INDIA- JAPAN COOPERATIVE SCIENCE PROGRAMME
COMMULATIVE PROGRESS REPORT FOR THE COLLABORATION

1. **Priority area of project:** *Astronomy, Astrophysics, Space & Planetary Science*

2. **Title of the project:** *Observational investigation of PAH and dust features in galactic and extra-galactic environments*

3. **DST's Reference No. Starting Date and Duration and total cost (for Projects): Ref no:** *DST/ INT/ JSPS/P-189/2014*

   Starting Date: *June 2, 2014*

   Duration: *2 Years*

   Total cost: *Rs.9, 16, 000.00 (Rs. Nine Lakh Sixteen Thousand Only)*

4. **Detail s of collaborating Scientist and Institute:**

INDIAN SIDE

Principal Investigator

Name	**Dr. Amit Pathak**
Institute	**Tezpur University**

JAPANESE SIDE

Principal Investigator

Name	**Dr. Itsuki Sakon**
Institute	**The University of Tokyo**

5. **Month & Year Since collaboration started Originally:** *The collaboration between Amit Pathak and Itsuki Sakon was being discussed since August, 2005. There had been several e-mail exchanges and meetings (specially at conferences of mutual interest). DST-JSPS project gave an excellent opportunity to formalize and concretize the collaboration.*

6. **Visits Undertaken in the Report Period: 8 visits (4 from Indian side, 4 from Japanese side)**

6.1 From India to Japan

S. No.	Name and Institute of Indian scientist	Japanese Host Scientist(s) and Institutes Visited	Duration From To
1.	Dr. Amit Pathak	Dr. Itsuki Sakon, The University of Tokyo	January 06 – 17, 2015
2.	Dr. Rupjyoti Gogoi	Do	January 06 – 17, 2015
3.	Ms. Mridusmita Buragohain	Do	August 11 – September 09, 2015
4.	Ms. Mridusmita Buragohain	Do	February 29 – March 20, 2016

6.1.1. No. of scientist visited: 2

6.1.2 No. of student visited: 2 (same student visited twice)

6.2 From Japan to India

S. No.	Name and Institute of Japanese scientist	Indian Host Scientist(s) and Institutes Visited	Duration From To
1.	Prof. Takashi Onaka	Dr. Amit Pathak, Tezpur University	December 14-21, 2014
2.	Dr. Itsuki Sakon	Do	December 14-21, 2014
3.	Dr. Itsuki Sakon	Do	November 30-December 6, 2015
4.	Aaron Bell	Do	November 23-December 3, 2015

6.2.1. No. of scientist visited: 3

6.2.2 No. of student visited: 1

7. Salient points of Scientific and Technical Results obtained:

No.	Objectives of the projects	Achieved, briefly indicate If not why?
1.	Theoretical spectroscopic study of deuteronated PAH molecules in relation to 4.44 and 4.65 μm bands	Deuteronated PAH molecules are proposed as potential candidate carriers for 4.44 and 4.65 μm bands. Manuscript published in **MNRAS**.
2.	To see the effect of increasing size of deuteronated PAH molecules on spectral data and make comparison with observation	Large size of deuteronated PAH molecules show a D/H ratio that is comparable to the observed D/H ratio. Manuscript in press in **Planetary & Space Science**.
3.	Correlation between IR and UV features	Correlations have been studied using SPITZER, AKARI (Japanese telescope) and GALEX data. Manuscript published in **Publication of the Astronomical Society of the Pacific**.
4.	Work on PAHs with aliphatic side group to compare with experimental spectrum obtained in the University of Tokyo	Several spectra of PAHs with aliphatic side groups have been obtained and shared with the Japanese PI. Data analysis is underway.
5.	Proposal for observation	Proposal for observation to Subaru Telescope has been submitted during the last visit to Tokyo. We are hopeful that the proposal will be accepted for observations.

8. Devices/ Instrument/Facilities Developed/ Patent field: *N/A*

9. Number of Joint Publication as Result of Collaboration:

(List may also be enclosed separately)

9.1 Number of Joint publications published in Journal: *03*

1. "Infrared Properties of laboratory-synthesized Nitrogencontaining Carbonaceous Composites (NCCs)"

I. Sakon, K. Sato, T. Onaka, Seiji Kimura, Setsuko Wada, Nanako Ogawa, Naohiko Ohkouchi & Amit Pathak, Asian Journ. Physics, Special Issue on Constituents of Interstellar Medium, eds. B. G. Anandarao & S. Rastogi, 2015, 24 (No. 8) 1143.

2. "Theoretical study of deuteronated PAHs as carriers for IR emission features in the ISM" M. Buragohain, Amit Pathak, P. J. Sarre, T. Onaka & I. Sakon, Mon. Not. Royal Astron. Soc., 2015, 454, 201.

3. "Mid-infrared vibrational study of deuterium containing PAH variants" M. Buragohain, Amit Pathak, P. J. Sarre, T. Onaka & I. Sakon, Planetary & Space Science, 2016 in press.

9.2 Number of Joint publications presented in seminar/workshop/conference: *02*

1."Mid-infrared vibrational study of deuterium-containing PAH variants" Mridusmita Buragohain, Amit Pathak, Peter Sarre, Takashi Onaka & Itsuki Sakon, Cosmic Dust, Tokyo, Aug. 17 – 21, 2015.

2. "Theoretical DFT studies of deuteronated PAHs" Amit Pathak, M. Buragohain, M. Hammonds & P.J. Sarre, International Conference on Interstellar Dust, Molecules and Chemistry (IDMC-2014), Tezpur University, Tezpur, Dec. 15 – 18, 2014.

10. Training of Scientific Manpower /Advanced facility utilized in Japan:

Training on data reduction techniques for SUBARU-COMICS Telescope data has been obtained during the visit of Ms. Mridusmita Buragohain. A telescope observation proposal is submitted requesting time for observation on the Japanese SUBARU telescope.

11. Number of Patents: *Nil*

12. Brief Remark on usefulness of the Collaboration:
(For both Indian as well as the Japanese side)

For quality research, a combined study of theory, experiments and observation is of immense importance in the area of Molecular Astrophysics. Indian side have been involved in theoretical spectroscopic study of interstellar PAH molecules. These theoretical results are used to understand the observed features in the interstellar medium by making comparison with the observational data. The observational counterpart has been carried out by Japanese side.

Using the theoretical data generated by the Indian side, we have been able to explain the observation of the Japanese side (AKARI telescope observations).

The Japanese side has also performed experiments on Quenched Carbonaceous Composites (QCCs) and have used the theoretical data generated by the Indian group to understand the spectrum of QCCs. QCCs consist of molecules belonging to the PAH family and may help in understanding the composition of PAHs in the interstellar medium.

13. Collaborative Activities envisaged in near Future:

The present DST – JSPS collaborative project has been extremely successful and has produced quality science. Outcome of the project have been published in International Journals of repute and have been presented at International Conferences.

We plan to submit another project in the forthcoming cycle in order to extend the present work to new observational, experimental and theoretical studies on infrared molecules and dust constituents of the interstellar medium.

Amit P. Naik 6.5.16

Signature with Date of the Principal Investigator

UTILIZATION CERTIFICATE AUDITED (TWO COPIES)
FOR THE FINANCIAL YEAR 2015-2016
(FOR THE PERIOD ENDING ON 31ST MARCH, 2016)

S. No.		Amount in Rs.		
1.	Title of the Project/Scheme	Observational investigation of PAH and dust features in Galactic and extra-galactic environments		
2.	Name of the Institution	Tezpur University		
3.	Name of the Principal Investigator	Amit Pathak		
4.	Deptt. of Science & Technology letter No. and Date of sanctioning the project	DST/INT/JSPS/P-189/2014; 02-06-2014		
5.	Head of account as given in the Original sanction letter	New Project Other Scientific Research (Major Head) International Cooperation (Minor Head) Cooperation with other countries Plan Expenditure		
6.	Amount brought forward from the previous financial year quoting DST letter No. & Date in Which the authority to carry forward the said amount was given	i)	Amount	Rs. 1,45,933.00
		ii)	Letter No.	DST/INT/JSPS/P-189/2014
		iii	Date	09-07-2015
7.	Amount received during the financial year (please give No. & Date of DST sanction letter for the amount	i)	Amount)	Rs. 1,50,000.00
		ii)	Letter No.	DST/INT/JSPS/P-189/2014
		iii	Date	09-07-2015
8.	Total amount that was available for expenditure (excluding commitments) during the financial year (S. No. 6 +7)	Rs. 2,95,933.00		
	Interest accrued during the financial year (2014-15) on unspent balance amount	Rs. 2057.00		
8.2	Interest accrued during the financial year (2015-16) on unspent balance amount	Rs. 2,368.00		
9.	Actual expenditure (excluding commitments) incurred during the financial year (up to 31 March)	Rs. 2,28,289.00		
10.	Total balance amount with accrued interest available at the end of financial year	Rs. 72,069 (Rs. 67,644.00 + Rs. 4,425.00)		
11.	Unspent balance amount refunded in favour of DDO, DST if any (Please give details of Cheque No. & Date)	Rs. 67,644.00 + Rs. 4,425.00		
12.	Amount to be carry forward to the next financial year (If applicable)	Not applicable		
13.	Whether Annual /Progress Report/Completion Report attached	Yes		
13.1	i) If yes			
13. 2.	ii) If no, reasons thereof			

Finance Officer
Tezpur University

for dte
28.5.16
DC Dean R&D

UTILISATION CERTIFICATE

Certified that out of **Rs. 1,50,000/-** of grants-in-aid sanctioned during the year 2015-16 in favour of The Registrar, Tezpur University under International Division, Department of Science and Technology, Ministry of Science and Technology this Ministry/Department letter No. *DST/INT/JSPS/P-189/2014 dated 09-07-2015* and **Rs. 1,45,933/-** on account of unspent balance of the previous year, a sum of **Rs. 2,28,289/-** has been utilized for the purpose of Research under the project for which it was sanctioned and that the balance of **Rs. 72,069/-**, that includes **Rs. 4,425/-**, the interest earned during the term of the project, remaining unutilized at the end of the year will be returned to the Department of Science and Technology.

Amit Pathak
Signature of Principal Investigator
Date 22.9.16

23/9/16
Signature of Finance Officer with date & seal
Finance Officer
Tezpur University

Signature of the Registrar of the Institute with date & seal
Registrar
Tezpur University

(TO BE FILLED IN BY DST)

1. Certified that I have satisfied myself that the conditions on which the grants-in-aid was sanctioned have been fulfilled/are being 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:-

   Kinds of checks exercised.

1.

2.

3.

Signature
Designation
Date