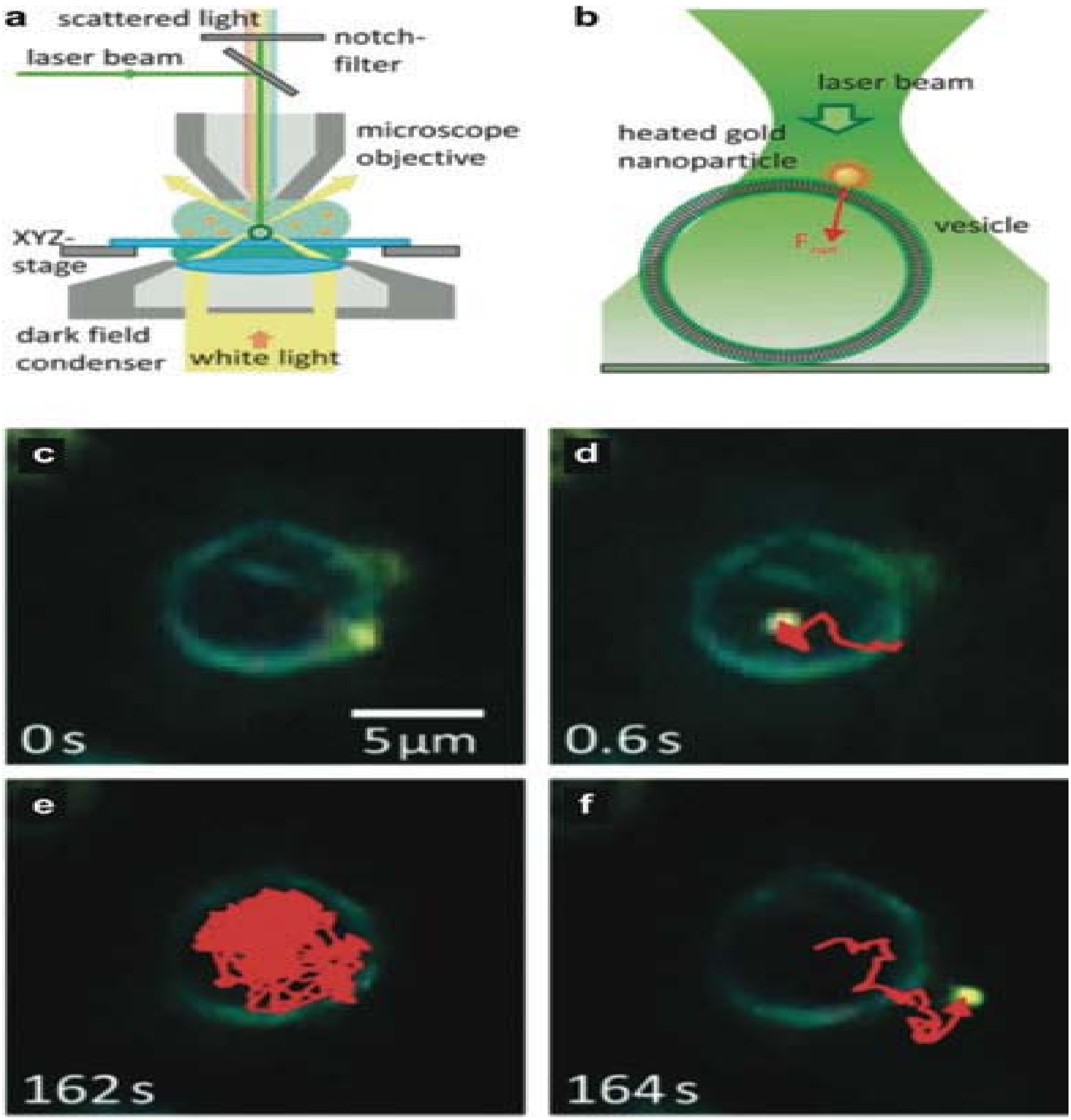

Figure: (online color at: www.lpr-journal.org) Illustration of the perforation of a phospholipid membrane using a trapped single gold NP. a) Schematic of the experimental setup used for optical injection and imaging [54]. b) Gold NPs are attached to the membrane of giant unilamellar vesicles prior to injection. The laser is defocused, resulting in a spot size of 6 µm at the focal plane of the microscope objective. c) A dipalmitoyl phosphatidylcholine vesicle before injection of a gold NP attached to the membrane. d,e) Tracking of the movement of the gold NP (red trace) shows it is confined to the inside of the vesicle. f) Often, after a certain time, the NP was observed leaving the vesicle at the same position at which it was injected. This suggests that the injection process forms a pore in the gel-phase membrane. (Reprinted with permission of ACS.)

j) Heat-Assisted Magnetic Recording (HAMR)

Magnetic recording, or magnetic storage, consists in storing binary information on a ferromagnetic film. Each bit value is spatially coded by the orientation of the magnetic dipole of ferromagnetic grains in one direction or the other (up/down or side to side). Idea is to benefit from the ability of metal nanotips to create a strong and confined optical field at its vicinity, which can be used to very locally heat the substrate over an area below the diffraction limit. In this application, it is not the temperature increase within the metal nanostructure itself that is involved in the mechanism, but rather the optical near-field [55]. In this pioneer work, the metal structure, acting as a near-field transducer (NFT), consisted of a triangular plate endowed with a sharp beak, as represented in fig

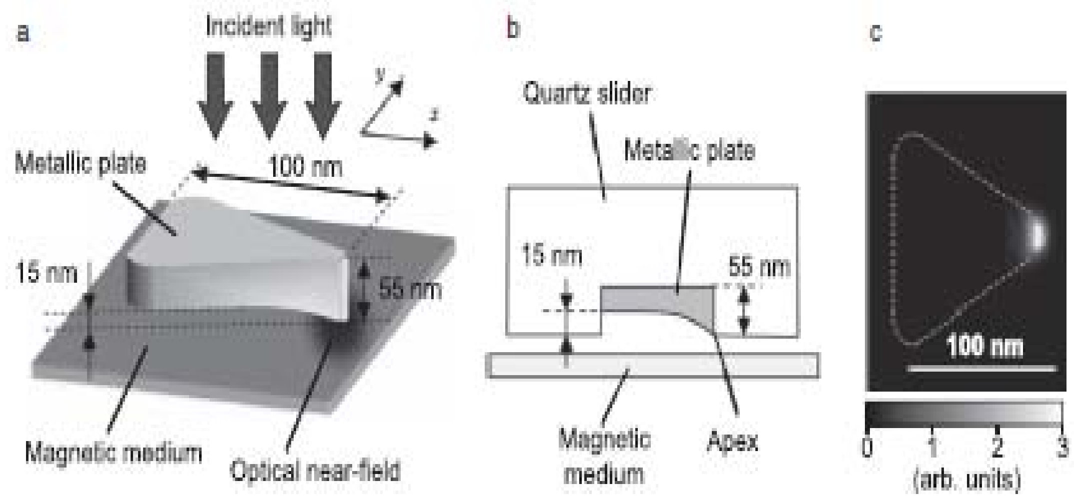

Figure: Gold is the material of choice for NFTs as it features a melting point (1064◦C) much higher than the Curie temperature of the magnetic medium in HAMR

(a) 3D view of near-field transducer (NFT)

(b) cross-sectional view

(c) Intensity distribution of the optical near-field calculated on the surface of the recording medium.

(Reproduced with permission from Reference [56]. Copyright 2006, The Optical Society)

k) Protein Denaturation: Application of Thermo-plasmonics

The thermal-induced denaturation of proteins using a pulsed laser to heat gold nanoparticles. The temporal and spatial confinement achieved when heating nanoparticles with a sub nanosecond laser could help achieve temperature as high as 470 K without boiling. The denaturation of chymotrypsin proteins within 300 ps at temperatures below 380 K. This work was carried out in the context of photothermal treatment of vessels or pigmented cells. It is that only solid-state absorbing particles (e.g., metal spheres, melanin, graphite, or iron oxide particles) can be used as such an energy acceptor for thermal micro effects. Dye molecules do probably not have the required photostability and will, therefore, rather produce photochemical damage than photothermal effects.[57]

l) Thermoplasmonics for Cell Biology

Gold nanoparticles as nanosources of heat have been proved efficient to perform local thermodynamic investigation on nanoscale and microscale biosystems, such as proteins, DNA, lipid membranes, vesicles or single living cells. This last section deals with this kind of application. In general, the state of most biosystems is highly dependent on temperature. The major drawback of such an approach is the inherent large thermal inertia. The smaller the system, the smaller the thermal inertia. For this reason, heating using a laser and an absorbing medium seems ideal. However, the main limitation of this approach is the difficulty to reliably measure a temperature distribution at the microscale. Gold nanoparticles seem ideal sources of heat: they can be designed to efficiently absorb in the infrared (a requirement to avoid phototoxicity of the high-power laser used for heating), they are biocompatible and they can lead to nano- and microscale heating, depending on the number of nanoparticles under illumination.[58]

IV. Results and Discussion

This review on applications of Gold nanoparticles as nano sources of heat provides an understanding of the interplay between optics and thermodynamics considerations and hence makes their modelling intricate. Expresses how the physical effects involved under pulsed illumination are the cause of heat generation. Also, emphasises on the small number of available thermal imaging techniques capable of probing the temperature near plasmonic structures has been drastically limited so far is now an advancing field. Discussed about the macroscopic photothermal effects such as tissue damage, fluid convection, chemical reactions or drug release. All the applications of thermo-plasmonics presented in this review feature different degrees of progress. While applications such as photothermal cancer therapy have already led to clinical trials, areas such as plasmonic-assisted nanochemistry or microfluidics are still at an early stage of development. Other promising areas of research, like plasmon-assisted magnetic recording , phononics or thermal microbiology at the single-cell level basics are being introduced .

V. Conclusions

Here we reviewed the recent progress in the emerging and fast-growing field of thermo-plasmonics, which investigates the use of plasmonic structures as nanosources of heat. The surface-plasmon resonance-enhanced optical properties of colloidal gold nanoparticles. The plasmonic photothermal therapy of cancer is achieved by using the strongly enhanced surface-plasmon resonance absorption of gold nanospheres and nanorods. We realized that heating at the single cell level is certainly one of the future active fields of research in thermoplasmonics, favoured by the development of more efficient and reliable temperature imaging techniques Photoacoustic imaging and Photothermal imaging.

VI. Further Scope of Work

Most efforts have been devoted to trying to find i) new nanoparticle morphologies. Besides nano shells, nanospheres, nanorods, nanocages and silica-coated nanoparticles, other morphologies have been introduced such as nano prisms, stars or tripods and ii) expanding the range of applications, from cancer diagnosis to imaging of atherosclerotic plaques, brain function and image-guided therapy [60].

Remaining Current Challenges in PPTT of Cancer: The fact that the results of the clinical trials on cancer therapy have not been communicated may be a sign that the targeted challenge is bigger than expected, and may be out of reach.

Restriction to subcutaneous tumors: Preclinical trials have been successfully conducted only on *subcutaneous* tumors, *i.e.*, tumors that are easily accessible, removable using simple surgery, and that do not need therapy.

Temperature spreading: Many approaches are based on a global photothermal effect under cw illumination. In such a case, the spatial distribution of the temperature will not be localized around each nanoparticle but rather delocalized throughout the whole tumor

Temperature nonuniformity: Another problem occurs under cw illumination. There is no reason for the nanoparticle distribution to be uniform in the tumor.

Temperature monitoring: Ideally, to make sure any part of the tumor reaches the desired temperature and no injury are caused to nearby organs, a three-dimensional map of the temperature increase would be required. But no imaging technique enables this performance, except MRI.

Opacity of human body: The human body is not transparent. This explains why magnetothermal treatments have reached phase-II clinical trials in PPTT approaches (human body is fully “transparent” to magnetic fields). Even in the infrared, it is difficult to reach a light penetration larger than one centimetre, not only because of water and blood absorption [59], but also due to tissue scattering.

Remaining Issues in Near-Field Assisted HAMR: One of the major problems is the heat generation within the metal near-field transducer Itself. One can hardly imagine that NFT could heat up a neighbouring solid via its near-field, while remaining cold. Gold nanoparticles are known to reshape at temperatures much weaker than the melting point of gold. The lifetime of the NFT may suffer from this problem. For this reason, efforts are made to find new materials in plasmonics that can sustain higher temperatures, such as metal nitrides (TiN, ZrN) or refractory metals (W, Mo). TiN and ZrN have been shown promising as their plasmonic resonance are similar to gold’s resonance (in wavelength and magnitude), and because they feature melting points close to 3000°C. However, they are not supposed to be good near-field enhancers [61]

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The Study of the Density of Physical Space and the Hubble Constant

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Abstract- According to the description of physical space by general relativity and the principle of symmetry, this paper deduces the density property of physical space. On this basis, the author modified the metric tensor in Einstein's gravitational field equation, introduced the density factor of physical space into coordinate transformation, and deduced the gravitational field equation with a cosmological constant term. According to the equation, the cosmological constant term is the product of curvature and density factor of physical space, which is a negative increment of curvature, showing the property of repulsive force. This property could take the place of dark matter and dark energy. The author deduced the formula for calculating the Hubble redshift with space density term through Robertson-Walker metric and calculated the Hubble constant generated by space density according to the known material parameters of the universe. The calculated value is 74.6607Km·s^{-1}Mpc^{-1}, which is consistent with the observational results reported in the literature.

Keywords: space density, metric tensor, gravitational field equation, Hubble constant, Hubble redshift, Mossbauer spectrum.

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The Study of the Density of Physical Space and the Hubble Constant

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Abstract- According to the description of physical space by general relativity and the principle of symmetry, this paper deduces the density property of physical space. On this basis, the author modified the metric tensor in Einstein's gravitational field equation, introduced the density factor of physical space into coordinate transformation, and deduced the gravitational field equation with a cosmological constant term. According to the equation, the cosmological constant term is the product of curvature and density factor of physical space, which is a negative increment of curvature, showing the property of repulsive force. This property could take the place of dark matter and dark energy. The author deduced the formula for calculating the Hubble redshift with space density term through Robertson-Walker metric and calculated the Hubble constant generated by space density according to the known material parameters of the universe. The calculated value is 74.6607Km ·s^{1} Mpc^{-1}, which is consistent with the observational results reported in the literature.

An experimental method to verify the density of physical space by using the fine structure of the Mossbauer spectrum of iron atoms is also presented, and a preliminary estimate of the accuracy of the experimental method is given.

Keywords: space density, metric tensor, gravitational field equation, Hubble constant, Hubble redshift, Mossbauer spectrum.

I. Preface

In 1929, The American astronomer Hubble published a classic paper on the expansion of the universe (Hubble, 1929):" A relation between distance and radial velocity among extra-galactic nebulae, "the main result of this paper is that "the distance of the galactic cloud is proportional to its redshift." Since then, scientists have observed the redshift of the river system using a variety of methods, In particular, after the Launch of the Hubble Space Telescope (HST), a team of researchers like W. Freedman used different methods to measure the Hubble constant H_0, The experimental results ranged from 68 ~ 82Km· S^{-1} · MPC^{-1} (Kirshner, 2004, Freedman et al. 2001, Freedman et al. 1999, Mould, 2002, Kennicutt et al. 1998, Sandage et al. 2006, Rims ,2009).

In March 2020, Chinese scholar Haitao Gao published an article entitled "The accelerated expansion of the universe may be an illusion of the observer "(Gao, 2020), In the paper, Haitao Gao calculated the Hubble constant with the density of physical space, and the results showed that the Hubble constant generated by the density of cosmic space was 114Km·s^{-1} MPC^{-1}.

Based on general relativity, this paper describes the difference between physical space and mathematical space and it discusses the relationship between the density of physical space and Einstein's equation of gravity or Robertson Walker's metric. By introducing the charge structure factor, the Hubble constant calculated by Haitao Gao in March 2020 is revised. Finally, the existence of physical space density is verified by the fine structure of the Mossbauer spectrum of γ-photon of iron atoms in liquid hydrogen as the medium.

II. The Theoretical basis of Hubble Redshift

In an isotropic universe, space can be described by the Robertson-Walker metric:

$$ds^2 = dt^2 - R^2(t)\left[\frac{dr^2}{1-kr^2} + r^2 \ (d\theta^2 + \sin^2\theta d\varphi^2)\right] \quad (1)$$

In the above equation, k is +1, -1, 0, respectively representing positive constant curvature space, negative constant curvature space and flat space. R (t) is the radius of constant curvature. Because of the uniform isotropy of space, it has no relation with three-dimensional space coordinates. It is a function of time t and has a dimension of length, also known as the cosmic scale factor.

Suppose that two points A and B in space are two points in the co-moving coordinate system,the distance when dt=0 is defined as the proper distance D_p, which does not change with the motion of the coordinate system.A and B choose coordinate system$\theta = \varphi$; at this point, the proper distance can be expressed as:

$$D_p = R(t)\int_0^{r_e}\frac{dr}{\sqrt{1-kr^2}} = \begin{cases} R(t)\sin^{-1} r_e & r=1 \\ R(t) r_e & r=0 \\ R(t)\,\mathrm{sh}^{-1} r_e & r=-1 \end{cases} \quad (2)$$

At A, r is 0, and at B, r is r_e, Definition: The natural velocity is the differential of the proper distance concerning time, we can get:

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$$v_p = \frac{dD_p}{dt} = \frac{\mathrm{d}\ (\mathrm{R(t)} \int_0^{r_e} \frac{dr}{\sqrt{1-kr^2}})}{dt} \cdot \frac{(\mathrm{R(t)} \int_0^{r_e} \frac{dr}{\sqrt{1-kr^2}})}{(\mathrm{R(t)} \int_0^{r_e} \frac{dr}{\sqrt{1-kr^2}})} = \frac{\dot{\mathrm{R}}(\mathrm{t})}{\mathrm{R(t)}} D_p \quad (3)$$

If $\frac{\dot{\mathrm{R}}(\mathrm{t})}{\mathrm{R(t)}} > 0$, we can conclude that the universe is expanding at an accelerating rate.

There is an assumption in the above derivation process; that is, the co-moving coordinate system is established. Therefore, the conclusion of the expansion of the universe is obtained under the assumption of the expansion of the universe, and formula two cannot be used as the theoretical proof of the accelerated expansion of the universe.

Since R(t) and D_p are difficult to observe directly, we can only verify the accelerating expansion of the universe by precise measurements of the optical signal.

Suppose that the light signal from the galaxy at t_e is received by earth at t_0. Also, another signal is sent at $t_e+\Delta t_e$ time galaxy, which is received at $t_0+\Delta t_0$ time on earth.We are interested in the relationship between Δt_0 and Δt_e, because if Δt_e is the period of an atomic clock, then Δt_0 is the corresponding value of that period at the receiving point,We can assume that galaxies and the Earth have the same θ and ψ values and take the radial coordinate of the earth as 0. The galaxy is located at r_e, then the light moves along the radial inward zero geodesics, and the equation of the light is:

$$\mathrm{d}t^2 - \mathrm{R}^2(\mathrm{t}) \frac{dr^2}{1-kr^2} = 0 \cdots\cdots\cdots\cdots \quad (4)$$

For the two signals, we can derive:

$$\int_{t_e+\Delta t_e}^{t_e} \frac{dt}{\mathrm{R(t)}} + \int_{t_0}^{t_0+\Delta t_0} \frac{dt}{\mathrm{R(t)}} = 0 \quad (5)$$

When Δt_e and Δt_0 are both very small quantities, the mean value theorem can be applied to make the following approximation:

$$\frac{\Delta t_0}{\mathrm{R}(\mathrm{t}_0)} - \frac{\Delta t_e}{\mathrm{R}(\mathrm{t}_e)} = 0 \quad (6)$$

Δt_e and Δt_0 are the periods of emitting and receiving signals respectively. The period of optical signals can be defined as the frequency of light. After sorting out the above formula, it can be seen that:

$$\frac{v_0}{v_e} = \frac{\lambda_e}{\lambda_0} = \frac{\mathrm{R}(\mathrm{t}_e)}{\mathrm{R}(\mathrm{t}_0)}. \quad (7)$$

Spectral redshift is defined as:

$$z = \frac{\lambda_0 - \lambda_e}{\lambda_e} = \frac{v_e - v_0}{v_0} = \frac{\mathrm{R}(\mathrm{t}_0)}{\mathrm{R}(\mathrm{t}_e)} - 1 = \frac{\mathrm{R}(\mathrm{t}_0) - \mathrm{R}(\mathrm{t}_e)}{\mathrm{R}(\mathrm{t}_e)} \quad (8)$$

As can be seen from the above equation, if R (t_0),>R (t_e), the redshift is positive, the universe is expanding.

We found by the above method, under the assumptions that the expansion of the universe, we got the scale factor and the relationship between the spectrum redshift, as long as we can observe the spectrum redshift, so, the expansion of the universe is the inevitable result in fact we do observe the spectrum redshift, and redshift is proportional to the redshift of an extragalactic nebula, so we think that the expansion of the universe is accelerating.

III. Problem is Put Forward

Now, let's observe formula 7:

$$z = \frac{\mathrm{R}(\mathrm{t}_0) - \mathrm{R}(\mathrm{t}_e)}{\mathrm{R}(\mathrm{t}_e)}. \quad (9)$$

As long as the scale factor R (t_0) > R (t_e), spectrum redshift is positive.

We need to think about is, R (t_0) > R (t_e) must be produced by the expansion of the universe?

For space, we need to confirm the following questions:

1. What are the properties of physical space?
2. Is physical space the same as mathematical space when coordinates are transformed?

IV. Discussion on the Properties of Physical Space and the Equations of the Gravitational Field

General relativity holds that physical space can be bent and physical space can expand. Therefore, according to the principle of symmetry, we infer that physical space can be compressed and physical space has density, which is a reasonable inference.

Therefore, physical space has density, which is one of the properties of physical space.

Mathematical space is a hypothetical space, there's no density convention, so we can determine that when we transform coordinates, the properties of mathematical space and physical space are different. We should consider the density of physical space.

In general relativity, the metric tensor of mathematical space is used to describe the properties of space. The metric tensor is defined as follows:

$$\mathrm{g}_{\mu v} = \boldsymbol{e_\mu} \cdot \boldsymbol{e_v} = \frac{\partial y^k}{\partial x_\mu} \frac{\partial y^k}{\partial v}. \quad (10)$$

Among them, the e_μ and e_υ is the basal vector coordinate system, in a Euclidean space, e_μ and $e_\upsilon$is different vector.

Now, we define a scalar B, which represents the density of space. By multiplying both sides of equation nine by the density of space, we can get:

$$b_\mu b_\upsilon g_{\mu\upsilon} = (b_\mu \boldsymbol{e_\mu}) \cdot (b_\upsilon \boldsymbol{e_\upsilon}) = \frac{\partial y^k}{\partial x_\mu}\frac{\partial y^k}{\partial \upsilon} \qquad (11)$$

According to cosmological principles, our universe is isotropic on large scales, and therefore b_μ and $b_\upsilon$can be considered as constants.

In Equation 8, R (t_0) is the scale factor of physical space, and R (t_e) is the scale factor of mathematical space. Because physical space has density, physical space has spatial increment compared with mathematical space, which can be expressed as follows:

$$\mathrm{R}(\mathrm{t}_0) = (1 + b_0 + a)\ \mathrm{R}(\mathrm{t}_e) \qquad (12)$$

In formula eight available:

$$z = \frac{\mathrm{R}(\mathrm{t}_0) - \mathrm{R}(\mathrm{t}_e)}{\mathrm{R}(\mathrm{t}_e)} = b_0 + a \qquad (13)$$

b_0 is the spectral redshift caused by the density of physical space, while a is the spectral redshift caused by the expansion of the universe.

It can be seen from Formula 11 that the density of physical space can also generate spectral redshift. As long as the spectral redshift is observed and compared with the spectral redshift calculated by using the known physical space density, the information of the universe can be obtained.

Physical spatial density has the following physical meanings:

A unit geometric measure (mathematical space), the amount of space contained (physical space).

When the base unit of geometric measurement of mathematical space is set as 1, let:

$$b_\mu b_\upsilon g_{\mu\upsilon} = (1 + \mathrm{c})\ g_{\mu\upsilon} \qquad (14)$$

Einstein's equation of gravitational field can be written as:

$$R_{\mu\upsilon} - \frac{1}{2}\ (1 + \mathrm{c})\ g_{\mu\upsilon} R = 8\pi G T_{\mu\upsilon} \qquad (15)$$

Make: $-\frac{1}{2}cR = \Lambda$ available:

$$R_{\mu\upsilon} - \frac{1}{2} g_{\mu\upsilon} R + \Lambda g_{\mu\upsilon} = 8\pi G T_{\mu\upsilon} \qquad (16)$$

Equation 12 is the gravitation equation with the cosmic factor. It can be seen that the physical meaning of the cosmic factor is the product of space density and space curvature scalar. For our universe on large scales can be thought of as isotropic constant curvature space, hence $\Lambda = -\frac{1}{2}cR$ is negative constant, is the representative of a negative increment of the curvature of the universe, the nature of the performance is the repulsion.

V. Calculate the Hubble Red Shift and Hubble Constant from the Density of Physical Space

In March 2020, Gao Haitao published a paper in which he calculated the Hubble redshift and The Hubble constant through the space density of protons in the universe, and derived the relationship between the linear density of protons in the universe and the Hubble constant. The expression is as follows:

$$z = 5.8571144 \cdot 10^{-12} NDP \qquad (17)$$

N ~ the number of protons per unit length in the observation path, in units: 1 /m.

D ~ the spatial distance between the observed object and the observer, unit: m.

P ~ the probability that light meets a proton per unit length.

The calculated Hubble constant is:

$$H_0 = v \approx \mathrm{zC} = 114.02793 Km \cdot s^{-1} \cdot \mathrm{Mpc}^{-1} \qquad (18)$$

The above results do not consider the shape factor of electron charge and proton charge but consider the proton charge as a sphere.

Since the charges in the universe are paired, each positive charge must have a negative charge, the effect of the electron's charge on the density of space needs to be taken into account.

According to the description of the material space theory (Gao, 2018), the gravitational mass of a proton is: $1.6726216378 \cdot 10^{-27}$Kg, Radius: $8.4087 \cdot 10^{-16}$m, the shape is a four-dimensional sphere; A proton is closely bound to a positive charge, and the charge of the positive charge is: $1.140152226 \cdot 10^{-15} m^3 s^1$ ($1.602176462 \cdot 10^{-19}$Coulomp). The structure of positive charge is: the cylindrical spiral with a radius of $8.4117893 \cdot 10^{-16}$m and a height of $2.0873379 \cdot 10^{-15}$m surrounds the cylindrical space. The spatial shape of the proton is shown in the figure below:

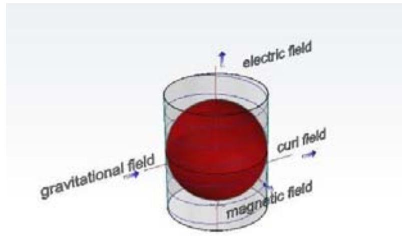

Figure 1: Spatial structure of a proton

The gravitational mass of an electron is: $9.10938215 \cdot 10^{-31}$Kg, Radius: $6.8693998 \cdot 10^{-17}$m, the shape is a four-dimensional sphere; An electron is closely bound to a negative charge, and the charge of the negative charge is: $1.140152226 \cdot 10^{-15} m^3 s^{-1}$ ($1.602176462 \cdot 10^{-19}$Coulomp). The structure of negative charge is: the cylindrical spiral with a radius of $8.4117893 \cdot 10^{-16}$m and a height of $2.0873379 \cdot 10^{-15}$m surrounds the cylindrical space. The spatial shape of the electron is shown in the figure below:

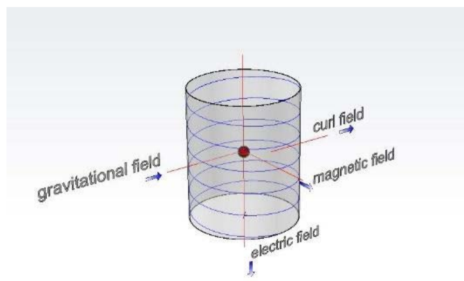

Figure 2: Spatial structure of electron

Considering the shape factor of charge (Gao, 2019), protons and light will scatter with the gravitational mass when they meet in the axial direction of the spiral space of charge, therefore, light can only pass through the charge space in the radial direction of the helical space without meeting the gravitational mass. Therefore, the effective coefficient of light passing through the proton charge space is:

$$A_P = \frac{S_1}{S_0} = \frac{2\pi R(H - H_1)}{2\pi RH + 2\pi R^2} \tag{19}$$

Where R is the radius of the cylinder, H is the height of the cylinder, and H_1 is the height of the cylinder occupied by the gravitational mass.

For protons in the free state, it can be calculated as follows:

$$A_P = \frac{2\pi 8.4118 * 10^{-16}(2.0873 * 10^{-15} - 8.4118 * 10^{-16})}{2\pi 2.0873 * 10^{-15} \times 8.4118 * 10^{-16} + 2\pi \ (8.4118 * 10^{-16})^2} = \frac{34.0662}{175.5822} = 42.553\% \tag{20}$$

According to the description of the material space theory, the electron charge of hydrogen atom is coaxial with that of the proton. Therefore, in the hydrogen atom, the light rays passing through the cylindrical electron charge in the direction of the cylinder axis will be scattered by the gravitational mass of the proton. This part of light is invalid. Therefore, the effective coefficient of light passing through the electronic space structure is:

$$A_e = \frac{S_1}{S_0} = \frac{2\pi RH}{2\pi RH + 2\pi R^2} \tag{21}$$

For the electrons in hydrogen atom, it can be calculated as follows:

$$A_e = \frac{2\pi 8.4118 * 10^{-16} \times 2.0873 * 10^{-15}}{2\pi 2.0873 * 10^{-15} \times 8.4118 * 10^{-16} + 2\pi \ (8.4118 * 10^{-16})^2} = 71.277\% \tag{22}$$

Ignoring the volume of the gravitational mass of the electron, the effective coefficient of the spatial structure of the free electron is $A_F=1$.

Let's say that 10% of the hydrogen atoms in the universe exist in a fully ionized state, where the light passes through the space between the charge of the free proton and the charge of the free electron, The remaining hydrogen atoms are bound plasma, Moreover, light cannot pass through the charge space of both electrons and protons in hydrogen, Suppose that the charge of the electron and the charge of the proton each account for 50% when the light passes through the space of the hydrogen atoms. Therefore, the coefficient of the actual light passing through the space of charge in the universe is:

$$A = 0.1A_F + 0.1\mathrm{A}_P + 0.5(0.9A_e + 0.9\mathrm{A}_P) = 0.6548 \quad (23)$$

Through the above calculation, equation 13 can be amended to:

$$z = 5.8571144 * 10^{-12} NDPA\cdot \quad (24)$$

The Hubble constant corresponding to the redshift can be calculated by plugging in all parameters:

$$v \approx \mathrm{zC} = 74.6607 Km \cdot s^{-1} \cdot \mathrm{Mpc}^{-1} \quad (25)$$

The results show that the spectral redshift generated by the density of physical space corresponds to the observed Hubble constant, and the redshift of the expansion of the universe in Equation 11 May not exist, so our universe may not be expanding.

VI. Suggestions for Verification Experiments on Physical Space Density

The core content of this paper is the corollary of the density of physical space. Although it is a reasonable corollary of the density of physical space from the symmetry principle, we need to prove the existence of the density of physical space through experiments.

In 1960, Pound R.V used the Mossbauer spectrum of iron atoms (Pound, Rebka. 1959), in his experiments to verify the gravitational redshift, and measured the gravitational redshift of the earth's surface as $2.46 \cdot 10^{-15}$(Pound, Rebka, 1960, Pound, Snider, 1964) with gamma photons within 1% accuracy. Therefore, we can design experiments according to the experimental principle of gravitational redshift to verify the redshift generated by the material space density of the earth environment.

According to Formula 14, the relevant parameters are substituted in (where: $A = 0.5(A_e + \mathrm{A}_P) = 0.569147$), and the following equation can be obtained:

$$z = 2.8041 \cdot 10^{-27} ND \cdot \quad (26)$$

Liquid hydrogen is selected as the medium to measure the spatial density at low temperatures. According to the properties of liquid hydrogen, the atomic line density of liquid hydrogen is: $N=3.4935 \cdot 10^9$ / m, therefore:

$$z = 0.9732 \cdot 10^{-17} D \quad (27)$$

Liquid hydrogen is injected into a horizontal pipe with a Fe^{57} γ-photon scattering source at one end and a γ-photon detection device at the other end when the experimental length of liquid hydrogen pipeline is 100 meters, the results can be obtained within the error range of 1% according to the experimental accuracy of gravitational redshift. If you take 10 meters of liquid hydrogen, you get a 10% error. Therefore, the existence of the density of physical space can be verified by experiments on earth, of course, to complete this experiment, also need to be detailed design and planning by professionals of photoelectric measurement.

VII. Conclusion

The density of physical space is derived from the description of physical space by general relativity and the properties of physical space inferred from the principle of symmetry. This property shows the difference between physical space and mathematical space, and in particular, physical space should take the density of space into account when carrying out coordinate transformation.

When considering the density of physical space, Einstein's equations of gravitational field would produce cosmological constants with repulsive forces that would replace dark matter and dark energy. In cases where the existence of dark matter and dark energy cannot be directly proved, it is necessary to conduct experiments to confirm the existence of physical space density.

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Alternative Explanation of the Cosmological Red Shift by the Tachyon Plasma Field in Intergalactic Space

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Keywords: *tachyon, plasma, cosmological redshift, zero-point fluctuation.*

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Abstract- From the assumption that intergalactic space is filled with tachyon plasma, it can be shown that the cosmological redshift can be explained by electromagnetic attenuation in the tachyon plasma field. According to this model, the photon propagates in a superluminal speed between intergalactic space.

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I. Introduction

The author proposed the model to explain the riddle of the rotational speed of the galaxy by using the tachyon field instead of dark matter because the tachyon repels with the ordinary matter [1]. According to this model, the cosmic space is filled with tachyons. By using this model, the author proposes an alternative cosmology instead of the conventional theory.

The current interpretation of observed redshift of light from distant galaxies is due to the expansion of the universe. Contrary to this interpretation, alternative explanations for the cosmological redshift were proposed by some researchers [2-4]. The tired light effect was proposed by Fritz Zwicky in 1929 as a possible alternative explanation for the observed cosmological redshift. The basic proposal amounted to light losing energy due to the distance it traveled rather than any metric expansion or physical recession of sources from observers. Other proposals for explaining how photons could lose energy included the scattering of light by intervening material in a process similar to observed interstellar reddening. However, all these processes would also tend to blur images of distant objects, and no such blurring has been detected. The author has shown that the gravitational field due to the zero-point fluctuation (ZPF) field can be cancelled by the tachyon field created out of the ZPF background and almost of all energy of the cosmic background radiation is due to the Cherenkov radiation from tachyons created from the ZPF field [5,6]. Contrary to their explanations for the cosmological redshift, the author also proposes the alternative mechanism of propagation of light and he presents that the cosmological redshift can be explained from the assumption that intergalactic space is filled with virtual tachyon plasma created from the ZPF field.

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II. Tachyon Field Generated From The ZPF Background

From the wave equation for the moving elementary particle shown as

$$i\hbar\frac{\partial\psi}{\partial t}=\sqrt{p^2c^2+m_0^2c^4}\,\psi\,, \tag{1}$$

which satisfies

$$\psi(x,t)=A\cdot\exp\left[-i\left(\frac{E}{\hbar}t-\frac{p}{\hbar}x\right)\right], \tag{2}$$

where ψ is wave function of the moving particle, c is a light speed, $\hbar$ is a Plank's constant divided by 2π, m_0 is a proper mass of the particle, E is energy of the particle and p is its momentum.

By using the proper acceleration given by $p=m_0\alpha t$, Eq.(1) can be rewritten as

$$\frac{\partial\psi}{\partial p}=-\frac{i}{m_0\alpha\hbar}\sqrt{p^2c^2+m_0^2c^4}\,\psi \tag{3}$$

According to the theory of quantum mechanics, the empty space is filled with virtual particles, most of which are low energy photons moving in an evanescent mode.

Supposing that the virtual photon created from ZPF field is accelerated to the light speed inside the quantum region with the size of the Plank length l_p, we have $\alpha=c^2/l_p$ from the uncertainty principle and $m_0=\hbar\omega/c^2$, where ω is an angular frequency of photons.

From which, the probability of the pair of a tachyon and an anti-tachyon created from ZPF vacuum by quantum tunneling effect can be estimated by [7]

$$T\approx\exp\left[-\gamma\ l_p\omega\right] \tag{4}$$

where

$$\gamma = -\frac{3\log 3 - 2 + 3\log(\hbar / c)}{\sqrt{3}c} \approx 5.62 \times 10^{-7}, \quad (5)$$

By quantum electrodynamics, spectral energy density of ZPF field in vacuum is given by [8]

$$\rho(\omega)d\omega = \frac{\hbar\omega^3}{2\pi^2 c^3} d\omega , \quad (6)$$

The mass of virtual photon created inside the quantum region with the size of the Plank length yields the Plank mass m_p from the uncertainty principle shown $\Delta p \cdot l_p \approx \hbar$.

From Eqs. (4) and (6), number of virtual tachyons created from ZPF field per unit volume can be roughly estimated by

$$N \leq \int_0^{\omega_c} \frac{\hbar\omega^3}{2\pi^2 m_p c^5} \exp\left[-\gamma\, l_p \omega\right] d\omega , \quad (7)$$

where ω_c is the cutoff frequency of ZPF field given by [8]

$$\omega_c = \left(\frac{\pi\, c^5}{\hbar G}\right)^{1/2} , \quad (8)$$

which has the order of the Plank frequency.

By the numerical equation, we have $N \leq 8.8 \times 10^{94}$ per unit volume from Eq.(7) and hence it can be considered that the empty space is filled with pairs of positive and negative charged virtual tachyons created from ZPF vacuum if the tachyon has an electric charge.

III. Electromagnetic Wave Traveling In a Tachyon Plasma Field

Supposing that the intergalactic space is filled with tachyon plasma created from ZPF field, electromagnetic waves below the plasma frequency are attenuated by scattering of particles inside plasma field given by [9]

$$mv = q\vec{E}\tau \quad (9)$$

where m is a mass of the particle, v is its velocity, q is its charge, $\vec{E}$ is an electric field and τ is the time interval between collisions.

From which, the resonant frequency of the tachyon plasma can be estimated by [9]

$$\omega_p = \sqrt{\frac{Nq^2}{m_t \varepsilon_0}} \quad (10)$$

where m_t is the mass of a tachyon given by

$$m_t = \frac{m_*}{\sqrt{v^2 / c^2 - 1}} \quad (11)$$

in which, m_* is an absolute values of the tachyon's proper mass.

From the uncertainty principle for the tachyon given by [10]

$$\Delta p \cdot \Delta t \approx \frac{\hbar}{v - c} , \quad (12)$$

The velocity of the tachyon moving in an empty space can be roughly estimated as $v \approx 2c$ [6]. Then the mass of the tachyon becomes

$$m_t \approx \frac{\hbar}{c l_p} , \quad (13)$$

from the relations, $m_t \approx \Delta p / 2c$ and $\Delta t \approx l_p / 2c$.

We suppose that the charge of the tachyon almost equals to that of electrons[11], the resonant angular frequency of tachyon plasma field can be evaluated as $\omega_p \approx 1.08 \times 10^{38} (rad / s)$ at most from the value $N \approx 8.8 \times 10^{94} / m^3$.

IV. Alternative Mechanism for the Light Propagation through the Intergalactic Space

Consensus by cosmologists and astrophysicists strongly support that astronomical bodies and structures in the universe are mostly influenced by gravity, Einstein's theory of general relativity and quantum mechanics, to explain the origin, structure and evolution of the universe on cosmic scales. Presently, plasma cosmology is openly rejected by the vast majority of researchers because it does not match modern observations of astrophysical phenomena or accepted cosmological theory. However, from the standpoint of tachyon plasma field, alternative mechanism for the light propagation in the space can be proposed.

According to the electromagnetic theory, electromagnetic waves in the plasma can be described as

$$\frac{\partial^2 \vec{E}}{\partial x^2} - \left(\frac{\omega_p}{u}\right)^2 \vec{E} = \frac{1}{u^2} \frac{\partial^2 \vec{E}}{\partial t^2} , \quad (14)$$

By substituting $E = A \cdot \exp[i(kx - \omega t)]$ into Eq.(14), we have

$$k = \pm i\sqrt{\omega_p^2 - \omega} / u \ , \qquad (15)$$

As the electric field can be described by $\vec{E} = -\nabla\phi - \partial\vec{A}/\partial t$ by using the scalar potential ϕ and the vector potential $\vec{A}$, the wave equation for the electromagnetic field can be given by [12]

$$\nabla^2\phi - \frac{1}{u^2}\frac{\partial^2}{\partial t^2}\phi = -\frac{\rho}{\varepsilon_0} \ , \qquad (16)$$

$$\nabla^2\vec{A} - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\vec{A} = -\mu_0\vec{J} + \left(\frac{1}{c^2} - \frac{1}{u^2}\right)\frac{\partial\nabla\phi}{\partial t} \ , \qquad (17)$$

where ρ is a charge density, $\vec{J}$ is a current density, ε_0 and μ_0 are a permittivity and a permeability of free space.

For the case when satisfying $\omega_p >> \omega$, the vector potential, the velocity of which in a free space equals the light speed, is rapidly attenuated and finally becomes zero from Eq.(15) and only longitudinal waves scalar potential is much higher that the light speed.

$$\nabla^2\phi - \frac{1}{c_l^2}\frac{\partial^2}{\partial t^2}\phi = -\frac{\rho}{\varepsilon_0} \ , \qquad (18)$$

$$\left(\frac{1}{c^2} - \frac{1}{c_l^2}\right)\frac{\partial\nabla\phi}{\partial t} = \mu_0\vec{J} \ , \qquad (19)$$

where c_l is the velocity of longitudinal waves.

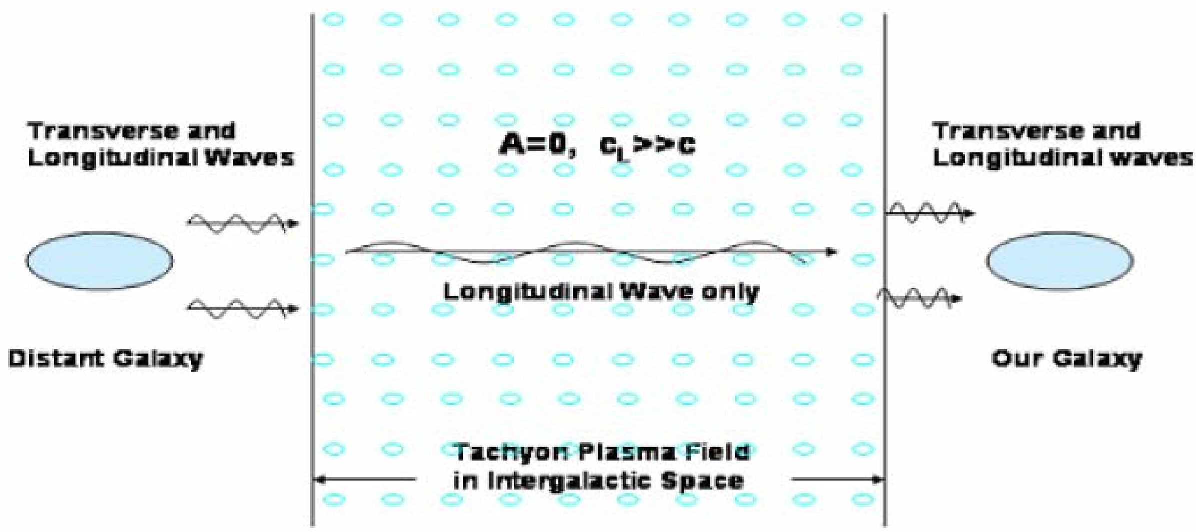

Figure 1: Wave propagation in the intergalactic space

Figure.1 shows the wave propagation in the intergalactic space, and transverse waves are attenuated inside tachyon plasma field between the intergalactic space and only longitudinal waves propagate through it and reach to our galaxy.

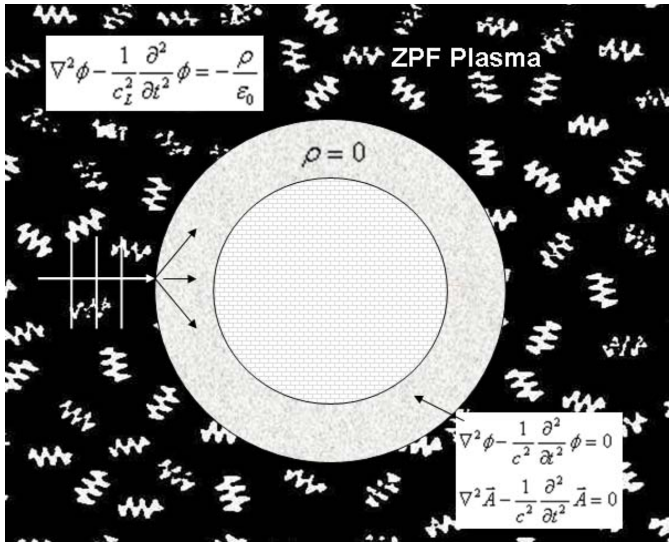

Figure 2: Transformation of mode of scalar waves into transverse and longitudinal waves

Supposing that there is no tachyon plasma field in the neighborhood of our planet as shown in Fig.2, where $c_l = c$, $\rho = 0$ and $\vec{J} = 0$, the scalar wave is transformed into transverse and longitudinal waves according to Eqs. (16) and (17), given by

$$\nabla^2\phi - \frac{1}{c_l^2}\frac{\partial^2}{\partial t^2}\phi = 0 , \tag{20}$$

$$\nabla^2\vec{A} - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\vec{A} = 0 , \tag{21}$$

From Eq.(15), we have $k \approx \pm i\omega_p / c_l$ for the photo traveling in a longitudinal mode inside the plasma field, which frequency is much lower than the plasma resonant frequency. Then the energy of the photon inside the plasma field is given by

$$E(x) = E_0 \exp(-\beta x) = E_0 \exp\left(-\frac{2\omega_p}{c_l}x\right), \tag{22}$$

where E is the energy of the photon, β is an attenuation constant and x is a traveling distance of the photon from its source.

V. Red Shift of the Light From the Distant Galaxies due to Tachyon Plasma Field

A minority of astrophysicists has been unconvinced that the cosmological redshifts as shown in Fig.3 are associated with a universal cosmological expansion. Skepticism and alternative explanations began appearing in the scientific literature in the 1960s. In particular, G. Burbidge, W. Tifft and H. Arp were all observational astrophysicists who proposed that there were inconsistencies in the redshift observations of galaxies and quasars.

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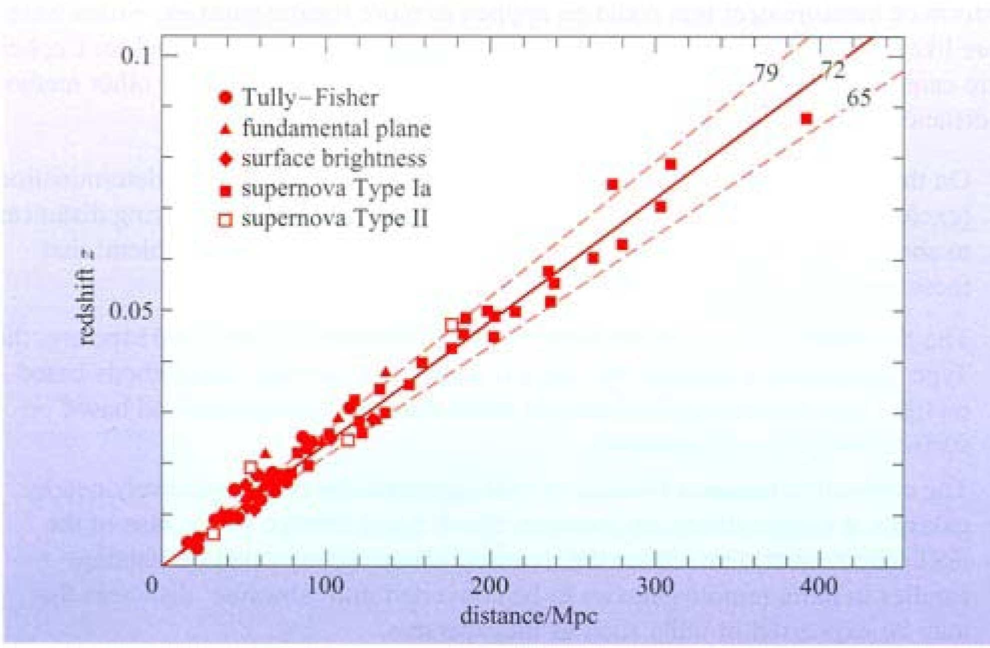

Figure 3: Cosmological redshift of distant astronomical bodies (www.astro.virginia.edu)

From the relation of energy of waves shown as $E = 2\pi\hbar c/\lambda$, the wavelength of the photon becomes

$$\lambda(x) = \lambda_0 \exp\left(\frac{2\omega_p}{c_l} x\right) \quad , \qquad (23)$$

where λ_0 is the wavelength of the photon at the instant of emission and λ is the wavelength of the photon at the distance of x.

If the values of $2\omega_p / c_l$ is negligibly small compared with unity, the relation of the redshift of the photon at the distance of x can be given by

$$\frac{\lambda - \lambda_0}{\lambda_0} = \exp\left(\frac{2\omega_p}{c_l} x\right) - 1 \approx \frac{2\omega_p}{c_l} x \ , \qquad (24)$$

From which, the receding velocity of distant galaxies can be obtained as

$$v/c = \frac{2\omega_p}{c_l} x \ , \qquad (25)$$

where the speed of the longitudinal wave in an intergalactic space can be estimated from the Hubble constant H_0 as

$$c_l \approx \frac{2\omega_p c}{H_0} \leq 3.24 \times 10^{64} (m/s), \qquad (26)$$

from relation given by $v = H_0 x$ [13].

Considering higher terms of in Eq.(24), the velocity of expansion becomes

$$v/c = \frac{2\omega_p}{c_l} x + \frac{1}{2}\left(\frac{2\omega_p}{c_l}\right)^2 x^2 + \frac{1}{6}\left(\frac{2\omega_p}{c_l}\right)^3 x^3 + \cdots , \qquad (27)$$

If we let $c_l = 3.24 \times 10^{64} (m/s)$, expanding velocity of galaxies can be calculated from Eqs.(25) and (27) respectively as shown in Fig.4 and Fig.5, where the horizontal line is for a distance in billion light years and the vertical line is for the receding speed divided by the light speed.

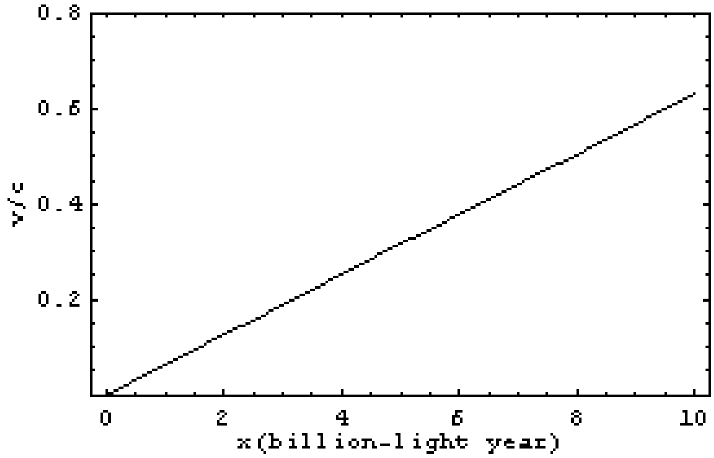

Figure 4: Speed of the distant galaxy predicted by Eq.(25)

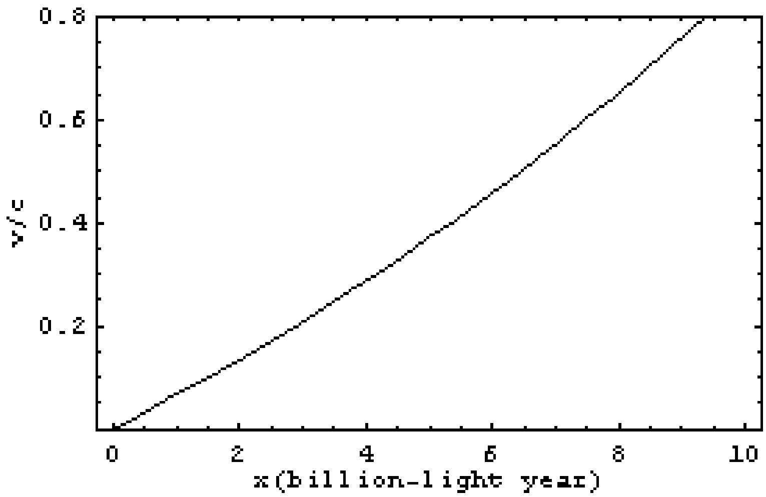

Figure 5: Speed of the distant galaxy predicted by Eq.(27)

From these figures, the calculation result considering higher terms shows that the receding speed of galaxies is accelerated with increased distance from us.

Recently astronomer groups have revealed the cosmic expansion is speeding up from the observation of very distant supernovae [14]. They concluded that their observation result is due to the repulsive cosmological constant, but it might also be explained by the attenuation of electromagnetic waves traveling in the intergalactic tachyon plasma field.

During the quasar controversies of the 1970s, these same astronomers were also of the opinion that quasars exhibited high redshifts not due to their incredible distance but rather due to unexplained intrinsic redshift mechanisms that would cause the periodicities and cast doubt on the Big Bang. If we suppose that the tachyon plasma field surrounding quasar is more dense due to the energy production mechanism than that of the intergalactic space, since the energy output required to explain the apparent brightness of cosmologically-distant quasars was far too high to be explainable by nuclear fusion alone, we can explain high redshift observed by the experiments.

This interpretation of the cosmological redshift is also compatible with the finding that redshifts increases with distance in discrete values, rather than in a continuous curve. Spectral studies indicated that cosmological redshifts are quantized [15-17], that cannot be explained by Doppler shift of the conventional theory.

In 1973, astronomer William G. Tifft was the first to report evidence of this pattern. Subsequent discourse focused upon whether redshift surveys of quasars have produced evidence of quantization in excess of what is expected due to selection effect or galactic clustering. The idea has been on the fringes of astronomy since the mid-1990s and is now discounted by the vast majority of astronomers, but a few scientists who espouse nonstandard cosmological models, including those who reject the Big Bang theory, have referred to evidence of redshift quantization as reason to reject conventional accounts of the origin and evolution of the universe. Instead of the conventional theory, observed quantized represents discrete steps in the decay of photon energy by the propagation of photons through intergalactic plasma field.

VI. Conclusion

In this paper, it is shown that the cosmic redshift of light can be explained by the attenuation of electromagnetic waves in the intergalactic tachyon plasma field. From which, the recent observation result that cosmic expansion is speeding up can also be explained by the exponential attenuation of electromagnetic waves in the intergalactic tachyon plasma field.

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Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

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Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

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Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

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- Writings
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- Printed material
- Graphic representations
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3. Final approval of the version of the paper to be published.

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The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

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Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
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.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

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

Format Structure

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

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative 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) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

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

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning 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 a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be 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. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). 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.

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Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. 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.

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

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

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

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

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. 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 for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

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

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

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

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon 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 for 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 of 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 criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to 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 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 avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

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

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite 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 approaches 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. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a 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 limit the initial two items to no more than one line each.

Reason for writing the article—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 for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- o Single section and succinct.
- o An outline of the job done is always written in past tense.
- o Concentrate on shortening results—limit background information to a verdict or two.
- o Exact spelling, clarity 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 of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets 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 for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory 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 soundly written procedures segment allows a capable scientist to replicate 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 to give the least amount of information that would permit another capable scientist to replicate 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 section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show 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:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the 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—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and 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 as 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. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give 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 manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit 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 section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an 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 implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully 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 the prospect, and let it drop at that. Make a decision as to whether each premise is supported or 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 an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of 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 other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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	A-B	**C-D**	**E-F**
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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

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