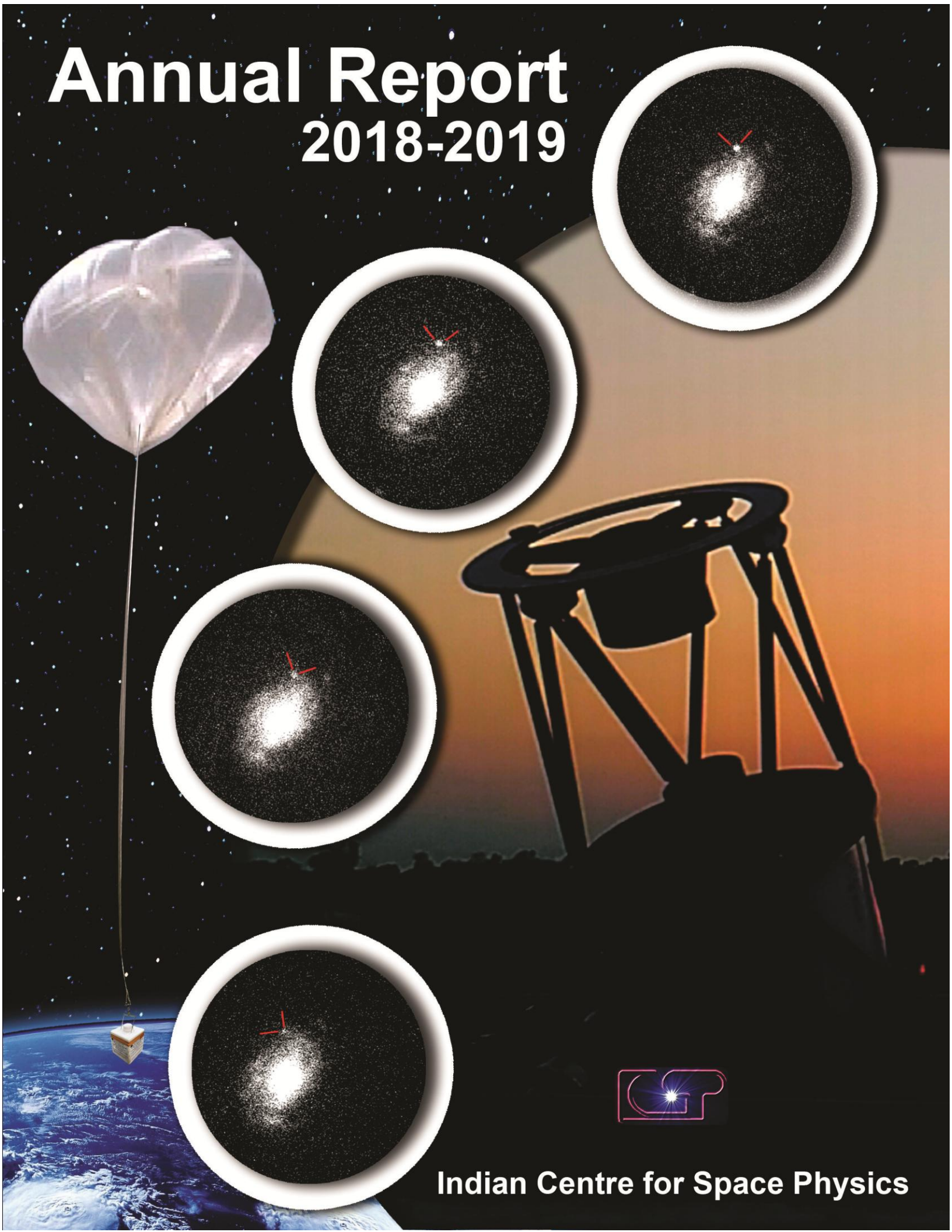
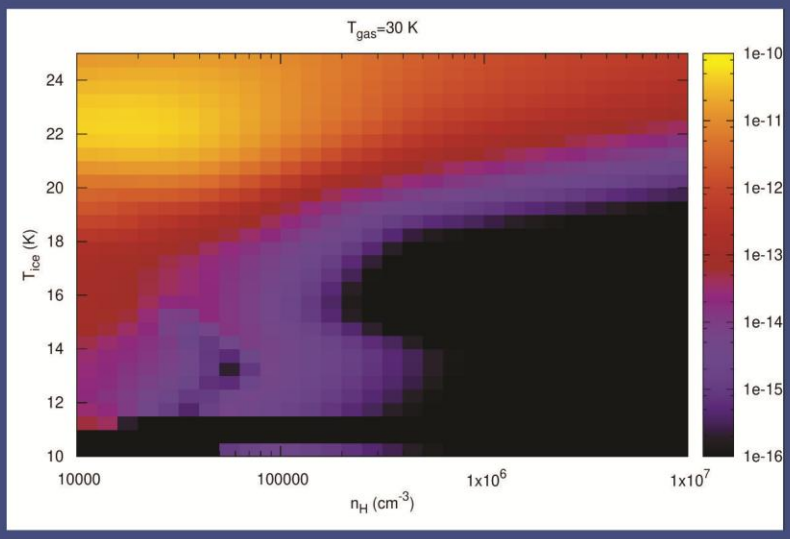
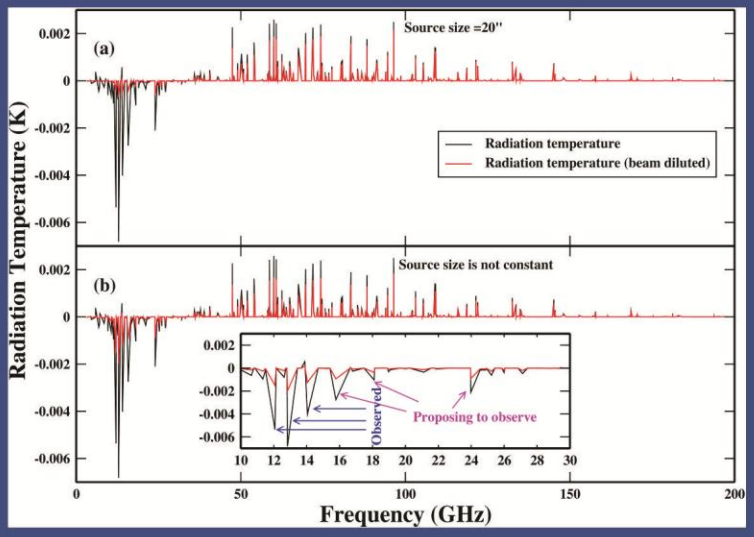
Annual Report
2018-2019

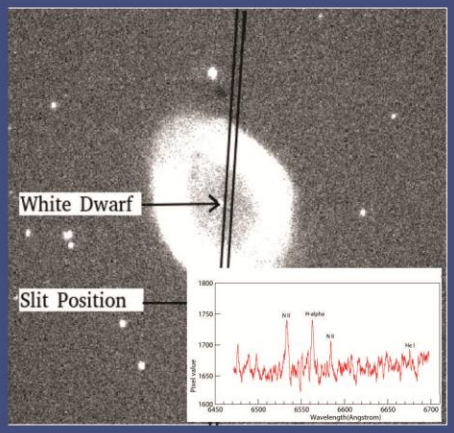


Indian Centre for Space Physics

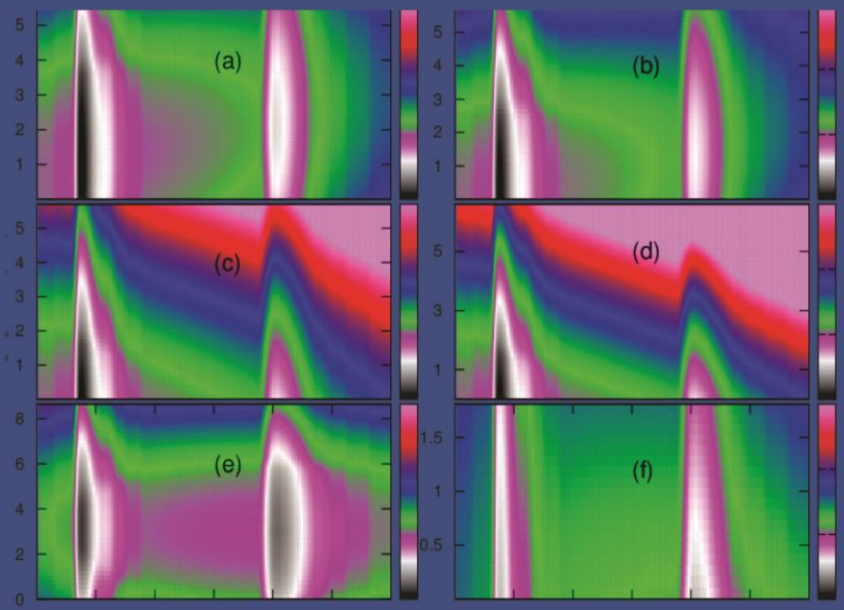


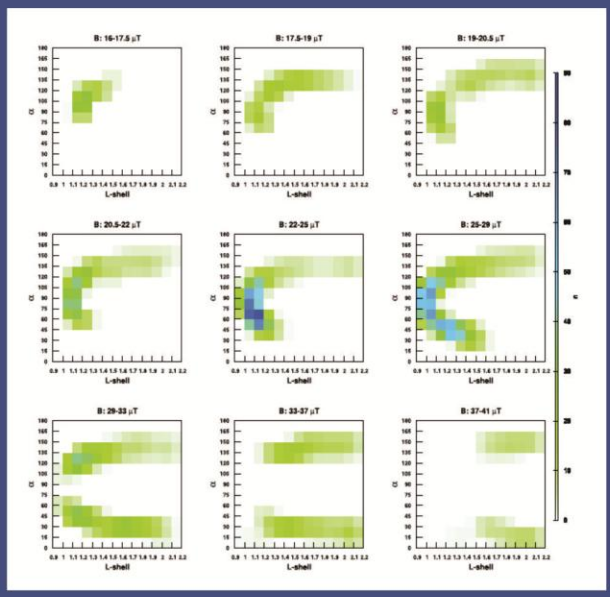


Radiative transfer and Astrochemical modeling of the first observed chiral molecule propylene oxide in space.



Tracking Instrument made at ICSP for low cost Balloon Borne Experiment (Left). VLF receivers fabricated at ICSP for all India campaign (Middle). Spectrum of Ring Nebula taken by Vasishta at IERCOO, Sitapur (Right).





Variation of ionospheric effective reflection height for six receiving locations for a C class flare (Left). CR daily average data in (L, a, B) cell on January 3, 2016. The color bar denotes the number of times the satellite passed through the same cell. (Right).

INDIAN CENTRE FOR SPACE PHYSICS
ANNUAL REPORT
(2018-2019)

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Accounts: 23
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Computer room: 25
Department of High Energy Astrophysics: 26
X-ray Laboratory: 27

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Front cover: Snapshots of Supernova 2018IVC at various phases of decay as monitored by Vashista, a 24 inch reflector at IERCOO, West Medinipur.

Report of the Governing Body

This is the Twentieth Annual report of Indian Centre for Space Physics (ICSP). The Centre has five major activities: Astrobiology/Astrochemistry; High Energy Astrophysics; Exploration of near space using lightweight balloons; Ionospheric research and earthquake science and optical astronomy. More than a dozen members including the faculties and research scholars attended 42nd COSPAR conference held at Caltech, Pasadena, the Astronomers' paradise. They also visited the Jet Propulsion laboratory. A highlight was the foundation stone laying ceremony at the site of the Integrated Campus on the Eastern Bypass which was witnessed by two dozens of world class National and International scientists. Several members attended the 15th Marcel Grossman conference in Rome. A book published by Springer and edited Prof. B. Mukhopadhyay (IISc) and Dr. S. Sasmal (ICSP) was released at the Science city on 15th November, 2018 by Prof. G. Bisnovatyi-Kogan. It contains fifty Chapters written by the present and the past PhD students of Prof. S.K. Chakrabarti. Several research papers were published in International journals by ICSP faculty members and their students. Several new students have joined making our present strength of regular PhD students to be twenty. Thus ICSP is proud to contribute to the manpower generation for the Nation in a significant way, despite its low budget as compared to the other Institutes with similar goals. This year we also saw three of our students receiving PhD Degree from Calcutta University.

In the area of Astrochemistry/Astrobiology, Chemical evolution in star forming regions having very complex sub-structures was studied and efforts were made to explain presence of numerous chemicals in these regions. In black hole astrophysics and astronomy, main emphasis was given to measure the properties of accretion flows and black hole masses using TCAF solution after the data from several satellites were analyzed. Some works were done on time lag properties of X-rays coming out of black hole accretion disks. TCAF was also applied to understand flows around neutron stars and super-massive black holes. In low cost balloon program we concentrated on analyzing data procured by our past 109 missions. Emphasis was given to have a light-weight pointing device to improve data quality and to reduce the background noise.

In the Ionospheric and Earthquake Research Centre and Optical Observatories (IERCOO), a branch of ICSP in West Medinipur, both the telescopes, namely Vashista (0.61m) and Arundhati (0.25m) are employed to procure data. Spectrometers and CCD cameras have been procured for world class research activities. We monitored the decay of intensity of a new Supernovae 2008IVC for about two weeks. We also caught a gamma-ray burst afterglow. A new study on high resolution observation of several nebular composition has been initiated. Several variable and periodic stars have been observed and the results are analyzed. Students of ionospheric sciences continue to monitor VLF signals and analyze satellite data. Emphasis was given to model earhquake related anomalies by Lithosphere-Atmosphere-Ionosphere coupling.

Our Malda branch has been active. We installed a VLF receiving unit and an antenna. Several popular talks have been given in local schools. The Government of West Bengal and the Central Government agencies, such as DST, ISRO, UGC and CSIR have been funding various projects and fellowships at ICSP. We thank ICSP office staff for timely compilation of the annual report and Audit reports.

Dr. Sonali Chakrabarti,
Honorary General Secretary
Indian Centre for Space Physics

Kolkata: September 29, 2019

Governing Body (GB) of the Centre

Prof. B.B. Bhattacharyya, President
Dr. Sonali Chakrabarti, Secretary
(From 1st December, 2018)
Prof. Sandip K. Chakrabarti, Secretary
(Resigned on 30th November, 2018)
Prof. S.K. Midya, Treasurer
Prof. Arun K. Tewari, Vice-President
Mr. Gurusaran Das Gupta, Member
Dr. S. C. Chakravarty, Member
Prof. A. R. Rao, Member
Mr. Prabir Kumar Das, Member

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Prof. S. K. Midya, Calcutta University
Prof. A. R. Rao, Ex-Tata Institute of Fundamental Research, Mumbai
Prof. S. K. Chakrabarti, ICSP
Prof. D. J. Saikia, Ex-National Center for Radio Astronomy, Pune
Prof. N. M. Ashok, Ex-PRL, Member
Prof. R. Gupta, Ex-IUCAA, Member
Secretary, State Council of Higher Education (ex-officio)

Academic Council Members

Prof. Sandip K. Chakrabarti (Chairman)
Dr. Ankan Das
Mr. Debashis Bhowmick
Dr. Sudipta Sasmal (Convenor)
Dr. Dipak Debnath
Mr. Rajkumar Maiti (non-Member Secretary)

Director

Prof. Sandip K. Chakrabarti (Tel. : +91 33 24366003,
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Email: ankan@csp.res.in / ankan.das@gmail.com)

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Public Information Officer

Mr. Rajkumar Maiti (Tel.: +91 33 24366003 Extn: 23,
Email: rajkumar@csp.res.in / rajkumarmaiti24@gmail.com)

Regular members and In Charge of Departments

Dr. Ankan Das, Assistant Professor-II	Astrochemistry / Astrobiology
Dr. Dipak Debnath, Assistant Professor-II	High Energy Astrophysics
Dr. Sudipta Sasmal, Assistant Professor	Ionospheric Science
Dr. Ritabrata Sarkar, Assistant Professor	Space Radiation
Mr. Debashis Bhowmick, Engineer-II	Instrumentation for Space Exploration

Honorary Faculty Members

Dr. B. B. Bhattacharyya, Ex-ISM, Dhanbad	Distinguished Professor
Dr. Shalivahan, IIT Dhanbad	Professor
Dr. S. Sharma Ex-SNBNCBS	Professor
Dr. S. Chakrabarti, M. M. Chandra College	Professor
Dr. S. C. Chakravarty, EX-ISRO	Senior Professor
Dr. A. K. Chatterjee, Malda College	Scientist
Dr. R. Chattopadhyay, Haripal Institution	Scientist
Dr. T. K. Das, Narasimha Dutta College	Assoc. Professor
Dr. P. K. Jana, Panipukur B.Ed. College	Scientist
Dr. M. M. Majumdar, DPI	Scientist
Prof. S. K. Midya, Calcutta University	Professor
Dr. G. Tarafdar, Barasat Govt. College	Scientist
Dr. B. G. Dutta, R.B.C. College	Scientist
Dr. S. K. Mondal, S-K-B University	Scientist
Dr. H. Ghosh, Heritage Institute of Tech.	Scientist
Dr. K. Giri, NITTTR, Kolkata	Scientist
Dr. S. Ray, G.H. College	Scientist
Dr. S. Pal, Medinipur City College	Scientist
Dr. A. K. Choudhury	Scientist

Senior Research Fellows

Mr. Arka Chatterjee (ICSP)	Mr. Dusmanta Patra (ICSP)
Mr. Prasanta Gorai (ISRO-RESPOND and CSIR)	Mr. Arghajit Jana (CSIR)

Junior Research Fellows

Mr. Debjit Chatterjee (DST-SERB)	Ms. Swati Chowdhury (DST-INSPIRE)
Mr. Abhijit Roy (DST-SERB)	Mr. Kaushik Chatterjee (DST-INSPIRE)
Mr. Subrata Kundu (DST-INSPIRE)	Mr. Arghajit Jana (DST-GITA upto May)
Mr. Suman Kumar Mondal (CSIR)	Mr. Ashim Chandra Sarkar(UGC)
Ms.Riya Bhowmick (UGC)	Mr. Abhrajit Bhattacharjee (ISRO)
Mr. Pabitra Sil (UGC)	Ms.Bratati Bhat (DST-INSPIRE)
Mr. Rupnath Sikdar (UGC)	Mr. Shyam Sarkar (CSIR)
Mr. Milan Sil (DST-INSPIRE)	Mr. Soujan Ghosh (Part time)
Mr. Rana Ghosh (ISRO)	

Visiting Research Fellows

Mr. Washimul Bari	Mr. Surya K. Maji	Mr. Dipak Sanki

Laboratory Staff

Mr. Arnab Bhattacharya	Junior Engineer (till June, 2018)
Mr. Souvik Manna	Technical Assistant
Mr. Hriday Roy	Laboratory Assistant

Office Staff

Mr. Rajkumar Maiti	Assistant Administrative Officer
Mr. Jyotisman Moitra	Computer Assistant
Mr. Ram Chandra Das	Office Assistant
Mr. Uttam Sardar	Office Helper

Security Staff

Mr. Parimal Das
Mr. Barun Chakraborty

Out of Station Facilities:

IERCOO at Sitapur, West Medinipur:

The Ionospheric and Earthquake Research Centre (IERC) for studying VLF, radio and optical astronomy was inaugurated at Sitapur, Paschim Medinipur, West Bengal in 2012. It has adequate computing and internet facilities, VLF antennas and receivers. After its expansion with a 0.25m Meade Optical Telescope and a 0.61m reflecting telescope, the branch name was changed to IERCOO. It has a guest house to accommodate 20 students for sky watching and optical observations. Solar power for electricity keeps this remote Centre running round the clock.

IERCOO campus (Left). Director / visitors building under construction, IERCOO (Right)

Balloon Facility at Bolpur, Birbhum:

This facility is used only during balloon flights twice per year for a period of about two months. It has all the facilities to launch balloons and retrieve payloads. Plan is being made to have a permanent facility.

Malda branch at English Bazar:

Two office rooms at Atul Market and the terrace are regularly used by the members of the Malda branch. It has computing and internet facilities and a small library. It has VLF antennas to receive VLF signals from transmitters all over the world.

ICSP new campus:

Construction of building at the new Integrated Campus on EM Bypass is in progress.

Brief Profiles of the Scientists of the Centre

Dr. Achintya K. Chatterjee: He is an Associate Professor and Ex. Head, Physics Department, Malda College and an honorary scientist of ICSP. He is currently doing data analysis RXTE satellite and observing SID by VLF antenna. He is also the President of the Malda Branch of ICSP.

Dr. Ankan Das: He is an Assistant Professor-II and HoD, Astrochemistry/Astrobiology of ICSP. He is also the Dean (Academic) and Acting Finance officer of the centre. His main research interest is in the formation of bio-molecules in star forming regions.

Mr. Arghajit Jana: He is an ISRO-RESPOND project Senior Research Fellow and is working on disk-jet connection of Black hole.

Mr. Arka Chatterjee: He is a Post-Doctoral Fellow at SNBNCBS working in Black Hole Astrophysics. His expertise is Photon Bending near very compact objects.

Mr. Arnab Bhattacharya: He is a junior engineer at ICSP and is involved in ICSP activities for software developments for balloon experiments.

Dr. Asit Kumar Choudhury: He is an Asst. Teacher at the L.M.S.M. Institution, Malda. He is working on data analysis of RXTE satellite and also observing SID using VLF. He is also the Secretary of the Malda branch of ICSP.

Mr. Abhijit Roy: He is a Junior Research Fellow in Instrumentation for Space Exploration under DST-SERB project and he is working on study of cosmic ray interaction with earth atmosphere by monte carlo simulation and small balloon born experiment.

Mr. Ashim Chandra Sarkar: He is a Junior Research Fellow in Optical Astronomy and he is working on spectroscopic study on planetary nebula at IERCOO, Sitapur.

Mr. Abhrajit Bhattacharya: He is Junior Research Fellow in ISRO project. He is working on the effects of Kerr spin parameter on the spectra of accretion disks around black holes.

Ms. Bratati Bhat: She is a Junior Research Scholar in Astrochemistry/ Astrobiology under DST-INSPIRE Project. She is working on Extraction of physical from the observed line profiles of interstellar medium.

Prof. Bimalendu B. Bhattacharyya: He is the President of the Governing Body and an Honorary Emeritus Professor. He is currently serving as the Chairman of the Science Advisory Council of NGRI, Hyderabad. He is an ex-Director of Indian School of Mines, Dhanbad. His field of specialization is the study of deep crustal structure on earth from magneto-telluric data.

Dr. Broja G. Dutta: He is an Assistant Professor at R.B.C. College, North 24 Paraganas and has completed his Ph.D. as a “Teacher Fellow” at ICSP under “Faculty Improvement Programme” of UGC. He is working on the time-lag properties of X-ray emission from accretion disks around black holes. He is an honorary Scientist of ICSP.

Mr. Debashis Bhowmick: He is an Engineer-II at ICSP and is the laboratory in Charge which oversees the activities related to VLF antennas, X-ray detector fabrication, test and evaluation and balloon experiments.

Mr. Debjit Chatterjee: He is a DST-SERB Project Research Scholar and is working on X-ray Astronomy as a Junior Research Fellow.

Dr. Dipak Debnath: He is an Assistant Professor-II and HOD of High Energy Astrophysics, ICSP. He is also Acting Administrative officer of the Centre. His main research interest is observational and theoretical studies of the properties of stellar massive black hole candidates during their X-ray active periods.

Mr. Dusmanta Patra: He is a Senior Research Fellow in Radio Astronomy and is working on Spectral aging analysis of Giant radio galaxies using Very Large Array and Giant Meter wave Radio Telescope. He studies multi-wavelength properties of Galactic micro-quasars.

Dr. G. Tarafdar: He is an honorary scientist of the Centre. He is a faculty at Barasat Govt. College.

Dr. H. Ghosh: He is an Assistant Professor at Heritage Institute of Technology. He works on Monte Carlo simulation of Radiative transfer around black holes.

Dr. K. Giri: He is an Assistant Professor at NITTTR, Kolkata. He works on numerical simulations of accretion flow around black holes.

Mr. Kaushilk Chatterjee: He is a Junior Research Fellow in High Energy Astrophysics under DST-INSPIRE project, working on spectral and timing properties of a few stellar massive black hole candidates during their active X-ray active phase.

Dr. M. M. Majumdar: He is an honorary scientist of ICSP. He is working on similarities of accretion flows around black holes and fluid dynamics in a converging-diverging duct.

Mr. Milan Sil: He is a Junior Research Scholar in Astrochemistry/ Astrobiology under DST- INSPIRE Project, working on physical and proto planetary disk.

Dr. P. K. Jana: He is teaching at the Panipukur B. Ed. College and is an honorary scientist of ICSP. He works on trends of Ozone depletion over India. He is an honorary Scientist of ICSP.

Mr. Prasanta Gorai: He is a DST project Senior Research Scholar in Astrochemistry/ Astrobiology and is working on the formation of various complex molecules in star forming regions.

Mr. Pabitra Sil: He is Junior Research Fellow in Optical Astronomy and he is working on transient sources at IERCOO, Sitapur.

Dr. R. Chattopadhyay: He is an Asst. Teacher at Haripal G. D. Institution. His research work includes Airglow and Ozone depletion. He is an honorary scientist of ICSP.

Mr. R. Khan: He is an Asst. Teacher of Bidhan Nagar Govt. High School and is involved in activities of ICSP observatories. He is in charge of the training using IERCOO Optical Telescopes.

Ms. Riya Bhowmick: She is a Junior Research Scholar in High Energy Astrophysics under UGC Project.

Mr. Rupnath Sikdar: He is a Junior Research Scholar in Space Radiation Department and he is working on Balloon borne experiments.

Dr. Ritabrata Sarkar: He is an Assistant Professor at ICSP. He is analyzing the data of balloon borne experiments which include corrections due to atmosphere and instrumental effects. He is also working on simulations of background radiations at various atmospheric and solar conditions.

Prof. S. K. Midya: He is a Professor and Ex-Co-ordinator of the Dept. of Atmospheric Science of Calcutta University and an honorary Professor of ICSP. He works on Airglow experiments, Ozone depletion problem and Earthquakes.

Dr. Sabyasachi Pal: He is an Honorary Scientist at ICSP. He is working at the Medinipur City College His research is on the transient radio sources and multi-wavelength study of known transient events. He is doing a galactic plane survey, main goal of which is to search for new supernova remnants..

Prof. Sandip K. Chakrabarti: He is the founding Secretary of ICSP and currently the Director of ICSP. His research interests range from physics of black hole accretion and outflows; high energy astrophysics; instrumentation for X-ray/gamma-ray observations and low cost balloon borne studies; ionospheric perturbations due to terrestrial and extra-terrestrial phenomena and their effects on VLF radio waves and Chemical Evolution of star forming regions.

Dr. Sonali Chakrabarti: She is an Associate Professor at the Maharaja Manindra Chandra College and an honorary Professor of the ICSP. Her research interest lies in the formation of bio-molecules in space, VLF research and study of the possibility to produce high resolution millimeter and microwave grating instruments. She became the General Secretary of ICSP from 1st December, 2018.

Mr. Shaym Sarkar: He is a Junior Research Fellow in Optical Astronomy and is working on Variable stars in clusters at IERCOO, Sitapur

Mr. Soujan Ghosh: He is a Technical Assistant cum project fellow working at IERCOO/ICSP, Sitapur. He works on Tropospheric and Ionospheric responses of Pre- and Co-Seismic Irregularities using Satellite and Ground Base Techniques also working on technical part of VLF projects.

Dr. Sudipta Sasmal: He is an Assistant Professor of ICSP. He is the Head of the Department of Ionospheric Sciences also he is a convener of executive committee of IERCOO/ICSP, Sitapur and he is also the convener of Academic Council at ICSP. He is working on observation and theoretical studies of Ionospheric irregularities.

Mr. Subrata Kundu: He is a Junior Research Fellow in Ionospheric Sciences under DST-INSPIRE Project and works on variation of GPS-TEC during Space Weather phenomenon and Sudden ionospheric disturbances using GPS-TEC data.

Ms. Swati Chowdhury: She is a Junior Research Fellow in Ionospheric Sciences under DST-INSPIRE Project. She is working on lightning in the atmosphere and its induced phenomena. She is also working on D region modelling in quiet and perturbed condition.

Mr. Suman K. Mondal: He is a Junior Research Fellow in Astrochemistry/Astrobiology under CSIR fellowship, working on the formation, destruction and excitation of molecules and their influence on the structure, dynamics and evolution of astronomical objects.

Dr. Suman Ray: . He is a Teacher at G.H. College and is working as an honorary scientist. He is in the VLF group and is working on the earthquake related anomalies of VLF signals.

Dr. Sushanta K. Mondal: He is an honorary scientist of ICSP and an Assistant Professor at S.K.B. University, Purulia. He works on effects of high energy radiation in ionosphere and their detection through VLF radio signal strength.

Dr. T. K. Das: He is an honorary Associate Professor of ICSP. His work is on the solar physics, especially on sunspots and classification of radio bursts. He also works on the geo-spot model of earthquakes, relationships between earthquakes and VLF etc.

Mr. Washimul Bari: He is an Asst. Teacher in Malda and is an honorary Senior Research Fellow at ICSP, Malda branch. He works on VLF studies of ionosphere and also data analysis of NASA/ISRO satellites.

Research Work Published/Accepted for Publication

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Impact Factor of Articles in International Journal by ICSP scientists in 2018-2019:

Impact Factor in 2018-2019				
Sl. No	**Journal Name**	**Impact Factor (IF)**	**No. Of publications**	**Total IF**
1	**ApJS**	**8.311**	**1**	**8.311**
2	**ApJ**	**5.580**	**2**	**11.16**
3	**MNRAS**	**5.231**	**7**	**36.617**
4	**AdSpR**	**1.746**	**4**	**6.984**
5	**AP&SS**	**1.885**	**1**	**1.885**
6	**JINST**	**1.366**	**1**	**1.366**
7	**Geomatics Natural Hazards & Risk**	**1.713**	**1**	**1.713**
Total Impact Factor				**68.036**

Departmental Progress Reports (2018-2019)

Department of Astrochemistry/Astrobiology

Birth sites of stars have a highly complex structure which consists of several individual gases and dust cores embedded in a lesser dense gas clump envelope. Different sub-structures (such as, accretion disk, outflow, outflow triggered shock, etc.) may exist which could eventually change the chemical structure of the region. Studying these chemical substructures could thus be very useful to identify the present stage of the star-forming zone. Presence of numerous complex organic molecules was reported around these regions. At ICSP, we study the formation of these molecules to explain different phases of the star formation. This is essential to understand the structure of our solar system and the origin of life in the universe. At present, our department has now two SRFs (Mr. Prasanta Gorai and Mr. Milan Sil) and three JRFs (Ms. Bratati Bhat, Mr. Suman Ghosh, and Mr. Rana Ghosh). This year, we have published three papers in refereed international journals and 16 in the conference proceedings/books. Dr. Ankan Das visited various International institutes (a. National Synchroton Radiation Research Centre, Taiwan, b) Max Plack Institute of Extraterrestrial Physics, Germany), attended numerous international conferences (at JAXA, Japan; Pasadena, USA; Kolkata; Pune; and Hyderabad) for presenting departmental research activities and scientific collaboration.

Ankan Das

(Dr. Ankan Das)
HOD, Astrochemistry/Astrobiology

Department of High Energy Astrophysics

Observational and theoretical aspects of black holes are studied during this period of time. There are total seven regular (Prof. Sandip K. Chakrabarti, Dr. Dipak Debnath, Mr. Arka Chatterjee, Mr. Arghajit Jana, Mr. Debjit Chatterjee, Mr. Kaushik Chatterjee, Ms. Riya Bhowmick and Mr. Abharajit Bhattacharjee) and visiting members (Dr. Broja Gopal Dutta and Md. Aslam Ali Molla) working in this group. Regular research fellows are working on various important topics on black holes under different national project grants. We have published two scientific papers in high impact refereed international journals. We have recruited two new student, one (Ms. Riya Bhowmick) as UGC-JRF grant fellow and another one (Mr. Abharajit Bhattacharjee) as ISRO/RESPOND project student. One new research project of ISRO/RESPOND has been sanctioned.

During this period, we visited different scholarly places to attend scientific conferences or workshops. We (Prof. S. K. Chakrabarti, Dr. Dipak Debnath) have attended XXVth Marcel Grossmann (MG15) meeting in Rome. We (Prof. S. K. Chakrabarti, Dr. Dipak Debnath, Dr. Broja Gopal Dutta, and Mr. Arghajit Jana) also went to Pasadena, California, to attend 42nd COSPAR (Committee On SPAce Research) Scientific Assembly. We (Prof. S. K. Chakrabarti, Dr. Dipak Debnath, and Mr. Arghajit Jana) visited Institute of Astronomy, National Tsing Hua University, Hsinchu, Taiwan, which was a part of DST/GITA sanction India-Taiwan joint co-operation project. International conference on "*Exploring the Universe: Near Earth space science to extragalactic astronomy*" (**EXPUNIV2018**) at S. N. Bose National Centre for Basic Sciences, Kolkata, was attended by all of our research scholars and faculty members.

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Dipak Debnath

(Dr. Dipak Debnath)
HOD, High Energy Astrophysics

Department of Instrumentation for Space Exploration

Instrumentation and data analysis aspects of Balloon borne science are studied in this department. VLF receiver instrumentation and overall maintenance, purchasing etc. are also done in this department at ICSP, IERCOO campus. There are total Six regular member (Mr. Debashis Bhowmick, Dr. Ritabrata Sarkar, Mr. Arnab Bhattacharya, Mr. Hriday Roy, Mr. Uttam Sardar, Mr. Souvik Manna) in this group. Latest phoswich payload, payload tracking device and its circuit implementation, testing, assembling etc. have been progressing for upcoming balloon borne missions. VLF receiver designing and implementation started for all India VLF campaigns. Upgrading the optical observatory room was carried out at IERCOO. Designing, supervision, electrification etc. of Directors building and the boundary wall progressed at IERCOO. Tendering and supervision of piling work and hostel block were done at the Integrated campus on EM bypass. Two scientific papers were published at high impact factor refereed international journals during this financial year, 2018-19. Dr. Ritabrata Sarkar has participated in COSPAR Symposium at 2018.

Debashis Bhowmick

(Mr. Debashis Bhowmick)
HOD, Instrumentation for Space Exploration

Department of Ionospheric Sciences

We mainly focus on observational and theoretical understanding of the ionospheric irregularities due to solar and terrestrial phenomena using multiparametric approaches through ground and space-based observations. We emphasize extensive observation and modeling of LAIC mechanism (all possible coupling channels), space weather events through upper atmospheric detection techniques, ionospheric and magnetospheric coupling using space-based observation. A new numerical modeling is being developed for understanding the VLF radio wave characteristics profile over India and its sub-continent region. Real time monitoring of VLF radio wave is carried out at IERCOO, Sitapur. Two research papers were published in reputed international journals along with several proceedings and books Chapters. Three Ph.D. students were registered in the University of Calcutta. Dr. Suman Chakraborty received his PhD degree from the University of Calcutta. Prof. S.K. Chakrabarti, Dr. S. Sasmal, Mr. S. Ghosh, Mr. S. Kundu and Ms. S. Chowdhury attended international conferences and gave oral/poster presentation in NARL, Tirupati; COSPAR meeting in Caltech, USA; PRL, Ahmedabad and SNBNCBS, Kolkata. Dr. Sasmal jointly edited a book which was published by Springer. Dr. Sasmal started collaborative research work with Prof. M. Hayakawa. Dr. Sasmal guided one M.Sc. and one B.Sc. project students.

Sudipta Sasmal.

(Dr. Sudipta Sasmal)
HOD, Ionospheric Sciences

Members of Scientific Societies/Committees

Ankan Das is a Member of Astrochemistry Society of India.

Sudipta Sasmal is a Member of Indian Polar Research Network. Also the Member of International Global Navigation Satellite System (IGNSS).

Prasanta Gorai is a Member of Royal Society of Chemistry (RSC).

Milan Sil is an affiliate member of Royal Society of Chemistry (RSC).

Ph.D. Degree Received

Suman Chakrborty received his Ph.D. Thesis on "*Modeling of lower ionospheric perturbations along Very Low Frequency radio wave propagation paths due to diverse physical phenomena*", (University of Calcutta), 2018.

Arka Chatterjee received his Ph.D. Thesis on "*Effects of Photon Bending on Observational Aspects of Black Hole Accretion",* (University of Calcutta), 2018.

Shree Ram Nagarkoti received his Ph.D. Thesis on "*Criteria For Formation Of The Boundary Layer Of A Black Hole Accretion Flow And Estimation Of Viscosity From Observational Data"*, (University of Calcutta), 2018.

Course of Lectures offered by ICSP members

Ankan Das and Dipak Debnath gave series of lectures on astrophysical topics at Ramakrishna Mission Residential College, Narendrapur; which is a part of astrophysics elective course for M.Sc. (Physics) 4th semester students.

Participation in National / International Conferences & Symposia

Sandip K. Chakrabarti gave an invited talk on ***"Black Holes"*** *at 15th Marcel Grossman Meeting, July 1-7, 2018, Rome. He also* gave several talks at 42nd COSPAR Assembly at Caltech, **July 14-22, 2018**. In **September, 2018** he gave 6 lectures on Black Hole Astrophysics at **NCTS Summer School** on Astrophysics on "*Accretion and Emission of Accreting Black Hole*" at National Tsing Hua University Taiwan. In **November, 2018** he gave another invited talk at exploring the universe conference at SNBNCBS on Black Holes.

Ankan Das gave a talk on "A Theoretical Prediction of the Abundances of Interstellar Prebiotic molecules", in July 2018, 42nd COSPAR 2018, Pasadena and "Deuteration of the Interstellar medium", 15th July 2018, B0.1 session of COSPAR 2018, Pasadena, CA, USA. In **August 2018,** he gave a lecture on "Importance of interstellar dust for the formation of complex molecules in hot cores", 16th August 2018, 11th Cosmic Dust meeting, JAXA, Sagamihara, Japan. In **December, 2018** he gave an oral presentation on Astrochemistry - from Theory to Observations, an introductory talk at the Astrochemistry session, INYAS-FOS Brainstorming Meeting, December, Hyderabad 2018. Gave another talk on "Astrochemical modeling to explain the presence of complex organic molecules in space", International Conference on Astrobiology, in December, 2018, Pune. In **March, 2019** he gave a talk on The Role of Interstellar dust on the formation of Complex Organic Molecules, Max Planck Institute for extraterrestrial Physics, Garching, Germany.

Dipak Debnath delivered an oral presentation at the fifteenth Marcel Grossmann (**MG15**) meeting on "*Recent Developments in Theoretical and Experimental General Relativity, Gravitation, and Relativistic Field Theory*" in July, 2018 in Rome. He delivered solicited and contributory lectures at the 42nd COSPAR Scientific Assembly in Pasadena in July, 2018. In **September 2018** he attended **NCTS Summer School** on Astrophysics on "*Accretion and Emission of Accreting Black Hole*" in Institute of Astronomy, National Tsing Hua University, Hsinchu, Taiwan during Sep 2-7, 2018. In **November, 2018** he delivered oral presentation at the International conference on "*Exploring the Universe: Near Earth space science to extragalactic astronomy*" (**EXPUNIV2018**) at S. N. Bose National Centre for Basic Sciences, Kolkata, India during Nov. 14-17, 2018.

Ritabrata Sarkar gave talks on "Simulated radiation from Crab pulsar detected in a light-weight phoswich detector on board meteorological balloon", in 42nd COSPAR Scientific Assembly, Pasadena, in July, 2018; A light-weight device for payload attitude measurement using micro-electronic inertia measurement unit suitable for small balloon borne missions, in 42nd COSPAR Scientific Assembly, 2018, Pasadena, in July, 2018; Instrumental developments of the meteorological balloon borne detectors for space exploration, in 42nd COSPAR Scientific Assembly 2018, Pasadena, USA, July, 2018; "Space exploration using light-weight payloads onboard meteorological balloons, at EXPUNIV2018, SNBNCBS, Kolkata, India, November, 2018.

Sudipta Susmal gave talks on Study of the characteristics of small, intermediate and long VLF radio wave propagation paths by using Long Wavelength Propagation Capability (LWPC) code and An Interactive study of Lithospheric - Ionospheric - Magnetospheric coupling through POES satellite Energetic Particle Burst during and prior to Nepal Earthquake, at the 42nd COSPAR Scientific Assembly, in July, 2018, Pasadena, California, USA. Numerical modeling of seasonal and diurnal variations of lower ionospheric reflection parameters based on IRI model, Ionospheric GPS Total Electron Content response over Indian region to the solar flares of the year 2017, Thermal Anomalies: As Lithospheric - Tropospheric interaction and precursory effect of large Earthquake, Unusual variation in the F- Layer prior to large Earthquake Comparative study of the possible anomalies in D-region electron density profile as computed from unusual terminator shifts in sub-ionospheric Very Low Frequency (VLF) signal during Honshu, 2011 and Nepal, 2015 earthquakes, Modeling of simultaneous multiple path VLF observation of solar flare using zenith angle profile and LWPC, Modeling of diurnal variation of VLF signal over signal propagation paths of various characteristics . He gave talks on Numerical modeling of long path propagation characteristics of radio waves as observed from Indian Antarctic stations, at Exploring the Universe: Near Earth Space Science to Extra-Galactic Astronomy, 14-17 November, 2018. Another talk on Indian Scientific Expedition to Antarctica: An Overview at the Ramkrishna Mission, Malda. He attended Workshop on Satellite Navigation and Application of GNSS/NavIC, 5-6 April, 2018, National Atmospheric Research Laboratory, Tirupati, India.

Prasanta Gorai gave talks on "Presence of higher order thiols in star-forming region", and 'Link between interstellar and cometary compositions' in July, 2018, at COSPAR, Pasadena, 'Link between Interstellar and Cometary Sulfur Bearing Species', in November, 2018, Exploring the Universe: Near Earth Space Science to Extra-Galactic Astronomy".

Milan Sil gave an oral presentation on "Binding energy a key to defining interstellar volatile species" and another oral presentation on "A systematic study of the pre-biotic aldimines and amines in hot cores" in COSPAR, Pasadena, in July 2018. A talk on "A New Set of Binding Energies for Astrochemical Modeling" in EXPUNIV2018, in Nov. 2018 was delivered.

Arghajit Jana gave talks on Accretion - Ejection mechanism of MAXI J1836-194 with the TCAF solution, Properties of the 2015 outburst of V404-Cygni from spectral analysis with the TCAF solution, Disk-Jet coupling of black hole sources with the TCAF solution and one poster on Accretion - Ejection mechanism of Swift J1753.5-0127 with the TCAF Solution, at 42nd COSPAR, 2018, Pasadena, In November 2018, he gave an oral presentation on Disk-Jet Connections in Black Holes at EXUNIV2018.

Debjit Chatterjee gave a talk on "Accretion Properties of the Black Hole XTE J1118+480 with the TCAF Solution at EXUNIV2018 in November, 2018

Bratati Bhat gave an oral presentation onRadiative transfer modeling of some observable Interstellar species at 'Exploring the Universe: Near Earth Space Science to Extra-Galactic Astronomy' in November 2018.

Swati Chowdhury gave an oral Presentation: Numerical modeling of seasonal and diurnal variations of lower ionospheric reflection parameters based on IRI mode lin EXUNIV2018 in Nov. 2018. She gave one poster presentation on Numerical modeling of seasonal and diurnal variations of lower ionospheric reflection parameters based on IRI model in October, 2018, at the15th International Symposium on Equatorial Aeronomy, Physical Research Laboratory, Ahmedabad.

Subrata Kundu attended a Workshop on Satellite Navigation & Application of GNSS/NaVIC inApril, 2018, National Atmospheric Research Laboratory, Gadanki, Andhra Pradesh. He attended 15th International Symposium on Equatorial Aeronomy in October, 2018, Physical Research Laboratory, Ahmedabad. He attended Exploring the Universe: Near Earth Space Science to Extragalactic Astronomy in November, 2018 and gave a talk on Comparison of Ionospheric Vertical Total Electron Content during high solar active year and low solar active year for Indian region.

Books

Exploring the Universe: From Near Space to Extra-Galactic, Springer International Publishing AG, B. Mukhopadhyay, S. Sasmal (eds.), and doi.org/10.1007/978-3-319-94607-8 40.

Ankan Das, Dipak Debnath, Ritabrata Sarkar, Sudipta Sasmal, Prosanta Gorai, Milan Sil, Bratati Bhat, Swati Chowdhury, Subrata Kundu, Debjit Chatterjee, Arghajit Jana, Soujan Ghosh, Asit K. Chowdhury Ashim Sarkar, Argha Sil, Shyam Sarkar wrote Chapters for this book.

Workshop / Seminar/ Conference organized

ICSP was the joint organizer of the conference "Exploring the Universe: Near Earth Space Science to Extragalactic Astronomy" at Science City, Kolkata

Visits abroad from the Centre

Sandip K. Chakrabarti and Dipak Debnath visited University of Rome "La Sapienza", Rome, Italy to attend MG15 Meeting, National Tsing Hua University, Hsinchu, Taiwan to present a series of Lectures in an Workshop and Pasadena Convention Centre to Organize several sessions of 42nd COSPAR hosted by Caltech, Pasadena

Ankan Das visited various International institutes (a. National Synchroton Radiation Research Centre, Taiwan, b) Max Planck Institute of Extraterrestrial Physics, Germany), attended numerous international conferences (at (a) JAXA, Japan, b) Pasadena, USA, Collaborative research & project work.

Sudipta Sasmal attended 42nd COSPAR Scientific Assembly, in July 2018, Pasadena.

Collaborative research & Project Work

Interstellar chemistry as a powerful tool to investigate physical conditions around the star forming regions and protoplanetary disks, A. Das, S.K. Chakrabarti: Funded by ISRO.

Abstract: It is a long-standing aspiration to use chemical properties of various interstellar species for the measurement of physical properties of molecules clouds and star forming regions. In this project, we want to test outcomes of various models of interstellar chemistry and cross check them with known results. Molecules with two or more hydrogen atoms would be useful to trace the dynamic properties because of their ortho to para spin orientations. Temperature dependency of this ortho to para ratio (in the high temperature, ortho to para ratio is close to 3.0 but at low temperatures, it drops significantly) would be an useful diagnostics tool for this purpose. During the star formation process, study of abundances of sulfur bearing species would be another option to use as a chemical clock. Circumstellar disk is a natural byproduct of a rotating cloud collapse. These disks are the birth sites of the planetary systems and are thus called the protoplanetary disks. Study of the chemical composition of these disks will provide some estimation of the initial chemical composition of future planets. Similarly, ambipolar diffusion is a phenomenon which controls the rate of star formation to some extent. Thus the measurement of ambipolar lengthscale would be essential. This is done by measuring differences in line widths of similar charged and neutral species. In this regard, we will use CASSIS interactive spectrum analyzer. Moreover, we will use CASSIS to model astronomical spectra of various species under different physical circumstances.

Low cost space exploration by weather balloon borne X-ray detector, R. Sarkar: Funded By DST/SERB.

Abstract: To see the sky in X-rays, detectors must be flown beyond Earth's atmosphere which obscure Xrays. For this purpose, detectors on board satellites are the best possible solution, as they offer a large number of stunning capabilities like carrying big detectors, stable platform for better pointing accuracy, longer time exposure, almost no residual atmosphere etc. But the main problem for this type of mission is that they have huge financial implication. Due to the orbital location these types of missions also have significant radiation hazards and in-orbit maintenance of the satellite is also very high. A significant level of scientific knowledge can be acquired with a different approach using several thousand times lower cost, by exploiting small sized payloads on board weather balloons. Typically these balloons can attain an altitude of 40 km above the ground, with a small sized payload of 4-5 kg. Thanks to the miniaturization of electronic components, these missions are possible. At this altitude level the overall possibility of radiation hazards are also low. ICSP has pioneered in this method and so far launched nearly 100 missions to near space. Presently ICSP has been able to track, recover and reuse all the payloads, thereby reducing the cost. In this proposal we want to build a small and light-weight yet sophisticated payload to measure the X-ray radiation from the extraterrestrial sources like Sun, X-ray binaries, GRB etc. as well as to measure secondary X-ray emission at various altitudes in the atmosphere due to cosmic ray interactions. For this purpose, we want to build a payload which includes a phoswich scintillator detector with NaI and CsI crystals in combination with a Photo-Multiplier Tube to measure Xray radiation. Using the existing scientific ballooning facility in ICSP, this detector may be taken above the atmosphere with low cost weather balloons and bring it back by parachutes. Since we can recover the payloads, same detectors may be used for several missions and have a comparative study of the results (for example, modulation of cosmic rays by solar activities in different phases of its cycle). A considerable knowledge of the secondary cosmic-ray flux through the different altitude in the atmosphere and in different time period can be obtained from the project which in turn reveal some important aspects of the Cosmic rays and its dependence with the solar activity. From the observation of the X-ray sources we will have a detailed knowledge of their temporal and spectral behavior of the corresponding sources.

X-ray Properties of Accretion Flows and Estimation of Fundamental Parameters of Black Hole Binaries, D. Debnath, Funded By DST/SERB.

Abstract: Study of a few black hole (BH) sources in X-rays to infer about spin, mass, distance, inclination angle, outflow rates, line properties, etc. will be done in the project using two-component advective flow (TCAF) solution. Recently Debnath his collaborators have successfully implemented most generalized black hole accretion flow solution TCAF (was introduced by Chakrabarti and his collaborators in mid-90s)

as an additive table model in NASA's spectral analysis software package XSPEC. TCAF model fitted spectra provides us information about the physical flow parameters, such as two component accretion (Keplerian and sub-Keplerian) rates, shock (location and compression ratio) other than mass of the black hole (if kept free while fitting spectra). Most probable values of the masses of few BH sources have also been successfully estimated from our spectral analysis with the TCAF solution. In this project, we will study accretion flow properties of few more BH sources with TCAF paradigm. We also try to estimate their intrinsic physical parameters (for e.g., spin, mass, distance, inclination angle, etc.) from our spectral study.

Accretion Characteristics of Galactic Outburst Sources from X-ray Observation, D. Debnath and S. K. Chakrabarti, Funded By DST/GITA

Abstract: The objective of this project is to study physical properties of some black-hole X-ray binary systems, such as black hole masses and accretion rates, with the synergy of strengths from two groups in India and in Taiwan, and also to enhance academic interactions between these two countries. Understanding physics in these systems will provide us with an important examination of our physics knowledge in extreme conditions, e.g., strong gravity. A population study of these will also bring some insights on accretion-disk physics and on stellar evolution in our galaxy.

Study of a few Persistent and Transient Black Holes using ASTROSAT and Other Satellite Data, D. Debnath & S. K. Chakrabarti, Funded by ISRO/RESPOND

Abstract: The main objectives of this project are to study black hole sources using data of India's first multi-wavelength astronomy satellite ASTROSAT. Depending upon the activity black holes are generally two types: persistent and transient. In the project, we will study a few of these type of objects to understand the flow properties of these objects. We have the plan to study both the temporal and spectral properties of these sources. Result obtained from ASTROSAT data will also be verified with data of other astronomy satellites. A long term variability in X-ray intensity (light curve) of different types (persistent, semi-persistent and outbursting) of stellar-mass black hole candidates (BHCs) will also be studied. This will help us to understand the physical mechanism behind rapid changes (class transitions) in light curves of GRS 1915+105, IGR J17091-3624 and other BH sources, in-depth analysis will be made on each variability class under TCAF paradigm.

Observation of anomalous characteristics of VLF signals in the earth-ionospheric wave guide using a network of receivers and their correlation with seismic events, S. Sasmal & S.K.Chakrabarti Funded by DST/SERB

Abstract: The main objective of this project is to understand the pre- and co-seismic phenomena associated with Lithosphere-Atmosphere-Ionosphere-Coupling (LAIC) mechanism using multi-parametric approach. A network of VLF receiving stations will be implemented in several places in India to identify the lower ionospheric irregularities. By using satellite and ground-based observations, these anomalies will be verified by thermal (latent heat, OLR, relative humidity), acoustics (atmospheric gravity wave) and electromagnetic (TCE) perturbations in the tropospheric and stratospheric region and based on the observation a numerical model will been developed. The observational and simulated evidences from all the connecting channel of LAIC will be utilized to improve the present LAIC mechanism and the possible pre-seismic processes will be identified by using this new process over the earthquake prone area in Indian landmass.

Guiding M. Sc. project students

Dr. Sudipta Sasmal supervised Mr. Aranya Bhoumik from Doon University, Dehradun, who succesfully completed project entitiled "Numerical Simulation of Ionospheric Response of Solar Flare Through Very Low Frequency (VLF) Radio Wave from Antarctica" for his M.Sc. summer project (Id. No.17PH62) in 2018. He also supervised Mr. Prashant Tiwari from Amity University, Kolkata for a project entitled "Thermal Anomalies during Earthquakes" for the completion of project course in sixth semester of B.Sc. (H) Physics in 2019.

Summary of Research Activities of the Scientists at the Centre

Astrobiology/Astrochemistry

Top: (L to R): A. Das, S. Chakrabarti and S.K. Chakrabarti
Bottom: (L to R): P. Gorai and M.Sil, B.Bhat and S.K. Mondal, R. Ghosh

A Major obstacle in Astrochemical modeling is the lack of knowledge about the binding energy (BE) of a chemical species which controls chemical enrichment of the Interstellar Medium. Due to the experimental limitations, the binding energy of the crucial interstellar species are yet to be known and thus very often we use educated approximation. Recently, we made an extensive effort to estimate the BE of 100 crucial interstellar species on water ice surface by applying quantum chemical approach (Das et al., 2018). Initially, we considered a few stable species for which experimental values of the BE were available and compared our obtained BE values with these species. We used various water clusters (monomer, dimer, trimer, tetramer, pentamer, and hexamer) as the adsorbent. We found that on an average, a minimum deviation for higher-order clusters such as pentamer or hexamer was obtained. Therefore we suggested to use these structures for the estimation of BEs for which experimental values are unknown.

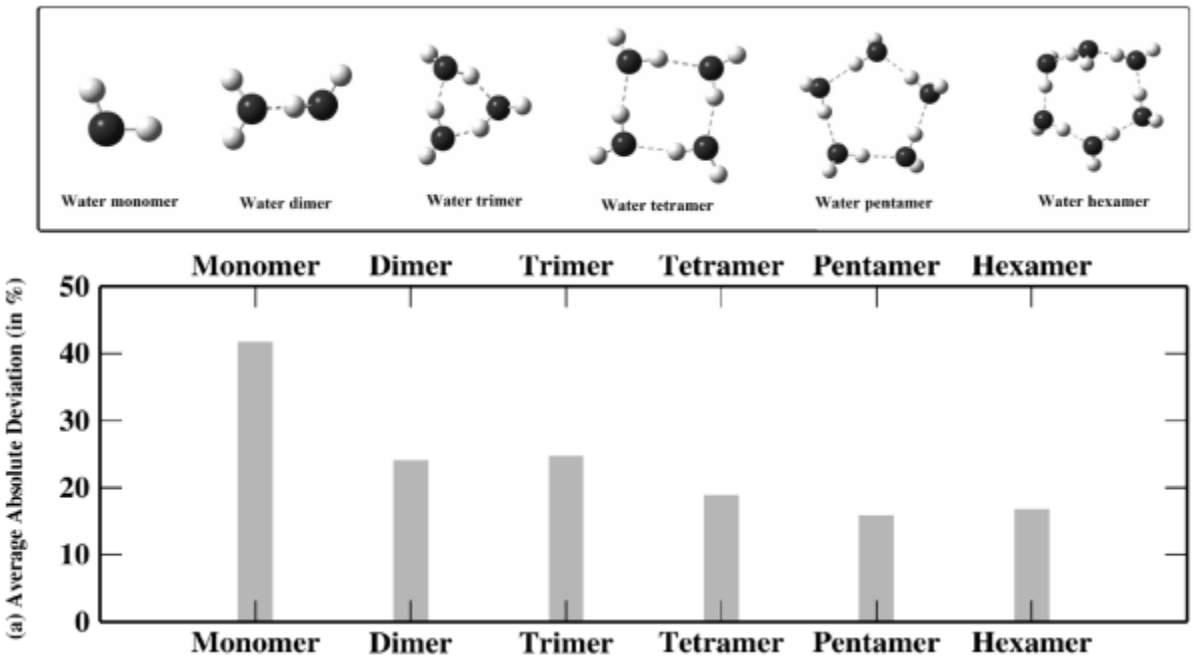


Fig. 1. Upper panel shows the used structure of various water clusters. The lower panel shows the average absolute deviation of calculated binding energies with different water clusters (Das et al. 2018).

Recently, Mcguire et al. (2016) observed first chiral molecule, propylene oxide (PrO) towards the cold shell surrounded the Sgr B2. They observed three transitions of propylene oxide in absorption. We used a combined radiative transfer and chemical modeling to explain the observed results. To find a parameter space for the formation of PrO in the dark cloud regime, we considered a dark cloud model. We varied the number density of total hydrogen (nH) in between $10^4 - 10^7$ cm^{-3} and ice temperature between 10-25 K and kept the gas temperature at 30 K. The resulting plot is shown in the left side of the Figure on the inside cover. It is clear from the plot that the observed abundance ($\sim 10^{-11}$) of PrO can be obtained in between the density range $10^4 - 10^5$ cm^{-3} and ice temperature range 20 - 25 K.

In the first Figure of the front inside cover: (Left) Parameter space for the abundance of PrO in the dark cloud conditions. The color bar represents the fractional abundance of PrO. (Right) Line parameters of PrO for non - LTE condition (Das et al., 2018).

In the right panel of the same Figure, we show the line parameters for PrO in non - LTE. Here, our target was to find out the line parameters which are relevant for the observations performed by McGuire et al.

(2016). We considered, T_{ex} = 5 K, column density of PrO =1 × 10^{13} cm^{-2} , FWHM =15 Km/s (for the observed three transitions, McGuire et al. (2016) obtained FWHM of 11.6, 15.8, 19.6 Km/s respectively and we considered an average of these values) and n_H = 10^5 cm^{-3}. Radiation temperature of PrO is presented in the right panel for both with beam dilution and without beam dilution correction. Most interestingly, with the given conditions, we obtained all the three observed transitions (12.07, 12.8 and 14.04 GHz) in absorptions. Additionally, we identified three other transitions at 15.78 GHz, 18.1 GHz and 23.98 GHz which might potentially be observed around the same region, where the other three transitions were observed. We studied the hot molecular core, G31.41+0.31. Figure 2 shows integrated emission of SiO outflow. We have calculated the various physical parameters (outflow mass, outflow momentum, kinetic energy, outflow mass loss, momentum loss, and kinetic energy loss) of the outflow. We have estimated the dynamical time scale of the outflow ~10^3 years and the outflow mass is ~50$M_\odot$. This suggests that the outflow associated with G31 is massive and characterized as young. Outflow mass loss rate is obtained ~10^{-2} -$10^{-3}$$M_\odot$ yr^{-1}.

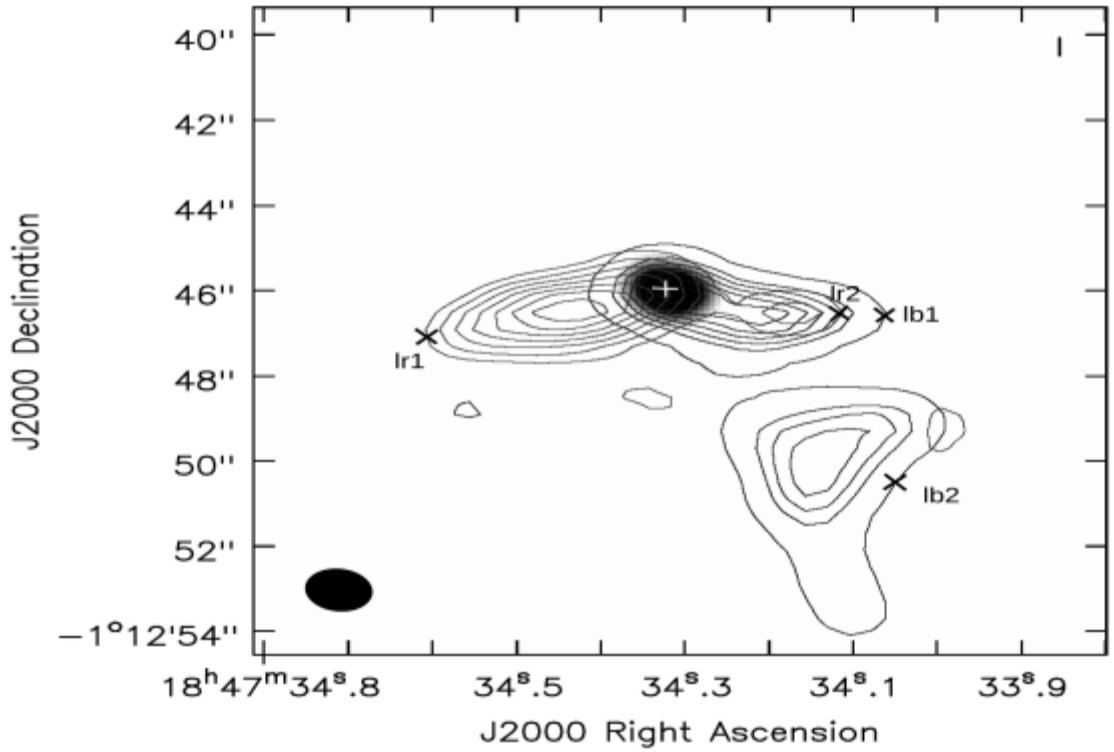


Fig. 2. Gray scale levels for the continuum at 94 Ghz. Blue-shifted emission of SiO integrated over 77-93 km s^{-1} where contour levels are at the 20, 30, 40, 50 ,60, 70, 80 % of the peak intensity. Red-shifted emission of SiO is integrated over 100-123 km s^{-1} . Ellipse at the below left corner of the image shows the synthesized beam (1.19 × 0.98). Plus sign indicates the position of the continuum. Two Cross signs at the outer contour of red lobes indicates lr1 and lr2 distance another two cross sign on the red lobes indicated lb1 and lb2 distance.

Sources of High Energy Radiations

Astrophysics of Black Holes and Neutron Stars

We continue our theoretical studies of how matter is accreted onto black holes, how matter is ejected from accretion disks in the form of jets and outflows and how radiation is emitted from these disks and outflows. Our current interest is to focus on the effects of the spin parameter on the emitted radiation. We also study how black holes focus photons to our side by bending the photon trajectory and cause apparent deformation of the disk image through Doppler and gravitational redshifts and time-lags among various energy components.

(L to R): S. K. Chakrabarti, A. Chatterjee, S. Nagarkoti, D. Debnath,

A. Bhattacharjee

We study the spectral and dynamic properties of flows around neutron stars. We find that except for the normal boundary layer on the hard surface, the flow with two components as proposed by Chakrabarti (1995, 1997) applicable for black holes remain the same. We vary the flow parameters, viscosity, surface temperature etc. to obtain various flow geometry. Thus the spectra contain an extra black body component from the normal boundary layer (NBOL) and are generally softer. Several quasi periodic oscillation (QPO) frequencies can be found in such a system as described in Bhattacharjee and Chakrabarti (2018).

We study the properties of a transonic flow around Kerr black holes using two dimensional numerical simulations. We find that the shock locations in 1D as predicted by Chakrabarti (1996) are reproduced perfectly by a TVD code. We also find that in 2D one needs to add an extra effect due to turbulent pressure of the back flow in order to explain the shock location. Both co- and contra-rotating flows are studied in Kim, Garain, Chakrabarti, Balsara, (2019).

With A. Ghosh we study the time of arrival of the viscous Keplerian component and the advective halo component of a two component accretion flows from the piling radius to the black hole horizon. We show that for low mass X-ray the time lag is few days while for high mass X-ray binaries the time lag is negligible. We also plot the dynamical slope of the ASM spectra and show that its excursion is directly related to the size of the disk. Also multiple loops indicate multiple flares inside a single flare.

Disk structure evolution in H1743-322

The recurring Galactic transient low mass X-ray binary H 1743-322 shows outbursts of durations of around 2 months in a gap of around 6 months to years between two outbursts. Although, H 1743-322 exhibited a long duration outburst (~ 9 months) in 2003 after more than two decades. This event was extensively studied in multi-wavelength bands by many groups. The striking feature is that the total energy released is extremely high as compared to that in other tens of outbursts which followed (see, Fig. 3a-c). Here we relook at this event. We show that the mass transfer rate from the binary is independent of the outburst size. The total energy release at an outburst is proportional to the preceding quiescent state.

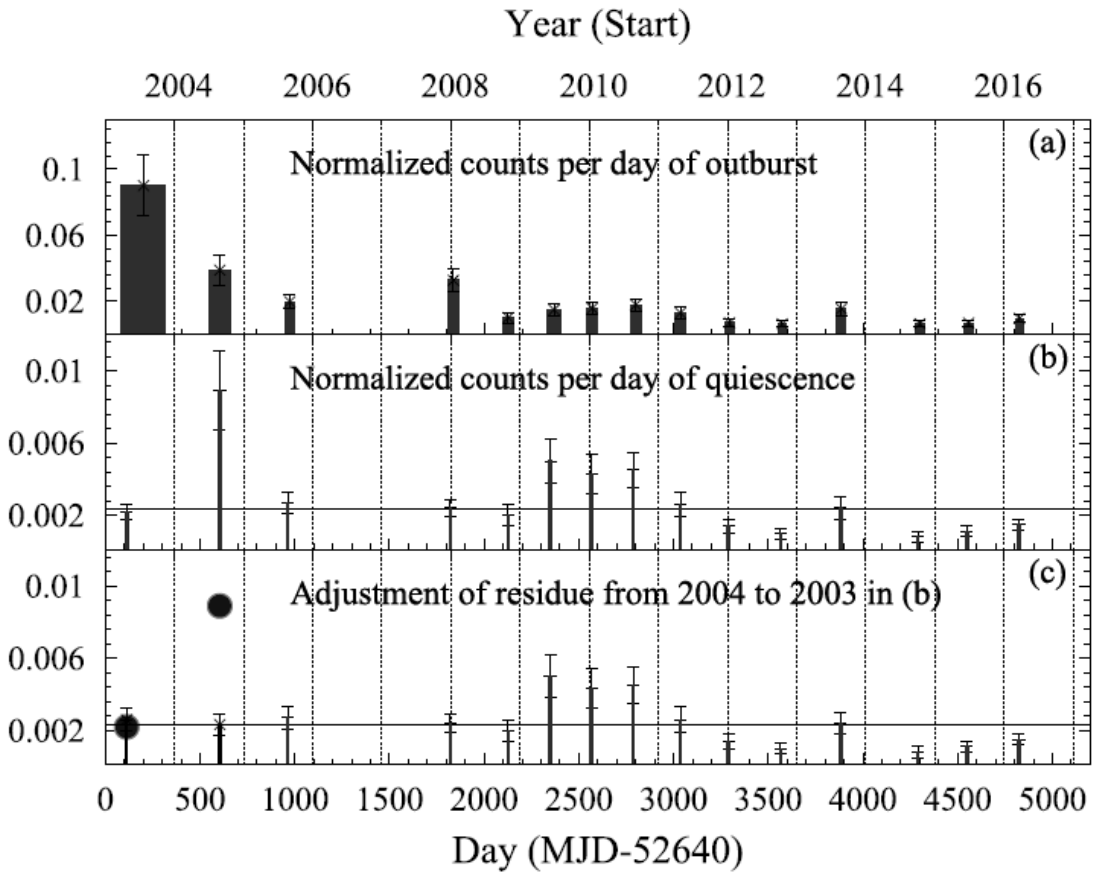


Fig. 3: The integrated counts per outburst is plotted against the day of the outburst to show that the energy release rate is independent of the outburst. This hypothesis becomes correct if the 2004 outburst is assumed to be a part of the 2003 outburst since the energy release in 2004 is much higher as compared to the preceding gap.

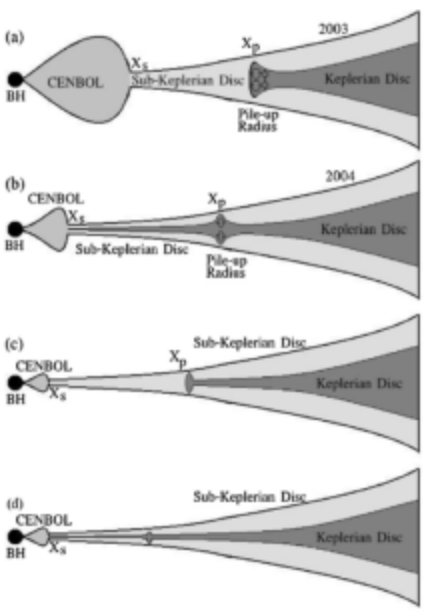


Fig. 4: A possible scenario of the evolution of the disc structure around H 1743–322 in successive outbursts. (a) The piling radius Xp = Xp2003 is very high prior to 2003 outburst and thus considerable matter had to be accumulated before high viscosity released the matter and triggered the outburst. (b) Location of piling radius Xp= Xp2004 < Xp2003 of 2004 outburst where some matter of previous outburst remained while the Keplerian disc from 2003 outburst is still fading away. (c) Piling radius at subsequent outburst is closer to the black hole and takes shorter time before new triggering occurs (d).

X-ray Astronomy



(L to R): D. Debnath, A. Jana, S. K. Chakrabarti



(L to R): D. Chatterjee, K. Chatterjee, R. Bhowmick,

The X-ray Astronomy group is involved in fitting observational results with various models. It also analyses results and interprets in terms of physical processes around black holes. Our major activity has been to implement the TCAF solution into HEASARC's spectral analysis software package XSPEC. This allows us to extract physical flow parameters directly from spectral fits. The nature of the evolution of these physical flow parameters allow us to find most convincing explanations for accretion flows around black holes. We also estimate the black hole mass from spectral analysis with the TCAF model.

i) ***Accretion flow properties of XTE J1118+480 during its 2000 outburst with the TCAF solution****:* In Chatterjee, Debnath, Jana & Chakrabarti (2019), we make detailed study of the spectral and temporal properties of the Galactic halo black hole candidate (BHC) XTE J1118+480 during its 2000 outburst. The archival data of RXTE PCA and HEXTE payloads are used in a broad energy range. TCAF model fitted combined spectra in 3-100 keV energy band are shown in Fig. 5. Low and very low frequency quasi-periodic oscillations (QPOs), with a general trend of increasing frequency are observed during the outburst. Spectral analysis is done using the combined data of PCA and HEXTE instruments with two types of models: the well known phenomenological power-law model and the current version of the fits file of two-component advective flow (TCAF) solution as an additive table model in XSPEC. Highly dominating contribution of a non-thermal power-law component as well as TCAF model fitted sub-Keplerian halo rate are observed during the entire period of the outburst. We suggest that this so-called outburst is due to enhanced jet activity. Indeed, the 'outburst' subsides when this activity disappears. We estimate X-ray fluxes coming from jet base using method based on constant normalization properties of the TCAF used earlier. Though the object was in hard state in the entire episode, the spectrum becomes slightly softer with rise in Keplerian disk rate in the late declining phase.

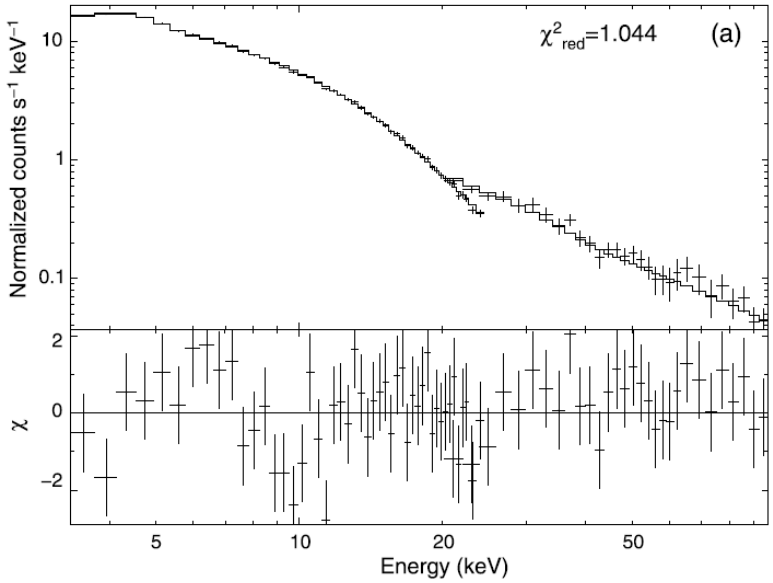


Fig. 5: TCAF model fitted PCA+HEXTE spectrum in 3-100 keV of XTE J1118+480 for observation IDs 50133-01-01-00 (UT=2000/04/08 ; MJD=51642.57) is shown.

ii) Mass Estimation of XTE J1118+480:

Each TCAF model fit gives us one best-fit mass (M_{BH}) value with some uncertainties, since here the mass of the BH is an input parameter to fit the spectrum. We get an average value of the mass of XTE J118+480 as $6.99^{+0.50}_{-0.59}$ M⊙ from the overall spectral fitting. we use M_{BH} vs. χ^2_{red} method as discussed in Molla et al. (2016) to verify this predicted mass. In Fig. 2, we show variation of the χ^2_{red} with M_{BH} of these two spectra of observation IDs: 50133-01-01-00 (MJD=51642.57) and 50407-01-07-00 (MJD=51683.50). Up to

the allowed 90% confidence χ^2_{red} obtain mass ranges for these two spectra as 6.78–7.13 M⊙ and 6.89–7.39 M⊙, respectively. A similar analysis is made for all observed spectra during 2000 outburst of XTE J1118+480 and finally we obtain the mass range of the source to be 6.25–7.40 M⊙. Now combining the results of the above-mentioned methods, we finally estimate the probable mass range of the source as 6.25–7.49 M⊙ or $6.99^{+0.50}_{-0.74}$ M⊙.

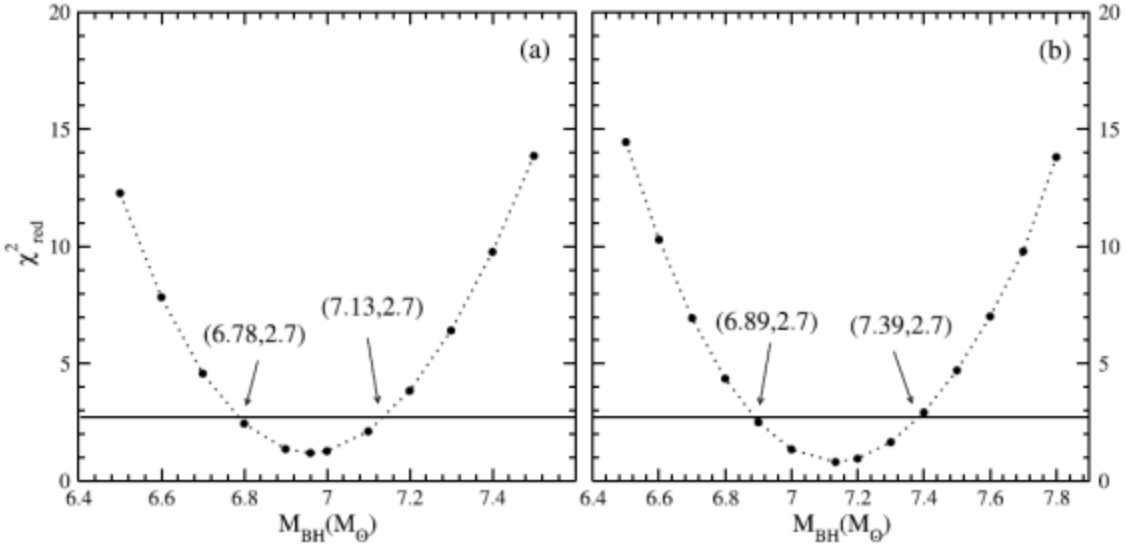
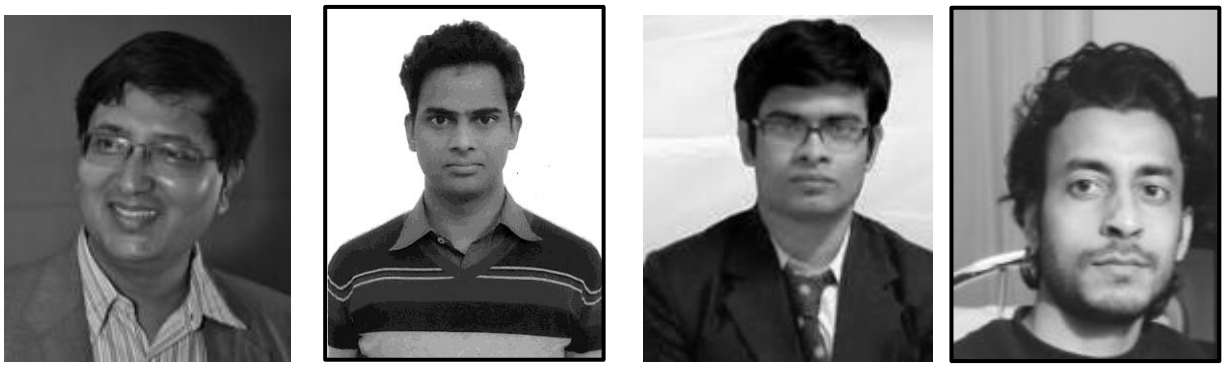


Fig. 6: Variation of TCAF with mass for model fitted χ^2_{red} observation IDs (a) 50133-01-01-00, and (b) 50407-01-07-00 are shown. To see these variations we kept all TCAF model parameters as frozen into their best-fit values, and the expected mass of the BH into different constant grid values as shown in the plots.

X-ray/Gamma Ray Experiments and Balloon borne Earth and Space Science



(L to R): S.K. Chakrabarti, D. Bhowmick, A. Bhattacharya, R. Sarkar

(L to R): H. Roy, U. Sardar, R.C. Das, A. Roy

R. Sikdar

Balloon borne experiments are required to probe the near space up to 40km height. ICSP has an independent space program in which we have been exploring space since 2007 with light weight balloons. We have already had 109 missions with balloons of mass ranging from 1kg to several kilos. We are able to study how the cosmic ray flux varies with height. We do not have pointing to any object but we can compute the photon direction using 9 degrees of freedom measurement at every moment of time. We primarily measure X-rays using Scintillation detectors with one or more scintillators in phoswich configuration. Our X-ray laboratory fabricates the payloads. Typically we fly these balloons in two seasons per year (pre- and post- monsoon) when the wind is favourable.

Physical interpretations of the measured values by balloon experiments require simulations of the backgrounds so that the real data may be obtained after noise and background subtraction. Thus a section of our scientists is studying the Earth's atmospheric and space radiation environment through Monte Carlo simulation and direct experiments with radiation detectors on board balloon platform. Such simulations results are also useful to fine tune the payload parameters before each experiment.

We discuss below some of the important progresses and results we achieved during the last year.

Simulation of cosmic ray interaction in the Earth's atmosphere:

To study the Earth's space radiation environment, we developed a framework using Geant4 toolkit to simulate the interaction of extraterrestrial high-energy radiation and particles in the Earth's magneto-atmosphere. We considered a full 3D description of the Earth's atmosphere and the geomagnetic field distribution in the simulation using latest model parameters. In Fig. 7 we show some major atmospheric parameters with the altitude and an example of geomagnetic field line distribution for a particular condition.

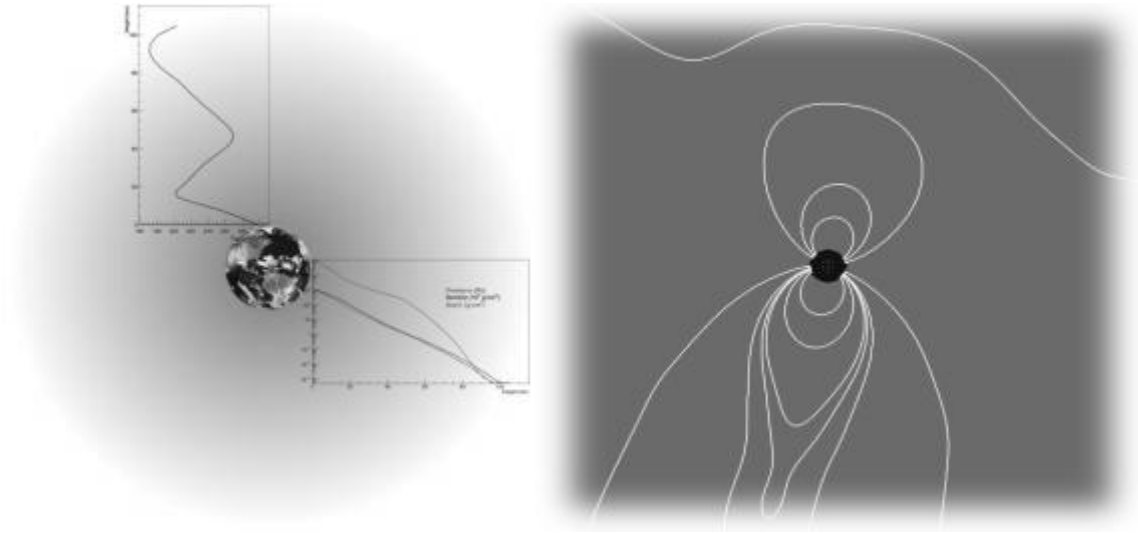


Fig. 7: (Left) Representation of geomagnetic field line distribution for particular solar condition. (Right) Change in atmospheric parameters to describe the atmospheric model used in the simulation.

We studied the radiative interaction of the CR protons and helium ions (effectively including the other heavier nuclei species) which are most abundant in the CR. We calculated the secondaries (proton, neutron, muon, electron, positron, photon) produced by the interaction of the primary particles at various heights in the atmosphere and at the satellite height. We compared the simulation results obtained with the observation results from AMS which was orbiting the Earth at a height about 400 km for the validation of

the calculation. In Fig. 8 we show a comparison of the simulation result with the AMS measurement for the downward cosmic ray proton flux.

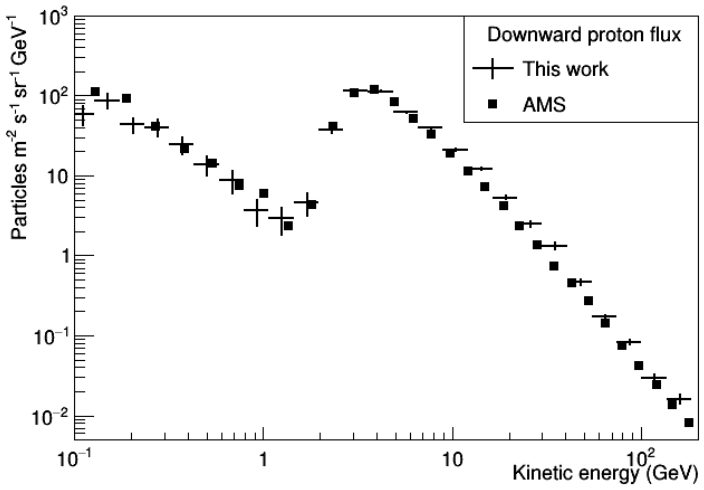


Fig. 8: Comparison of our simulation result with AMS measurement of downward proton flux of cosmic ray origin.

We then calculated the radiation effects of the cosmic ray interaction in the atmosphere at balloon height and used the result to estimate its contribution to the counts in the balloon-borne detectors. We show in Fig. 9 the radiation data at the altitude of 30 km as observed by the balloon-borne detector with segregated components contributing to the overall counts.

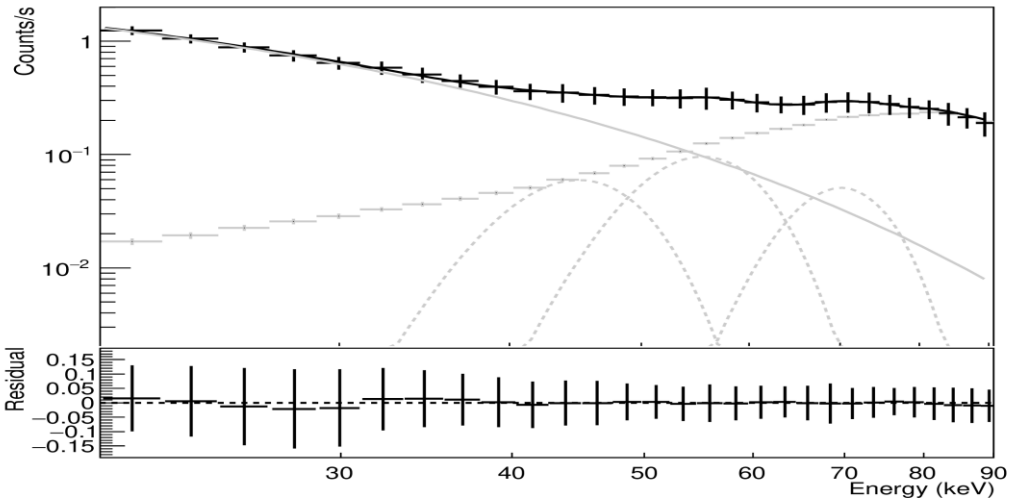


Fig. 9: The total radiation spectrum (black points) in a balloon-borne phoswich detector, fitted with several components like: external cosmic-ray induced counts (gray points), activation and spallation induced internal radioactivity counts (gray solid line) and other internal line emissions (gray dashed lines).

The transportation of charged particles through the Earth's magnetosphere is important for many space radiation related phenomena. To calculate the charged particle tracks in the magnetosphere, we solve Lorentz equation of motion to compute the trajectory of these charged particles. Here, in Fig. 10 (left) we plot trajectory of two protons with 15 MeV energy at 2 and 4 Earth radii with pitch angle 35 deg, considering a dipolar approximation of Earth's magnetic field. However, the gyration of charged particles in the magnetic field may result in longer trajectories during transportation from one place to another. For some purposes it is sufficient to consider smooth trajectories along the guiding center of the gyro-motion. Guiding center gives a smooth trajectory by averaging the gyration motion of charged particles around the magnetic field. So, it takes less computation time compared to the actual Lorentz motion. In Fig. 10 (right) we plot the trajectory of the same protons by solving guiding center equation of motion.

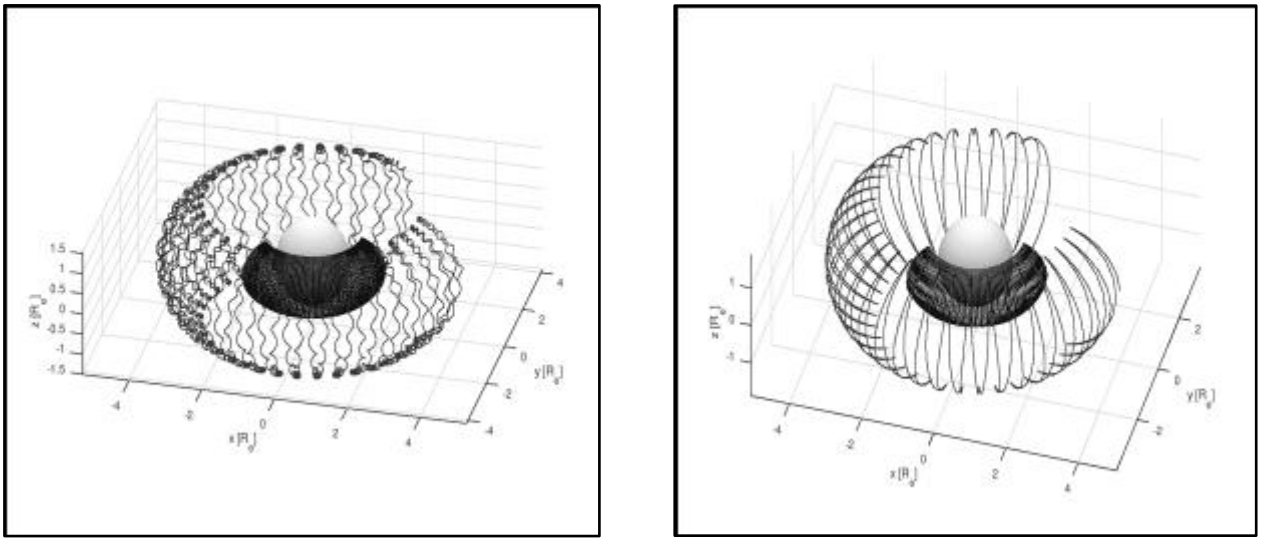


Fig. 10: (Left) Proton (15 MeV) trajectories in geomagnetic field according to Lorentz equation of motion; red: 4 Earth radii, blue: 2 Earth radii. (Right) Trajectories of the same particles according to guiding center equation of motion.

Payload design for balloon-borne experiment:

We have developed, optimized and tested of a new phoswich detector made of NaI/CsI crystals attached to a PMT for the ongoing balloon-borne experiment with light weight meteorological balloons. Calibration process yields a very good resolution of the detector (~ 14% at 59.5 keV) compared to the similar detectors used in other experiments (e.g., RT2). We integrated the detector and other ancillary instruments required for the mission into a compact payload system. We designed a very light-weight payload structure suitable for this kind of experimental paradigm. To decrease the random motion of the payload induced by the wind turbulence and balloon drift, we introduced a decoupling mechanism into the payload system. Its performance is to be tested under real mission situation.

We further developed the data analysis software for the purpose of formatting and filtering the raw data from the detector and several other instruments in the experiment to make the date ready to be used for further analysis. We also developed some temporal and spectral analysis tools to extract scientific information from the data. To facilitate the testing of the inertial measurement unit (IMU), we developed a software for live testing of the IMU data. A very crucial issue for the success of these kind of missions is the prediction of the landing location of the payload. In this concern, we modified our prediction software for the plastic balloons using the wind information and previous flight profiles.

Ionospheric Sciences

Top (L to R):*S. Sasmal, S.K. Chakrabarti, S. Chakraborty, T. Basak,*
Bottom (L to R): S. Ghosh, S. Kundu, S. Chowdhury, A. Choudhury,
S. Ray, D. Bhowmick,

Radiation Belt Electron Precipitation

Ionospheric-magnetospheric transition region and the time correlation of particle rate fluctuation with earthquake has been a subject of interest the last few decades. Van Allen Radiation Belt (VAB) is a zone of energetic charged particles originated from the solar wind that are captured by Earth's magnetic field lines. There are several Low Earth Orbital (LEO) satellites to observe the count rate of energetic particles in the VAB. To understand such phenomena, data from Medium Energy Proton and Electron Detector (MEPED) instrument which is on-board the NOAA-15 satellite is used. A comparative study of the effects of a land earthquake and an ocean earthquake on the observed particle bursts (PBs) have been executed. The transport of electromagnetic emissions of seismic origin from the ground to the magnetosphere through the ionosphere depends on various land and atmospheric variables. One of the primary parameters is ground conductivity. The conductivity of the ocean surface is much higher compared to that of the land surface and thus, an ocean earthquake is expected to impact the ionosphere-magnetosphere region more than a land earthquake. With this aim, one land earthquake on January 3, 2016 and an ocean earthquake on December 6, 2016 are considered for analysis. The data was taken from the NOAA website and we analysed it for the entire months of January and December 2016. For the January 3 (land) earthquake, PBs were found to be accumulated only around the earthquake day, being maximum on the day of the earthquake and with the complete absence of such events on days away from the event day. For the December 6 (ocean) earthquake, the effects were found to be post-seismic in nature and existed for days away from the earthquake day. Also, the maximum particle count rate recorded on the day of the December 6 earthquake was found to be significantly higher as compared to the January 3 earthquake. A decisive factor behind such phenomena could be the difference in ground conductivity of land and ocean surface.

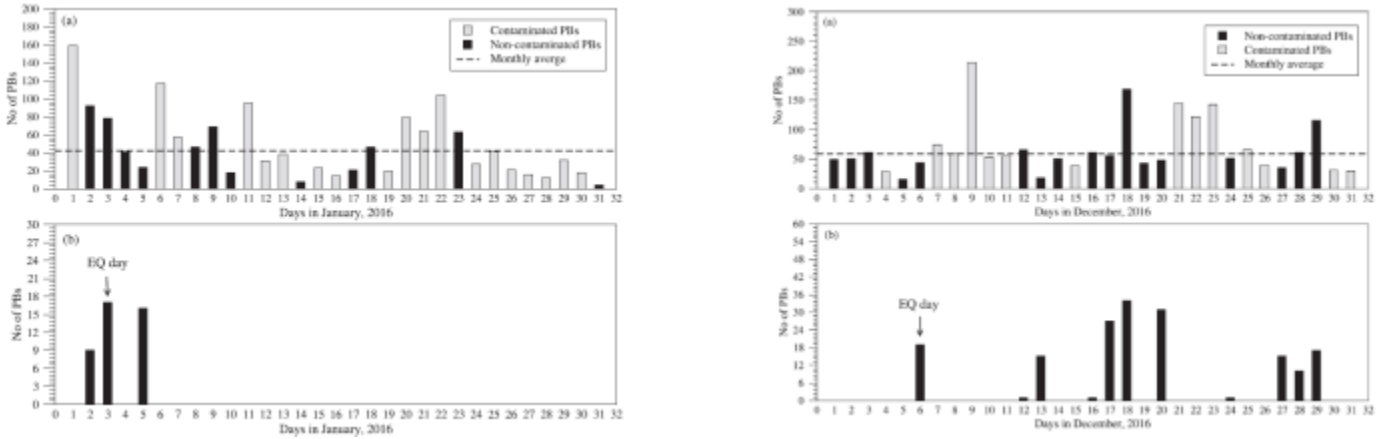


Fig. 11: Variation of energetic particle bursts associated with January 3, 2016 (land earthquake, Left) and December 6, 2016 (ocean earthquake, Right) as recorded from LEO satellite.

Study of Ionospheric Total Electron Content

Total Electron Contents (TECs) of the earth's ionosphere is defined as the total number of free thermal electron in a unit area along a path between radio transmitter and receiver. As the ionospheric F-layer has the most populated region of electrons, TEC is mostly measured from 150 to 450 km in the quanta of $10^{16}$to 10^{19}electrons per m^2. Global Positioning System (GPS), which generally uses dual-frequency radio signals, is the main system to estimate the TEC. The International GNSS Service (IGS) is the open source of TEC data available globally to compute spatio-temporal profile of Vertical TEC (VTEC) using specialized algorithm. A new algorithm is developed to compute the VTEC variation and it has been tested for Solar flares, geomagnetic storm and seismic events.

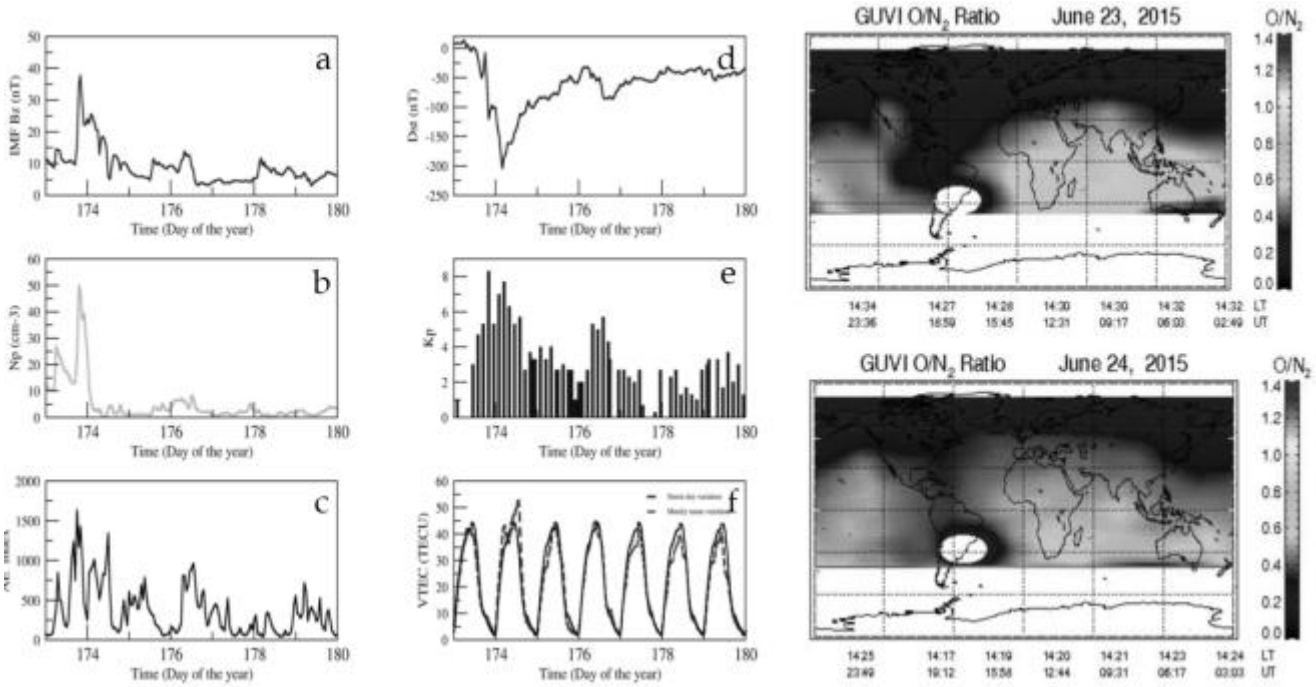
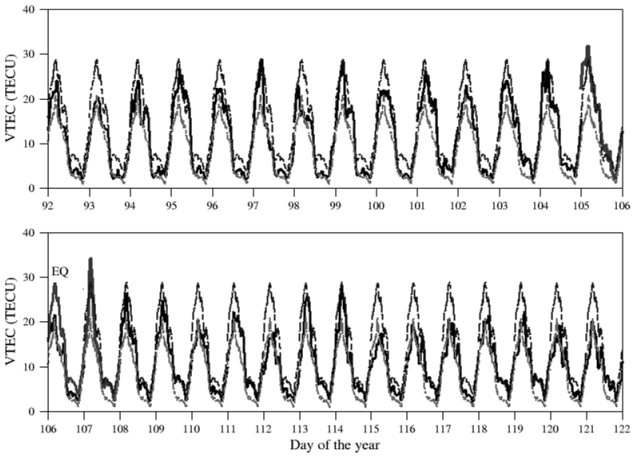


Fig. 12: The variation of geomagnetic storm indices with the enhancement of TEC.

To study the variation of TEC (as computed from IGS station Bangalore) with other solar activity indices, a geomagnetic storm was chosen which occurred on 23rd June 2015. The minimum Dst for the storm is -204 nT on 4:00 UT (9:30 IST). The variation of (a) interplanetary magnetic field (Bz), (b) proton density (N), (c) planetary index (Kp), (d) auroral index (AU), (e) disturbance storm index (Dst) and (f) TEC are shown in the Figure 2 during the storm period 22nd to 27th June, 2005. There is an enhancement of TEC on the storm day such as the other parameter. As there is depletion of TEC during the recovery period of Dst, the storm is treated as a negative storm. This can be verified with the sharp depletion in the thermo-ionospheric [O/N_2] ratio as observed by TIMED/GUVIon the next day of the storm.

A strong earthquake occurred in Kumamoto, Japan ((32.793^0 N, 130.749^0 E) on 15th April 2016 (Day of the year-106) at 16:25 UT (16th April, 1:25 JST) with a magnitude of M = 7.0. To study the variation of TEC, an IGS station AIRA (31.82406 ^{0} N, 130.5996 ^{0} E) has been chosen in Japan which is situated at a distance of 190 km from the epicenter. A 30 days period of VTEC observation has been conducted (Figure 13). There is a significant increment in VTEC on the earthquake day with respect to the Upper bound and Lower bound TEC anomaly on the 105th and 108thday. The first increase is due to the major shock of 15th April followed by several aftershocks till 18th April, 2016.



Pre-Seismic Thermal Anomalies

Thermal excitation is one of the major channels of the Lithosphere-Atmosphere-Ionosphere Coupling (LAIC) mechanism. According to LAIC, Radon, which is the primary source of air ionization in near surface, is found to increase from active faults and cracks in seismically active areas before large earthquakes.

Fig. 13: Variation of VTEC during Kumamoto earthquake.

The ion generated from this ionization coagulates with water molecules present in the atmosphere resulting in drastic change in air temperature and relative humidity. Attachment of water molecules to the newly formed ions increase the surface latent heat flux (SLHF). This increment in latent heat is observed through various remote sensing satellite as well as in many ground-based measurements which measures surface air temperature and other atmospheric parameters. A satellite-based observation has been done using data from NOAA database where SLHF fluctuation was computed for the period of April 4 to April 27, 2016 by eliminating the average seasonal variation of SLHF for the year of 2016, 2017 and 2018. Figure 4 shows such variation of SLHF where it is clearly shown that there is a significant enhancement happened on April 11 followed by effects of aftershocks on April 16, 17 and 18, 2016. Slowly the effects die out from the epicentral region.

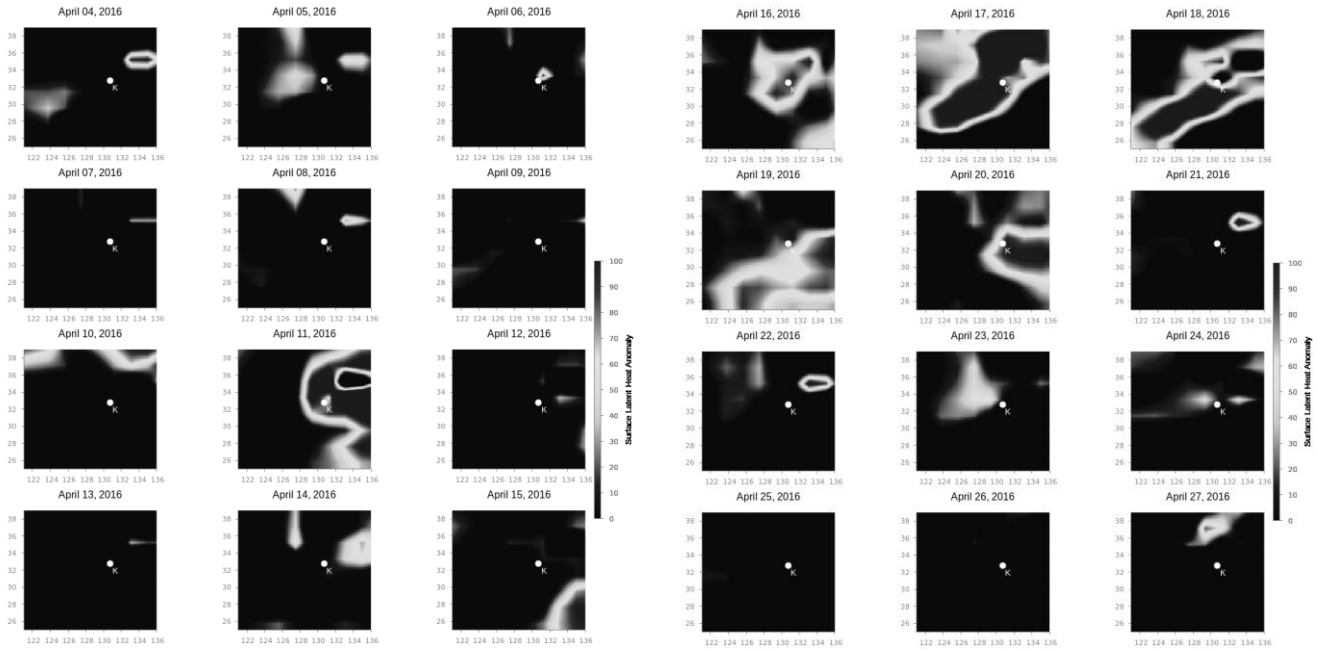


Fig. 14: Variation of Surface Latent Heat Flux (SLHF) during Kumamoto earthquake

Very Low Frequency Observation/Simulation

Sub-ionospheric Very Low Frequency signal suffers total internal reflection by Ionospheric D-layer and gets back to earth due to the critical frequency theory of refraction of electromagnetic wave. Numerical modeling of lower D-region ionosphere is rather difficult as the production and recombination processes of electron and ions are comparatively faster than other layers. Wait's two component model and Long Wave Propagation Capability (LWPC) is an excellent combined tool to model this VLF radio wave using two major ionospheric parameters viz. steepness parameter (β) and effective reflection height (h'). By computing the electron density profile using the IRI model, a database of such two parameters have been created for several baselines. By computing the log linear slope of electron density (β) from IRI and Wait's model the temporal and spatial distribution of β and h' over several paths are obtained. The diurnal VLF signal amplitude profile is simulated using the LWPC. Using the results of VLF campaign the first order simulation was done. Figure 15 shows the observed and simulated signal amplitude profile for VTX-Kolkata (W-type) and VTX-Pune (E type) signal amplitude profile.

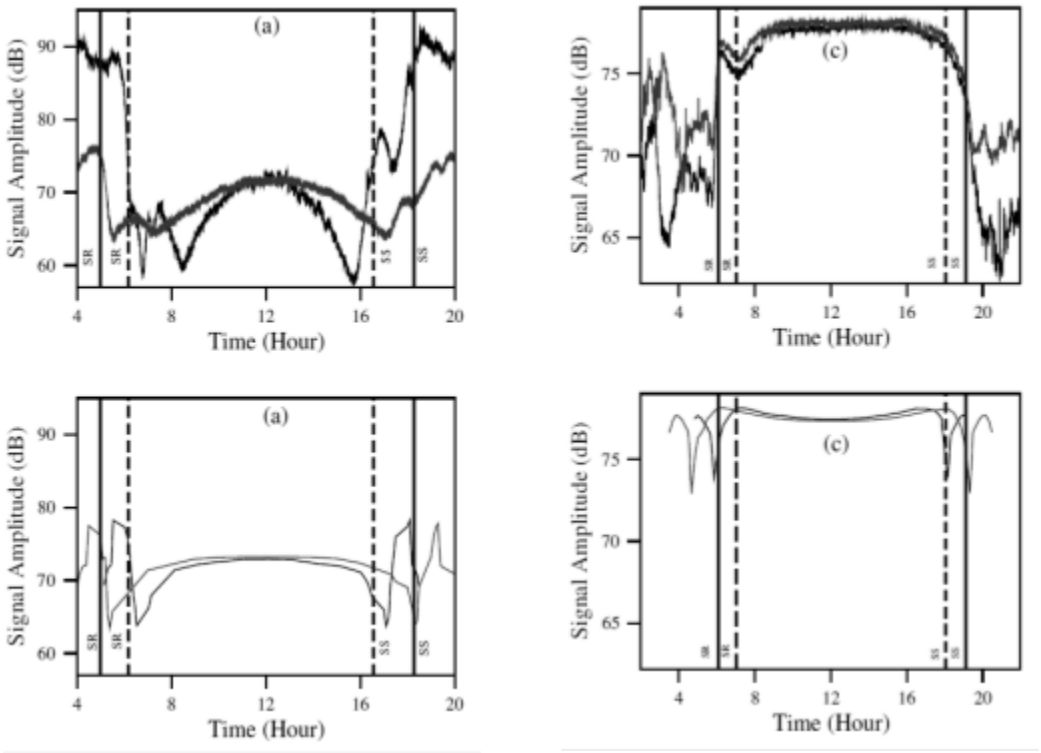
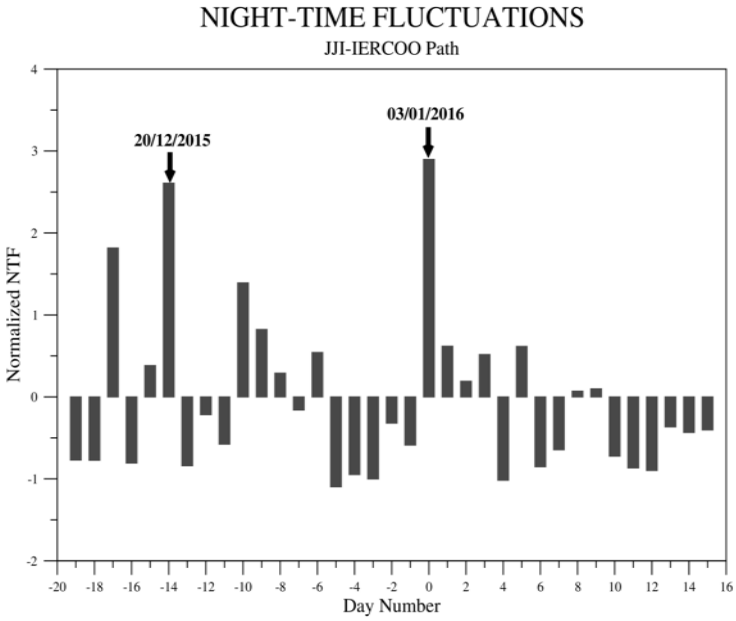


Fig. 15: Observed and simulated signal using IRI, Wait's model and LWPC for VTX-Kolkata (Left) and VTX-Pune (Right)

Just like VTEC, geomagnetic storm also excites the VLF radio signal amplitude fluctuations. For the LAIC mechanism one needs to eliminate the chances of contamination due to geomagnetic storm form the lower ionospheric irregularities. To exhibit such process, night time VLF signal amplitude fluctuation has been computed for the Imphal earthquake occurred on January 3, 2016. Coincidentally, two geomagnetic storms happened one in December 20, 2015 and another in January 1, 2016. The VLF amplitude shows significant increase for the JJI-IERCOO baseline which suppressed the seismogenic effects in VLF signal and the amplitude fluctuation is mainly due to the storms.

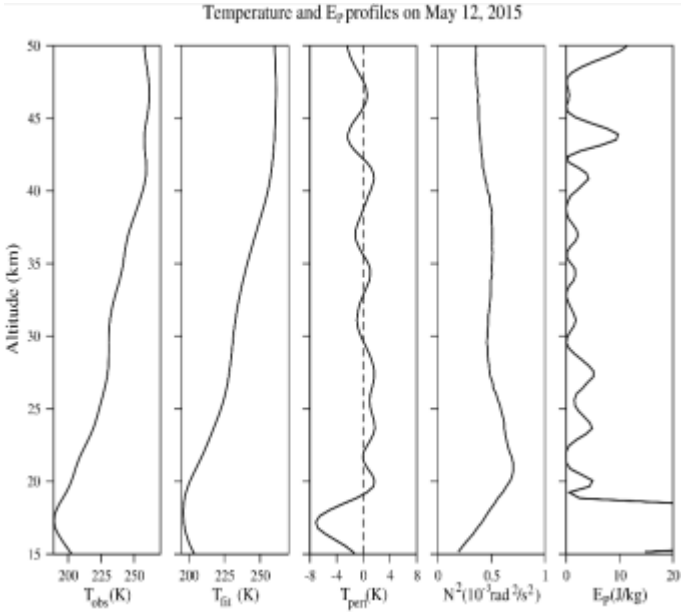


Study of Atmospheric Gravity Waves

Atmospheric Gravity Waves mainly transport the energy and momentum from the troposphere and circulate it in mesosphere and thermosphere. These transports have a great impact on the spatial and temporal characteristics of the middle and upper atmosphere.

Fig. 16: Nighttime VLF amplitude variation during geomagnetic storms

AGW can be studied from the Linear theory model and also from the parameterization of the effects of gravity wave. As the first procedure does not give significant results about the gravity waves, the scientists have chosen the second one. The frequency of the gravity wave spectrum lies between Coriolis frequency to the local Brunt–Väisälä frequency. Satellite observations revealed the global distributions of GWs in the middle atmosphere and their implications on the gravity waves in the thermosphere using the temperature profiles measured by the Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) instrument onboard the Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED) satellite.



AGW plays a major role in the LAIC mechanism to couple the lithospheric irregularities due to pressure generated waves to the mid-atmosphere. SABER/TIMED data are being analyzed by computing the potential energy (Ep) of the seismogenic gravity wave as computed from the altitude profile of temperature (T). Figure 17 shows the altitude variation of T and E_p for the Nepal earthquake. It is found that wavelike structure are generated having period from 45 to 60 minutes. This is also being verified with VLF data.

Fig. 17: Atmospheric Gravity Wave as computed from SABER/TIMED instrument.

Airglow/Ozone Depletion/Seismological effects



(L to R): S. K. Midya, R. Chattopadhyay, P. K. Jana

Airglow and Ozone depletion activities are led by Prof. S.K. Midya and his collaborators. The activity includes study of effects of solar parameters on the airglow emission lines. Other work includes study of variation of Ozone over India and Antarctica. Some works on different tropospheric phenomena, lightning activity, ionospheric phenomena and earthquake are done by this group.

The Ionospheric and Earthquake Research Centre and Optical Observatory (IERCOO)

(L to R, top):S.K. Chakrabarti, S. Sasmal, D. Bhowmick, R. Khan, S. Chakrabarty
(L to R, Middle):S. Ghosh, A.C. Sarkar, P. Sil, S. Sarkar

This year mainly extensive optical observations and the data processing were carried out. In photometry, a bright supernova SN2018ivc in M77 galaxy with the telescope Vashista (CDK24) using various filters. Searching variable sources in an open cluster and the stars from NSV catalog was done. Some objects were found to have short time periodicities. Further verification is needed. The spectra of Saturn and its ring system and the variation of tangential velocity with radial distance for the parent body and its ring system were studied as a test problem. The Ring nebula is being studied using the spectrometer. Several lectures and tutorial classes were conducted. The students published a Chapter in a Springer book and presented their results in an international conference in SNBNCBS, Kolkata. Some preliminary results on exoplanets were also presented in COSPAR at Pasadena. Students from department of ionospheric sciences continue to monitor real time VLF signals. Pre-seismic anomalies in thermal, acoustics and electromagnetic channels have been studied mainly from NOAA satellite observations. Students from Maharaja Manindra Chandra college visited IERCOO/ICSP and spent one night for optical observations. They have successfully completed a scientific project on Saturn's ring using the telescope. Construction of several buildings and the boundary wall is in progress in this campus.

Executive Committee of ionospheric and earthquake research centre, Sitapur, Paschim Medinipur

Prof. Sandip Kumar Chakrabarti *Chairman.*
Mr. Subrata Burai *Vice-Chairman.*
Dr. Sudipta Sasmal *Convener/Member Secretary.*
Mr. Debashis Bhowmick *Member.*
Mr. Rana Khan *Member.*

Activities of the Indian Centre for Space Physics, Malda Branch



(L to R): A. Chatterjee, Asit K. Choudhury, and Wasimul Bari

The Malda Branch of Indian Centre for Space Physics organized various types of scientific meetings since its inception. It has a VLF antenna and a receiver to continue their research on VLF sources and sudden atmospheric disturbances as well as lightning and earthquake. Some students are engaged in analysis of data obtained from IXAE and RXTE. Several scientific papers on class transitions, solar flare and earthquake have been published.

ICSP organized a Space Science Symposium at Ramkrishna Mission Vivekananda Vidyamandir, Malda on 29.04.2018. The speakers include Prof Sandip K Chakrabarti, Dr. Sudipta Sasmal, Dr. Achintya K Chatterjee and Dr. Asit K Choudhury from ICSP.

A Sky Watching Programme was organized at Gour Mahavidyalaya on 18.09.2018 by Achintya K Chatterjee and other ICSP members.

Asit K Choudhury, Washimul Bari and other ICSP members organized a sky watch programme on the roof of ICSP Malda Branch, Atul Market on 12.02.2019. About 100 students of different schools attended the programme.

This year the branch Secretary Mr. Asit K Choudhury received Ph.D degree from MAKAUT, in the convocation held on 02.11.2018 on his thesis entitled “Sources of High Energy Radiation and their effects on the Very Low Frequency (VLF) Radio Signals”.

Achintya K Chatterjee, President of ICSP Malda Branch, was invited to present scientific talks on the followings: 1 .Black Hole and Hawking Radiation – RKMVVM Malda & ICSP – 29.04.2018. 2. Chalo Pori Physics (Let’s read Physics) – SSM & RMSA Seminar at Malda Zilla School – 16.08.2018. 3.. “Rahasyamoy Biswabrahmanda” – RKMVVM 75 years celebration – 04.01.2019. 4. “Solar System” – 50 years of Naya Bazar High School - 22.01.2019. He also gave an oral presentation at Maghnath Saha

college on 18.03.2019 and also gave a talk at Gangarampore college on 19.03.2019. Asit K. Choudhury, Secretary of ICSP Malda Branch presented a talk on 'Unusual Precursory Behaviour of VLF signal parameters Before Devastating Nepal Earthquake, 25th April, 2015' at Exploring the Universe: Near Earth Space Science to Extra-Galactic Astronomy in Nov. 2018; 'Mistery of Comets & Meteorites' in a Space Science Symposium at Ramkrishna Mission Vivekananda Vidyamandir, Malda on 29.04.2018.

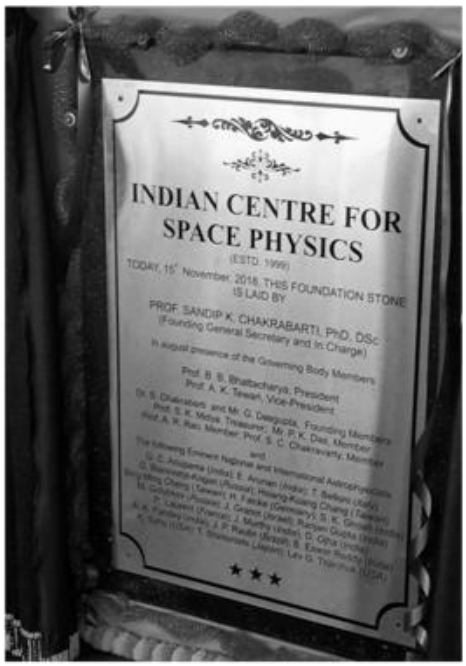
Corresponding Address for Malda branch:

Dr. A.K. Chatterjee/ Mr. A. K. Choudhury/ Mr. S. Das
Indian Centre for Space Physics, Malda Branch, Atul Market, Malda, 732101.

Co-ordinating Body of the Malda Branch of the Centre

Dr. Achintya K. Chatterjee, *President*
Mr. Asit K. Choudhury, *Secretary*
Mr. Zahirul Islam, *Member*
Dr. Ankur Sensharma, *Member*
Mr. Prithwiraj Sarkar, *Member*
Mr. Nilmadhab Nandi, *Member*
Mr. Kankar Bandopadhyay, *Vice President*
Mr. Subhankar Das, *Treasurer*
Mr. Gobinda Chandra Mandal, *Member*
Ms. Tamali Chatterjee, *Member*
Mrs. Sutapa Chatterjee, *Member*
Mr. Utpal Chatterjee, *Member*

Activities at the New Campus on EM Bypass



Snapshots from the upcoming Integrated campus on the Eastern Bypass. S.K. Chakrabarti performing rituals before the Foundation stone is unveiled in presence of worldwide eminent scientists and Governing Body members. Various stages of the construction activity of underground 146 no. piles and a section of the upcoming building in the first phase.

Office Staff at the Head quarter and Eastern By-pass campus

Mr. Rajkumar Maiti
(Asst. Administrative officer)

Mr.Jyotisman Moitra
(Computer Assistant)

Mr. Ram Chandra Das
(Office Assistant)

Mr. Uttam Sardar
(Office Helper)

Mr. Parimal Das
(Security)

Independent Auditors' Report

To
The Members of
Indian Centre for Space Physics

Report on the Audit of the Financial Statements

Opinion
We have audited the accompanying Financial Statements of **Indian Centre for Space Physics** ("the Institute"), which comprises the Balance Sheet as at 31st March, 2019, and the Statement of Income and Expenditure and the Cash Flow Statement for the year then ended, and notes to the financial statements, including a summary of significant accounting policies and other explanatory information.

In our opinion and to the best of our information and according to the explanations given to us, the aforesaid financial statements give the information required by the Companies Act, 2013("the Act") in the manner so required and give a true and fair view in conformity with the accounting standards prescribed under section 133 of the Act read with Rule 7 of the Companies (Accounts)Rules, 2014 (as amended from time to time('the AS') and other accounting principles generally accepted in India('the Indian GAAP'), of the state of affairs of the Institute as at 31st March, 2019 and its surplus and cash flows for the year ended on that date.

Basis for Opinion
We conducted our audit of the financial statements in accordance with the Standards on Auditing (SAs) specified under Section 143 of the Act. Our responsibilities under those Standards are further described in the "***Auditors' Responsibilities for the Audit of the Financial Statements***" section of our report. We are independent of the Institute in accordance with the Code of Ethics issued by the Institute of Chartered Accountants of India together with the independence requirements that are relevant to our audit of the financial statements under the provisions of the Act and the Rules there under, and we have fulfilled our other ethical responsibilities in accordance with these requirements and the Code of Ethics. We believe that the audit evidences we have obtained are sufficient and appropriate to provide a basis for our opinion on the financial statements.

Key Audit Matters
Key audit matters are those matters that, in our professional judgment, were of most significance in our audit of the financial statements of the current period. These matters were addressed in the context of our audit of the financial statements as a whole, and in forming our opinion thereon, and we do not provide a separate opinion on these matters.

Information Other than Financial Statements and Auditor's Report Thereon
The Institute's Board of Directors is responsible for the preparation of the other information. The other information comprises the information included in the Board's Report including Annexure to Board's Report, but does not include the financial statements and our auditors' report thereon.

Our opinion on the financial statements does not cover the other information and we do not express any form of assurance or conclusion thereon. In connection with our audit of the financial statements, our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial statements or other information obtained during the course of our audit or otherwise appears to be materially misstated.

If, based on the work we have performed, we conclude that there is a material misstatement of this other information; we are required to report that fact. We have nothing to report in this regard.

Management's Responsibility for the Financial Statements
The Institute's Board of Directors is responsible for the matters stated in section 134(5) of the Act with respect to the preparation of these financial statements that give a true and fair view of the financial position, financial performance and cash flows of the Institute in accordance with the AS and the Indian GAAP., This responsibility also includes maintenance of adequate accounting records in accordance with the provisions of the Act for safeguarding of the assets of the Institute and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the

preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, the Board of Directors is responsible for assessing the Institute's ability to continue as going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the board of Directors either intends to liquidate the Institute or to cease operations, or has no realistic alternatives but to do so.

The Board of Directors is responsible for overseeing the Institute's financial reporting process.

Auditors' Responsibility for the Audit of the Financial Statement

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditors' report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatement can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of user taken on the basis of these financial statements.

As part of an audit in accordance with SAs, we exercise professional judgment and maintain professional skepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for my opinion. The risks of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.

- Obtain an understanding of internal financial controls relevant to the audit in order to design audit procedures that are appropriate in the circumstances, *but not for the purpose of expressing an opinion on whether the Institute has in place an adequate internal financial controls with reference to financial statements and the operating effectiveness of such controls.*

- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by management.

- Conclude on the appropriateness of management's use of the going concern basis of accounting and based on the audit evidence obtained, whether a material uncertainly exists related to events or conditions that may cast significant doubt on the Institute's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the Institute to cease to continue as a going concern.

- Evaluate the overall presentations, structure and content of the financial statements, including the disclosures, and whether the financial statement represent the underlying transactions and events in a manner the achieves fair presentation.

Materiality is the magnitude of misstatements in the financial statements that, individually or in aggregate, makes it probable that the economic decisions of a reasonably knowledgeable user of the financial statements may be influenced. We consider quantitative materiality and qualitative factors in (i) planning the scope of my audit work and evaluating the results of my work; and (ii) to evaluate the effect of any identified misstatements in the financial statements.

We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during my audit.

We also provide those charged with governance with a statement that we have complied with relevant ethical requirements regarding independence, and to communicate with them all relationships and other matters that may reasonably be thought to bear on our independence, and where applicable, related safeguards.

From the matters communicated with those charged with governance, we determine those matters that were of most significance in the audit of the financial statements of the current period and are therefore the key audit matters. We describe these matters in my auditor's report unless law or regulation precludes public disclosure about the matter or when, in extremely rare circumstances, we determine that a matter should not be communicated in our report because the adverse consequences of doing so would reasonably be expected to outweigh the public interest benefits of such communications.

Report on Other Legal and Regulatory Requirements

1. This being a company licensed to operate under section 8 of the Act, therefore, the matters specified in paragraph 3 and 4 of Companies (Auditor's Report) Order, 2016 ("the Order"), issued by the Central Government of India in terms of sub-section (11) of Section 143 of the Act are not required to be reported.

2. As required by Section 143(3) of the Act, we report that:

   a) We have sought and obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purpose of our audit;

   b) In our opinion, proper books of account as required by law have been kept by the Institute so far as it appears from our examination of those books;

   c) The Balance Sheet, the Income and Expenditure Account and the Cash Flow Statement dealt with by this report are in agreement with the books of account;

   d) In our opinion, the aforesaid financial statements comply with the Accounting Standards specified under section 133 of the Act read with Rule 7 of the Companies (Accounts) Rules, 2014;

   e) On the basis of written representations received from the directors as on March 31, 2019 taken on record by the Board of Directors, none of the directors is disqualified as on March 31, 2019 from being appointed as director in terms of Section 164(2) of the Act;

   f) With respect to the adequacy of the internal financial controls over financial reporting of the Institute and the operating effectiveness of such controls, refer to our separate report in "**Annexure A**"; and

   g) With respect to the other matters to be included in the Auditor's Report in accordance with Rule 11 of the Companies (Audit and Auditors) Rules, 2014, in our opinion and to the best of our information and according to the explanations given to us:

      i. The Institute does not have any pending litigations which would impact its financial positions;

      ii. The Institute did not have any long-term contracts including derivative contracts for which there were any material foreseeable losses; and

      iii. There has been no amount required to be transferred to the Investor Education and Protection Fund by the Institute.

For SSKA & Associates
Chartered Accountants
FRN # 328751E

Jagdish Mohata, ACA
(*Partner*)
M. No. # 307910

Kolkata, the 27th day of September, 2019.

Annexure - A to the Independent Auditors' Report

(Referred to in paragraph (2)(f) under '**Report on Other Legal and Regulatory Requirements**' section of our Report of even date)

Report on the Internal Financial Controls under Clause (i) of Sub-section 3 of Section 143 of the Companies Act, 2013 ("the Act")

We have audited the internal financial controls over financial reporting of **Indian Centre for Space Physics** ("the Institute") as of 31st March, 2019 in conjunction with our audit of the financial statements of the Company for the year ended on that date.

Management's Responsibility for Internal Financial Controls

The Institute's management is responsible for establishing and maintaining internal financial controls based on the internal control over financial reporting criteria established by the Institute considering the essential components of internal control stated in the Guidance Note on Audit of Internal Financial Controls over Financial Reporting issued by the Institute of Chartered Accountants of India ('ICAI'). These responsibilities include the design, implementation and maintenance of adequate internal financial controls that were operating effectively for ensuring the orderly and efficient conduct of its business, including adherence to Institute's policies, the safeguarding of its assets, the prevention and detection of frauds and errors, the accuracy and completeness of the accounting records, and the timely preparation of reliable financial information, as required under the Act,

Auditors' Responsibility

Our responsibility is to express an opinion on the Institute's IFC based on our audit. We conducted our audit in accordance with the Guidance Note on Audit of Internal Financial Controls over Financial Reporting (the "Guidance Note") and the Standards on Auditing, issued by ICAI and deemed to be prescribed under section 143(10) of the Act, to the extent applicable to an audit of internal financial controls, both applicable to an audit of Internal Financial Controls and, both issued by the Institute of Chartered Accountants of India. Those Standards and the Guidance Note require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether adequate internal financial controls over financial reporting was established and maintained and if such controls operated effectively in all material respects.

Our audit involves performing procedures to obtain audit evidence about the adequacy of the IFC and their operating effectiveness. Our audit of IFC included obtaining an understanding of IFC with reference to these financial statements, assessing the risk that a material weakness exists, and testing and evaluating the design and operating effectiveness of internal control based on the assessed risk. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion on the Institute's IFC.

Meaning of Internal Financial Controls over Financial Reporting

A Institute's IFC with reference to Financial Statements is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A Institute's IFC includes those policies and procedures that –

(1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the Institute;

(2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the Institute are being made only in accordance with authorizations of management and directors of the Institute; and

(3) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the Institute assets that could have a material effect on the financial statements.

Inherent Limitations of Internal Financial Controls over Financial Reporting

Because of the inherent limitations of IFC, including the possibility of collusion or improper management override of controls, material misstatements due to error or fraud may occur and not be detected. Also, projections of any evaluation of the internal financial controls over financial reporting to future periods are subject to the risk that the IFC may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

Opinion

In our opinion, the Institute has, in all material respects, an adequate IFC and such IFC were operating effectively as at 31st March, 2019, based on the IFC criteria established by the Institute's considering the essential components of internal control stated in the Guidance Note on Audit of Internal Financial Controls Over Financial Reporting" issued by the Institute of Chartered Accountants of India.

For SSKA & Associates
Chartered Accountants
FRN # 328751E

Jagdish Mohata, ACA
(*Partner*)
M. No. # 307910

Kolkata, the 27th day of September, 2019.

INDIAN CENTRE FOR SPACE PHYSICS

Balance Sheet as at 31st March, 2019

Funds and Liabilities	Note	As at 31st March 2019	As at 31st March 2018
		(Rs.)	(Rs.)
Capital Fund			
Life Membership Fees	**1**	23,000	23,000
Reserves and Surplus	**2**	30,074,236	17,942,154
		30,097,236	17,965,154
Current Liabilities	**3**	3,463,013	1,810,061
		3,463,013	1,810,061
Total		**33,560,249**	**19,775,215**
Assets			
Non-current Assets			
Fixed Assets	**4**		
Tangible		11,184,493	5,119,980
Intangible		23,220	46,445
Capital Work-in-Progress		8,051,150	5,581,657
		19,258,864	10,748,081
Current Assets			
Cash and Bank Balances	**5**	14,167,283	7,953,159
Short-term Loans and Advances	**6**	134,103	1,073,975
		14,301,386	9,027,134
Total		**33,560,249**	**19,775,215**
General Information	**12**		
Significant Accounting Policies	**13**		

As per our report of even date attached.
For SSKA & Associates
Chartered Accountants
FRN # 328751E

Jagdish Mohata, ACA
(Partner)
M. No. # 307910
Kolkata, 27th day of September, 2019.

For and on behalf of Board of Directors

Sd./- Sonali Chakraborty
(Honorary Secretary, Indian Centre for Space Physics)

Sd./- S. Middya
(Honorary Treasurer, Indian Centre for Space Physics)

Sd./- B.B. Bhattacharyya
(Honorary President, Indian Centre for Space Physics)

INDIAN CENTRE FOR SPACE PHYSICS

Statement of Income and Expenditure for the Year Ended 31st March, 2019

Particulars	Note	Year ended 31st March 2019 (Rs.)	Year ended 31st March 2018 (Rs.)
Grants and Other Incomes			
Grants Received	**7**	13,173,870	11,321,154
Other Income	**8**	1,453,300	649,676
		14,627,170	**11,970,830**
Expenditure			
Employee Benefits Expense	**9**	6,663,288	6,475,956
Other Expenses	**10**	6,909,230	5,032,759
		13,572,518	**11,508,715**
Tax Expense		-	-
Excess of Income over Expenditure for the year		**1,054,651**	**462,115**
Less: Depreciation & Amortisation Expenses		(486,824)	(1,439,691)
Add: Reserves Brought Forward		10,384,553	11,362,129
Reserve Carried to Balance Sheet		**10,952,380**	**10,384,553**
General Information	**12**		
Significant Accounting Policies	**13**		

As per our report of even date attached.

For SSKA & Associates

Chartered Accountants

FRN # 328751E

Jagdish Mohata, ACA

(Partner)

M. No. # 307910

Kolkata, 27th day of September, 2019.

For and on behalf of Board of Directors

Sd./- Sonali Chakraborty
(Honorary Secretary, Indian Centre for Space Physics)

Sd./- S. Middya
(Honorary Treasurer, Indian Centre for Space Physics)

Sd./- B.B. Bhattacharyya
(Honorary President, Indian Centre for Space Physics)

INDIAN CENTRE FOR SPACE PHYSICS

Cash Flow Statements for the year ended 31st March, 2019

	Year Ended March 31, 2019	Year Ended March 31, 2018
	(Rs.)	(Rs.)
A. Cash Flow from Operating Activities:		
Excess / (Short) of Income over Expenditure	567,827	(977,576)
Adjustment for:		
Depreciation	486,824	1,439,691
Operating Profit Before Working Capital Changes	1,054,651	462,115
Adjustment for:		
Current Assets	939,872	1,716,730
Current Liabilities and Provisions	1,652,953	(367,260)
Change in Working Capital	2,592,825	1,349,471
Cash Flow From Operations	3,647,476	1,811,586
Net Cash Generated by Operating Activities (A)	**3,647,476**	**1,811,586**
B. Cash Flow From Investing Activities		
(Purchase of Fixed Assets)	(6,528,114)	(2,056,890)
(Capital Advances)	(2,469,494)	(5,581,657)
(Investment in)/Maturity of Fixed Deposits	(4,814,721)	3,705,863
Cash Flow From Investing Activities (B)	**(13,812,328)**	**(3,932,683)**
C. Cash Flow From Financing Activities		
Corpus Fund Received	11,564,255	2,085,845
Cash Flow From Financing Activities (C)	**11,564,255**	**2,085,845**
D. Net Increase/(Decrease) in Cash and Cash Equivalents (A+B+C)	1,399,403	(35,252)
E. Opening Balance of Cash and Cash Equivalents	1,950,035	1,985,287
F. Closing Balance of Cash and Cash Equivalents (D+E)	**3,349,438**	**1,950,035**

Notes:

i. Cash and Cash Equivalents represents the amount as mentioned in Note 5 **'Cash and Cash Equivalents'.**

ii. All figures in brackets represent outflows.

As per our report of even date attached.
For SSKA & Associates

Chartered Accountants

FRN # 328751E

Jagdish Mohata, ACA

(Partner)

M. No. # 307910

Kolkata, 27th day of September, 2019.

Sd./- Sonali Chakraborty
(Honorary Secretary, Indian Centre for Space Physics)

Sd./- S. Middya
(Honorary Treasurer, Indian Centre for Space Physics)

Sd./- B.B. Bhattacharyya
(Honorary President, Indian Centre for Space Physics)

INDIAN CENTRE FOR SPACE PHYSICS

Notes to Financial Statements

Particulars		31.03.2019		31.03.2018
		(Rs.)		(Rs.)
Note-1				
Life Membership Fees				
Life Membership Fees [`500/- for Forty Six members]		23,000		23,000
		23,000		**23,000**
Note-2				
Reserves and Surplus				
Surplus		10,952,380		10,384,553
Corpus Fund (For purchase of Asset with Specific Direction)		5,471,756		5,471,756
Building Fund		9,990,986		-
Fund For Specific Purpose		3,659,114		2,085,845
		30,074,236		**17,942,154**
Note-3				
Current Liabilities				
Unutilised Grants		3,337,800		1,717,767
Other Payables				
Liabilities for Expenses		125,213		92,294
		3,463,013		**1,810,061**
Note-4				
Fixed Assets - Refer Next Page				
Note-5				
Cash & Bank Balances				
Cash & Cash Equivalents				
Cash in hand	4,870		19,448	
Axis Bank Ltd.	4,43,127		342,330	
Bandhan Bank Ltd.	946,208		1,574,608	
Union Bank of India	1,939,836		-	
Central Co-operative Bank Ltd.	15,397	3,349,438	13,649	1,950,035
Other Bank Balances				
Fixed Deposits with Banks		10,817,845		6,003,124
		14,167,283		**7,953,159**

Note-6

Short-term Loans and Advances

Security Deposits	5,100	5,100
Advance to Employees	11,500	11,500
Balance with Revenue Authorities	108,397	116,791
Grant Receivables	-	931,478
Advances recoverable in cash or in kind or for which the value to be received	9,106	9,106
	134,103	**1,073,975**

Note-7

Grant Received

Grant-in-Aid	13,173,870	11,321,154
	13,173,870	**11,321,154**

Note-8

Other Income

Guest House Rent	168,000	102,450
Interest on Fixed Deposits	517,227	514,343
Interest on Income Tax Refund	603	4,900
Interest on Bank Deposits	23,020	8,988
Grant for Overheads	647,450	-
Miscellaneous Income	97,000	18,995
	1,453,300	**649,676**

Note-9

Employee Benefits Expense

Salaries & Stipend	6,163,028	6,056,670
Contribution to Pension Fund	500,260	419,286
	6,663,288	**6,475,956**

Note-10

Other Expenses

Fund draw for Project Expenses	3,938,327	2,726,404
Office Expenses	2,010,164	1,363,388
Statutory Audit Fees	17,700	11,800
Other Services	-	2,360
Postage	6,930	730
Travelling & Conveyance	284,505	232,785
Telephone, Fax & Internet	85,090	84,934
Printing & Stationary		

	47,552	29,770
Professional Fees	38,540	61,986
Rent & Electricity	462,334	518,602
Miscellaneous Expenses	18,089	-
	6,909,230	**5,032,759**

Note-11

Details of Grants Received

Particulars		
CSIR PROJECT, Delhi	-	16,274
West Bengal Government	9,252,957	9,174,694
MoES, Delhi	-	-
DST-FTYS, Delhi	153,111	150,000
DST-SERB, Delhi *	2,180,000	600,000
ICTP, Italy	-	-
INSPIRE PROJECT, DELHI	2,396,640	1,185,186
ISRO Projects, Bangalore	1,566,000	195,000
GITA	55,987	1,041,100
Others	16,658	
Last Year Grant used thie year	1,537,767	
Less: Received at the end of the year, fully unutilised	(142,500)	(1,041,100)
Less: Grant for Overhead Expenses	(647,450)	-
Less: Unutilised Grants	(3,195,300)	-
	13,173,870	**11,321,154**

INDIAN CENTRE FOR SPACE PHYSICS

Notes to Financial Statements

Note 12
General Information

*"**Indian Centre for Space Physics***" **(CIN: U73100WB1999NPL090718),** is a public limited company ("Limited by Guarantee") licensed to operate under section under section 8 of the Companies Act, 2013 (originally known as under section 25 of the Companies Act, 1956) as "Not for Profit Company" and is presently engaged in development and research projects related to Space and Physics at its premises at **Chalantika 43, Garia Station Road, Kolkata - 700 084**.

Note 13
Significant Accounting Policies

(i) Basis of accounting & preparation of financial statements

The financial statements of the company have been prepared in accordance with the Generally Accepted Accounting Principle in India (Indian GAAP). The Company has prepared these financial statements to comply in all material respects with the accounting standards notified under Section 133 of the Companies Act, 2013 ('the Act'), read together with paragraph 7 of the Companies (Accounts) Rules, 2014. The financial statements have been prepared on accrual basis and under the historical cost convention.

(ii) Fixed Asset

Tangible Fixed Assets have been valued at cost plus other incidental expenses incurred in connection with acquisition thereof.

Intangible Fixed Assets have been valued at cost plus other incidental expenses incurred in connection with acquisition thereof.

(iii) Depreciation and Amortisation

Depreciation on Fixed Assets has been provided on Straight Line Method based on the useful life of tangible assets prescribed in schedule II to the Companies Act, 2013.

Amortisation on Intangible Fixed Assets has been provided by assuming the life of the asset is for 5 years.

(iv) Cash Flow Statement

Cash Flows are reported using the Indirect Method as set out in Accounting Standard - 3 : Cash Flow Statement, whereby profit before tax is adjusted for the effects of transactions of a non-cash nature, any deferrals or accruals of past or future operating cash receipts or payments and item of income or expenses associated with investing or financing flows. The Cash Flows from Operating, Investing and Financing activities of the Company are segregated based on the available information.

INDIAN CENTRE FOR SPACE PHYSICS

Notes to Financial Statements

(v) Revenue Recognition

The Company receives grants for its operation and running the projects from various State and Central Government funding agencies. Some International research organization fund is also received. The Company submits Utilization Certificate and Statement of Expenditure. The funds are recognised only when it is received. Grants received are recognized as income on receipt basis. All these funds are spent according to their earmarking. Funds originating from overhead, Guest House income, and Interests on fixed deposit are treated net income to the Company spent for its own development purpose.

(vi) Employees Benefits

As per provision laid out in Rules and By Laws approved by the Governing Body, it has several academic and non-academic staff members who are treated as regular members who enjoy benefits as Permanent members including structured salary and National Pension System (NPS). Semi-permanent employees enjoy NPS benefits and a certain annual salary increment but not structured salary. The rest are strictly taken on contractual basis, renewable after a period subject to their good performance. Being an Autonomous Body, the Governing Body decides the career advancement policy for the permanent and semi-permanent members. Career path of contractual members are governed by respective funding agencies. The provisions of Employees Provident Fund (EPF) are not applicable to the Company as they have less than twenty Staff members.

(vii) Earning per Share

The Company is a Section 8 "Not for Profit Company". It does not generate any income/revenue from its activities and is also limited by Guarantee. Therefore, the provisions of AS-20 are not applicable.

(viii) Provisions and Contingencies

The Company creates a provision when there is present obligation as a result of a past event that probably requires an outflow of resources and a reliable estimate can be made of the amount of the obligation. A disclosure for a contingent liability is made when there is a possible obligation that may, but probably will not, require an outflow of resources. When there is a possible obligation or a present obligation in respect of which the likelihood of outflow of resources is remote, no provision or disclosure is made.

(ix) No related party transactions have been entered into by the Company during the Current financial year.

(x) Previous years figures have been regrouped/reclassified wherever necessary to correspond with the current year's classification/disclosure.

INDIAN CENTRE FOR SPACE PHYSICS

Note to Financial Statements

Note-4 **Amount in Rs.**

Fixed Assets

Particulars	Gross Block				Depreciation				Net Block	
	As on 01.04.17	Addition during the year	Sale during the year	As on 31.03.18	As on 01.04.17	During the year	Adjusted on deletion	As on 31.03.18	As on 31.03.18	As on 31.03.17
Tangible										
Computers	1,978,428	36,712	-	2,015,140	1,665,350	201,978	-	1,867,328	147,812	313,078
Furniture	156,331	16,940	-	173,271	120,965	3,762	-	124,727	48,544	35,366
Office Equipment	108,396	724,746	-	833,142	65,058	13,986	-	79,044	754,098	43,338
Scientific Equipment	5,406,210	-	-	5,406,210	3,557,460	1,086,479	-	4,643,939	762,270	1,848,749
Telescope		5,739,215		5,739,215				-	5,739,215	-
Boundary Wall	1,338,020	-	-	1,338,020	312,319	55,500	-	367,819	970,201	1,025,701
Land * #	-	-	-	-	-	-	-	-	-	-
Expansion of laboratory	1,417,019	-	-	1,417,019	-	-	-	-	1,417,019	1,417,019
(Work-in-progress)						-			-	-
Development of land	308,380	-	-	308,380	-	-	-	-	308,380	308,380
Car	161,794	-	-	161,794	148,296	10,618	-	158,914	2,880	13,498
Books	76,045	-	-	76,045	76,045	-	-	76,045	-	-
Electrical Items	458,240	10,500	-	468,740	343,390	44,144	-	387,534	81,207	114,851
Current Year	**11,408,863**	**6,528,114**	**-**	**17,936,976**	**6,288,883**	**1,416,467**	**-**	**7,705,350**	**10,231,626**	**5,119,980**
Intangible										
Software	116,118		-	116,118	69,673	34,837	-	104,510	11,608	46,445
Current Year	**116,118**	**-**	**-**	**116,118**	**69,673**	**34,837**	**-**	**104,510**	**11,608**	**46,445**
Current Year Total	11,524,981	6,528,114	-	18,053,094	6,358,556	1,451,304	-	7,809,860	10,243,234	5,166,424
Previous Year Total	9,468,091	2,056,890	-	11,524,981	4,918,865	1,439,691	-	6,358,556	5,166,424	4,549,226

* On lease from Govt. of West Bengal (Approx. Area 0.41 acres in Kolkata). # 0.25 acres from private donation.

INDIAN CENTRE FOR SPACE PHYSICS

(CIN: U73100WB1999NPL090718)
43 Chalantika, Garia Station Road
Kolkata-700084, West Bengal
Email: root@csp.res.in
Phone: 033 24366003

BOARD'S REPORT

To
The Members of
INDIAN CENTRE FOR SPACE PHYSICS

Your Directors have great pleasure in presenting their **Twentieth Annual Report** together with the Audited Financial Statements of the Company for the year ended 31st March, 2019.

1 FINANCIAL SUMMARY

The Financial Results of the Company for the year under report are as under:

Particuars	**Current Year 31st March, 2019**	**Previous Year 31st March, 2018**
Grant Received	13,173,870	11,321,154
Other Income	1,453,300	649,676
Total Income	**14,627,170**	**11,970,830**
Employee Benefits Expenses	6,663,288	6,475,956
Other Expenses	6,909,230	5,032,759
Depreciation	486,824	1,439,691
	13,085,694	**10,069,024**
Excess of Income over Expenditure for the year	**1,541,476**	**1,901,806**

2 OPERATIONAL REVIEW

Grant received for specific purposes and for maintenance purposes for the year ended 31st March, 2019 aggregated to `**13,173,870/-** . The other income is `**14,53,300/-**. The Excess of Income over Expenditure for the year is ` **15,41,476/-**

3 DIVIDEND

As the company falls under the purview of Section 8 of the Companies Act 2013, therefore, It is not applicable.

4 MEMBERSHIP

During the year no new Life Members of the company are enrolled . The total Life Members as on 31st March, 2019 is 46 (Forty Six).

5 DEPOSITS

The Company has not accepted any deposits within the meaning of Section 73 to Section 76 of the Companies Act, 2013 and the Rules framed there under.

6 DIRECTORSHIP

A Appointment of Directors /Cessation of Directorship

Prof. Sandip Kumar Chakrabarti (DIN: 00683375) has resigned from the Board w.e.f. 01.12.2018. The Board placed on record its appreciation for the valuable services and guidance so provided during his tenure as Director of the Company..

B Appointment of Independent Director/Woman Director/Small Shareholder Director

The provisions relating to appointment of Independent Director or Woman Director or Small Shareholder's Director are not applicable to the Section-8 Company. Therefore, no such directors are appointed.

C Retirement by rotation

Since the company is a Section-8 Company the provision of retirement of Directors by rotation is not applicable.

7 DETAILS OF HOLDING, SUBSIDIARY, JOINT VENTURE OR ASSOCIATE COMPANIES

The Company does not have any holding, subsidiary, joint venture or an associate Company during the year or at the end of the financial year.

8 AUDITORS

A STATUTORY AUDITORS

The Members of the Company had, at its 15th Annual General Meeting ("AGM") held on 21st September, 2014, approved the appointment of **M/s. SSKA & Associates,** (**Firm Registration No. 328751E**) Chartered Accountants, Kolkata, as the Statutory Auditors of the Company. The board recommend the auditors to continue and offer them for reappointment for a further period of 5 years commencing from the conclusion of this annual general meeting till the conclusion of 20th Annual General Meeting. As required under Section 139 of the Companies Act, 2013, the Company has obtained a written consent from the Auditors to such continued appointment and also a certificate from them to the effect that their appointment, if approved, would be in accordance with the conditions prescribed under the Companies Act, 2013 and the rules made there under.

B SECRETARIAL AUDITORS

Secretarial Audit has been made mandatory only for bigger Companies. Section 204 of the Companies Act, 2013 has kept this company out of the purview of Secretarial Audit. Therefore, there is no requirement to appoint secretarial auditor.

C COST AUDITORS

Section 148 of the Companies Act, 2013 (read with Rules framed there under) kept the Company out of the purview of maintaining of cost records and cost audit. Therefore, the Company need not to appoint any cost auditor.

9 COMMENTS ON QUALIFICATION, RESERVATION OR ADVERSE REMARK OR DISCLAIMER MADE

The Auditors Report to the Members on the Accounts of the Company for the financial year ended 31st March, 2019, does not contain any qualification, reservation or adverse remark. Further, the observations made in the Auditor's report are self explanatory and therefore, do not call for any further explanations.

10 DETAILS PERTAINING TO NET WORTH OF THE COMPANY

The Net worth of the company at the beginning and at the end were `17,965,154/- and `3,00,97,236/- respectively , and hence increases by ` 12,132,082/-

11 REQUIREMENTS AS PER SECTION 134(3) OF THE COMPANIES ACT, 2013

A EXTRACT OF THE ANNUAL RETURN AS PER SECTION 92(3)

The extract of the Annual Return as on the Financial year ended 31st March, 2019 as provided under Section 92(3) of the Companies Act, 2013 in **Form MGT 9** is at **Annexure- I**.

B NUMBER OF MEETINGS OF THE BOARD OF DIRECTORS

During the Financial Year 2018-19, meetings of the Board of Directors of the Company were held, details of which are as follows:

Date of Meeting	Number of Directors Present
19/09/2018	9
17/11/2018	7
30/03/2019	6

C DIRECTORS' RESPONSIBILITY STATEMENT

Pursuant to the requirement clause (c) of sub-section (3) of Section 134 of the Companies Act, 2013, your Directors confirms that:

(a) In the preparation of the annual accounts for the year ended 31st March, 2019, the Company has followed the applicable accounting standards and there are no material departures from the same;

(b) The directors have selected such accounting policies and applied them consistently and made judgments and estimates that are reasonable and prudent so as to give a true and fair view of the state of affairs of the Company and of the surplus at the end of the financial year.

(c) The directors have taken proper and sufficient care for the maintenance of adequate accounting records in accordance with the provisions of this Act for safeguarding the assets of the Company and for preventing and detecting fraud and other irregularities;

(d) The directors have prepared the annual accounts on a going concern basis;

(e) The Company being unlisted, sub clause (e) section 134(5) of the Companies Act, 2013 pertaining to laying down internal financial controls, is not applicable to the Company; and

(f) The directors have devised proper systems to ensure compliance with the provisions of all applicable laws and that such systems were adequate and operating effectively.

D NOMINATION AND REMUNERATION POLICY

Since all the Directors are holding Honorary posts, therefore no such policy is required.

E PARTICULARS OF LOANS GIVEN, INVESTMENTS MADE, GUARANTEES GIVEN, AND SECURITIES PROVIDED UNDER SECTION 186 OF THE COMPANIES ACT, 2013

There are no such loans and guarantees given or investments made under section 186 by the company.

F PARTICULARS OF CONTRACTS OR ARRANGEMENTS WITH RELATED PARTIES REFERRED TO IN SECTION 188(1) OF THE COMPANIES ACT, 2013

There are no contracts or arrangements with related parties under section 188(1) by the company.

G THE STATE OF COMPANY'S AFFAIRS

The Company continues to operate within the purview of its Memorandum of Association and no ammendments were necessary. It's function has been normal.

H THE AMOUNTS, IF ANY, WHICH COMPANY PROPOSES TO BE CARRIED TO ANY RESERVES IN THE BALANCE SHEET

Corpus Fund of ` 13,650,100 received during the year for specific purpose from various recognised bodies for specific projects.

I MATERIAL CHANGES AND COMMITMENTS, IF ANY, AFFECTING THE FINANCIAL POSITION OF THE COMPANY WHICH HAVE OCCURRED BETWEEN THE END OF THE FINANCIAL YEAR OF THE COMPANY TO WHICH THE FINANCIAL STATEMENTS RELATE AND THE DATE OF THE REPORT

There are no changes and commitments, affecting the financial position of the Company between the end of financial year of the Company to which the financial statements relate and the date of the report.

J PARTICULARS OF EMPLOYEES

Total number of employees (Academic & Non-Academic) is : 31

K CONSERVATION OF ENERGY, TECHNOLOGY ABSORPTION, FOREIGN EXCHANGE EARNINGS AND OUTGO

Our company has partially implemented green energy policy. As a result there are Solar Pannels for generating power into office campuses.

L STATEMENT INDICATING DEVELOPMENT AND IMPLEMENTATION OF A RISK MANAGEMENT POLICY FOR THE COMPANY INCLUDING IDENTIFICATION THEREIN OF ELEMENTS OF RISK, IF ANY, WHICH IN THE OPINION OF THE BOARD MAY THREATEN THE EXISTENCE OF THE COMPANY

Not Applicable.

M DETAILS ABOUT THE POLICY DEVELOPED AND IMPLEMENTED BY THE COMPANY ON CORPORATE SOCIAL RESPONSIBILITY INITIATIVES TAKEN DURING THE YEAR

Not Applicable.

N STATEMENT INDICATING THE MANNER IN WHICH FORMAL ANNUAL EVALUATION HAS BEEN MADE BY THE BOARD OF ITS OWN PERFORMANCE AND THAT OF ITS COMMITTEES AND INDIVIDUAL DIRECTORS

Through Research Advisory Council and Governing Body meetings.

O THE DETAILS OF SIGNIFICANT AND MATERIAL ORDERS PASSED BY THE REGULATORS OR COURTS OR TRIBUNALS IMPACTING THE GOING CONCERN STATUS AND COMPANY'S OPERATIONS IN FUTURE

There are no orders passed by the regulators or courts or tribunals impacting the going concern status and Company's operations in future.

P DETAILS PERTAINING TO REMUNERATION AS PER RULE 5(1) OF THE COMPANIES (APPOINTMENT AND REMUNERATION OF MANAGERIAL PERSONNEL) RULES, 2014

As the Company is a Section 8 Company, Rule 5(1) of the Companies (Appointment and Remuneration of Managerial Personnel) Rules, 2014 is not applicable.

Q ADEQUACY OF INTERNAL FINANCIAL CONTROL WITH REFERENCE TO FINANCIAL STATEMENTS

The Board has adopted the policies and procedures for ensuring the orderly and efficient conduct of its business, including adherence to the Company's policies, the safeguarding of its assets, the prevention and detection of fraud and errors, the accuracy and completeness of the accounting records, and the timely preparation of reliable financial disclosures.

R DISCLOSURE UNDER THE SEXUAL HARRASSMENT OF WOMEN AT WORKPLACE (PREVENTION, PROHIBITION AND REDRESSAL) ACT, 2013

The Company is committed to provide a safe and conductive work environment to its women employees. During the year under review, no case of sexual harassment was reported.

12 <u>ACKNOWLEDGEMENT</u>

Your Directors place on record their appreciation for employees at all levels, who have contributed to the growth and performance of your Company. Your Directors also wish to place on record their appreciation for the members for their continued support. Your Directors also thank the Central and State Governments, and other statutory authorities and other bodies engaged in space and other projects like ISRO, DST etc for their continued support.

For and on behalf of the Board of Directors

SONALI CHAKRABARTI

Place: Kolkata *(Director)*

Date: The 27th day of September, 2019. **[DIN:00684937]**

Participants of EXUNIV-2018 sponsored by ICSP (Left). Prof. S. K, Chakrabarti with some of his present and past Ph.D. students (Right).

Felicitation of Prof. S. K. Chakrabarti on his 60th birthday at Science city (Left).A. Springer Book Authored by 50 students of Prof. Chakrabarti and edited by B. \Mukhopadhyay and S. Sasmal (Center) is being released by Prof. Genady Bishnovatyi-Kogan (Right).

Eminent scientists at the Foundation Stone laying ceremonyat the Integrated campus of ICSP on E.M. Bypass (Left). Prof. S. K. Chakrabarti teaching Project Students the basics of optical astronomy at IERCOO, Sitapur (Left). Project students and faculties at IERCOO workshop (Right).

Faculties of ICSP with their students at 42nd COSPAR, Pasadana (Left). VLF group discussion meeting at 42nd COSPAR (Right).

Dr. Ankan Das presenting a lecture at the First INYAS-Frontiers of Science (FoS) Brainstorming Meeting, hyderabad (Left). Dr. S. Sasmal with an M.Sc. Project student (Right).

ICSP new campus on E.M. Bypass under construction

Students' dining hall, IERCOO