

UNIVERSITY GRANTS COMMISSION  
BAHADUR SHAH ZAFAR MARG  
NEW DELHI- 110002

Annual/Final Report of the work done on the Major/ Minor Research Project.

1. Project report No. : Final report
  2. UGC Reference No.: F.42-790/2013(SR) dated March 22, 2013
  3. Period of report : 5<sup>th</sup> June 2013 to 31<sup>st</sup> March 2017
  4. Title of research project : **“Study on neutrino masses and mixings in the context of recent neutrino oscillation data”**.
  5. (a) Name of the Principal Investigator : Dr. Mrinal Kumar Das  
(b) Dept. and University/ College where work has progressed:  
**Department of Physics, Tezpur University.**
  6. Effecting date of starting of the project : 05-06-2013
  7. Grants approved and expenditure incurred during the period of the report:
    - (a) Total amount approved : Rs. 10,50,800/-
    - (b) Total grant received: Rs. 9,47,280/-
    - (c) Interest Earned: Rs.11,410/-
    - (d) Total Expenditure : Rs. 8,80,487/-
    - (e) Unspent Balance : Rs. 78,203/-
    - (f) Report of the work done : Separate sheets attached as Annexure IV
  8. (a) Brief objective of the project:  
The primary objectives of the project are:
    - Theoretical prediction of texture of neutrino mass matrices from SO(10) GUT with or without supersymmetry.
    - Study of prediction of neutrino masses and mixing from framework of seesaw types (I,II,III) and their combinations and discrimination of neutrino masses-normal vs inverted hierarchical.
    - Studies on neutrino mass matrices which lead to deviation from tri-bimaximal mixings and their origins from the general structure of gauge symmetry.
    - Study of non-zero texture of the right-handed Majorana mass matrices  $M_R$  which can be useful to explore baryogenesis through leptogenesis provided.
- (b) Work done so far and results achieved and publications, if any, resulting from the work (Give details of the papers and names of the journals in which it has been published or accepted for publication):

(i) **“Radiative generation of non-zero  $\theta_{13}$  in MSSM with broken  $A_4$  flavor symmetry”** by M. K. Borah, D. Borah and M. K. Das, *Nucl. Phys. B885, 76-96(2014)*



(ii) "Perturbations to the  $\mu$ - $\tau$  symmetry, leptogenesis and lepton flavor violation with the type II seesaw mechanism" by M. K. Borah, D. Borah, M. K. Das and Sudhanwa Patra, *Phy. Rev. D* 095020 (2014)

(iii) "Corrections to scaling Neutrino Mixing: non-zero  $\Theta_{13}$ ,  $\delta$  CP and Baryon Asymmetry" by Rupam Kalita, Debasish Borah, Mrinal Kumar Das, *Nucl. Phys. B* 894, 307-327 (2015)

(iv) "Discriminating Majorana Neutrino Textures in the light of Baryon Asymmetry" by M. K. Borah, D. Borah and M. K. Das, *Phy. Rev. D* 91, 113008 (2015)

(v) "Neutrino Phenomenology and scalar dark Matter with  $A_4$  flavour symmetry in Inverse and type II seesaw", by A. Mukherjee and M. K. Das, *Nucl. Phys. B* 913, 643-663(2016)

(vi) "Common origin of nonzero  $\Theta_{13}$  and Dark Matter in an  $S_4$  flavor symmetric model with Inverse seesaw" A. Mukherjee, D. Borah and M. K. Das, accepted for publication in *Phy. Rev. D*

(c) Has the progress been according to the original plan of work and towards achieving the objective, if not, state reason: Yes

(d) Please indicate the difficulties, if any, experienced in implementing the project: Due to non-receiving the 2<sup>nd</sup> installment, it was difficult to maintain the progress of the project as fellowship of the project fellow was dis-continued from January 2015.

(e) If project has not been completed, please indicate the time by which it is likely to be completed. A summary of the work done for the period (Annual basis) may please be sent to the Commission on a separate sheet: N/A

(f) If the project has been completed, please enclose a summary of the findings of the study. Two bound copies of the final report of the work done may also be sent to the Commission on a separate sheet.

(g) Any other information, which would help in evaluation of work done on the project. At the completion of the project, the first reports should indicate the outputs such as (a) Manpower trained (b) Ph.D awarded (c) Publication of results (d) other impact, if any: Project fellow Mr. Manikanta Borah has been awarded Ph.D degree on the work associated with the findings of the project.

PRINCIPAL INVESTIGATOR

Date: 3/1/18

Principal Investigator  
Title "Study on Neutrino ..... data"  
Department of Physics  
TEZPUR UNIVERSITY

REGISTRAR, Tezpur University

Date:

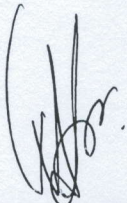
Registrar  
Tezpur University



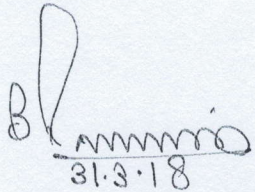
**UNIVERSITY GRANTS COMMISSION**  
**BAHADUR SHAH ZAFAR MARG**  
**NEW DELHI – 110 002**


**Utilization Certificate (2016 – 17)**

Certified that Grant-in-aid of Rs. 2,60,480/- (Rupees Two Lakhs Sixty Thousand Four Hundred Eighty only) was sanctioned by the University Grants Commission as 2<sup>nd</sup> installment under the scheme of support for Major Research Project entitled "**Study on neutrino masses and mixing in context of recent neutrino oscillation data**" vide UGC letter No. F.No. 42 – 790/2013(SR) dated March 22, 2013 and an unspent amount of Rs. 13,243/- (Rupees Thirteen Thousand Two Hundred Forty Three only) from the previous year (first installment) have been remained. Amount of Interest earned is of Rs. 11,410/- (Rupees Eleven Thousand Four Hundred and Ten only). Out of which an amount of Rs. 2,06,930/- (Rupees Two Lakh, Six Thousand, Nine Hundred Thirty only) has been utilized for the purpose which it was sanctioned and an unutilized balance of Rs. 78,203/- (Fifty Three Thousand, Five Hundred Fifty only) have been remained, which is to be returned to UGC. Kindly let us know the bank account number associated with University Grants Commission to which we can send the total unspent balance mentioned above.

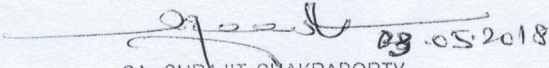
  
**PRINCIPAL INVESTIGATOR**  
 Date:

*Principal Investigator*  
 Title: "Study on neutrino masses and data"  
 Department of Physics  
 TEZPUR UNIVERSITY

  
**FINANCE OFFICER**  
 Tezpur University  
 Date:  
 Finance Officer  
 Tezpur University

  
**REGISTRAR**  
 Tezpur University  
 Date: Registrar  
 Tezpur University

For SURAJIT CHAKRABORTY & CO.  
 CHARTERED ACCOUNTANTS

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



**UNIVERSITY GRANTS COMMISSION**  
**BAHADUR SHAH ZAFAR MARG**  
**NEW DELHI - 110 002**

**STATEMENT OF EXPENDITURE IN RESPECT OF MAJOR / MINOR RESEARCH PROJECT**

1. Name of Principal Investigator DR. MRINAL KUMAR DAS  
 2. Dept. Of University / College Physics, Tezpur University  
 3. UGC approval No. and Date F. No. 42 - 790/2013 (SR) dated March 22, 2013  
 4. Title of the Research Project "Study on neutrino masses and mixing in the context of recent neutrino oscillation data"  
 5. Effective date of starting the project 05.06.2013  
 6. (a) Period of Expenditure: From 27.05.2016 to 31.03.2017  
 (b) Details of Expenditure \_\_\_\_\_

| S. No. | Item   | Amount Approved Rs. | Grant released as 1 <sup>st</sup> installment Rs. | Grant sanctioned in May 2016 Rs. | Expenditure incurred Rs. |            |            |            | Total Expenditure | Balance From 1 <sup>st</sup> and 2 <sup>nd</sup> installment |
|--------|--|---------------------|---|----------------------------------|--------------------------|------------|------------|------------|-------------------|--|
|        |  |                     |   |                                  | 2013-2014                | 2014-2015  | 2015-2016  | 2016-2017  |                   |  |
| 1      | Books & Journals   | 60,000/-            | 60,000/-  | ---                              | 59,927/-                 | ---        | ---        | ---        | 59,927/-          | 73/-   |
| 2      | Equipment  | 2,00,000/-          | 2,00,000/-  | ---                              | 86,416/-                 | ---        | ---        | ---        | 86,416/-          | 1,13,584/-   |
| 3      | Honorarium   | Nil                 | ---   | ---                              | ---                      | ---        | ---        | ---        | ---               | ---  |
| 4      | Contingency  | 70,000/-            | 35,000/-  | 28,000/-                         | 24,913/-                 | ---        | 3,060/-    | 24,990/-   | 52,963/-          | 10,037/-   |
| 5      | Field Work / Travel  | 1,00,000/-          | 50,000/-  | 40,000/-                         | 34,947/-                 | 20,086/-   | 1,000/-    | 9,940/-    | 65,973/-          | 24,027/-   |
| 6      | Chemicals/Glassware/consumable   | 30,000/-            | 15,000/-  | 12,000/-                         | ---                      | 14,862/-   | ---        | 12,000/-   | 26,862/-          | 138/-  |
| 7      | Hiring Services (Consumable)   | NIL                 | ---   | ---                              | ---                      | ---        | ---        | ---        | ---               | ---  |
| 8      | Overhead   | 62,800/-            | 62,800/-  | ---                              | 62,346                   | ---        | ---        | ---        | 62,346            | 454/-  |
| 9      | Any other items (Please specify)   | NIL                 | -   | -                                | -                        | -          | -          | -          | -                 | ---  |
| 10     | Honorarium to Principal Investigator (form... to .....)  | NIL                 | ---   | ---                              | ---                      | ---        | ---        | ---        | ---               | ---  |
| 11     | Staff (date of appointment) (from 27.05.2013 to 31.03.2015) (Please give details of staff appointment in the | 5,28,000/-          | 2,64,000/-  | 1,80,480/-                       | 1,38,133/-               | 1,25,867/- | 1,02,000/- | 1,60,000/- | 5,26,000/-        | -81,520  |

For SURAJIT CHAKRABORTY & CO.  
CHARTERED ACCOUNTANTS

CA, SURAJIT CHAKRABORTY  
(Proprietor)

Membership No.- 305054

*(Signature)*  
Finance Officer  
Tezpur University



|    |  |             |            |            |            |            |            |            |            |          |
|----|--|-------------|------------|------------|------------|------------|------------|------------|------------|----------|
|    | prescribed format annexure ix as per xi plan guidelines of Major Research Project) |             |            |            |            |            |            |            |            |          |
| 12 | Interest earned  |             |            |            |            |            |            |            |            | 11,410/- |
| 13 | Total  | 10,50,800/- | 6,86,800/- | 2,60,480/- | 4,06,682/- | 1,60,815/- | 1,06,060/- | 2,06,930/- | 8,80,487/- | 78,203/- |

(c) Project Fellow : Date of Appointment 05.06.2013

| S. No. | Expenditure Incurred  | From to | Amount Approved (Rs.) | Expenditure Incurred (Rs.) |
|--------|---|---------|-----------------------|----------------------------|
| 1.     | Honorarium to PI (Retired Teachers) Rs. 12,000/- p.m. Project Fellow Fellowship @ Rs. 14,000/- p.m. |         | Nil                   |                            |

1. It is certified that the appointment (s) have been made in accordance with the terms and conditions laid down by the Commission.
2. It as a result of checks or audit objective, some irregularly is noticed, later date, action will be taken to refund, adjust or regularize the objected amounts.
3. Payment @ revised rates shall be made with arrears on the availability of additional funds.
4. It is certified that the grant of Rs. **9,47,280.00** (Rupees Nine lakh Forty Seven thousand Two hundred Eighty only) received from the University Grants Commission and interest earned of an amount of Rs. **11,410/-** , under the scheme of support of Major Research Project entitled "Study on neutrino masses and mixing in the context of recent neutrino oscillation data" vide UGC letter No. F. No. 42 – 790/2013 (SR) dated March 22, 2013 from which has been utilized an amount of Rs. **8,80,487.00/-** in purpose for which it was sanctioned. The unspent balance of Rs. 78,203/- is returned vide "NEFT UTR No. SBIN318099975846".

PRINCIPAL INVESTIGATOR

Date:

Principal Investigator  
Title "Studies on neutrino masses and mixing in the context of recent neutrino oscillation data"  
Department of Physics  
TEZPUR UNIVERSITY

FINANCE OFFICER

Tezpur University

Date:

Finance Officer  
Tezpur University

REGISTRAR

Tezpur University

Date:

Registrar  
Tezpur University

For SURAJIT CHAKRABORTY & CO.  
CHARTERED ACCOUNTANTS'

03.05.2018  
CA, SURAJIT CHAKRABORTY  
(Proprietor)