Global Journal of Science Frontier Research

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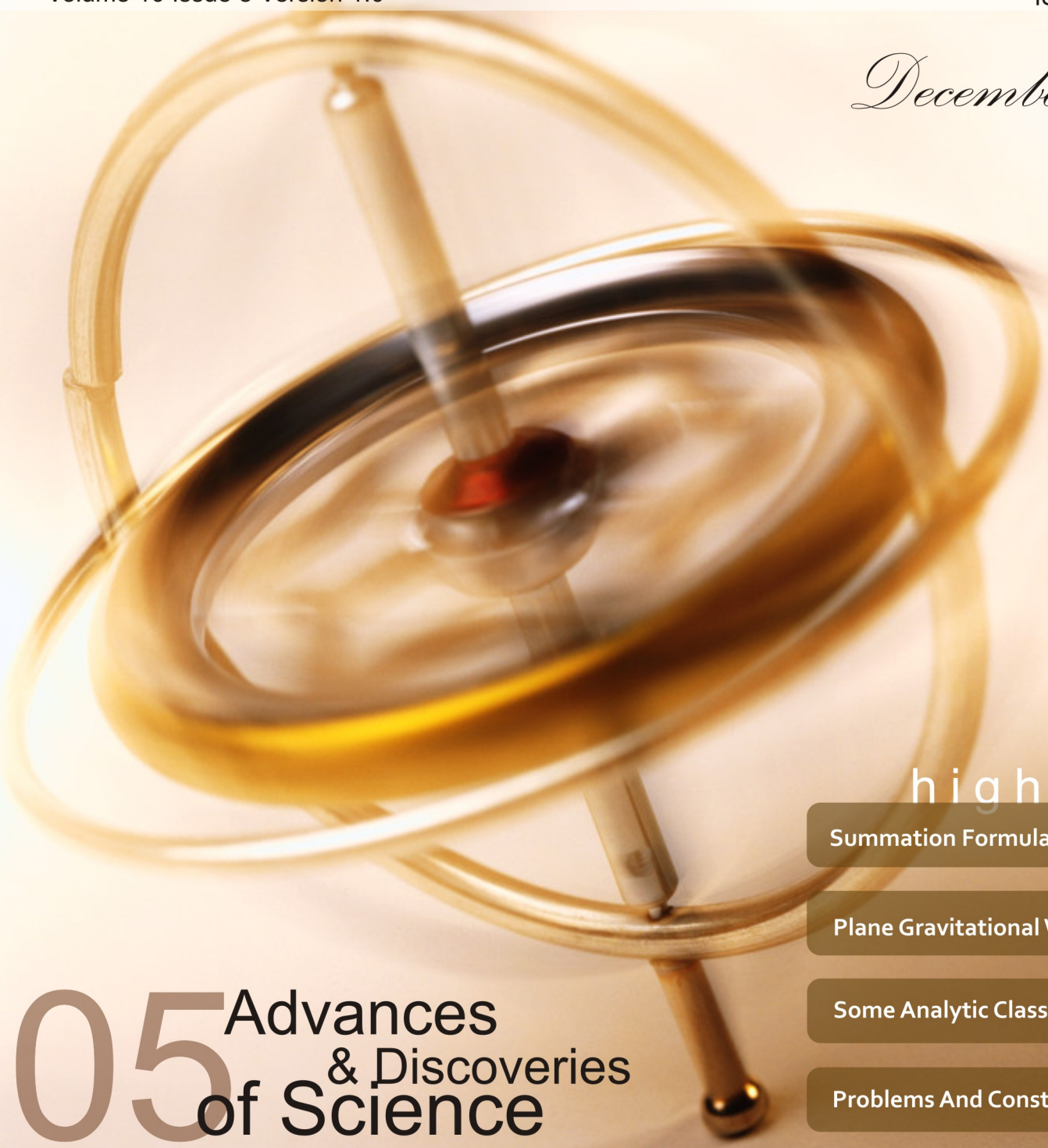
Volume 10 Issue 8 Version 1.0

ISSN: 0975-5896

December 2010



highlights

Summation Formulae Based

Plane Gravitational Waves

Some Analytic Classes

Problems And Constraints of Rabbitry

05 Advances & Discoveries of Science

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Global Journal of Science Frontier Research

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Volume 10 Issue 8 (Ver. 1.0)

Global Association of Research

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USA Tax ID: 98-0673427

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Contents of the Volume

From the Chief Author's Desk

We see a drastic momentum everywhere in all fields now a day. Which in turns, say a lot to everyone to excel with all possible way. The need of the hour is to pick the right key at the right time with all extras. Citing the computer versions, any automobile models, infrastructures, etc. It is not the result of any preplanning but the implementations of planning.

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Intentions are very clear to do best in all possible way with all care.

Dr. R. K. Dixit
Chief Author
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Efficacy Of Selected Plant Extracts On The Oviposition Deterrent And Adult Emergence Activity Of *Callosobruchus Maculatus* .F (Bruchidae; Coeleoptera)

GJSFR-G (FOR)
Classification: 060799

J.Shifa vanmathi[1] , C.Padmalatha[2], A.J.A.Ranjit Singh[3] and S.Suthakar isaac[4]

Abstract- **A study was undertaken to find out the effect of aqueous extracts of *Phyllanthus amarus, Ocimum tenuiflorum, Cynodon dactylon, Catharanthus roseus, Azadirachta indica, Tephrosia Purpurae, Morinda pubescens, Calotropis gigantea, Vitex negundo* and *Sesbania grandiflora* on oviposition deterrent and F_1 adult emergence were carried out at three different concentrations (1%, 3%, 5%) using black gram *Vigna munga* (L.) against *C. maculatus.* Maximum oviposition deterrent activity was observed in *C. dactylon* treatment *(*84.32%) which was par with *O. tenuiflorum* followed by *P.amarus* (83.83%) at higher concentration. All these plant extracts showed above 50% oviposition deterrent activity even at lower concentration. Reduction in F_1 adult emergence was also high after using these plant extracts.**

Keywords: *Callosobruchus maculatus*, aqueous extracts, oviposition deterrent activity, adult emergence.

I. INTRODUCTION

The cowpea beetle, *Callosobruchus maculatus* is a cosmopolitan insect pest of cowpea. It is a field -to-store pest as its infestation of cowpea often begins in the field as the mature pods dry (Huignard *et al.,* 1985; Sathyaseelan *et al.,* 2008) and when such seeds are harvested and stored, the pest population increases rapidly and results in total destruction within a short duration of 3-4 months (Rahman and Talukder, 2006). It multiplies very rapidly in storage (Ouedraogo *et al*, 1996) and reported 8.5% loss in pulses during post harvest handling and storage in India. Synthetic chemical insecticides have proved to be effective in the control of the beetle.Earlier, Petrolium ether extrat of neem (Ranjana Saxena and Beenam Saxena 2000), dichloromethane and methanol extract of *Acorus calamus* and *Cassia siamia* (Jayakumar *et al.,* 2005a), *Jatropha curcas* seed oil (Adebowale and Adedire, 2006), powdered leaves and extracts of *Vitex negundo* (Rahman and Talukder, 2006), plant lectins derived from *Cicer arietinum* (Sadeghi *et al*, 2006) and powder of *Terminalia chebula* and *Cassia auriculata* (Govindan and Jeyarajan Nelson, 2008) were reported to have significant oviposition deterrent and other biological activity against *C. maculatus.* In this context, based on the earlier literatures and easy availability of the plants, ten plants were screened viz *Phyllanthus amarus, Ocimum tenuiflorum, Cynodon dactylon, Catharanthus roseus, Azadirachta indica, Tephrosia purpurae, Morinda pubescens, Calotropis gigantea, Vitex negundo* and *Sesbania grandiflora* for their oviposition deterrent and adult emergence activity against *C.maculatus*

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II. MATERIALS AND METHODS

1. *Insect culture*

Black gram seeds infested by the *C. maculatus* were collected from the grocery shop and brought to the laboratory. The infested seeds were set aside in a plastic container and covered with muslin cloth till the emergence of adult. Healthy adults emerged from the container were shifted to another plastic container and provided cleaned blackgram seed for oviposition and maintained at 28 ± 2°C and 70 ± 5% R.H. The container was undisturbed until the emergence of adults. Freshly emerged subsequent generations were used for further experiments.

2. *Preparation of plant extracts*

Fresh leaves of selected plants *Phyllanthus amarus, Ocimum tenuiflorum, Cynodon dactylon, Catharanthus roseus, Azadirachta indica, Tephrosia Purpurae, Morinda pubescens, Calotropis gigantea, Vitex negundo* and *Sesbania grandiflora* were collected at their respective places and brought to the laboratory. Each plant material was dried under shade and powdered by using electric grinder and pass through a 20 mesh sieve and kept in a 1 kg capacity polypropylene bag. 300 g of each powdered plant material were taken into 1 litre capacity conical flask and 1000 ml of distilled water was added to it and shaken for 8 h in a mechanical shaker and then kept it for 24 h. The extract was separated using fine muslin cloth and then filtered. The filtrate was collected in a 2 litre capacity conical flask and volume was made up to 1000.ml. This was considered as stock solution. Required concentrations (1%, 3%, 5%) were prepared from the stock solution.

3. Oviposition deterrent activity

Black gram seeds were cleaned and sterilized at 45° C for 6 h in order to kill the eggs and developing larvae. For each concentration, 25g blackgram seeds were taken in a conical flask and mixed with each concentration of aqueous extracts and seeds treated with water alone used as control. After thorough mixing the seeds were air dried and they were stored in plastic containers and 5 pairs of newly emerged adult *C maculatus* were introduced in each container. Three replicates were maintained for each concentration and control. After 15 days, number of eggs laid on treated seeds (Ts) and control seeds (Cs) were recorded and the percentage of oviposition deterrence (POD) was calculated as POD |(Ts-Cs)/Cs|X 100.

4. Adult Emergence activity

After the eggs were counted the experimental set up was kept undisturbed till the emergence of F_1 adults from the treated and untreated seeds. The number of F_1 adults emerged from the control seeds (Ac) and treated seeds (At) were recorded. The percentage reduction in F_1 adult (PRA) emergence (Fl) was calculated as PRA |(Ac-At)/ Ac|X 100.

5. Data analysis

Mean number of eggs laid on treated and control seeds and F_1 adult emergence were calculated using the above said formula. The data obtained from the experiments were subjected to two-way analysis of variance (ANOVA).

III. RESULT AND DISCUSSION

Earlier literature indicate the importance of plant extract in protecting seeds by way of direct mixing of the dried leaves, plant powders, solvent extracts, vegetable/ essential oils on seeds during post harvest storage (Rajapakse, 1996; Ngamo *et al.,* 2007; Meera Srivastava and Lalitha Gupta, 2007; Zahra Sahaf and Moharramipour, 2008; Othira *etal.,* 2009)
The reduction in oviposition was increased with the increase in dosage of each treatment. Earlier, Olaifa and Erhun (1998) found that higher concentration of the powder of *Piper guineense* significantly reduced the oviposition. These earlier findings are in conformation with the present study. Higher concentrations of plant extracts (5%) were found to be effective as compound to lower ones (1% and 3%) in bringing down the egg laying by the pest insect. Present study revealed that, maximum oviposition deterrent activity was observed in *O. tenuiflorum and C. dactylon* followed *by P. amarus* (Table 1). It is noteworthy that all these plant extracts showed more than 50% of deterrent activity even at lower concentration. It appears that these plant extracts might possess repellent and/or oviposition deterrent principles. Oviposition detergency may be due to the changes induced in physiology and behaviour in the adult of *C. maculatus* as reflected by their egg laying capacity.The data shown in Table 2 revealed the effect of leaf extracts on adult emergence of pulse beetle. A significant reduction in adult emergence was among the treatments. It is added that efficacy of these selected plant extracts was much stronger against F_1 than egg laying. Jayakumar *et al.* (2003) reported that plant extracts have obvious effects on postembryonic survival of the insect and resulting reduction in adult emergence in all the concentrations of different plants. In the present study, maximum reduction in the adult emergence was observed in the seeds treated with *Azadirachta indica.* Adult emergence was reduced to 5.66±0.66 at 1% 2.66±0.33 at 3% and 1.66± 0.33 at 5% concentration of *Azadirachta indica* . It was followed by T.purpurae (82.11%) at 1% (88.62%) at 3% and (94.31%)at 5% concentrations. However *O.tenuiflorum* was found to be effective in reducing the adult emergence at a higher concentration. Annie Bright (2001) and Raja *et al.* (2001) reported that botanicals inhibited adult emergence in C. *maculatus.* in cowpea. They further stated that, when the eggs were laid on treated seeds, the toxic substance present in the extract may enter in to the egg through chorion and suppressed their embryonic development. It is in agreement with the present study that adult emergence was greatly reduced in treated seeds than control seeds.Raja *et al.* (2001), Keita *et al.* (2001) and Sathyaseelan et al. (2008) reported that various plant products were effective in reducing oviposition and adult emergence of *C. maculatus* only, *but the* seed quality .and germination were not affected. These results are in accordance with our findings. The present investigation has brought out the efficacy of *Phyllanthus amarus, Ocimum tenuiflorum, Cynodon dactylon, Catharanthus roseus, Azadirachta indica, Tephrosia Purpurae, Morinda pubescens, Calotropis gigantea, Vitex negundo* and *Sesbania grandiflora.* Preparation of these aqueous extracts and application on the seeds are so easy and cheaper. Hence, effectual plant extract can be used as one of the component in Integrated Pest Management especially small godowns or shop retailer for short term storage.

***Heading** 1 Table: 1 Effect of plant extracts on Oviposition of pulse beetle, C. maculatus*

Treatment	Total no. of Eggs laid		
	Conc % v/w		
	1%	3%	5%
Control	134.00±2.88		
Phyllanthus amarus	39.66±0.66 (70.4)	31.66±1.45 (76.37)	21.66±0.33 (83.83)
Ocimum tenuiflorum	38.66±5.23 (71.14)	27.33±3.38 (79.6)	21.00±0.00 (84.32)
Cynodon dactylon	41.33±3.28 (69.15)	28.33±2.33 (78.85)	21.00±1.15 (84.32)
Catharanthus roseus	49.66±1.85 (62.94)	39.66±4.25 (70.4)	30.33±1.76 (77.36)
Azadirachta indica	55.33±4.33 (58.7)	43.66±5.45 (67.41)	26.00±0.57 (80.59)
Tephrosia Purpurae	69.00±2.30 (48.5)	55.00±2.00 (58.95)	40.66±1.20 (69.65)
Morinda pubescens	65.33±2.33 (51.24)	49.66±1.66 (62.94)	44.00±1.00 (67.16)
Calotropis gigantea	63.33±1.20 (52.73)	52.33±0.88 (60.94)	41.66±1.45 (68.91)
Vitex negundo	70.33±5.60 (51)	53.33±1.76. (60.2)	44.00±2.51 (67.16)
Sesbania grandiflora	73.66±3.52 (45.02)	52.00±4.50 (61.19)	35.00±0.57 (73.88)

Within the column values was statistically significant ($P<0.05$)

Heading 2 *Table: 2 Effect of plant extracts on adult emergence of pulse beetle, C. maculatus*

Treatment	Total no. of Eggs laid		
	Conc % v/w		
	1%	3%	5%
Control	41.00±0.57		
Phyllanthus amarus	27.00±3.00 (34.15)	15.66±0.33 (34.15)	14.33±0.33 (65.04)
Ocimum tenuifloum	20.33±0.33 (50.41)	20.33±0.33 (50.41)	4.00±0.57 (90.24)
Cynodon dactylon	27.66±2.66 (32.52)	19.00±4.93 (53.66)	10.00±0.00 (75.61)
Catharanthus roseus	36.33±0.33 (11.38)	26.00±0.00 (36.59)	16.33±0.33 (60.16)
Azadirachta indica	5.66±0.66 (86.18)	2.66±0.33 (93.50)	1.66±0.33 (95.93)
Tephrosia Purpurae	7.33±0.33 (82.11)	4.66±0.33 (88.62)	2.33±0.33 (94.31)
Morinda pubescens	26.33±0.33 (35.77)	21.66±0.33 (47.15)	19.00±0.57 (53.66)
Calotropis gigantea	24.66±0.33 (39.84)	21.33±0.33 (47.97)	18.00±0.57 (56.10)
Vitex negundo	27.33±0.66 (33.33)	23.00±0.57 (43.90)	19.00±0.57 (53.66)
Sesbania grandiflora	27.33±0.66 (33.33)	23.00±0.57 (43.90)	19.00±0.57 (53.66)

Within the column values was statistically significant ($P<0.05$)

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Two Summation Formulae Based On Half Argument Associated To Hypergeometric Function

GJSFR-F; A.M.S. Subject Classification (2000): 33C60, 33C70

SALAHUDDIN

***Abstract*-The aim of the present paper is to obtain two summation formulae based on half argument associated to Hypergeometric function.The results derived in this paper are of general character and are believed to be new.**

A.M.S. Subject Classification (2000): 33C60 , 33C70

Keywords and Phrases: Contiguous relation,Recurrence relation, Gauss second summation theorem.

I. Introduction

Generalized Gaussian Hypergeometric Function of one variable is difined by

$$ {}_AF_B\left[\begin{array}{ccc} a_1, a_2, \cdots, a_A & ; & \\ & & z \\ b_1, b_2, \cdots, b_B & ; & \end{array}\right] = \sum_{k=0}^{\infty} \frac{(a_1)_k (a_2)_k \cdots (a_A)_k z^k}{(b_1)_k (b_2)_k \cdots (b_B)_k k!} $$

or

$$ {}_AF_B\left[\begin{array}{ccc} (a_A) & ; & \\ & & z \\ (b_B) & ; & \end{array}\right] \equiv {}_AF_B\left[\begin{array}{ccc} (a_j)_{j=1}^{A} & ; & \\ & & z \\ (b_j)_{j=1}^{B} & ; & \end{array}\right] = \sum_{k=0}^{\infty} \frac{((a_A))_k z^k}{((b_B))_k k!} \tag{1} $$

where the parameters $b_1, b_2, \cdots, b_B$ are neither zero nor negative integers and A, B are non-negative integers.

Contiguous Relation is defined by

[Andrews p.363(9.16), E. D. p.51(10), H.T. F. I p.103(32)]

$$ (a-b)\ {}_2F_1\left[\begin{array}{ccc} a, & b & ; \\ c & & ; \end{array} z\right] = a\ {}_2F_1\left[\begin{array}{ccc} a+1, & b & ; \\ c & & ; \end{array} z\right] - b\ {}_2F_1\left[\begin{array}{ccc} a, & b+1 & ; \\ c & & ; \end{array} z\right] \tag{2} $$

Recurrence relation is defined by

$$ (z+1) = z\ \Gamma(z) \tag{3} $$

Gauss second summation theorm is defined by [Prud., 491(7.3.7.5)]

$$ {}_2F_1\left[\begin{array}{ccc} a, & b & ; \\ \frac{a+b+1}{2} & & ; \end{array} \frac{1}{2}\right] = \frac{\Gamma(\frac{a+b+1}{2})\ \Gamma(\frac{1}{2})}{(\frac{a+1}{2})\ \Gamma(\frac{b+1}{2})} \tag{4} $$

$$ = \frac{2^{(b-1)}\ \Gamma(\frac{b}{2})\ \Gamma(\frac{a+b+1}{2})}{(b)\ \Gamma(\frac{a+1}{2})} \tag{5} $$

In a monograph of Prudnikov et al., a summation theorem is given in the form [Prud., p.491(7.3.7.3)]

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$$ {}_2F_1\left[\begin{matrix} a,\ b \\ \frac{a+b-1}{2} \end{matrix};\ \frac{1}{2}\right] = \sqrt{\pi}\left[\frac{\Gamma(\frac{a+b+1}{2})}{\Gamma(\frac{a+1}{2})\,\Gamma(\frac{b+1}{2})} + \frac{2\,\Gamma(\frac{a+b-1}{2})}{\Gamma(a)\,\Gamma(b)}\right] \tag{6} $$

Now using Legendre's duplication formula and Recurrence relation for Gamma function, the above theorem can be written in the form

$$ {}_2F_1\left[\begin{matrix} a,\ b \\ \frac{a+b-1}{2} \end{matrix};\ \frac{1}{2}\right] = \frac{2^{(b-1)}\,\Gamma(\frac{a+b-1}{2})}{\Gamma(b)}\left[\frac{\Gamma(\frac{b}{2})}{\Gamma(\frac{a-1}{2})} + \frac{2^{(a-b+1)}\,\Gamma(\frac{a}{2})\,\Gamma(\frac{a+1}{2})}{\{\Gamma(a)\}^2} + \frac{\Gamma(\frac{b+2}{2})}{\Gamma(\frac{a+1}{2})}\right] \tag{7} $$

B. MAIN RESULTS OF SUMMATION FORMULAE

$$ {}_2F_1\left[\begin{matrix} a,\ \ b \\ \frac{a+b+21}{2} \end{matrix};\ \frac{1}{2}\right] = \frac{2^b\,\Gamma(\frac{a+b+21}{2})}{(a-b)\,\Gamma(b)}\times $$

$$ \times\left[\frac{\Gamma(\frac{b}{2})}{\Gamma(\frac{a+1}{2})}\left\{\frac{512a(-34459425+71697105a-53809164a^2+20570444a^3-4574934a^4)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+\right.\right. $$

$$ +\frac{512a(626934a^5-53676a^6+2796a^7-81a^8+a^9+127734435b-74042088ab+158767116a^2b)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+ $$

$$ +\frac{512a(-27708840a^3b+12096426a^4b-856824a^5b+129276a^6b-3192a^7b+171a^8b)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+ $$

$$ +\frac{512a(17316372b^2+224894564ab^2-24458852a^2b^2+50456476a^3b^2-2913460a^4b^2)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+ $$

$$ +\frac{512a(1236444a^5b^2-27132a^6b^2+3876a^7b^2+65285444b^3+10669336ab^3+65808020a^2b^3)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+ $$

$$ +\frac{512a(-2041360a^3b^3+3959980a^4b^3-69768a^5b^3+27132a^6b^3+6670026b^4+27977614ab^4)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+ $$

$$ +\frac{512a(1272620a^2b^4+4954820a^3b^4-41990a^4b^4+75582a^5b^4+3074466b^5+1144712ab^5)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+ $$

$$ +\frac{512a(2479348a^2b^5+33592a^3b^5+92378a^4b^5+150708b^6+453492ab^6+34884a^2b^6)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+ $$

$$+\frac{512a(50388a^3b^6+22116b^7+7752ab^7+11628a^2b^7+399b^8+969ab^8+19b^9)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512b(-34459425+127734435a+17316372a^2+65285444a^3+6670026a^4+3074466a^5)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512b(150708a^6+22116a^7+399a^8+19a^9+71697105b-74042088ab+224894564a^2b)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512b(10669336a^3b+27977614a^4b+1144712a^5b+453492a^6b+7752a^7b+969a^8b)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512b(-53809164b^2+158767116ab^2-24458852a^2b^2+65808020a^3b^2+1272620a^4b^2)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512b(2479348a^5b^2+34884a^6b^2+11628a^7b^2+20570444b^3-27708840ab^3+50456476a^2b^3)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512b(-2041360a^3b^3+4954820a^4b^3+33592a^5b^3+50388a^6b^3-4574934b^4+12096426ab^4)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512b(-2913460a^2b^4+3959980a^3b^4-41990a^4b^4+92378a^5b^4+626934b^5-856824ab^5)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512b(1236444a^2b^5-69768a^3b^5+75582a^4b^5-53676b^6+129276ab^6-27132a^2b^6)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512b(27132a^3b^6+2796b^7-3192ab^7+3876a^2b^7-81b^8+171ab^8+b^9)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}\Big\}-$$

$$-\frac{\Gamma(\frac{b+1}{2})}{\Gamma(\frac{a}{2})}\Big\{\frac{1024(34459425+127734435a-17316372a^2+65285444a^3-6670026a^4)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{1024(3074466a^5-150708a^6+22116a^7-399a^8+19a^9+71697105b+74042088ab)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{1024(224894564a^2b-10669336a^3b+27977614a^4b-1144712a^5b+453492a^6b-7752a^7b)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{1024(969a^8b+53809164b^2+158767116ab^2+24458852a^2b^2+65808020a^3b^2-1272620a^4b^2)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{1024(2479348a^5b^2-34884a^6b^2+11628a^7b^2+20570444b^3+27708840ab^3+50456476a^2b^3)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{1024(2041360a^3b^3+4954820a^4b^3-33592a^5b^3+50388a^6b^3+4574934b^4+12096426ab^4)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{1024(2913460a^2b^4+3959980a^3b^4+41990a^4b^4+92378a^5b^4+626934b^5+856824ab^5)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{1024(1236444a^2b^5+69768a^3b^5+75582a^4b^5+53676b^6+129276ab^6+27132a^2b^6)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{1024(27132a^3b^6+2796b^7+3192ab^7+3876a^2b^7+81b^8+171ab^8+b^9)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{1024(34459425+71697105a+53809164a^2+20570444a^3+4574934a^4+626934a^5+53676a^6)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{1024(2796a^7+81a^8+a^9+127734435b+74042088ab+158767116a^2b+27708840a^3b)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{1024(12096426a^4b+856824a^5b+129276a^6b+3192a^7b+171a^8b-17316372b^2)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{1024(224894564ab^2+24458852a^2b^2+50456476a^3b^2+2913460a^4b^2+1236444a^5b^2)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{1024(27132a^6b^2+3876a^7b^2+65285444b^3-10669336ab^3+65808020a^2b^3+2041360a^3b^3)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{1024(3959980a^4b^3+69768a^5b^3+27132a^6b^3-6670026b^4+27977614ab^4-1272620a^2b^4)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{1024(4954820a^3b^4+41990a^4b^4+75582a^5b^4+3074466b^5-1144712ab^5+2479348a^2b^5)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{1024(-33592a^3b^5+92378a^4b^5-150708b^6+453492ab^6-34884a^2b^6+50388a^3b^6)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{1024(22116b^7-7752ab^7+11628a^2b^7-399b^8+969ab^8+19b^9)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}\Bigg\}\Bigg] \qquad (8)$$

$${}_2F_1\left[\begin{matrix}a,\ b\ ;\\ \frac{a+b+22}{2}\ ;\end{matrix}\ \frac{1}{2}\right]=\frac{2^b\ \Gamma(\frac{a+b+22}{2})}{(a-b)\ \Gamma(b)}\times$$

$$\times\left[\frac{\Gamma(\frac{b}{2})}{\Gamma(\frac{a}{2})}\left\{\frac{1024(-185794560a+262803456a^2-150105600a^3+46315520a^4-8618400a^5+1012368a^6)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}\times\right.\right.$$

$$+\frac{1024(-75600a^7+3480a^8-90a^9+a^{10}+185794560b+802676736ab-241497600a^2b)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{1024(451573760a^3b-62262240a^4b+22911264a^5b-1390800a^6b+182400a^7b-3990a^8b)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{1024(190a^9b+262803456b^2+241497600ab^2+886415360a^2b^2-62739520a^3b^2)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{1024(115995760a^4b^2-5555600a^5b^2+2015520a^6b^2-38760a^7b^2+4845a^8b^2+150105600b^3)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{1024(451573760ab^3+62739520a^2b^3+193593280a^3b^3-4522000a^4b^3+7648640a^5b^3)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{1024(-116280a^6b^3+38760a^7b^3+46315520b^4+62262240ab^4+115995760a^2b^4+4522000a^3b^4)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{1024(11757200a^4b^4-83980a^5b^4+125970a^6b^4+8618400b^5+22911264ab^5+5555600a^2b^5)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{1024(7648640a^3b^5+83980a^4b^5+184756a^5b^5+1012368b^6+1390800ab^6+2015520a^2b^6)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{1024(116280a^3b^6+125970a^4b^6+75600b^7+182400ab^7+38760a^2b^7+38760a^3b^7)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{1024(3480b^8+3990ab^8+4845a^2b^8+90b^9+190ab^9+b^{10})}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{4096b(166035456a+34142208a^2+43209472a^3+4122240a^4+1370064a^5+60672a^6+7368a^7)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}\times$$

$$+\frac{4096b(120a^8+5a^9+166035456b+192064768a^2b+14013184a^3b+14821520a^4b+593408a^5b)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{4096b(172824a^6b+2736a^7b+285a^8b-34142208b^2+192064768ab^2+42987424a^3b^2)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{4096(1240320a^4b^2+1103368a^5b^2+15504a^6b^2+3876a^7b^2+43209472b^3-14013184ab^3)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{4096b(42987424a^2b^3+2648600a^4b^3+25840a^5b^3+19380a^6b^3-4122240b^4+14821520ab^4)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{4096b(-1240320a^2b^4+2648600a^3b^4+41990a^5b^4+1370064b^5-593408ab^5+1103368a^2b^5)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{4096b(-25840a^3b^5+41990a^4b^5-60672b^6+172824ab^6-15504a^2b^6+19380a^3b^6+7368b^7)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{4096b(-2736ab^7+3876a^2b^7-120b^8+285ab^8+5b^9)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}\Big\}-$$

$$-\frac{\Gamma(\frac{b+1}{2})}{\Gamma(\frac{a+1}{2})}\Bigg\{\frac{4096a(166035456a-34142208a^2+43209472a^3-4122240a^4+1370064a^5-60672a^6)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{4096a(7368a^7-120a^8+5a^9+166035456b+192064768a^2b-14013184a^3b+14821520a^4b)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{4096a(-593408a^5b+172824a^6b-2736a^7b+285a^8b+34142208b^2+192064768ab^2)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{4096a(42987424a^3b^2-1240320a^4b^2+1103368a^5b^2-15504a^6b^2+3876a^7b^2+43209472b^3)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{4096a(14013184ab^3+42987424a^2b^3+2648600a^4b^3-25840a^5b^3+19380a^6b^3+4122240b^4)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{4096a(14821520ab^4+1240320a^2b^4+2648600a^3b^4+41990a^5b^4+1370064b^5+593408ab^5)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{4096a(1103368a^2b^5+25840a^3b^5+41990a^4b^5+60672b^6+172824ab^6+15504a^2b^6)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{4096a(19380a^3b^6+7368b^7+2736ab^7+3876a^2b^7+120b^8+285ab^8+5b^9)}{\Big(\prod_{\beta=0}^{9}\{a-b-2\beta\}\Big)\Big(\prod_{\sigma=1}^{10}\{a-b+2\sigma\}\Big)}+$$

$$+\frac{1024(185794560a+262803456a^2+150105600a^3+46315520a^4+8618400a^5+1012368a^6)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{1024(75600a^7+3480a^8+90a^9+a^{10}-185794560b+802676736ab+241497600a^2b)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{1024(451573760a^3b+62262240a^4b+22911264a^5b+1390800a^6b+182400a^7b+3990a^8b)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{1024(190a^9b+262803456b^2-241497600ab^2+886415360a^2b^2+62739520a^3b^2)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{1024(115995760a^4b^2+5555600a^5b^2+2015520a^6b^2+38760a^7b^2+4845a^8b^2-150105600b^3)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{1024(451573760ab^3-62739520a^2b^3+193593280a^3b^3+4522000a^4b^3+7648640a^5b^3}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{1024(116280a^6b^3+38760a^7b^3+46315520b^4-62262240ab^4+115995760a^2b^4-4522000a^3b^4)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{1024(11757200a^4b^4+83980a^5b^4+125970a^6b^4-8618400b^5+22911264ab^5-5555600a^2b^5)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{1024(7648640a^3b^5-83980a^4b^5+184756a^5b^5+1012368b^6-1390800ab^6+2015520a^2b^6)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{1024(-116280a^3b^6+125970a^4b^6-75600b^7+182400ab^7-38760a^2b^7+38760a^3b^7+3480b^8)}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}+$$

$$+\frac{1024(-3990ab^8+4845a^2b^8-90b^9+190ab^9+b^{10})}{\Big(\prod_{\alpha=0}^{10}\{a-b-2\alpha\}\Big)\Big(\prod_{\delta=1}^{9}\{a-b+2\delta\}\Big)}\Bigg\}\Bigg] \qquad (9)$$

C. DERIVATION OF SUMMATION FORMULA (8) :

Substituting $c=\frac{a+b+21}{2}$ and $z=\frac{1}{2}$ in equation (2), we get

$$(a-b)\ {}_2F_1\left[\begin{matrix}a,\ b\\ \frac{a+b+21}{2}\end{matrix};\ \frac{1}{2}\right]=a\ {}_2F_1\left[\begin{matrix}a+1,\ b\\ \frac{a+b+21}{2}\end{matrix};\ \frac{1}{2}\right]-b\ {}_2F_1\left[\begin{matrix}a,\ b+1\\ \frac{a+b+21}{2}\end{matrix};\ \frac{1}{2}\right]$$

Now using Gauss second summation theorem, we get

$$L.H.S=a\,\frac{2^b\ \Gamma(\frac{a+b+21}{2})}{\Gamma(b)}\Bigg[\frac{\Gamma(\frac{b}{2})}{\Gamma(\frac{a+1}{2})}\Bigg\{\frac{512(-34459425+71697105a-53809164a^2+20570444a^3)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(-4574934a^4+626934a^5-53676a^6+2796a^7-81a^8+a^9+127734435b-74042088ab)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(158767116a^2b-27708840a^3b+12096426a^4b-856824a^5b+129276a^6b-3192a^7b)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(171a^8b+17316372b^2+224894564ab^2-24458852a^2b^2+50456476a^3b^2-2913460a^4b^2)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(1236444a^5b^2-27132a^6b^2+3876a^7b^2+65285444b^3+10669336ab^3+65808020a^2b^3)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(-2041360a^3b^3+3959980a^4b^3-69768a^5b^3+27132a^6b^3+6670026b^4+27977614ab^4)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(1272620a^2b^4+4954820a^3b^4-41990a^4b^4+75582a^5b^4+3074466b^5+1144712ab^5)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(2479348a^2b^5+33592a^3b^5+92378a^4b^5+150708b^6+453492ab^6+34884a^2b^6)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(50388a^3b^6+22116b^7+7752ab^7+11628a^2b^7+399b^8+969ab^8+19b^9)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}\Big\}-$$

$$-\frac{\Gamma(\frac{b+1}{2})}{\Gamma(\frac{a+2}{2})}\Big\{\frac{512(34459425+127734435a-17316372a^2+65285444a^3-6670026a^4+3074466a^5)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(-150708a^6+22116a^7-399a^8+19a^9+71697105b+74042088ab+224894564a^2b)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(-10669336a^3b+27977614a^4b-1144712a^5b+453492a^6b-7752a^7b+969a^8b)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(53809164b^2+158767116ab^2+24458852a^2b^2+65808020a^3b^2-1272620a^4b^2)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(2479348a^5b^2-34884a^6b^2+11628a^7b^2+20570444b^3+27708840ab^3+50456476a^2b^3)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(2041360a^3b^3+4954820a^4b^3-33592a^5b^3+50388a^6b^3+4574934b^4+12096426ab^4)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(2913460a^2b^4+3959980a^3b^4+41990a^4b^4+92378a^5b^4+626934b^5+856824ab^5)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(1236444a^2b^5+69768a^3b^5+75582a^4b^5+53676b^6+129276ab^6+27132a^2b^6)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}+$$

$$+\frac{512(27132a^3b^6+2796b^7+3192ab^7+3876a^2b^7+81b^8+171ab^8+b^9)}{\Big(\prod_{\zeta=1}^{9}\{a-b-(2\zeta-1)\}\Big)\Big(\prod_{\eta=1}^{10}\{a-b+(2\eta-1)\}\Big)}\Bigg\}\Bigg]-$$

$$-b\,\frac{2^{b+1}\,\Gamma(\frac{a+b+21}{2})}{\Gamma(b+1)}\Bigg[\frac{\Gamma(\frac{b+1}{2})}{\Gamma(\frac{a}{2})}\Bigg\{\frac{512(34459425+71697105a+53809164a^2+20570444a^3)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(4574934a^4+626934a^5+53676a^6+2796a^7+81a^8+a^9+127734435b+74042088ab)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(158767116a^2b+27708840a^3b+12096426a^4b+856824a^5b+129276a^6b+3192a^7b)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(171a^8b-17316372b^2+224894564ab^2+24458852a^2b^2+50456476a^3b^2+2913460a^4b^2)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(1236444a^5b^2+27132a^6b^2+3876a^7b^2+65285444b^3-10669336ab^3+65808020a^2b^3)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(2041360a^3b^3+3959980a^4b^3+69768a^5b^3+27132a^6b^3-6670026b^4+27977614ab^4)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(-1272620a^2b^4+4954820a^3b^4+41990a^4b^4+75582a^5b^4+3074466b^5-1144712ab^5)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(2479348a^2b^5-33592a^3b^5+92378a^4b^5-150708b^6+453492ab^6-34884a^2b^6)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(+50388a^3b^6+22116b^7-7752ab^7+11628a^2b^7-399b^8+969ab^8+19b^9)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}\Bigg\}-$$

$$-\frac{\Gamma(\frac{b+2}{2})}{\Gamma(\frac{a+1}{2})}\Bigg\{\frac{512(-34459425+127734435a+17316372a^2+65285444a^3+6670026a^4)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(3074466a^5+150708a^6+22116a^7+399a^8+19a^9+71697105b-74042088ab)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(224894564a^2b+10669336a^3b+27977614a^4b+1144712a^5b+453492a^6b+7752a^7b)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(969a^8b-53809164b^2+158767116ab^2-24458852a^2b^2+65808020a^3b^2+1272620a^4b^2)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(2479348a^5b^2+34884a^6b^2+11628a^7b^2+20570444b^3-27708840ab^3+50456476a^2b^3)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(-2041360a^3b^3+4954820a^4b^3+33592a^5b^3+50388a^6b^3-4574934b^4+12096426ab^4)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(-2913460a^2b^4+3959980a^3b^4-41990a^4b^4+92378a^5b^4+626934b^5-856824ab^5)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(1236444a^2b^5-69768a^3b^5+75582a^4b^5-53676b^6+129276ab^6-27132a^2b^6)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}+$$

$$+\frac{512(27132a^3b^6+2796b^7-3192ab^7+3876a^2b^7-81b^8+171ab^8+b^9)}{\Big(\prod_{=1}^{10}\{a-b-(2\psi-1)\}\Big)\Big(\prod_{\xi=1}^{9}\{a-b+(2\xi-1)\}\Big)}\Bigg\}\Bigg]$$

On simplification ,we prove the result (8).
Similarly, we can prove the result (9).

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35.

Existence Of $Z = (z\text{-}t)$ Type Plane Gravitational Waves Carrying Some Energy In Six-Dimensional Space-Time

GJSFR-A (FOR)
Classification: 020105

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Abstract **: This paper, which asserts the existence of $Z=(z - t)$ type plane gravitational waves carrying some energy and momentum in the direction of their propogation in six dimensional space-time.**

Keywords **:** Metric tensor, Plane Gravitational Waves, Energy Momentum Pseudo tensor of Einstein and energy momentum tensor of Landau and Lipschitz.

I. INTRODUCTION

In general relativity one of the problem is to be solved is whether or not there exist gravitational waves carrying energy. H.Takeno [1] mathematically investigated two types of purely plane gravitational waves of $Z=(z - t)$ and $Z = \left(\frac{t}{z}\right)$ type and obtained the line elements for both waves respectively in four dimensional space time V_4 as,

$$ds^2 = -Adx^2 - 2Ddxdy - Bdy^2 - dz^2 + dt^2 , \qquad (1.1)$$

and

$$ds^2 = -Adx^2 - 2Ddxdy - Bdy^2 - Z^2(C-E)dz^2 - 2ZEdzdt + (C+E)dt^2 . \qquad (1.2)$$

Furthermore, by calculating non vanishing components of energy momentum pseudo tensors of Einstein and Landua and Lipschitz, Takeno [1], conclude that both the waves carries some energy and momentum in the direction of their propogation. In this paper we propose to obtain the existence of $Z=(z - t)$ type plane gravitational waves carrying some energy and momentum in the direction of their propogation in the sense of Takeno [1] by extending to Six-dimensional space-time deduced by Adhav and Karade[3].

II. DEFINITION

A plane wave g_{ij} is defined as non flat solution of the field equation

$$R_{ij} = 0 \ , \quad i, j = 1,2,3,4,5,6. \qquad (2.1)$$

In an empty region of space-time with,

$$g_{ij} = g_{ij}(Z),\ Z = Z(x^i) \ \text{ where } \ x^i = (x, y, u, v, z, t) \tag{2.2}$$

In some suitable co-ordinate system such that,

$$g^{ij} Z_{,i} Z^{,j} = 0 \quad \left(Z_{,i} = \frac{\partial Z}{\partial xi} \right), \tag{2.3}$$

$$Z = Z(z,t), \quad Z_{,5} \neq 0, \quad Z_{,6} \neq 0 \tag{2.4}$$

The signature convention adopted is,

$$g_{aa} < 0 \quad \begin{vmatrix} g_{aa} & g_{ab} \\ g_{ba} & g_{bb} \end{vmatrix} > 0, \quad \begin{vmatrix} g_{11} & g_{12} & g_{13} \\ g_{21} & g_{22} & g_{23} \\ g_{31} & g_{32} & g_{33} \end{vmatrix} < 0$$

$$\begin{vmatrix} g_{11} & g_{12} & g_{13} & g_{14} \\ g_{21} & g_{22} & g_{23} & g_{24} \\ g_{31} & g_{32} & g_{33} & g_{34} \\ g_{41} & g_{42} & g_{43} & g_{44} \end{vmatrix} > 0, \quad \begin{vmatrix} g_{11} & g_{12} & g_{13} & g_{14} & g_{15} \\ g_{21} & g_{22} & g_{23} & g_{24} & g_{25} \\ g_{31} & g_{32} & g_{33} & g_{34} & g_{35} \\ g_{41} & g_{42} & g_{43} & g_{44} & g_{45} \\ g_{51} & g_{52} & g_{53} & g_{54} & g_{55} \end{vmatrix} < 0, \quad g_{66} > 0 \ , \tag{2.5}$$

(Not summed for a & b; a,b=1,2,3,4,5) ,

and accordingly

$$g = det(g_{ij}) < 0. \tag{2.6}$$

III. THE PLANE WAVE METRIC

We adopt the space-time deduced by Adhav and Karade [3] for Z=(z-t) type plane gravitational waves in six-dimensional space-time,

$$ds^2 = -dl^2 - (C - E)dz^2 + 2Edzdt + (C + E)dt^2, \tag{3.1}$$

$$dl^2 = \big(- Adx^2 - 2Ddxdy - 2Gdxdu - 2Idxdu - 2Idxdv - Bdy^2 - 2Hdydu - 2Idydv - Edu^2 - 2Kdudv - Ldv^2\big)$$

It is known that E in (3.1) can be transformed away by suitable transformation of co-ordinate, so in new system.

$$ds^2 = -dl^2 - Cdz^2 + Cdt^2 \ . \tag{3.2}$$

By using transformation $z^1 + t^1 = z + t$ and $z^1 + t^1 = \int C(z)dz$, (3.2) can be transformed into simpler form

$$ds^2 = -dl^2 - dz^2 + dt^2 \ . \tag{3.3}$$

The components of metric tensor g_{ij} and g^{ij} for (3.3) are as follows

$$\left[g_{ij}\right] = \begin{bmatrix} -A & -D & -G & -I & 0 & 0 \\ -D & -B & -H & -J & 0 & 0 \\ -G & -H & -F & -K & 0 & 0 \\ -I & -J & -K & -L & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}, \tag{3.4}$$

where A > 0, B > 0, F > 0, L > 0

and

$$\begin{aligned} m = {} & ABFL - ABK^2 - AH^2L + 2AHJK = AJ^2F - D^2FL + D^2K^2 \\ & + 2DGHL - 2DHIK - 2DGJK \_ 2DFIJ - BG^2L + 2BGIK \\ & + G^2J^2 - 2GHIJ - BFI^2 + H^2I^2 \end{aligned} \tag{3.5}$$

n = -1

$$g^{ij} = \begin{bmatrix} -A' & -D' & -G' & -I' & 0 & 0 \\ -D' & -B' & -H' & -J' & 0 & 0 \\ -G' & -H' & -F' & -K' & 0 & 0 \\ -I' & -J' & -K' & -L' & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}, \tag{3.6}$$

where, $A' = \dfrac{\left(-BFL + B^2K + H^2L - 2HJK + FJ^2\right)}{m}$,

$$B' = \frac{\left(-AFL + AK^2 + G^2L - 2GJK + FI^2\right)}{m},$$

$$D' = \frac{\left(DFL + DK^2 - HGL + HIK + GJK\right)}{m},$$

$$G' = \frac{(-DHK + DJK + BGL - BIK - GJ^2 + HIJ)}{m},$$

$$H' = \frac{(AHL - AJK - DGL + DIK + GIJ - HI^2)}{m},$$

$$I' = \frac{(DHK - DFJ - BJK + BFI + HGI - H^2 I)}{m},$$

$$J' = \frac{(-AHK + AFI + DGK - DFI - G^2 I + GHI)}{m},$$

$$K' = \frac{(ABK - AHJ - D^2 K + DHI + DGJ - BGI)}{m},$$

$$F' = \frac{(-ABL + AJ^2 + D^2 L - DIK + BI^2)}{m},$$

$$L' = \frac{(-ABF + AH^2 + D^2 F - 2GDH + BG^2)}{m}.$$

The non-vanishing components of christoffel symbols for metric (3.3) are,

$$\left\{\begin{matrix}1\\15\end{matrix}\right\} = -\left\{\begin{matrix}1\\16\end{matrix}\right\} = P, \qquad \left\{\begin{matrix}3\\15\end{matrix}\right\} = -\left\{\begin{matrix}3\\16\end{matrix}\right\} = P'$$

$$\left\{\begin{matrix}1\\25\end{matrix}\right\} = -\left\{\begin{matrix}1\\26\end{matrix}\right\} = Q, \qquad \left\{\begin{matrix}3\\25\end{matrix}\right\} = -\left\{\begin{matrix}3\\26\end{matrix}\right\} = Q'$$

$$\left\{\begin{matrix}1\\35\end{matrix}\right\} = -\left\{\begin{matrix}1\\36\end{matrix}\right\} = R, \qquad \left\{\begin{matrix}3\\35\end{matrix}\right\} = -\left\{\begin{matrix}3\\36\end{matrix}\right\} = R'$$

$$\left\{\begin{matrix}1\\45\end{matrix}\right\} = -\left\{\begin{matrix}1\\46\end{matrix}\right\} = S, \qquad \left\{\begin{matrix}3\\45\end{matrix}\right\} = -\left\{\begin{matrix}3\\46\end{matrix}\right\} = S'$$

$$\left\{\begin{matrix}2\\15\end{matrix}\right\} = -\left\{\begin{matrix}2\\16\end{matrix}\right\} = T, \qquad \left\{\begin{matrix}4\\15\end{matrix}\right\} = -\left\{\begin{matrix}4\\16\end{matrix}\right\} = T' \qquad (3.7)$$

$$\left\{\begin{matrix}2\\25\end{matrix}\right\} = -\left\{\begin{matrix}2\\26\end{matrix}\right\} = U, \qquad \left\{\begin{matrix}4\\25\end{matrix}\right\} = -\left\{\begin{matrix}4\\26\end{matrix}\right\} = U'$$

$$\left\{\begin{matrix}2\\35\end{matrix}\right\} = -\left\{\begin{matrix}2\\36\end{matrix}\right\} = V, \qquad \left\{\begin{matrix}4\\35\end{matrix}\right\} = -\left\{\begin{matrix}4\\36\end{matrix}\right\} = V'$$

$$\left\{\begin{matrix}2\\45\end{matrix}\right\}=-\left\{\begin{matrix}2\\46\end{matrix}\right\}=W,\qquad \left\{\begin{matrix}4\\45\end{matrix}\right\}=-\left\{\begin{matrix}4\\46\end{matrix}\right\}=W'$$

$$\left\{\begin{matrix}5\\11\end{matrix}\right\}=-\left\{\begin{matrix}6\\11\end{matrix}\right\}=-\frac{\overline{A}}{2},\qquad \left\{\begin{matrix}5\\12\end{matrix}\right\}=-\left\{\begin{matrix}6\\12\end{matrix}\right\}=-\frac{\overline{D}}{2}$$

$$\left\{\begin{matrix}5\\13\end{matrix}\right\}=-\left\{\begin{matrix}6\\13\end{matrix}\right\}=-\frac{\overline{G}}{2},\qquad \left\{\begin{matrix}5\\14\end{matrix}\right\}=-\left\{\begin{matrix}6\\14\end{matrix}\right\}=-\frac{\overline{I}}{2}$$

$$\left\{\begin{matrix}5\\22\end{matrix}\right\}=-\left\{\begin{matrix}6\\22\end{matrix}\right\}=-\frac{\overline{B}}{2},\qquad \left\{\begin{matrix}5\\23\end{matrix}\right\}=-\left\{\begin{matrix}6\\23\end{matrix}\right\}=-\frac{\overline{H}}{2}$$

$$\left\{\begin{matrix}5\\24\end{matrix}\right\}=-\left\{\begin{matrix}6\\24\end{matrix}\right\}=-\frac{\overline{J}}{2},\qquad \left\{\begin{matrix}5\\33\end{matrix}\right\}=-\left\{\begin{matrix}6\\33\end{matrix}\right\}=-\frac{\overline{F}}{2}$$

$$\left\{\begin{matrix}5\\34\end{matrix}\right\}=-\left\{\begin{matrix}6\\34\end{matrix}\right\}=-\frac{\overline{K}}{2},\qquad \left\{\begin{matrix}5\\44\end{matrix}\right\}=-\left\{\begin{matrix}6\\44\end{matrix}\right\}=-\frac{\overline{L}}{2}.$$

Where

$$P=\frac{A'\overline{A}+D'\overline{D}+G'\overline{G}+I'\overline{I}}{2m},\qquad P'=\frac{F'\overline{G}+K'\overline{I}+G'\overline{A}+H'\overline{D}}{2m}$$

$$Q=\frac{A'\overline{D}+D'\overline{B}+G'\overline{H}+I'\overline{J}}{2m},\qquad Q'=\frac{F'\overline{H}+G'\overline{D}+H'\overline{B}+K'\overline{J}}{2m}$$

$$R=\frac{A'\overline{G}+D'\overline{H}+G'\overline{F}+I'\overline{K}}{2m},\qquad R'=\frac{F'\overline{F}+G'\overline{G}+H'\overline{H}+K'\overline{K}}{2m}$$

$$S=\frac{A'\overline{I}+D'\overline{J}+G'\overline{K}+I'\overline{L}}{2m},\qquad S'=\frac{F'\overline{K}+K'\overline{L}+H'\overline{J}+G'\overline{I}}{2m}$$

$$T=\frac{B'\overline{D}+H'\overline{G}+J'\overline{I}+D'\overline{A}}{2m},\qquad T'=\frac{L'\overline{I}+I'\overline{A}+J'\overline{D}+K'\overline{G}}{2m}$$

$$U=\frac{B'\overline{B}+D'\overline{D}+H'\overline{H}+J'\overline{J}}{2m},\qquad U'=\frac{L'\overline{J}+I'\overline{D}+J'\overline{B}+K'\overline{H}}{2m}$$

$$V=\frac{B'\overline{H}+D'\overline{G}+H'\overline{F}+J'\overline{K}}{2m},\qquad V'=\frac{L'\overline{K}+K'\overline{F}+J'\overline{H}+I'\overline{G}}{2m}$$

$$W=\frac{B'\overline{J}+D'\overline{I}+H'\overline{K}+J'\overline{K}}{2m},\qquad W'=\frac{L'L+I'\overline{I}+J'\overline{J}+K'\overline{K}}{2m}.$$

Pawar et.al [5] investigated coexistence of Z= (z - t) type plane gravitational waves with electromagnetic waves in six-dimensional space-time and obtained exact solution of field equation (2.1) as,

$$N = 8\pi\{\sigma^2 A' - 2\sigma\rho D' - 2\eta G' - 2\sigma\xi I' + \rho^2 B' + 2\rho\eta H' + 2\rho\xi J' + \eta^2 F' + 2\eta\xi K' + \xi^2 L'\} \quad . \tag{3.8}$$

IV. SOME USEFUL FORMULAE

For metric (3.3) and from (3.7) we made following formulae which are useful to calculate the components of pseudo tensors.

$$\sqrt{-g} = \sqrt{m}, \quad \left(\sqrt{-g}\right), i = \left(0,0,0,0,\frac{\overline{m}}{2m},-\frac{\overline{m}}{2m}\right) \tag{4.1}$$

$$\left\{\begin{matrix}1\\1i\end{matrix}\right\} = \left\{\begin{matrix}1\\2i\end{matrix}\right\} = \left\{\begin{matrix}i\\3i\end{matrix}\right\} = \left\{\begin{matrix}i\\4i\end{matrix}\right\} = 0, \quad \left\{\begin{matrix}i\\5i\end{matrix}\right\} = -\left\{\begin{matrix}i\\6i\end{matrix}\right\} = \frac{\overline{m}}{2m}, \tag{4.2}$$

$$\left\{\begin{matrix}b\\a5\end{matrix}\right\} = -\left\{\begin{matrix}a\\b5\end{matrix}\right\}, \quad g^{pq}\left\{\begin{matrix}r\\pq\end{matrix}\right\} = 0, \quad g^{pq}\left\{\begin{matrix}r\\ps\end{matrix}\right\}\left\{\begin{matrix}s\\qr\end{matrix}\right\} = 0$$

$$\left\{\begin{matrix}p\\ac\end{matrix}\right\}\left\{\begin{matrix}d\\bp\end{matrix}\right\} = 0, \quad \left\{\begin{matrix}b\\5a\end{matrix}\right\}\left\{\begin{matrix}a\\5b\end{matrix}\right\} = -\left\{\begin{matrix}b\\5a\end{matrix}\right\}\left\{\begin{matrix}q\\6b\end{matrix}\right\} = \left\{\begin{matrix}b\\6a\end{matrix}\right\}\left\{\begin{matrix}a\\6b\end{matrix}\right\}, \tag{4.3}$$

$$\left\{\begin{matrix}q\\5p\end{matrix}\right\}\left\{\begin{matrix}p\\5q\end{matrix}\right\} = -\left\{\begin{matrix}q\\5p\end{matrix}\right\}\left\{\begin{matrix}p\\6q\end{matrix}\right\} = \left\{\begin{matrix}q\\6p\end{matrix}\right\}\left\{\begin{matrix}p\\6q\end{matrix}\right\} \quad .$$

Where,

$$\overline{m} = \{-A'\overline{A} - 2D'\overline{D} - 2G'\overline{G} - 2I'\overline{I} + B'\overline{B} - 2H'\overline{H} - J'\overline{J} - F'\overline{F} - 2K'\overline{K} - L'\overline{L}\}$$

and i = 1,2,3,……. ,6 a, b, c, d = 1, 2, 3, 4; p, q, r, s = 5,6 and summation convention is used with respect to these indices.

V. PSEUDO-TENSOR OF EINSTEIN

We calculate the components of energy-momentum Pseudo-tensor t_i^j introduced by Einstein which satisfies the conservation relation in the form

$$\left\{\sqrt{-g}\left(T_i^{\,j}+t_i^{\,j}\right)\right\}_{,j}=0 \quad \left(,j=\frac{\partial}{\partial x^j}\right), \quad (i\;\; j=1,2,3,\ldots,6\;) . \qquad (5.1)$$

When $T_i^{\,j}$ is energy momentum tensor of matter coincides with $E_i^{\,j}$

According to Einstein theory the $t_i^{\,j}$ expresses the energy momentum due to gravitational field and is given by

$$16\pi\sqrt{-g}\,t_i^{\,j}=\begin{Bmatrix} j \\ mn\end{Bmatrix}\left(\sqrt{-g}\,g^{mn}\right)_{,i}-\left(\log\sqrt{-g}\right)_{,m}+$$
$$\delta_i^{\,j}\left[\begin{Bmatrix} h \\ mk\end{Bmatrix}\begin{Bmatrix} k \\ nh\end{Bmatrix}g^{mn}\sqrt{-g}-g^{mn}\begin{Bmatrix} h \\ mn\end{Bmatrix}\left(\sqrt{-g}\right)_{,h}\right] . \qquad (5.2)$$

If we substitute (3.3) and (3.7) into (5.2) and using (4.1), (4.2) and (4.3) we obtain following result;

$$t_5^5=\frac{\beta}{16\pi m},$$
$$t_5^6=t_6^5=\frac{-\beta}{16\pi m}, \qquad (5.3)$$
$$t_6^6=\frac{\beta}{16\pi m} .$$

Where

$$\beta=\frac{1}{2}\left\{2\overline{D}\,\overline{D'}-2\overline{G}\,\overline{G'}-2\overline{I}\,\overline{I'}-2\overline{J}\,\overline{J'}-2\overline{K}\,\overline{K'}-\overline{A}\,\overline{A'}-\overline{B}\,\overline{B'}+\overline{F}\,\overline{F'}+\overline{L}\,\overline{L'}\right\}$$

And other $t_i^{\,j}=0$.

From above, we have

$$t_5^5=-t_5^6=-t_6^5=t_6^6=\phi\ , \qquad (5.4)$$

where $16\pi\phi=\dfrac{\beta}{m}$. (5.5)

Here ϕ is a function of Z and does not Vanish in general.

VI. . Pseudo-tensor of Landau and Lifshitz

Next we calculate the components of the symmetric energy momentum pseudo-tensor t^{*ij} proposed by Landau and Lipshitz which satisfies the conservation relation in the form

$$\left\{(-g)\left(T^{ij}+t^{*ij}\right)\right\}_{ij}=0, \qquad (i,j=1,2,3,\ldots.6)$$

and it is given by expression

$$\begin{aligned}
16\pi t^{*ij} &= \left(g^{ik}g^{jl}-g^{ij}g^{kl}\right)\left[2\left\{\begin{matrix} h \\ kl \end{matrix}\right\}\left\{\begin{matrix} m \\ hm \end{matrix}\right\}-\left\{\begin{matrix} m \\ kh \end{matrix}\right\}\left\{\begin{matrix} h \\ lm \end{matrix}\right\}-\left\{\begin{matrix} h \\ kh \end{matrix}\right\}\left\{\begin{matrix} m \\ lm \end{matrix}\right\}\right] \\
&+ g^{ik}g^{mn}\left[\left\{\begin{matrix} i \\ kh \end{matrix}\right\}\left\{\begin{matrix} h \\ mn \end{matrix}\right\}+\left\{\begin{matrix} i \\ mn \end{matrix}\right\}\left\{\begin{matrix} h \\ kh \end{matrix}\right\}-\left\{\begin{matrix} j \\ nh \end{matrix}\right\}\left\{\begin{matrix} h \\ km \end{matrix}\right\}-\left\{\begin{matrix} j \\ km \end{matrix}\right\}\left\{\begin{matrix} h \\ nh \end{matrix}\right\}\right] \\
&+ g^{jk}g^{mn}\left[\left\{\begin{matrix} i \\ kh \end{matrix}\right\}\left\{\begin{matrix} h \\ mn \end{matrix}\right\}+\left\{\begin{matrix} i \\ mn \end{matrix}\right\}\left\{\begin{matrix} h \\ kh \end{matrix}\right\}-\left\{\begin{matrix} i \\ nh \end{matrix}\right\}\left\{\begin{matrix} h \\ km \end{matrix}\right\}-\left\{\begin{matrix} i \\ km \end{matrix}\right\}\left\{\begin{matrix} h \\ nh \end{matrix}\right\}\right] \\
&- g^{hk}g^{mn}\left[\left\{\begin{matrix} i \\ hm \end{matrix}\right\}\left\{\begin{matrix} j \\ kn \end{matrix}\right\}-\left\{\begin{matrix} i \\ hk \end{matrix}\right\}\left\{\begin{matrix} j \\ mn \end{matrix}\right\}\right], \qquad \left(t^{*ij}=t^{*ji}\right) \quad .
\end{aligned} \tag{6.1}$$

If we substitute (3.3) and (3.7) into expression (6.1) and using (4.1), (4.2) and (4.3) we obtain following result :

$$t^{*55}=t^{*56}=t^{*65}=t^{*66}=\phi^{*}, \quad \text{other } t^{*ij}=0, \tag{6.2}$$

where

$$16\pi\phi^{*}=-\frac{\left\{\beta+\dfrac{\overline{m}^{2}}{m}\right\}}{m}, \tag{6.3}$$

and

$$\begin{aligned}
\beta = [\ & \left(\overline{A}\,\overline{B}-\overline{D}^{2}\right)\left(FL-K^{2}\right)+\left(\overline{A}\,\overline{F}-\overline{G}^{2}\right)\left(BL-J^{2}\right)+\left(\overline{A}\,\overline{L}-\overline{I}^{2}\right)\left(BF-H^{2}\right) \\
& \left(\overline{F}\,\overline{B}-\overline{D}^{2}\right)\left(AL-I^{2}\right)+\left(\overline{L}\,\overline{B}-\overline{J}^{2}\right)\left(AF-G^{2}\right)+\left(\overline{F}\,\overline{L}-\overline{K}^{2}\right)\left(AB-D^{2}\right) \\
& +2\left(\overline{A}\,\overline{B}-\overline{DG}\right)\left(JK-LH\right)+2\left(\overline{A}\,\overline{J}-\overline{D}\,\overline{I}\right)\left(JF-KH\right)+2\left(\overline{A}\,\overline{K}-\overline{I}\,\overline{G}\right)\left(JH-BK\right) \\
& +2\left(\overline{B}\,\overline{G}-\overline{H}\,\overline{D}\right)\left(IK-LG\right)+2\left(\overline{B}\,\overline{I}-\overline{D}\,\overline{J}\right)\left(GK-FI\right)+2\left(\overline{B}\,\overline{K}-\overline{J}\,\overline{H}\right)\left(IG-AK\right) \\
& +2\left(\overline{F}\,\overline{D}-\overline{H}\,\overline{G}\right)\left(JI-LD\right)+2\left(\overline{F}\,\overline{I}-\overline{K}\,\overline{G}\right)\left(JD-BI\right)+2\left(\overline{F}\,\overline{J}-\overline{H}\,\overline{K}\right)\left(ID-AJ\right) \\
& +2\left(\overline{L}\,\overline{D}-\overline{I}\,\overline{J}\right)\left(GH-FD\right)+2\left(\overline{L}\,\overline{H}-\overline{K}\,\overline{J}\right)\left(GD-AH\right)+2\left(\overline{L}\,\overline{G}-\overline{I}\,\overline{K}\right)\left(HD-BG\right) \\
& +2\overline{H}\,\overline{I}\left(2HI-DK-JG\right)+2\overline{G}\,\overline{J}\left(2GJ-DK-HI\right)+2\overline{D}\,\overline{K}\left(2DK-GJ-HI\right)\ ].
\end{aligned}$$

Again ϕ^{*} is not zero in general.

To compare results (5.4) with (6.2) we introduce the quantity t^{ij} in the coordinate system, as,

$$g^{ik}t^{j}_{k}=t^{ij}=t^{ij}. \tag{6.5}$$

Then we have from (5.4)

$$t^{55} \quad t^{56} = t^{65} = t^{66} = \phi = \frac{-\beta}{16\pi m} \qquad (6.6)$$

Here we find that t^{ij} and t^{*ij} are composed of similar components but they are not same.

When the field equations (3.8), is satisfied, we have

$$N = \frac{\overline{m}}{2m} - \frac{\overline{m}^2}{4m^2} - \frac{\beta}{2m} = 8\pi\left(\sigma^2 A' - 2\sigma\rho D' - 2\eta G' - 2\sigma\xi I' + \rho^2 B' + 2\rho\eta H' + 2\rho\xi J' + \eta^2 F' + 2\eta\xi K' + \xi^2 L'\right) \qquad (6.7)$$

Hence we have,

$$-16\pi\phi = 2\left(N - \frac{\overline{m}}{2m} + \frac{\overline{m}^2}{4m^2}\right),$$
$$and\ 16\pi\phi^* = 2\left(N - \frac{\overline{m}}{2m}\right) \qquad (6.8)$$

Also when space-time is empty, we have N=0, ϕ and ϕ* becomes respectively

$$-16\pi\phi = \frac{\left(-\overline{m} + \frac{\overline{m}^2}{2m}\right)}{m},$$
$$16\pi\phi^* = -\frac{\overline{m}}{2m}. \qquad (6.9)$$

Again these values are functions of *Z* and do not vanish in general.

VII. CONCLUSION

We conclude that, the energy momentum pseudo tensors (5.1) or (6.1) which expresses the energy momentum due to gravitational field hence the gravitational waves given by (3.3) carry some energy and momentum in the direction of their propogation.

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Some Analytic Classes of Banach Function Spaces

GJSFR-F; AMS: Primary 32A36, 46E15, 30H05

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***Abstract*-We introduce a new class of functions, called the SK(p, q)−type spaces of analytic functions in the unit disk, then we give some characterizations of Bergman spaces by our SK(p, q) spaces.**

AMS:Primary 32A36, 46E15, 30H05.
Key words and phrases : Bergman spaces, $\mathcal{S}_K(p,q)-$spaces

I INTRODUCTION

Let $\mathbb{D} = \{z : |z| < 1\}$ be the unit disk in the complex plane $\mathbb{C}$, $\partial\mathbb{D}$ its boundary and $H(\mathbb{D})$ be the class of all holomorphic functions in $\mathbb{D}$. For each $a \in \mathbb{D}$, the Green's function with logarithmic singularity at $a \in \mathbb{D}$ is denoted by $g(z,a) = \log\frac{1}{|\varphi_a(z)|}$, where $\varphi_a(z) = \frac{a-z}{1-\bar{a}z}$ is a Möbius transformations of $\mathbb{D}$. Assume that $K : [0,\infty) \to [0,\infty)$ is a right-continuous and nondecreasing function. The space $\mathcal{Q}_K$ of all functions $f \in H(\mathbb{D})$ such that

$$\|f\|^2_{\mathcal{Q}_K} = \sup_{a\in\mathbb{D}} \int_{\mathbb{D}} |f'(z)|^2 K(g(z,a))dA(z) < \infty, \text{ (see [15])}.$$

For an analytic function f on $\mathbb{D}$ and $0 < \alpha < \infty$. If

$$\|f\|_{\mathcal{B}^\alpha} = \sup_{z\in\mathbb{D}} (1-|z|^2)^\alpha |f'(z)| < \infty,$$

then f belongs to $\alpha-$Bloch space $\mathcal{B}^\alpha$. The little $\alpha-$Bloch space $\mathcal{B}^\alpha_0$ consists of analytic functions f on $\mathbb{D}$ such that

$$\lim_{|z|\to 1} (1-|z|^2)^\alpha |f'(z)| = 0.$$

For $0 < p < \infty$, the Bergman space $\mathcal{A}^p$ is the set of analytic functions f in the unit disk $\mathbb{D}$ with

$$\|f\|^p_{\mathcal{A}^p} = \frac{1}{\pi}\int_{\mathbb{D}} |f(z)|^p \, dA(z) < \infty,$$

where $dA(z)$ denotes Lebesgue area measure. If $p > 1$, $\mathcal{A}^p$ is a Banach space with norm $\|.\|_{\mathcal{A}^p}$. If $0 < p < 1$, it is a complete metric space, where the metric is given by $d(f,g) = \|f-g\|^p_{\mathcal{A}^p}$. $\mathcal{A}^2$ is a Hilbert space with inner product

$$\langle f, g\rangle = \frac{1}{\pi}\int_{\mathbb{D}} f(z)\overline{g(z)}\, dA(z)$$

and reproducing kernel $k_a(z) = \frac{1}{(1-\bar{a}z)^2}$ at $a \in \mathbb{D}$. It actually turns out that this holds for $f \in \mathcal{A}^p$, $1 \le p < \infty$. For more information about Bergman spaces we refer to [3, 4, 5, 6, 7, 14, 16].
A space closely related to $\mathcal{A}^p$ is $\mathcal{A}^{-n}$ $(n > 0)$, which consists of functions f analytic in $\mathbb{D}$ with

$$\|f\|_{\mathcal{A}^{-n}} = \sup_{z\in\mathbb{D}} |f(z)|(1-|z|^2)^n < \infty.$$

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$\mathcal{A}^{-n}$ is also a Banach space. It is easy to see that for any $\delta > 0$, $\mathcal{A}^{-\frac{1}{p-\delta}} \subseteq \mathcal{A}^p$. One can also check that $\mathcal{A}^p \subseteq \mathcal{A}^{-\frac{2}{p}}$. The space $\mathcal{A}^{-n}$ has been studied extensively (see [5, 10, 12, 13] and others). In this work, if $n = 1$ we call that $f \in \mathcal{A}^{-1}$. It should be remarked here that a function f is in the Bloch space if the derivative of f is in $\mathcal{A}^{-1}$ (see [5]). Palmberg in [10] introduced the $\mathcal{N}_p-$spaces, (with $p \in (0, \infty)$) consist of $f \in H(\mathbb{D})$ such that

$$\|f\|^2_{\mathcal{N}_p} = \sup_{a\in\mathbb{D}} \int_{\mathbb{D}} |f(z)|^2(1 - |\varphi_a(z)|^2)^p dA(z) < \infty,$$

when $p = 1$, $\mathcal{N}_p$ coincides $\mathcal{N}_1$. The $\mathcal{N}_1-$space was introduced in [8].
Very recently El-Sayed and Bahkit [1, 2] introduced the space $\mathcal{N}_K$ of holomorphic functions. This space consists of $f \in H(\mathbb{D})$ such that

$$\|f\|^2_{\mathcal{N}_K} = \sup_{a\in\mathbb{D}} \int_{\mathbb{D}} |f(z)|^2 K(g(z, a))dA(z) < \infty.$$

If

$$\lim_{|a|\to 1} \int_{\mathbb{D}} |f(z)|^2 K(g(z, a))dA(z) = 0,$$

then f is said to belong to $\mathcal{N}_{0,K}$. Clearly, if $K(t) = t^p$, then $\mathcal{N}_K = \mathcal{N}_p$; since $g(z, a) \approx (1 - |\varphi_a(z)|^2)$. For $K(t) = 1$ it gives the Bergman space $\mathcal{A}^2$.

In this paper, we introduced the new space $\mathcal{S}_K(p, q)$ by the right continuous and nondecreasing function $K : [0, \infty) \to [0, \infty)$. For $0 < p < \infty, -2 < q < \infty$, we say that a function f analytic in $\mathbb{D}$ belongs to the space $\mathcal{S}_K(p, q)$ if

$$\|f\|^p_{\mathcal{S}_K(p,q)} = \sup_{a\in\mathbb{D}} \int_{\mathbb{D}} |f(z)|^p(1 - |z|^2)^q K(g(z, a))dA(z) < \infty.$$

Clearly, if $p = 2, q = 0$, then $\mathcal{S}_K(p, q) = \mathcal{N}_K$. For $K(t) = 1$ it gives the Bergman-type space $\mathcal{A}^p_q$. It is easy to check that $\|\cdot\|_{\mathcal{S}_K(p,q)}$ is a complete semi-norm on $\mathcal{S}_K(p, q)$ and it is Möbius invariant in the sense that $\|f \circ \phi\|_{\mathcal{S}_K(p,q)} = \|f\|_{\mathcal{S}_K(p,q)}$ whenever $f \in \mathcal{S}_K(p, q)$ and $\phi \in \mathrm{Aut}(\mathbb{D})$, where $\mathrm{Aut}(\mathbb{D})$ is the group of all Möbius maps of the unit disk.

In this paper we show some relations between $\mathcal{S}_K(p, q)$ and $\mathcal{A}_\alpha$ for a nondecreasing K, and give a general way to construct different spaces $\mathcal{S}_{K_1}(p, q)$ and $\mathcal{S}_{K_2}(p, q)$ by using some functions K_1 and K_2. We assume from this paper that

(1)

It is also clear that $\mathcal{S}_K(p, q)$ contains all constant functions. If $\mathcal{S}_K(p, q)$ consists of just the constant functions, we say that it is trivial.

An important tool in the study of $\mathcal{S}_K(p, q)$ spaces is the auxiliary function ϕ_K defined by

$$\phi_K(s) = \sup_{0<t<1} \frac{K(st)}{K(t)}, \qquad 0 < s < \infty. \tag{2}$$

The following condition has played a crucial role in the study of $\mathcal{S}_K(p, q)$ spaces:

$$\int_1^\infty \phi_K(s)\frac{ds}{s^2} < \infty. \tag{3}$$

The function theory of $\mathcal{S}_K(p,q)$ obviously depends on the properties of K. Given two weight functions K_1 and K_2, we are going to write $K_1 \lesssim K_2$ if there exists a constant $C > 0$, independent of t, such that $K_1(t) \leq K_2(t)$ for all t. The notation $K_1 \gtrsim K_2$ is used in a similar fashion. When $K_1 \lesssim K_2 \lesssim K_1$, we write $K_1 \approx K_2$.
Two quantities A_f and B_f, both depending on an analytic function f on $\mathbb{D}$, are said to be equivalent, written as $A_f \approx B_f$, if there exists a finite positive constant C not depending on f such that for every analytic function f on $\mathbb{D}$ we have:

$$\frac{1}{C}B_f \leq A_f \leq CB_f \ \ (\text{see } [11]).$$

If the quantities A_f and B_f, are equivalent, then in particular we have $A_f < \infty$ if and only if $B_f < \infty$. Given two weight functions K_1 and K_2, we are going to write $K_1 \lesssim K_2$ if there exists a constant $C > 0$, independent of t, such that $K_1(t) \lesssim CK_2(t)$ for all t. The notation $K_1 \lesssim K_2$ is used in a similar fashion. When $K_1 \lesssim K_2 \lesssim K_1$, we write $K_1 \approx K_2$.
Recall that the function

$$f(r) = \sum_k^{\infty} a_k r^{n_k} \ \ (\text{with } \ n_k \in \mathbb{N} \ ; \ \text{for all } \ k \in \mathbb{N})$$

is said to belong to the Hadamard gap class (also known as lacunary series) if there exists a constant $c > 1$ such that $\frac{n_{k+1}}{n_k} \geq c$ for all $k \in \mathbb{N}$ (see [9]).
Before proving theorems we recall a few facts about the Möbius function φ_a. First, the function φ_a is easily seen to be it own inverse under composition:

$$(\varphi_a \circ \varphi_a)(z) = z \quad \text{for all} \quad z \in \mathbb{D}$$

The following identity can be obtained by straight forward computation:

$$1 - |\varphi_a(z)|^2 = \frac{(1-|a|^2)(1-|z|^2)}{|1-\overline{a}z|^2} \ , \quad (a, z \in \mathbb{D}).$$

A slightly different form in which we will apply the above identity is:

$$\frac{1-|\varphi_a(z)|^2}{1-|z|^2} = |\varphi_a'(z)| \ , \quad (a, z \in \mathbb{D}). \tag{4}$$

For $a \in \mathbb{D}$, the substitution $z = \varphi_a(w)$ results in the Jacobian change in measure given by $dA(w) = |\varphi_a'(z)|^2 dA(z)$. For a Lebesgue integrable or a non-negative Lebesgue measurable function h on $\mathbb{D}$ we thus have the following change-of-variable formula:

$$\int_{D(0,r)} h(\varphi_a(w)) dA(w) = \int_{D(a,r)} h(z) \left(\frac{1-|\varphi_a(z)|^2}{1-|z|^2} \right)^2 dA(z) \ . \tag{5}$$

Proposition 1.1 *For f is non-constant function. If (1) does not hold, then f / $\in \mathcal{S}_K(p,q)$.*

Proof: By assumption there exists at least one point $a \in \mathbb{D}$ such that $f(a) \neq 0$. By

$$(1-|a|^2)^p |f(a)|^p \leq \frac{1}{2\pi} \int_0^{2\pi} |(f \circ \varphi_a)(re^{i\theta})|^p d\theta, \qquad 0 < r < 1,$$

we conclude that

$$\begin{aligned}
&\int_{\mathbb{D}} |f(z)|^p (1-|z|^2)^q K(g(z,a))dA(z) \\
= &\int_{\mathbb{D}} |(f\circ\varphi_a)(z)|^p (1-|\varphi_a(z)|^2)^{q+2} \times (1-|z|^2)^{-2} K(\log\frac{1}{|z|})dA(z) \\
\geq &\ C\,(1-|a|^2)^{|q+2|}\int_0^1 \left(\int_0^{2\pi} |(f\circ\varphi_a)(re^{i\theta})|^p d\theta\right) \times (1-|r|^2)^q K(\log\frac{1}{r})rdr \\
\geq &\ C\,(1-|a|^2)^{|q+2|+p}|f(a)|^p \int_0^1 (1-r^2)^q K(\log\frac{1}{r})rdr \ = \ \infty,
\end{aligned}$$

which means that $f \notin \mathcal{S}_K(p,q)$.

III HOLOMORPHIC SK(p, q) CLASSES

In this section we state some basic Banach space properties of the $\mathcal{S}_K(p,q)-$spaces.

Theorem 2.1 *Let $0<p<\infty, -2<q<\infty$. Then*
(i) $\mathcal{S}_K(p,q) \subset \mathcal{A}_{\frac{q+2}{p}}$.
(ii) $\mathcal{S}_K(p,q) = \mathcal{A}_{\frac{q+2}{p}}$ *if and only if*

$$\int_0^1 (1-r^2)^{-2}\, K(\log(1/r))rdr < \infty. \tag{6}$$

Proof: (i) For a fixed $r\in(0,1)$, let

$$E(a,r) = \{z\in\mathbb{D},\ |z-a|<r(1-|a|)\}.$$

We know that $E(a,r)\subset D(a,r)$ and for any $z\in E(a,r)$, we have

$$(1-r)(1-|a|) \leq 1-|z| \leq (1-r)(1-|a|),$$

which mans that $1-|z|^2 \approx 1-|a|^2$ for any $z\in E(a,r)$. Since $|f(z)|^p$ is subharmonic, for $a\in\mathbb{D}$,

$$\begin{aligned}
\int_\Delta |f(z)|^p (1-|z|^2)^q\, K(g(z,a))dA(z) &\geq K(\log\frac{1}{r})\int_{D(a,r)} |f(z)|^p (1-|z|^2)^q dA(z) \\
&\geq \pi r^2\, K(\log\frac{1}{r})(1-|a|^2)^{q+2}|f(a)|^p.
\end{aligned}$$

If $f\in\mathcal{S}_K(p,q)$, then by estimate above we have

$$\sup_{a\in\mathbb{D}}(1-|a|^2)^{q+2}|f(a)|^p < \infty.$$

Hence $f\in\mathcal{A}_{\frac{q+2}{p}}$. The proof of (i) is complete
(ii) Let (4) hold. To prove $\mathcal{S}_K(p,q) = \mathcal{A}_{\frac{q+2}{p}}$. We only need to show that $\mathcal{A}_{\frac{q+2}{p}} \subset \mathcal{S}_K(p,q)$.
For $f\in\mathcal{A}_{\frac{q+2}{p}}$ we notice that

$$\begin{aligned}\int_{\mathbb{D}} |f(z)|^p(1-|a|^2)^q\ K(g(z,a))dA(z) &\leq \|f\|^p_{\mathcal{A}_{\frac{q+2}{p}}}\int_{\mathbb{D}}(1-|z|^2)^{-2}\ K(g(z,a))dA(z)\\ &= \|f\|^p_{\mathcal{A}_{\frac{q+2}{p}}}\int_{\mathbb{D}}(1-|w|^2)^{-2}\ K(\log(1/|w|))dA(w)\\ &= 2\pi\ \|f\|^p_{\mathcal{A}_{\frac{q+2}{p}}}\ \int_0^1(1-r^2)^{-2}\ K(\log(1/r))rdr\ <\ \infty.\end{aligned}$$

Hence $f \in \mathcal{A}_{\frac{q+2}{p}} \subset \mathcal{S}_K(p,q)$ and we have proved that (4) is a sufficient condition that $\mathcal{S}_K(p,q) = \mathcal{A}_{\frac{q+2}{p}}$. Conversely, we assume that $\mathcal{S}_K(p,q) = \mathcal{A}_{\frac{q+2}{p}}$. To prove that (4) is a necessary condition, we study the Hadamard gap function $f_a(z) = \sum_{j=1}^{\infty} a_j\ 2^{\frac{j(q+2-p)}{p}} z^{2^j}$, we assume that (4) dos not hold; that is,

$$\int_0^1(1-r^2)^{-2}\ K(\log(1/r))rdr = \infty.$$

Thus we find a continuous strictly decreasing function $h : [0,1) \to [0,0)$ tending to zero at 1 such that

$$\int_0^1 h(r)(1-r^2)^{-2}\ K(\log(1/r))rdr = \infty. \tag{7}$$

It is easy to see that

$$r^{2^{k+2}-2} \geq \exp\{-2^{k+2}(1-r)\}, \quad r \in \left[\frac{1}{2},1\right). \tag{8}$$

We know that for $\alpha > 0, t^{2\alpha}\exp\{-4t\}$ is decreasing in $[\frac{\alpha}{2}, \frac{\alpha+2}{2}]$ and

$$\sup_{t>0} t^{2\alpha}\exp\{-4t\} = t^{2\alpha}\exp\{-4t\}|_{t=\frac{\alpha}{2}} = \left(\frac{\alpha}{2}\right)^{2\alpha} e^{-2\alpha}.$$

There exists an integer k for $\frac{3}{4} \leq r < 1$, such that $\frac{\alpha}{2} \leq 2^k(1-r) < \frac{\alpha+2}{2}$ and

$$2^{2\alpha k}\exp\{-2^{k+2}(1-r)\} \geq \left(\frac{\alpha+2}{2}\right)^{2\alpha} e^{-2(\alpha+1)}(1-r)^{-2\alpha}. \tag{9}$$

For $\frac{3}{4} \leq r < 1$ and k above we define

$$f_a(z) = \sum_{j=1}^{\infty} a_j\ \ 2^{j\frac{(q+2)}{p}} z^{2^j+1},$$

where $a_j = [h(1-\frac{2p+q+2}{2^{(j+1)}p})]^{\frac{1}{p}}, \quad j = 0,1,2\cdots$. By (6) and (7) we conclude that

$$\begin{aligned}M_2^2(r,f_a) &= \int_0^{2\pi}|f_a(re^{i\theta})|^2d\theta = 2\pi\sum_{k=1}^{\infty} a_k^2 2^{2k(\frac{q+2}{p})} z^{2^{k+1}-2}\\ &\geq 2\pi h^{\frac{2}{p}}(r)2^{2k(\frac{q+2}{p})}\exp\{-2^{k+2}(1-r)\}\\ &\geq Ch^{\frac{2}{p}}(r)(1-r)^{\frac{-2(q+2)}{p}}.\end{aligned}$$

Since f_a is defined by a Hadamard gap series, we have

$$M_2(r,f_a) \approx M_p(r,f_a),$$

where

$$M_p(r,f_a) = \left(\int_0^{2\pi}|f_a(re^{i\theta})|^p d\theta\right)^{\frac{1}{p}}.$$

Therefore,

$$\begin{aligned}
&\sup_{a\in\mathbb{D}}\int_{\mathbb{D}}|f_a(z)|^p(1-|z|^2)^qK(g(z,a))dA(z)\\
\geq\ &\int_0^1 M_p^p(r,f_a)(1-r^2)^qK(\log\frac{1}{r})rdr\\
\approx\ &\int_0^1 M_2^p(r,f_a)(1-r^2)^qK(\log\frac{1}{r})rdr\\
\geq\ &C\int_{\frac{3}{4}}^1 h(r)(1-r)^{-2}K(\log\frac{1}{r})rdr=\infty.
\end{aligned}$$

It means that $f_a\in\mathcal{A}_{\frac{q+2}{p}}\backslash\mathcal{S}_K(p,q)$, which is a contradiction. Hence (4) holds.

Theorem 2.2 *Let $0<p<\infty,-2<q<\infty$. Then*
(i) $\mathcal{S}_{0,K}(p,q)\subset\mathcal{A}_{0,\frac{q+2}{p}}$.
(ii) $\mathcal{S}_{0,K}(p,q)=\mathcal{A}_{0,\frac{q+2}{p}}$ *if and only if* (4) *holds.*

Proof: (i) Without loss of generality, we assume that $K(1)>0$, from the proof of Theorem 2.1 we have

$$\begin{aligned}
\pi(1/e)^2\ K(1)(1-|a|^2)^{q+2}|f(z)|^p\ &\leq\ K(1)\int_{E(a)}|f(z)|^p(1-|z|^2)^qdA(z)\\
&\geq\ K(1)\int_{D(a,1/e)}|f(z)|^p(1-|z|^2)^qdA(z)\\
&\geq\ \int_D|f(z)|^p(1-|z|^2)^q\ K(g(z,a))\ dA(z),
\end{aligned}$$

where $E(a)=\{z\in\mathbb{D}:|z-a|<\frac{1}{e}(1-|a|)\}$. If $f\in\mathcal{S}_{0,K}(p,q)$, we have

$$\lim_{|a|\to1}(1-|a|^2)^{\frac{q+2}{p}}|f(a)|=0.$$

Hence $f\in\mathcal{A}_{0,\frac{q+2}{p}}$. The proof of (i) is complete
(ii) We only need to show that $\mathcal{A}_{0,\frac{q+2}{p}}\subset\mathcal{S}_{0,K}(p,q)$. Assume that

$$A=\int_0^1(1-r^2)^{-2}\ K(\log(1/r))rdr<\infty.$$

For given $\varepsilon>0$ there exists an $r_1,0<r_1<1$, such that

$$\int_{r_1}^1(1-r^2)^{-2}\ K(\log(1/r))rdr<\ \varepsilon\ . \tag{10}$$

Then we have

$$\begin{aligned}
&\int_{\mathbb{D}\backslash D(a,r_1)}|f(z)|^p(1-|a|^2)^q\ K(g(z,a))dA(z)\\
\leq\ &\|f\|^p_{\mathcal{A}_{\frac{q+2}{p}}}\int_{\mathbb{D}\backslash D(a,r_1)}(1-|z|^2)^{-2}\ K(g(z,a))dA(z)\\
=\ &\|f\|^p_{\mathcal{A}_{\frac{q+2}{p}}}\int_{r_1<|w|<1}(1-|w|^2)^{-2}\ K(\log(1/|w|))dA(w)
\end{aligned}$$

$$\begin{aligned} &= 2\pi \|f\|^p_{\mathcal{A}^{\frac{q+2}{p}}} \int_{r_1}^1 (1-r^2)^{-2} K(\log(1/r)) r dr \\ &< 2\pi \varepsilon \|f\|^p_{\mathcal{A}^{\frac{q+2}{p}}}. \end{aligned}$$

Similarly, if $f \in \mathcal{A}_{0,\frac{q+2}{p}}$, we have that

$$|f(\varphi_a(w))|(1-|\varphi_a(w)|^2)^{\frac{q+2}{p}} \to 0$$

uniformly for $|w| \le r$ if $|a| \to 1$, where r is fixed and $0 < r < 1$. Then

$$\begin{aligned} &\lim_{|a|\to 1} \int_{D(a,r_1)} |f(z)|^p (1-|z|^2)^q K(g(z,a)) dA(z) \\ = &\lim_{|a|\to 1} \int_{|w|<r_1} |f(\varphi_a(w))|^p (1-|\varphi_a(w)|^2)^{q+2} (1-|w|^2)^{-2} K(\log \frac{1}{|w|}) dA(z) \\ \le &\; C \lim_{|a|\to 1} \sup_{|w|<r_1} |f(\varphi_a(w))|^p (1-|\varphi_a(w)|^2)^{q+2} = 0. \end{aligned}$$

By the above it is easy to see that

$$\lim_{|a|\to 1} \int_{\mathbb{D}} |f(z)|^p (1-|z|^2)^q K(g(z,a)) dA(z) = 0.$$

Conversely, by the proof conversely of Theorem 2.1, we have

$$\begin{aligned} &\sup_{a\in\mathbb{D}} \int_{\mathbb{D}} |f_a(z)|^p (1-|z|^2)^q K(g(z,a)) dA(z) \\ \ge &\int_0^1 M_p^p(r,f_a)(1-r^2)^q K(\log \frac{1}{r}) r dr \\ \approx &\int_0^1 M_2^p(r,f_a)(1-r^2)^q K(\log \frac{1}{r}) r dr \\ \ge &\; C \int_{\frac{3}{4}}^1 h(r)(1-r)^{-2} K(\log \frac{1}{r}) r dr = \infty. \end{aligned}$$

It means that $f_a \in \mathcal{A}_{0,\frac{q+2}{p}} \backslash \mathcal{S}_{0,K}(p,q)$, which is a contradiction. Hence (4) holds.

III WEIGHTED FUNCTIONS ON SK(p, q) CLASSES

The following result means that the weight functions K can be chosen as bounded.

Theorem 3.1 *We assume that* $K_1(1) > 0$ *and* $K_2(r) = \inf\{K_1(r), K_1(1)\}$. *Then* $\mathcal{S}_{K_2}(p,q) = \mathcal{S}_{K_1}(p,q)$.

If $f \in \mathcal{S}_{K_2}(p,q)$, f must be

$$\begin{aligned} &\int_{D(a,1/e)} |f(z)|^p (1-|z|^2)^q K_1(g(z,a)) dA(z) \\ \le &\; \|f\|^p_{\mathcal{A}^{\frac{q+2}{p}}} \int_{D(a,1/e)} (1-|z|^2)^{-2} K_1(g(z,a)) dA(z) \\ = &\; \|f\|^p_{\mathcal{A}^{\frac{q+2}{p}}} \int_{D(0,1/e)} (1-|w|^2)^{-2} K_1(\log(1/|w|)) dA(w) \le C \|f\|^p_{\mathcal{A}^{\frac{q+2}{p}}}. \end{aligned}$$

Hence $f \in \mathcal{S}_{K_1}(p,q)$ and the theorem is proved.

Corollary 3.1 *Let $0 < p < \infty, -2 < q < \infty$. Then $f \in \mathcal{S}_K(p,q)$ if and only if*

$$\sup_{a\in\mathbb{D}} \int_{\mathbb{D}} |f(z)|^p (1-|z|^2)^q K(1-|\varphi_a(z)|^2) dA(z) < \infty. \tag{11}$$

Lemma 3.1 *Let $0 < p < \infty, -2 < q < \infty$. Then*

(i) *$f \in \mathcal{A}_{\frac{q+2}{p}}$ if and only if there exists $\delta \in (0,1)$ such that*

$$\sup_{a\in\mathbb{D}} \int_{D(a,\delta)} |f(z)|^p (1-|z|^2)^q K(g(z,a)) dA(z) < \infty; \tag{12}$$

(ii) *$f \in \mathcal{A}_{0,\frac{q+2}{p}}$ if and only if there exists $\delta \in (0,1)$ such that*

$$\lim_{|a|\to 1} \int_{D(a,\delta)} |f(z)|^p (1-|z|^2)^q K(g(z,a)) dA(z) = 0. \tag{13}$$

Proof: (i) Assume $f \in \mathcal{A}_{\frac{q+2}{p}}$. For any $\delta \in (0,1)$ and $a \in \mathbb{D}$, we have

$$\begin{aligned}
&\int_{D(a,\delta)} |f(z)|^p (1-|z|^2)^q K(g(z,a)) dA(z) \\
= &\int_{D(0,\delta)} |f(\varphi_a(z))|^p (1-|(\varphi_a(z))|^2)^{q+2} (1-|z|^2)^{-2} K\left(\log\frac{1}{|z|}\right) dA(z) \\
\leq &\|f\|^p_{\mathcal{A}_{\frac{q+2}{p}}} \int_{D(0,r)} (1-r^2)^{-2} K(\log\frac{1}{r}) r dr \\
\leq &C \|f\|^p_{\mathcal{A}_{\frac{q+2}{p}}}.
\end{aligned}$$

Conversely, suppose that (10) holds for some δ, $0 < \delta < 1$. By the proof of Theorem 2.1 we have

$$\begin{aligned}
&\int_{D(a,\delta)} |f(z)|^p (1-|z|^2)^q K(g(z,a)) dA(z) \\
\geq &K\left(\log\frac{1}{\delta}\right) \int_{D(a,\delta)} |f(z)|^p (1-|z|^2)^q dA(z) \\
\geq &K\left(\log\frac{1}{\delta}\right) \int_{E(a,\delta)} |f(z)|^p (1-|z|^2)^q dA(z) \\
\geq &\delta^2 K\left(\log\frac{1}{\delta}\right) |f(a)|^p (1-|a|^2)^{q+2},
\end{aligned}$$

which shows that $f \in \mathcal{A}_{\frac{q+2}{p}}$.

(ii) We omit the proof since its proof is similar to that of (i) above.

Theorem 3.2 *Let* $0 < p < \infty, -2 < q < \infty$. *Assume* $K_1(r) \leq K_2(r)$ *for* $r \in (0,1)$ *and* $\frac{K_1(r)}{K_2(r)} \to 0$ *as* $r \to 0$. *If* (4) *is divergent for* K_2, *then*

$$\mathcal{N}_{K_2}(p,q) \subsetneqq \mathcal{N}_{K_1}(p,q).$$

Proof: It is clear that $\mathcal{S}_{K_2}(p,q) \subset \mathcal{S}_{K_1}(p,q)$. Suppose that $\mathcal{S}_{K_2}(p,q) = \mathcal{S}_{K_1}(p,q)$. From the open mapping theorem, we know that the identity mapping from one of these spaces into the other one is continuous. Thus there exists a constant C such that

$$\|\cdot\|_{\mathcal{S}_{K_2}(p,q)} \leq C\|\cdot\|_{\mathcal{S}_{K_1}(p,q)}.$$

Since $\frac{K_1(r)}{K_2(r)} \to 0$ as $r \to 0$, then there exists $r_0 \in (0,1)$ such that $K_1(r) \leq \frac{1}{2C}K_2(r)$ for $0 < r < r_0$. Choose $t_0 = e^{-r_0}$ and deduce that if $f \in \mathcal{S}_{K_2}(p,q)$, then

$$\begin{aligned} & \sup_{a\in\mathbb{D}} \int_{\mathbb{D}} |f(z)|^p (1-|z|^2)^q K_2(g(z,a))dA(z) \\ \leq\ & C \sup_{a\in\mathbb{D}} \int_{D(a,t_0)} |f(z)|^p (1-|z|^2)^q K_1(g(z,a))dA(z) \\ +\ & \frac{1}{2} \sup_{a\in\mathbb{D}} \int_{\mathbb{D}} |f(z)|^p (1-|z|^2)^q K_2(g(z,a))dA(z). \end{aligned}$$

Therefore,

$$\begin{aligned} & \int_{\mathbb{D}} |f(z)|^p (1-|z|^2)^q K_2(g(z,a))dA(z) \\ \leq\ & 2C \sup_{a\in\mathbb{D}} \int_{D(a,t_0)} |f(z)|^p (1-|z|^2)^q K_1(g(z,a))dA(z). \end{aligned}$$

By Lemma 3.1 there exists a constant C' such that for $f \in \mathcal{S}_{K_2}(p,q)$,

$$\sup_{a\in\mathbb{D}} \int_{\mathbb{D}} |f(z)|^p (1-|z|^2)^q K_2(g(z,a))dA(z) \leq\ C'\ \|f\|^p_{\mathcal{A}_{\frac{q+2}{p}}}. \tag{14}$$

If $h \in \mathcal{A}_{\frac{q+2}{p}}$ and $h_r(z) = h(rz), 0 < r < 1$, then $\|h_r\|_{\mathcal{A}_{\frac{q+2}{p}}} \leq \|h\|_{\mathcal{A}_{\frac{q+2}{p}}}$. Since $h_r \in \mathcal{S}_{K_2}(p,q)$, we can choose $f = h_r$ in the inequality (12). Using Fatou's lemma, we deduce that

$$\sup_{a\in\mathbb{D}} \int_{\mathbb{D}} |h(z)|^p (1-|z|^2)^q K_2(g(z,a))dA(z) \leq\ C'\ \|h\|^p_{\mathcal{A}_{\frac{q+2}{p}}}.$$

We have proved that $h \in \mathcal{S}_{K_2}(p,q)$. It means that

$$\mathcal{S}_{K_2}(p,q) = \mathcal{A}_{\frac{q+2}{p}}.$$

It follows from Theorem 2.1 that the integral (4) with $K = K_2$ must be convergent, a contradiction. We obtain that

$$\mathcal{S}_{K_2}(p,q) \subsetneqq \mathcal{S}_{K_1}(p,q).$$

This completes the proof.

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Problems And Constraints of Rabbitry In India: A Study of Himachal Pradesh

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GJSFR-G FOR Classification: 830307

I. INTRODUCTION

The state of Himachal Pradesh has achieved the distinction of being regarded as model of hill development. Agriculture and allied activities continues to be the mainstay of majority of the population as they provide livelihood to about 71 per cent of the working population. Only about 17.2 per cent of net sown area is irrigated and the rest is all rainfed. In the state, agriculture exhibits the blend of both progressive and the traditional nature. The objectives of the government policy to meet immediate challenges of poverty, unemployment and malnutrition include full employment, economic growth, price stability, wage maintenance, reduced inequality in income distribution, regional balance, protection of the national environment, greater opportunities for women and minorities. The effective route to development is to raise productivity of agricultural sector, which will then act as a stimulus to other areas of the economy. To boost the meager income of small holdings there is a need for incorporation of the supplementary enterprises which not only increase productivity and income but also induces stability in the farm income. Rabbitry is one such micro-enterprise which is economical because of their early maturity, prolificacy (7-8 young ones) and short gestation period (31 days). The credit of introducing and popularizing Angora rabbits in India goes to ICAR through its North Temperate Regional Station of Central Sheep and Wool Research Institute (CSWRI), Garsa, Kullu in Himachal Pradesh. The rabbits require a few inputs and can be reared by workers lacking in great physical strength. Rabbitry gives an opportunity to develop 20 subsidiary industries including nursery raising wool farming, cage fabrication; feed formulation, shearing, wool collection and grading etc. The meat obtained from rabbitry is low in fat and cholesterol level. It can close protein gap and raise income of rural and sub-urban people. The present study is an attempt to study the problems and constraints of rabbitry in Himachal Pradesh and suggest suitable policy measures.

II. METHODOLOGY

Complete enumeration of the rabbit farms in the state was done. The list of rabbit entrepreneurs in each district was obtained with the help of officials of the Development Blocks, progressive rabbit entrepreneurs, traders, concerned officials of government etc. Though rabbitry for wool is taken-up in all districts except Una, Bilaspur and Lahaul and Spiti, where the climatic conditions are not congenial, Chamba, Hamirpur, Kangra, Kinnaur, Kullu, Mandi, Shimla, and Solan districts were chosen for the study.In each district a list of rabbit entrepreneurs was prepared alongwith their flock size. The rabbit farms were categorised into small, medium and large classes with the help of cumulative cube root frequency method according to distribution of the flock size. For each category the size and number of rabbit farms have been given in Table 1

TABLE -1 CLASSIFICATION OF THE RABBIT FARMS

Sr. No.	Category	Number of Rabbits	Number of Rabbit Farms	Percentage of Rabbit Farm
1.	Small	Less than 25	93	54.70
2.	Medium	25-150	45	26.47
3.	Large	≥150	32	18.83
	Total		170	100.00

The problems and constraints confronted by rabbit entrepreneurs have been categorised into different sub-heads viz; production, financial, marketing and institutional problems. The per cent response was recorded on different size of rabbit farms. To test the difference in the extent of problems confronted on different size of farms, chi-square test was employed to test the rejection or acceptance of the following null hypothesis.

H_o : Pi 1= pi 2 = pi 3 = pi 4

Pij = Problems on different categories of farms.

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The value of chi square was compute as follow:

$$n\left[\sum_{I=1}^{k}\sum_{j=1}^{k}\frac{fij^2}{fionj}-1\right]\sim\chi^2_{(k-1)(l-1)}\ df.$$

Where

$$Fio=\sum_{J=i} fij$$

$$n=\sum_{i=1}^{k} fij$$

If calculated value is greater than table value. Ho (null hypothesis) is rejected

III. RESULTS AND DISCUSSION

The problems and constraints faced by rabbit entrepreneurs have been categorised into four subheads viz; production, financial, marketing and institutional problems. The rabbit entrepreneurs were interviewed in respect of various problems and their response has been given in various sub-heads. The null-hypothesis (Ho: = pi1 = pi2 = pi3 = pi4) i.e. the extent of problems is same in all the categories of rabbit entrepreneurs was tested. The calculated value (χ^2 = 411.65) of Chi-square was greater than the table value (χ^2= 112.33). Therefore, it led to the rejection of null-hypothesis i.e. hypothesis of no difference and revealed that the problems differ significantly in different categories of entrepreneurs and they can be reduced if proper management practices are adopted by rabbit entrepreneurs and requires different way of tackling for each category.

A) Production Problems of Rabbit Entrepreneurs

The production problems of rabbit entrepreneurs have been further sub-categorised into twelve types viz; availability of feed, price of feed, shortage of fodder, availability of cages, feeders, waterers, process of equipments, problem of pests and diseases, availability of veterinary aid, availability of medicine, availability of labour, high labour wages, availability of fresh blood (breeding animals to avoid inbreeding), maintenance of financial and pedigree records. The different problems confronted by wool rabbitry entrepreneurs are given in Table 2 and are as under.The availability of quality feed is an important component in rabbit production. About 52 per cent of rabbit entrepreneurs reported that the feed was not available at right time. The rabbit entrepreneurs reported that the sub-standard feed led to deaths *en-masse* and heavy losses to them. The perusal of the table reveals that the gravity of the problem and farm size has an inverse relationship.The feed prices when compared to output prices are quite high. About 72 per cent of the rabbit entrepreneurs on overall farms reported this problem and the gravity of the problem and farm size shows inverse relationship. The per cent response decreased with increase in farm size.The commonly fed fodder in the study area are common grasses, bamboo leaves, barseem, *biul* leaves and kitchen waste. About 12 per cent of the rabbit entrepreneurs reported acute shortage of fodder in the study area especially during winter. The maximum shortage of fodder was experienced on medium farms (15.56 per cent) followed by small and large farms.About 18 per cent of the entrepreneurs reported that the inputs like cages, feeders and waterers are not available. The extent of problem increased with the increase in farm size hence showed positive correlation between gravity of problem and farm size.The problem of high prices of cages, feeders and waterers showed a positive correlation with the size of the farm. About 24 per cent of rabbit entrepreneurs on all farms reported the problems of high prices of these equipments.

TABLE 2. PRODUCTION PROBLEMS OF THE RABBIT ENTREPRENEURS

(Per cent)

Sr. No.	Particulars	Farm Size			
		Small	Medium	Large	All farms
	roduction Problems:				
1.	Quality fe d not available at appropriate	72.04	35.56	16.13	52.07
2.	Feed prices not reasonable	94 62	51 11	35.48	7 19
3	Shortag of fodder	11.83	15.56	9.68	12.43
4.	Cages, feeders and waterers not availabl at right time	6.45	28 89	35.48	7 75
5.	Price of cages, f eders and wat rers are high.	7.53	37.78	54.84	24.26
6.	Problem of pest and diseases	1.08	11.11	29.03	8.88
7	Veterinary aid not available wh n required	7 53	35 56	45 16	21.89
8.	Medicines not available at right time	6.45	24.44	6.45	11.24
9.	Labour not available when required	58.06	22.22	16.13	40.83
10.	Labour charges not reasonable	37.63	26.66	25.81	31.95
1	Non-availability of f sh blood.	8 71	31 11	9.68	36
12.	maintenance of financial and pedigre records	97.85	7 .	74.19	86. 9
	Total number of farms	93	45	31	169

Note: Figures have been rounded off to their nearest digit.

The problem of pest and diseases was depicted by about 9 per cent of entrepreneurs on all farms and the per cent response increased with the increase in farm size.About 22 per cent of rabbit entrepreneurs confronted this problem on all farms category of rabbit entrepreneurs. The gravity of non-availability of veterinary aid and farm size showed positive correlation. The maximum response of 45.16 per cent was reported on large farms followed by 35.56 per cent on medium farms and 7.53 per cent on small farms.The non-availability of medicines was reported to the extent of about 11 per cent on all farms. The maximum per cent response was recorded on medium farms 24.44 per cent. However, it was a tie (6.45 per cent) on small and large farms.The non-availability of labour was experienced by about 41 per cent on all farms category. The gravity of the problem of non-availability of labour and farm size showed an inverse relationship. The response was maximum on small farms (58.06 per cent) followed by medium farms 22.22 per cent on medium farms and 16.13 per cent on large farms.The high wages of labour for attending rabbits was experienced by about 32 per cent of entrepreneurs on all farms category. The extent of the problem decreased with increase in size and thereby showing an inverse relationship between extent of problem and farm size. The response recorded was as high as 37.63 per cent on small farms followed by 26.66 per cent on medium farms and 25.81 per cent on large farms.The inbreeding in rabbits leads to decreased output, high incidence of diseases and mortality among the flock. Therefore, introduction of fresh blood of pure strain at frequent intervals is very important to eliminate the adverse consequences of inbreeding in a rabbitry. About 31 per cent of rabbit entrepreneurs on all farms reported the problem of non-availability of fresh blood. The gravity of the problem was maximum on small farms (38.71 per cent) followed by medium farms 31.11 per cent and 9.68 per cent on large farms thereby depicting inverse relationship between extent of problem and farm size.

The problem of maintaining financial and pedigree records was as high as about 86 per cent on all farms.

B) Financial Problems of Rabbit Entrepreneurs

The establishment of rabbitry units requires some capital investment in the beginning. The finance is needed to construct shed, purchase cages, waterers, feederers and purchase of the breeding stock. The banks have a scheme to finance small and marginal farmers or agricultural labourers for small units size of 10 female+2 male. However, if large farmers entrepreneurs are interested to take up the scheme they could be financed more than one unit depending upon individual needs and merits of each case. The banks also make provision for providing veterinary aid, fodder and

concentrated feed and training of beneficiaries. The loan limit is Rs. 2430.00 for a unit of 10 females+2 males for fur/ meat and Rs 8850.00 for a unit of wool type breeding rabbits. Considering larger loan required for the latter unit, it is necessary that beneficiaries with adequate resources and experience be selected. The disbursement of loan is against purchase of equipments and breeding animals on the supply of bills of such items. The initial recurring expenses for first 6 months for pelleted feed have been capitalized term loan. The disbursement against supply of feed is also done against bills of supply. The loan against breeding animals is disbursed only when equipment and initial stock of one month feed is purchased and inexperienced farmer receives adequate training. Margin money by beneficiaries at the rate of 15 to 25 per cent for wool unit as per ARDC norms is envisaged. The rate of interest to ultimate borrowers will depend upon the amount of loan raised. However, the rate of interest varies from 12 per cent to 23.75 per cent with quarterly or half yearly interests. The security against the loan is hypothecation of rabbits, feed, fodder, equipment fixtures and other movable created out of the bank loan. Secondly, creation of equitable mortgage/ charge over applicants land where sheds are constructed and thirdly, third party guarantee of sufficient worth good for loan amount.The supervision of the credit is through regular visits to the unit in order to ensure proper utilization of loan amount disbursed for construction of sheds, purchase of equipments and rabbit stock. Thereafter, monthly inspections will be carried out regularly when the project commences.The bank also makes a provision for adequate and comprehensive insurance cover in respect of shed equipment against fire, theft, earthquake, riots and rabbit mortality during the period of loan and relevant policies are also arranged in favour of bank. Banks assume that daily requirements of about two hours per unit for adult rabbits and the progeny, scheme would provide additional employment of 90 days per year per unit.The contact with the farmers through survey revealed that majority of the farmers are not aware of the loan facility.

TABLE 3. FINANCIAL PROBLEMS OF THE RABBIT ENTREPRENEURS

(Per cent)

Sr.		Farm Size			
No.	Particulars	Small	Medium	Large	All farms
1.	Credit not available at appropriate time	93.55	86.67	96.77	92.31
2.	Credit given not supervised	95.70	93.33	96.77	95.27
3.	Available credit is inadeq ate	93.55	86.67	96.77	92.31
	Total number of farms	93	45	31	169

Note: Figures have been sounded off to their nearest digit.

The non-availability of credit at appropriate time was reported by 92.31 per cent of rabbit entrepreneurs on all farms situation. The maximum response to this problem was recorded on large farms 96.77 per cent followed by small farms 93.55 per cent and medium farms 86.67 per cent.Since the rabbit industry in Himachal Pradesh is in recession and banks advance loans only to those entrepreneurs whose risk bearing ability and repayment capacity is high. Small rabbit entrepreneurs do not gather courage to have loan under present circumstances when rabbit industry is passing through a slump.About 95 per cent of rabbit entrepreneurs on all farms situations reported that credit once given is not properly supervised. He response recorded was maximum on large farms (96.77 per cent) followed by small and medium rabbit entrepreneurs respectively.The rabbit entrepreneurs reported that credit given is not adequate 92.31 per cent of rabbit entrepreneurs on all farms reported that available credit was inadequate. Among different size of rabbit entrepreneurs, the maximum response was recorded on large farms and it was to the tune of 96.77 per cent followed by small farms 93.55 per cent and 86.67 per cent on medium farms.

C) Marketing problems

The availability of proper marketing facilities is a pre-requisite for the development of any enterprise. An efficient marketing system for the disposal of farm produce leads to faster growth and development. The profitability also depends on the factors like location of market, storage, transportation facilities and grading of farm products. So far there is no stable and organized market for Angora rabbit farming on large scale. There is a demand for better breeds of Angoras but the sale/ disposal of ordinary surplus animals is not organized and ensured. The various marketing problems noticed on farms are as under:

TABLE 4: MARKETING PROBLEMS OF THE RABBIT ENTREPRENEURS

(Per cent)

Sr. No.	Particulars	Farm Size			
		Small	Medium	Large	All farms
1.	Inadequate Transportation Facilities	0	11.11	45.16	11.24
2.	Regular markets for farm product	37.63	37.78	51.61	40.24
3.	Unremunerative price of meat	100.00	100.00	100.00	100.00
4.	Unremunerative price of wool	100.00	100.00	100.00	100.00
5.	Problem of grading of wool	29.03	2.22	9.68	18.34
6.	High marketing costs	10.75	31.11	61.29	24.26
7.	Support price by Govt.	43.01	62.22	77.42	54.44
8.	Price of rabbits for remunerative	98.92	73.33	77.42	88.17
9.	Demand of wool products seasonal	100.00	95.56	100.00	98.82
	Total number of farms	93	45	31	169

Note: Figures have been sounded off to their nearest digit.

Transportation plays an important role in the marketing of produce which has to be shifted from the point of production to the point of final consumption. Comparatively the problem of transportation of the inputs and produce was revealed by a less number of rabbit entrepreneurs. On all farms situation only 11.24 per cent of entrepreneurs reported this problem. Maximum response in favour of inadequate transportation was recorded on large farms (45.16 per cent) followed by large farms (11.11 per cent). However, the problem of transportation was not confronted on small farms.Rabbitry entrepreneurs in the study area reported to have insufficient market system.There were no ready buyers of rabbit products, especially wool, locally, so the farmers had either to transport it to distant towns or sell in the local market at low premium. About 40 per cent of the farmers on all farms situation responded to this problem.The problem of unremunerative prices of meat was responded positively by each and every entrepreneur on all categories of farms. Rabbit meat could not be popularized among meat eaters in Himachal Pradesh.However, rabbit meat has many desirable traits like low fat and cholesterol, high proteins and minerals. The wool rabbits when become uneconomical with the passage of age are sold at throw away prices. Therefore, 100 per cent of rabbit entrepreneurs in all the categories confronted this problem.The problem of unremunerative prices of wool has been responded positively by each and every rabbit entrepreneur on all the categories of farms. With the liberalisation the access to market by developed nations has increased. The Government of India has reduced tariff on import of wool to a greater extent and as a result the rabbit wool was available at a cheaper rate than home produced. Therefore, in the recent past year the prices of wool have slashed and frames are not getting remunerative prices for their produce.The different grades of rabbit wool have different prices and traders cheat rabbit entrepreneurs by designating their produce as “B” grade wool. The problem of grading of wool before selling was revealed by 18.34 per cent of rabbit entrepreneurs on all farms situation. The maximum response was recorded on small farms which was to the extent of 29.03 per cent followed by large farms (9.68 per cent) and medium farm 2.22 per cent.The marketing costs in rabbitry includes the cost of transportation, storage and other fees if any. High marketing costs were reported by 24.26 per cent of rabbit entrepreneurs on all farms situations. The problem of high marketing cost and size of the farm showed a positive correlation. The gravity of the problem of high marketing costs increased with the increase in farm size. On small farms 10.75 per cent of rabbit entrepreneurs responded to this problem. On medium farms (31.11 per cent) and on large farms 61.29 per cent reported this problem.About 54 per cent of rabbit entrepreneurs on all farms situation revealed that the government should fix suppose price for rabbit wool. The per cent response of the rabbit entrepreneur increased with the increase in size of a farm. 43.01 per cent of small farms, 62.22 per cent of medium farms and 77.42 per cent of large rabbit entrepreneurs revealed that government should fix the support price for rabbit wool.The rabbits are purchased for establishing new rabbit units and also for cross-breeding purpose. About 88 per cent of rabbit entrepreneur on all farms situation revealed that the existing price of the animals is not

remunerative. The problem of unremunerative prices was reported by 98.92 per cent entrepreneurs on small farms followed by large farms (77.42 per cent) and medium farms (73.33 per cent).The demand for rabbit wool and other products is seasonal. During winter the demand for wool products rises, whereas, it decreases in other months of the year. The seasonal demand for wool products was reported by 98.82 per cent on all farms.

D) Institutional Problems

The institutional problems faced by rabbit entrepreneurs have been studied under subheads like lack of training and extension facilities and availability of package of practices and presented in Table 5.The knowledge acquired through training is of great relevance. The different institutions organize training programmes for rabbit entrepreneurs. About 27 per cent of rabbit entrepreneurs on all farms situation reported that existing training facilities are not adequate. The

TABLE-5: INSTITUTIONAL PROBLEMS OF THE RABBIT ENTREPRENEURS

(Per cent)

Sr.No.	Particulars	Farm Size			
		Small	Medium	Large	All farms
1.	Training Facilities not adequate	12.90	51.11	32.26	26.63
2.	Lack of Extension Facilities	93.55	66.67	83.87	84.62
3.	Package of Practices available	100.00	53.33	74.19	82.84
	Total number of farms	93	45	31	169

Note: Figures have been sounded off to their nearest digit.

maximum response in favour of this problem was found on medium farms 51.11 per cent) followed by large farms (32.26 per cent) and small farms (12.90 per cent).The rabbit entrepreneurs expect time to time help and guidance from different agencies of government. 84.62 per cent of rabbit entrepreneurs on all farms reported the lack of extension facilities. The improved technology developed by research institutes is disseminated through package of practices. The 82.84 per cent of rabbit entrepreneurs reported the non-availability of package of practices. Cent per cent response with regard to this problem was recorded on small farms. However, 53.33 per cent of medium farms and 74.19 per cent of large farms reported this problem, respectively.

IV. FUTURE STRATEGY AND POLICY IMPLICATION

The rabbit wool industry in Himachal Pradesh is in recession. In order to revive the industry the following policy points may be taken into consideration by the planners and policy makers:

i) For making rabbit as a viable livestock species it has to be introduced on scientific lines. The Government of India and Indian Council of Agricultural Research may open a National Rabbit Research Centre as has been done in case of sheep, goat, horses, camels, buffaloes and poultry thereby accepting rabbit as also one of the important livestock species having overall multifaceted utility to the country. Training of scientists, technicians and farmers should also be a component objective of such a National Rabbit Research Centre

ii) Case of slashing down of the import duty abruptly should be taken-up with the Ministry of Commerce, Government of India, so that the prices of the imported wool are at par with the domestic produce and domestic production is encouraged

iii) Good Angora rabbits are always in demand by the government agencies in other states which are keen to introduce rabbitry as supplementary enterprises. The rabbits are also required by private entrepreneurs within the state as well as in other states. The sale and disposal of surplus animals if organized through some state/ private marketing agencies/ farmers' cooperatives will bring economic gains to Angora farmers.

iv) The provision of training to rabbit entrepreneurs should be strengthened and package of practices should be readily available. Involvement and training of farm women has to be further encouraged. The farmers should make a co-operative and should shear the rabbit wool at one time for the uniform length and quality. Awareness among the entrepreneurs will abridge the gap between existing and recommended levels of inputs.

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

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

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

Key Words

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

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

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

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

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.

- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

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

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

Acknowledgements: Please make these as concise as possible.

References

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

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

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

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

Tables, Figures and Figure Legends

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

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

Preparation of Electronic Figures for Publication

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

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

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

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

6. AFTER ACCEPTANCE

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

6.1 Proof Corrections

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

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

(Free of charge) from the following website:

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

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

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

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

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

6.3 Author Services

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

6.4 Author Material Archive Policy

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

6.5 Offprint and Extra Copies

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Before start writing a good quality Science Frontier Research Paper, let us first understand what is Science Frontier Research Paper? So, Frontier Research Paper is the paper which is written by professionals or scientists who are associated to Physics, Mathematics, Chemistry, Zoology, Botany, Bio-tech, Geology, Military Science, Environment and all Interdisciplinary & Frontier Subjects etc., or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

Techniques for writing a good quality Applied Science Research Paper:

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

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

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

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

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

6. Use of computer is recommended: At a first glance, this point looks obvious but it is first recommendation that to write a quality research paper of any area, first draft your paper in Microsoft Word. By using MS Word, you can easily catch your grammatical mistakes and spelling errors.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Informal Guidelines of Research Paper Writing

Key points to remember:

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

Final Points:

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

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

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

General style:

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

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

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

In every sections of your document

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

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

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

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

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

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

Title Page:

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

Abstract:

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

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

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can

maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

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

Approach:

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

Introduction:

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

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

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.
- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

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

Materials:

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

Methods:

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

Approach:

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

What to keep away from

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

Results:

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

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.

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

Content

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

What to stay away from

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

Approach

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

Figures and tables

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

Discussion:

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

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.

- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

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

Administration Rules Listed Before Submitting Your Research Paper to Global Journals Inc. (US)

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

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

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.
- Do not give permission to anyone else to "PROOFREAD" your manuscript.

Written Material: You may discuss with your guides and key sources.

- Do not copy or imitate anyone else paper. (Various Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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

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

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

Index

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ISSN 9755896