Name of the Project: A Plasma-Based Study of Solar Equilibrium Structure and Fluctuation Dynamics

Sanction Number: SR/FTP/PS-021/2011

Name of PI : Dr. Pralay Kumar Karmakar
Address : Department of Physics, Tezpur University
Napaam-784028, Assam, India

To:
Officer on Special Duty
Science and Engineering Research Board (SERB)
5 & 5A, Lower Ground Floor, Vasant Square Mall
Sector-B, Pocket-5, Vasant Kunj
New Delhi-110070 (India)

Date: 08-07-2016

Sub: Submission of project-completion technical report
Ref: Your e-mail, on project-inspection, dated 11-04-16

Sir/Madam,

Please refer to your e-mail on the subject and reference on the SERB-sponsored project as clearly mentioned above. In this reference, we, at first, express our deepest gratitude to SERB and its officials for the extended support to our R&D activities in a humble way at our small university. It is my pleasure, as a PI, to let you know that the supported project has succeeded to result in new findings in the interest of Plasma and Astrophysical communities.

The list of the project-centered publications and relevant details prepared as per your helpful advice are furnished herewith for your kind consideration and needful action.

In addition to the above, a small number of works are likely to appear elsewhere. Kindly be informed, hereby, that the required remaining formalities with all full details are being completed within a month, or at the earliest.

Thanking you with regards.
Sincerely,-

(Pralay Kr. Karmakar)
Principal Investigator

Name of the Project: A Plasma-Based Study of Solar Equilibrium Structure and Fluctuation Dynamics

Sanction Number: SR/FTP/PS-021/2011

Name of PI : Dr. Pralay Kumar Karmakar
Address : Department of Physics, Tezpur University
Napaam-784028, Assam, India

Annexure-IX

PROJECT COMPLETION REPORT

1. Title of the project: **A Plasma-Based Study of Solar Equilibrium Structure and Fluctuation Dynamics**

2. Principal Investigator(s) and Co-Investigator(s): **Dr. Pralay K. Karmakar**
   (no Co-Investigator)

3. Implementing Institution(s) and other collaborating Institution(s): **Tezpur University**

4. Date of commencement: **16-08-2012 (with manpower) & 06-03-2012 (without manpower)**

5. Planned date of completion: **14-08-2015**

6. Actual date of completion: **14-08-2015**

7. Objectives as stated in the project proposal:

   1) To study the effect of electronic inertia on nonlinear normal mode propagation through transonic plasmas in a self-gravitating system.
   2) To study the origin of solar plasma fluctuations and their nonlinear propagation.
   3) To investigate the effects of electronic inertia and magnetic field on star formation and associated normal modes.
   4) To study the dynamical evolution of the GES under the lowest order correction of plasma thermal species
   5) To investigate the role of magnetic field on the GES formation and its surface fluctuation.
   6) To study the long-standing solar *T*-valley (cold chromospheres) problem in the solar interior.

8. Deviation made from original objectives if any, while implementing the project and reasons thereof: It is evident that no deviation has been allowed in our proposed studies. Moreover, the gravito-electrostatic mysteries in many additional self-gravitating plasmas have also been explored in detail.

9. Experimental work giving full details of experimental set up, methods adopted, data collected supported by necessary table, charts, diagrams & photographs: As such, no experimental work was proposed in the original project. However, numerical and simulational experiments have particularly been performed to explore the Sun and its atmosphere in the framework of plasma-based theory. Some important results in graphs and tables are presented below.

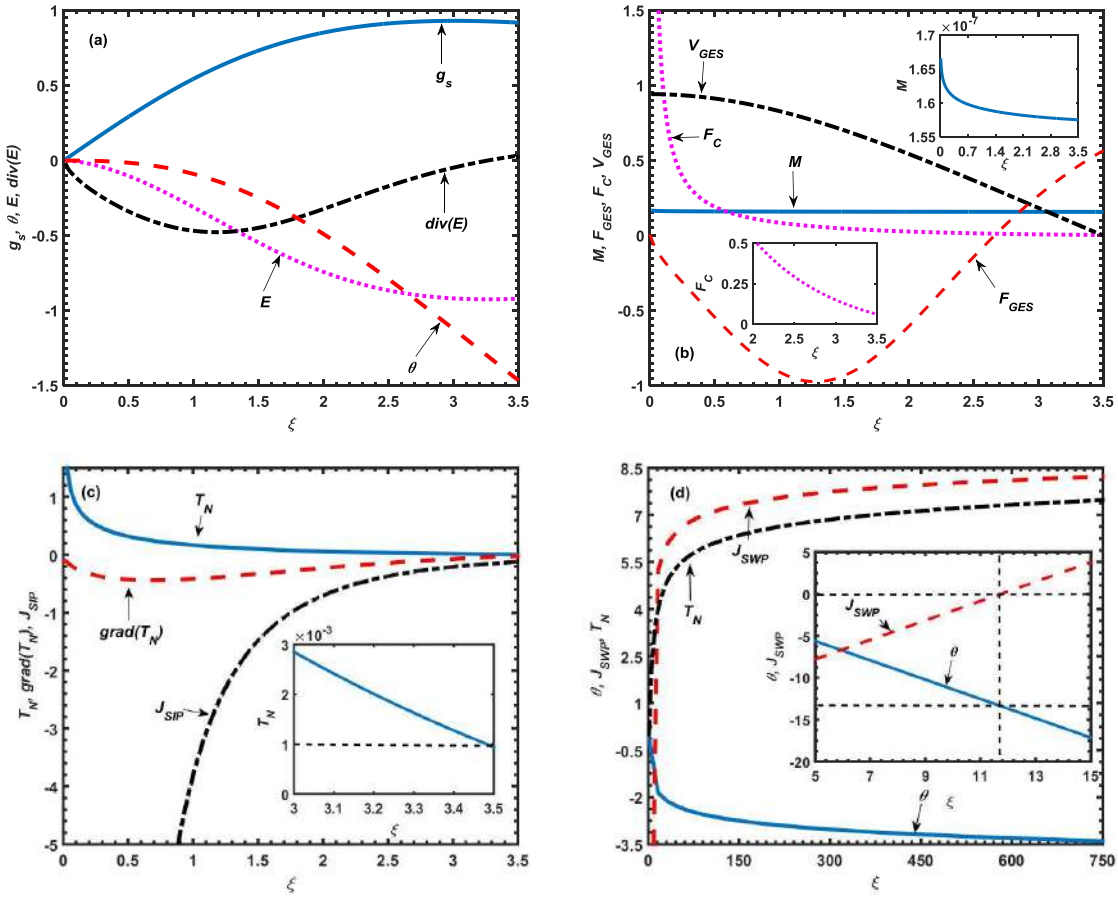

Figure1: Profiles of the various solar plasma parameters with variation in position in normalized form. In figure 1(a), g_s represents the self-gravity of the solar plasma. It is found to be maximum at $\xi = 3.5$. Thus, by the principle of maximization of the gravity, the surface of the Sun is located at $\xi = 3.5$, which is the solar radius. The physical length is $R_O = 3.5\lambda_J = 7\times10^8$ m, where, λ_J is the Jeans length. The physical value of the gravity at the surface is found to be $g = 0.6c_S^2/\lambda_J = 260$ m s^{-2}. In the same figure, E represents the electric field, which is equal in magnitude with the self-gravity. Thus, the self-gravity is balanced by the electrostatic force-field at the solar surface. In figure 1(b), M represents the normalized ion flow velocity which is clearly non-zero at the surface. This shows that the plasma in the solar interior continuously comes out of the surface to form the solar wind. Thus, the origin of the solar wind plasma lies in solar interior itself. In the same figure, F_{GES} represents the net effective GES force on the plasma. It is positive at the surface which provides the necessary momentum to the particles to cross the gravitational barrier. In figure 1(c), T_N represents the normalized temperature. The physical temperature at the surface comes out to be $T_O = T_N T_0 = (1\times10^{-3}) \times (6\times10^6) = 6\times10^3$ K. In the same figure, J_{SIP} represents the net electric current density which is negative. Thus, a finite negative current flows across the solar surface. In figure 1(d), J_{SWP} represents the net current density in the solar atmosphere. This current, as clearly visible in the inset, undergoes a sign reversal after a few solar radii to become positive. The corresponding surface is known as the floating surface. In the same figure, T_N represents the normalized temperature in the solar atmosphere. The coronal temperature found to be $T_c = 6\times10^6$ K, which is in good agreement with the observed value.

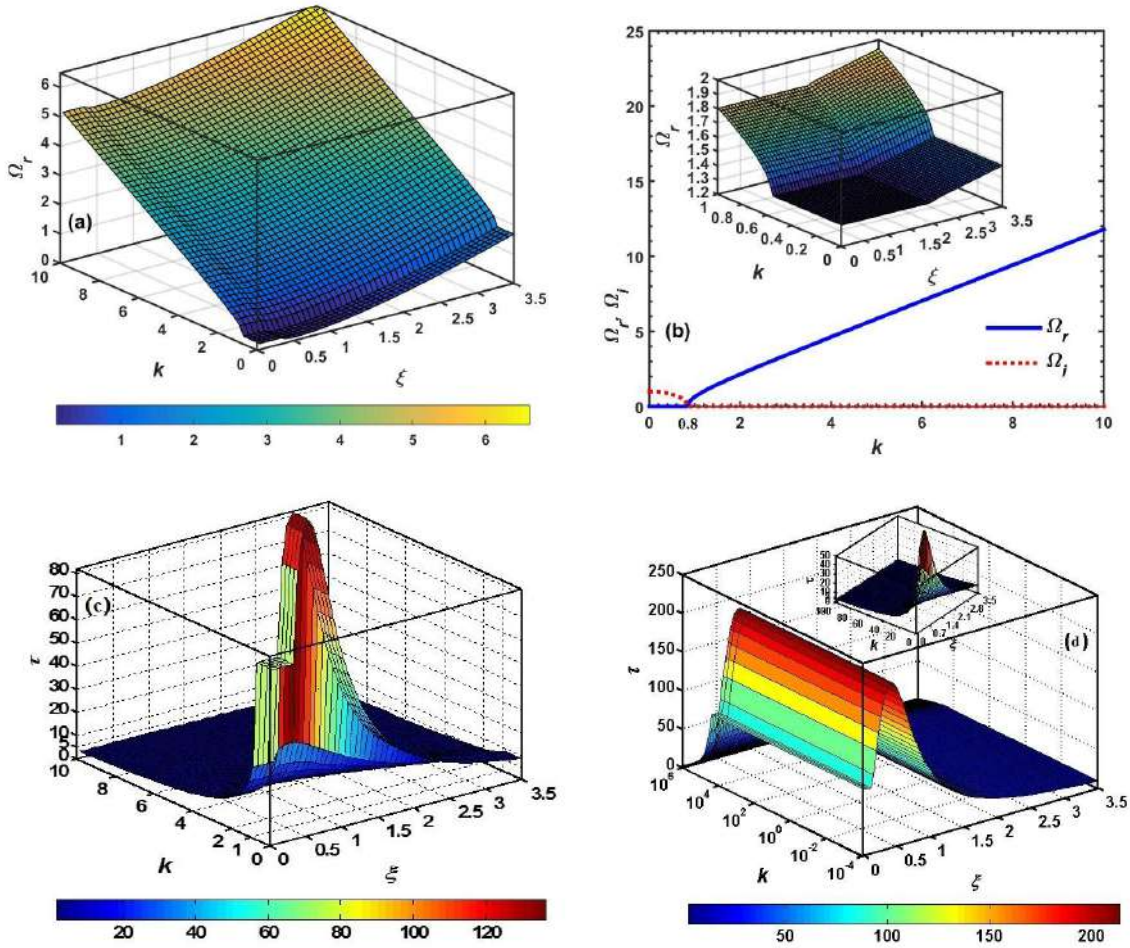

Figure 2: Profiles of the GES-based solar plasma fluctuation dynamics with variation in position and wavenumber in normalized form. In figure 2(a), we show the real frequency in the SIP. It depicts a specific domain in the *k*- space with $k = 10^{-4} – 0.8$, where the frequency is constant. This is the same domain representing the usual Jeans mode with purely growing character [figure 2(b)]. This is quasi-linearly transformed into an oscillatory mode, termed as the *GES-oscillator*. The time period of oscillation of this mode, as shown in figure 2(c) is $\tau =$ 10 minutes. Beyond $k = 0.8$, the fluctuations propagates as proper wave, termed as the plasma *GES-wave* mode. This mode exists in the k-domain of $k = 0.8\text{-}10^5$. The time period of this mode lies in the range of $\tau = 3\text{-}5$ minutes. Beyond $k = 10^5$, the self-gravitational fluctuations becomes much weaker and the pure electrostatic fluctuation propagates as the *acoustic* or *p-mode*. These wave modes propagate independently without any hindrance from the proposed wall boundary of the GES-Sun.

10. Detailed analysis of results indicating contributions made towards increasing the state of knowledge in the subject:

    A novel theoretical model namely gravito-electrostatic sheath, is developed and extended to study the equilibrium structure and stability of the Sun and its atmosphere. Two distinct classes of coupled sets of basic governing equations in normalized closed form are

formulated for the bounded and unbounded scales in isolation. It is found that the plasma in the solar interior possess finite non-zero velocity ($v_i \sim 3$ cm s^{-1}) at the solar surface, which shows that the origin of the solar wind lies in the solar interior itself. This is in contrast to the Parkers result, which tells that the solar wind originates at the surface. In addition, it also predicts a non-zero negative current ($J = -10^{12}$ A m^{-2}) across the solar surface. This current undergoes the sign reversal beyond the solar surface.

The temperature predicted by this model are in good agreement with the standard values. According to the GES model, the temperatures of the solar surface and corona come out to be $T_\odot = 6000$ K and $T_c = 6\times10^6$ K, respectively, which are in good correspondence with the observed values. It provides a unique mechanism based on the GES formation to explain the coronal heating and acceleration of the solar wind.

The magnetic field acts to broaden the GES which is in accordance with the laboratory plasma sheath. Also, the effect of magnetic field on sheath potential is found to be similar as in the laboratory case. The current-voltage characteristics of the solar plasma shows that the solar surface behaves as a linear Ohmic-like conductor with minimum conductivity, in comparison to the interior and atmosphere.

From the nonlocal stability analysis, it is found that the GES-Sun supports three distinct natural normal modes. The identified normal modes are characterized and termed as the *GES-oscillator*, *GES-wave* and the usual classical *p*-mode. The time periods of oscillation of these modes at the solar surface lies in the range of 3-10 minutes that exactly matches with the time periods of observed helioseismic waves and surface oscillations. In the solar wind, only the acoustic mode survives. It is admitted that the proposed GES model needs further refinements in the thermodynamic aspects with a proper equation of state to make it more realistic for future applications extensively.

11. Conclusions summarizing the achievements and indication of scope for future work:

A detailed qualitative, quantitative and comparative study of the solar plasma equilibrium structure associated relevant physical parameters under our GES model is carried out to describe the distinct structural features of the solar interior, exterior and it's coupled atmosphere. It is found that the origin of the supersonic solar wind plasma lies in the solar interior itself. The Sun bears a negative electron current flowing across the spherical surfaces of the GES-based Sun. The effect of the magnetic field and temperature on the GES, which is of the order of the Jeans length, is found to be similar with the laboratory plasma sheath, of the order of Debye length. Thus, there is a scale invariance of the sheath properties. Moreover, the stability analysis gives three distinct normal modes in the solar interior with time periods exactly matching with the time periods of observed helioseismic wave and oscillation at the solar surface boundary.

The model has a large number of applications and future scopes. One can carry out theoretical analysis for the GES-driven nonlinear turbulence and its nonlinear saturation mechanism. Study of parametric coupling of the GES-oscillator with the SWP bulk acoustic modes forms another interesting problem in astrophysical plasmas. The study of the GES-surface modes is as well another area to properly understand the patching of the bounded and unbounded plasmas at the defined SSB. Moreover, the consideration of abundances can be modelled in the form of multi-species plasma with different variable non-isothermal temperatures and may become another hotspot theoretical problem for further research. One will have to wait till further improvements of the GES theory presented here are carried out in the future to prove its reality and applicability.

In addition to above, a number of new findings on gravito-electrostatic equilibrium structure and associated fluctuation dynamics in space, cosmic, and astrophysical environments are also investigated in detail. It is convincingly proved that, unlike current astrophysical scenarios, the consideration of static equilibrium configuration in the framework of local theory is inadequate. Application of non-local theory amid inhomogeneous equilibrium unveil many hidden characteristics of astrophysical plasmas in the form of new collective modes, hybrid eigen-structure and discrete oscillations previously remaining unaddressed as well as unexplored. In summary, we can conclude that the project has been greatly successful in exploring many new properties of self-gravitating plasma systems, including gravito-electrostatics and coupled fluctuations, on the astrophysical hydrodynamic scales of space and time.

Finally, we are extremely thankful to SERB-DST for financial support and cooperation extended to us through the successfully completed project.

12. S&T benefits accrued:

i. List of Research publications

Year: 2015-16					
SN	Author (in order)	Title of paper	Journal details	Publisher	IF
1	P. K. Karmakar, H. P. Goutam, M. Lal and C. B. Dwivedi	Stability analysis of the gravito-electrostatic sheath-based solar plasma	Monthly Notices of the Royal Astronomical Society, 2016, 15pp (in Press)	Wiley	5.4
2	B. Borah, A. Haloi and P. K. Karmakar	A generalized hydrodynamic model for acoustic mode stability in viscoelastic plasma fluid	Astrophysics and Space Science, 2016, 11pp (in Press); DOI 10.1007/s10509-016-2739-7	Springer	2.2
3	P. K. Karmakar and B. Borah	Global gravito-electrostatic fluctuations in self-gravitating spherical non-uniform charged dust clouds	Astrophysics and Space Science 361, 115, 2016, 22pp	Springer	2.2
4	B. Borah, A. Haloi and P. K. Karmakar	Atypical gravito-electrostatic fluctuations in the presence of active ion-inertial dynamics	Journal of Plasma Physics 82, 905820206, 2016, 31pp	Cambr UP	0.8
5	M. Gohain and P. K. Karmakar	A generalized two-fluid model of plasma sheath equilibrium structure	Europhysics Letters 112, 45002, 2015, 6pp	IoP	2.0
6	Hari Prasad Goutam and Pralay Kumar Karmakar	Equilibrium structure of gravito-electrostatic sheath in presence of inhomogeneous temperature distribution	Europhysics Letters 112, 39001, 2015, 6pp	IoP	2.0
7	A. Haloi and P. K. Karmakar	Nonlinear gravito-electrostatic waves in self-gravitating complex plasma in presence of	Astrophysics and Space Science 358, 41, 2015, 9pp	Springer	2.2

		ion-drag effects			
8	H. P. Goutam and P. K. Karmakar	Gravitoelectromagnetic sheath	Astrophysics and Space Science 357, 127, 2015, 15pp	Springer	2.2
9	B. Borah and P. K. Karmakar	A theoretical model for electromagnetic characterization of a spherical dust molecular cloud equilibrium structure	New Astronomy 40, 49, 2015, 15pp	Elsevier	1.1
Year: 2014-15					
SN	Author (in order)	Title of paper	Journal details	Publisher	IF
10	B. Borah and P. K. Karmakar	Pulsational mode fluctuations and their basic conservation laws	Advances in Space Research 55, 416, 2015, 11pp	Elsevier	1.1
11	H. P. Goutam and P. K. Karmakar	A simple model for plasma evolution solar coronal loops	International Journal of Advanced Research in Physical Sciences 2(2), 41, 2015, 9pp	ARC	2.2
12	M. Gohain and P. K. Karmakar	Gravito-electrostatic fluctuations in a polytropic charged dust cloud	Physica Scripta 89, 125604, 2014, 12pp	IoP	1.1
13	B. Borah and P. K. Karmakar	Nonlinear waves in a self-gravitating charge-varying collisional dust molecular cloud in presence of diverse equilibrium inhomogeneities	Physica Scripta 89, 125602, 2014, 26pp	IoP	1.1
14	P. K. Karmakar, M. Gohain and U. Deka	Stability analysis of the polytropic solar wind	Canadian Journal of Physics 92(11), 1419, 2014, 5pp	NRC	0.9
15	H. P. Goutam and P. K. Karmakar	An inertia-based theoretical study of the Debye shielding in different plasma configurations	Canadian Journal of Physics 92(6),459, 2014, 5pp	NRC	0.9
16	P. K. Karmakar and B. Borah	New aspects on stability analysis of a planar charge-varying collisional dust molecular cloud with finite thermal inertia	Communications in Physics 24, 45, 2014, 12pp	VAS	Inx
Year: 2013-14					
SN	Author (in order)	Title of paper	Journal details	Publisher	IF
17	P. K. Karmakar and B. Borah	New oscillatory shock-like patterns in solar plasma with Boltzmann-distributed electrons	European Scientific Journal 10(3), 499, 2014, 21pp	ESP	0.6
18	P. K. Karmakar and B. Borah	Inertia-centric stability analysis of a planar uniform dust molecular cloud with weak neutral-charged dust frictional	Plasma Science and Technology 16(5), 433, 2014, 14pp	IoP	0.5

		coupling			
19	P. K. Karmakar and B. Borah	Nonlinear pulsational eigenmodes of a planar collisional dust molecular cloud with grain-charge fluctuation	European Physical Journal D 67, 187, 2013, 14pp	Springer	1.5
20	P. K. Karmakar and B. Borah	Nonlinear self-gravitational solar plasma fluctuations with electron inertia	Contributions to Plasma Physics 53(7), 516, 2013, 13pp	Wiley	0.8
Year: 2012-2013					
SN	Author (in order)	Title of paper	Journal details	Publisher	IF
21	P. K. Karmakar and B. Borah	Inertia-induced excitation theory for nonlinear electrostatic eigenmodes in solar plasma	Journal of Science 3, 215, 2013, 25pp	WASci	Inx
22	P. K. Karmakar and B. Borah	New nonlinear eigenmodes in self-gravitating spherical charged dust molecular cloud	Physica Scripta 86, 025503, 2012, 11pp	IoP	1.1
23	P. K. Karmakar	A new technique for electromagnetic characterization of spherical charged dust molecular cloud	Results in Physics 2, 77, 2012, 12pp	Elsevier	0.7
24	P. K. Karmakar and C. B. Dwivedi	A numerical characterization of the Gravito-Electrostatic Sheath equilibrium structure in solar plasma	International Journal of Astronomy and Astrophysics 2, 77, 2012, 12pp	SCIRP	0.8

ii. Manpower trained on the project
Research Scientists or Research Associates

a) No. of Ph.D. produced : 1 (produced), 1 (submitting)

b) Other Technical Personnel trained: Nil

iii. Patents taken, if any: N/A

13. Financial Position:

No	**Financial Position/ Budget Head**	**Funds Sanctioned**	**Funds Received**	**Expenditure**	**% of Total cost**
A	**Non-recurring (Capital items)**				
I	Minor equipment (Computer system, scanner, printer, etc.)	1,50,000/-	1,50,000/-	1,50,000/-	100%
B	**Recurring (General items)**				
I	Manpower	6,60,600/-	5,68,258/-	5,68,258/-	
II	Consumables	30,000/-	30,000/-	30,000/-	
III	Travel	90,000/-	87,316/-	87,316/-	

IV	Contingencies	1,10,000/-	1,10,000/-	1,10,000/-	
V	Overhead charges	2,08,000	2,04,426/-	2,04,426/-	
B/	**Total**	**10,98,000/-**	**10,00,000/-**	**9,99,607/-**	**100%**
	Net Total (A + B/)	**12,48,000/-**	**11,50,000/-**	**11,49,607**	**100%**

14. Procurement/ Usage of Equipment

a)

S No	**Name of Equipment**	**Make/ Model**	**Cost (FE/ Rs)**	**Date of Installation**	**Utilisation Rate (%)**	**Remarks regarding maintenance/ breakdown**
1.	Desktop Computer	HP 6200	31,850×2 = 63,700/-	30-08-2012	100%	In good state
2.	Document Scanner	HP	21,000/-	30-08-2012	100%	In good state
3.	Computer NoteBook	HP	44,000/-	30-08-2012	100%	In good state
4.	Laser Printer	HP Laser	16,500/-	30-08-2012	100%	In good state

b) Plans for utilizing the equipment facilities in future: We plan to make all the equipments and facilities, whatever we have had via the project, accessible to all of our department in particular and of University in general, for scientific promotion and academic growth.

Name and Signature with Date

Dr. P. K. Karmakar

(Principal Investigator)

DEPARTMENT OF PHYSICS
TEZPUR UNIVERSITY
(*A Central University by an Act of Parliament*)
NAPAAM::TEZPUR::784028
ASSAM::INDIA

Dr. P. K. Karmakar
Associate Professor
Ph: +91-3712-267007/8/9
[Ext. 5562 (C) & 5550 (O)]

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: pkr5@rediffmail.com
Fax: +91-3712-267005/6
Web: http://www.tezu.ernet.in/

Letter No.- F. 11. 14/Per/2006(Phys)/FTP/1471 Date: 20-03-2018

To:
Officer on Special Duty
Science and Engineering Research Board (SERB)
5 & 5A, Lower Ground Floor, Vasant Square Mall
Sector-B, Pocket-5, Vasant Kunj
New Delhi-110070 (India)

Sub: Submission of **final UCs-SEs** for Fast Track Project (SR/FTP/PS-021/2011)
Ref: Dy. No. SERB/F/**2525**/2011-12 dated 05-03-2012

Sir,

Please refer to my ongoing DST sponsored Fast Track Research Project (SR/FTP/PS-021/2011) entitled, ***"A plasma-based study of solar equilibrium structure and fluctuation dynamics"***, bearing the sanction order Dy. No. SERB/F/**2525**/2011-12 dated 05-03-2012.

The supported project was successfully completed in 2016. It resulted in a number of new findings relevant in the interest of Plasma and Astrophysical communities. All the completion details, published articles and related files were sent to you on 08-07-2016.

The final accounted set of the Utilization Certificate (UC) and Statement of Expenditure (SE) for the entire project fund are enclosed herewith for your kind consideration and needful closure action. The unspent amount **[₹ 24,300/- (Twenty four thousand three hundred only)]** is herewith refunded to you via Demand Draft No. 050625, dated 16-03-2018.

Thanking you,
With kind regards.

Sincerely yours'-

(P. K. Karmakar)
Principal Investigator

Dr. P.K. Karmakar
Associate Professor
Department of Physics
Tezpur University

Statement of Expenditure for general head

(Recurring)

Project entitled: "A plasma-based study of solar equilibrium structure and fluctuation dynamics"

(Ref: SERB/F/2525/2011-2012 dated 05-03-2012)

Sl. No. (i)	Sanctioned Heads (ii)	Total funds allocated (indicate sanctioned or revised) (iii)	Fund Unspent 3rd year (iv) (2014-2015)	Fund received (4th year) (v) (2015-2016)	Total fund available (iv) +(v) = (vi) (2015-2016)	Expenditure Incurred (4th year) (vii) (2015-2016)	Balance out of total amount received (vi) - (vii) =(viii)
1	Manpower	6,60,000/-	64,000/-	nil	64,000/-	64,000/-	0/-
2	Consumable	30,000/-	10,000/-	nil	10,000/-	10,000/-	0/-
3	Travel	90,000/-	0/-	nil	0/-	0/-	0/-
4	contingency	1,10,000/-	40,000/-	nil	40,000/-	40,000/-	0/-
5	Overhead	2,08,000/-	77,835/-	nil	77,835/-	77835/-	0/-
6	Interest earned						24,300/-
	Total	**10,98,000/-**	**191835/-**	nil	**191835**	**191835/-**	**24,300/-**

27/02/18

Name and Signature

Principal Investigator

Dr. Pralay Kumar Karmakar

Date:

Principal Investigator
A plasma based study of ...
Title ...
Department of Physics
TEZPUR UNIVERSITY

Signature 27/2/18

Competent Financial Authority

Date and Seal

Finance Officer
Tezpur University

For SURAJIT CHAKRABORTY & CO.
CHARTERED ACCOUNTANTS

10.03.2018

CA. SURAJIT CHAKRABORTY
(Proprietor)
Membership No.- 305054

Annexure-II

UP-TO-DATE STATEMENT OF EXPENDITIRE FOR GENERAL HEAD

(Submitted for the period 1st April 2015 to 31st March 2015)

1. Sanction Order No. and date: SERB/F/2525/2011-12 dated 05-03-2012
2. Total Project Cost: 1098000/-
3. Revised Project Cost (if applicable): N/A
4. Date of Commencement : 1st April 2012
5. Statement of Expenditure:

(Expenditure incurred during financial year 2014-2015)

Month and Year	Expenditure incurred
1st April 2015- 31st March 2016	**Rs.191835/-** (Expenditure incurred)

6. Grant received in each year:
   a. **1st Financial year: Rs.5,00,000/-**
   b. **2nd Financial year: Rs. 2,50,000/-**
   c. **3rd Financial year: Rs.4,00,000/-**
   d. **4th Financial year Rs. 0/-**
   e. **Interest accrued, if any Rs. 24300**
   f. **Total (a+b+c+d+e) : Rs. 11,74,300**

For SURAJIT CHAKRABORTY & CO.
CHARTERED ACCOUNTANTS

10.09.2018

CA. SURAJIT CHAKRABORTY
(Proprietor)
Membership No.- 305054

Annexure-III

UTILISATION CERTIFICATE (2 COPIES) FROM 1st APRIL 2015 TO 31st MARCH 2016

(For recurring items)

1. **Title of the Project/Scheme:** A plasma-based study of solar equilibrium structure and fluctuation dynamics
2. **Name of the Institution:** Tezpur University
3. **Principal Investigator:** Dr. Pralay Kumar Karmakar
4. Sanction order No. & Dt. SERB/F/2525/2011-12 dated 05-03-2012
5. **Head of account as given in the original sanction order:**

Sl. No	Head	1st year	2nd year	3rd year	4th year	Total
B	Recurring (General items)					
1	JRF (One)- Rs. 16000 -16000-18000 + HRA @10%	2,11,200/-	2,11,200/-	2,37,600/-	NIL	6,60,000/-
2	Consumables	10,000/-	10,000/-	10,000/-	NIL	30,000/-
3	Travel	30,000/-	30,000/-	30,000/-	NIL	90,000/-
4	Contingencies including books and journals	30,000/-	40,000/-	40,000/-	NIL	1,10,000/-
5	Overhead charges	68,800/-	68,800/-	70,400/-	NIL	2,08,000/-
	Total	3,50,000/-	3,60,000/-	3,88,000/-	NIL	10,98,000/-

6. **Amount brought forward from previous Financial year quoting DST letter no and date in which the authority to carry forward the said amount was given:**
   - i. **Amount: 1,91,835/-**
   - ii. **Letter No. SERB/F/2525/2011-12**
   - iii. **Date: 05/03/2012**
7. **Amount received during the financial year (Please give DST letter/order no and date):**
   - i. **Amount: NIL**
   - ii. **Letter/order No.**
   - iii. **Date**
8. **Interest earned (2012-2016)** **Rs.24300/-**
9. **Total amount that was available for expenditure: (including commitments)** **Rs.2,16,135/-**
10. **Actual expenditure incurred during the financial Year (1st April' 15 to 31st march' 16):** **Rs.1,91,835/-**
11. **Balance amount available at the end (31st March, 2016):** **Rs. 24,300/-**
12. **Unspent balance to be refunded, if any** **Rs. 24,300/-**
13. **Amount to be carried forward to the next financial year (if applicable):** **N/A**

For SURAJIT CHAKRABORTY & CO.
CHARTERED ACCOUNTANTS
10/03/2019
CA. SURAJIT CHAKRABORTY
(Proprietor)
Membership No.- 305054

Finance Officer
Tezpur University

UTILISATION CERTIFICATE FOR GENERAL HEAD

Certified that NIL –of grant- in and sanctioned during the year **2015-2016** in favour of **Dr. Pralay Kumar Karmakar** under the Department of Science and Technology (DST) letter/order no. SERB/F/2558/2014-2015 dated 08-07-2014 and **Rs.1,91,835/-** unspent balance of previous year, (DST) letter/order No. SERB/F/4890/2013-2014 dated 24-10-2013, and interest earned (2012-2016) **Rs. 24300/-.** Sum of **Rs,1,91,835/-** has been utilized for the purpose of salaries, TA/DA, contingencies, etc. for which it was sanctioned and the balance of **Rs.24,300/-** remain unspent at the end of the year 2015-2016, which is refunded via RTGS/DD....Dated...16/03/2018....with...DD. No. "050625"

27/02/18

Signature of PI

Date:

Principal Investigator
Title A plasma based study of...
Department of Physics
TEZPUR UNIVERSITY

27/2/18

Signature of Finance/
Account Officer

Date:

Finance Officer
Tezpur University

Signature of Registrar/
Head of the institute

Date:

Registrar
Tezpur University

For SURAJIT CHAKRABORTY & CO.
CHARTERED ACCOUNTANTS

10.03.2018

CA. SURAJIT CHAKRABORTY
(Proprietor)
Membership No.- 305054

(To be filled in by DST)

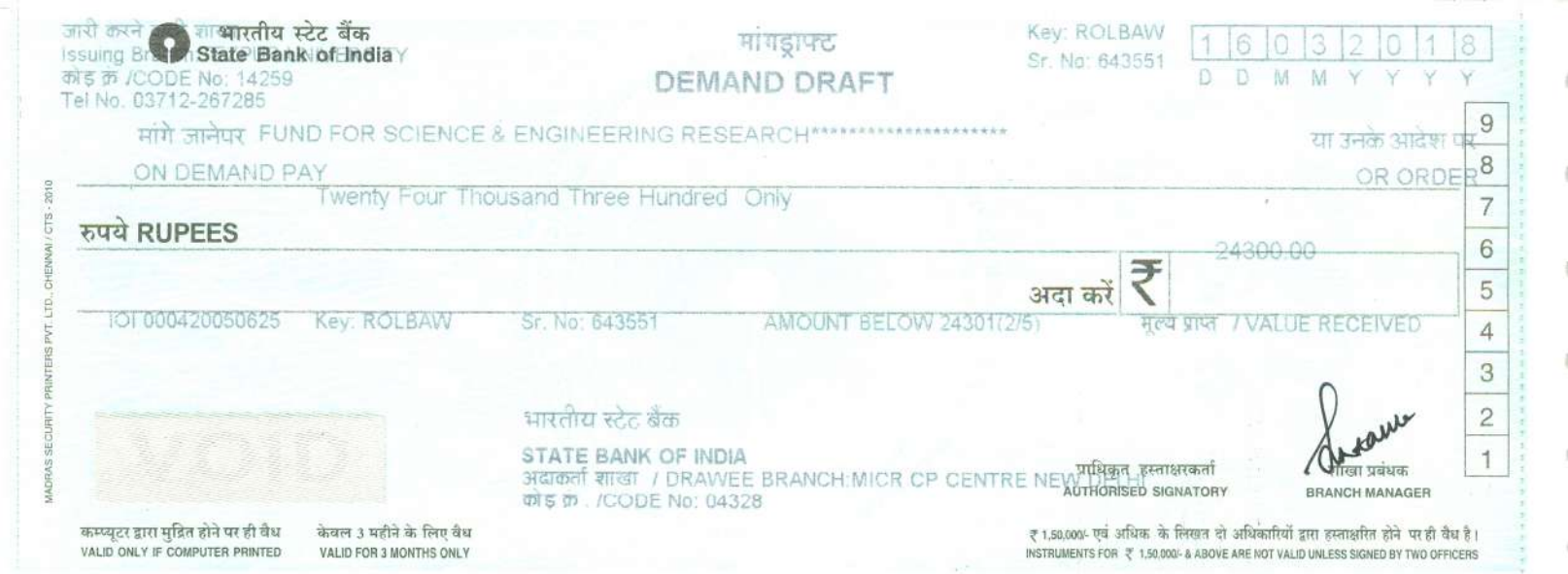
Certified that I have satisfied that the conditions on which the grant-in-aid was sanctioned have been fulfilled and that I have exercised the following checks to see that the money was actually utilized for the purpose for which it was sanctioned:-

1.
2.
3.
4.
5.

Signature: .....

Designation: .....

Date:.....



जारी करने [illegible] शाखा
Issuing Br[illegible]
कोड क्र /CODE No: 14259
Tel No. 03712-267285

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State Bank of India

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