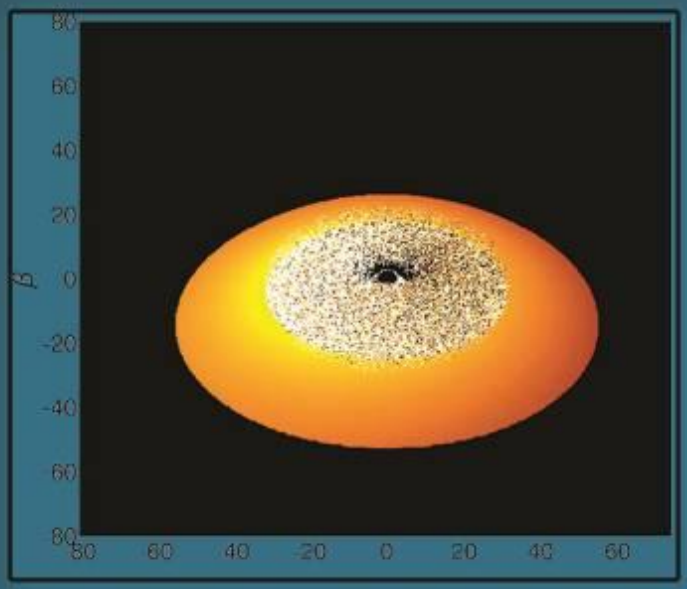
Annual Report (2015-2016)

Indian Centre for Space Physics



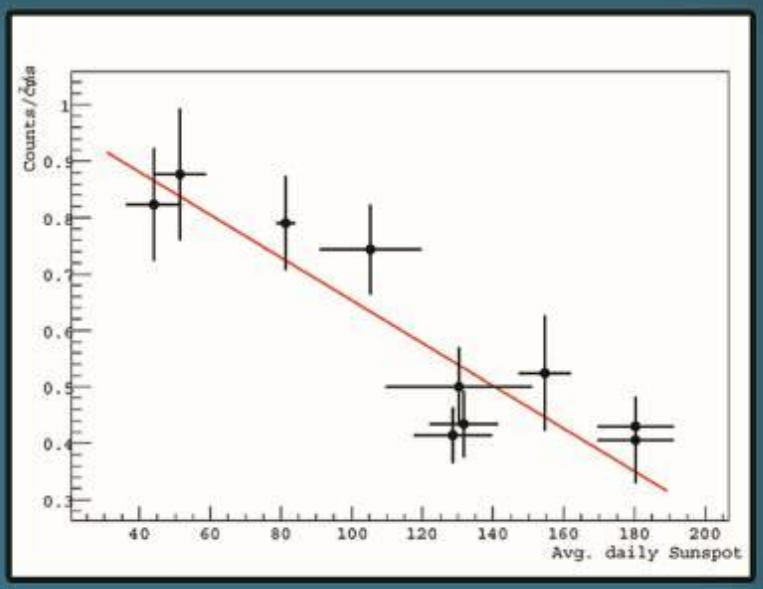
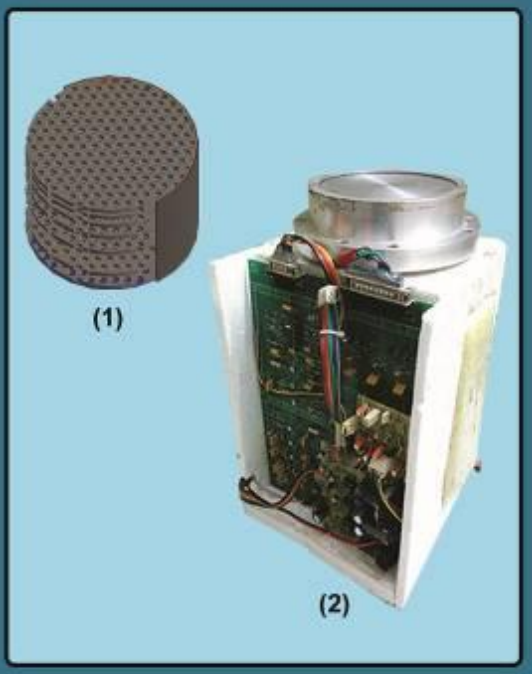
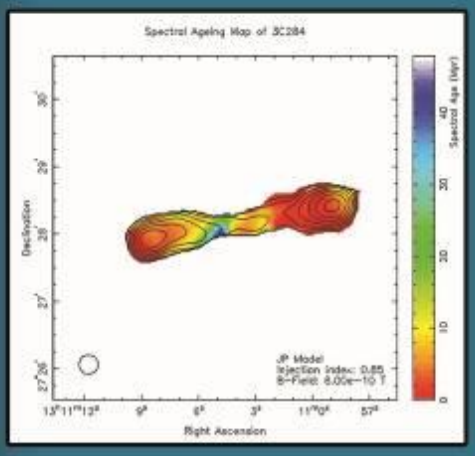
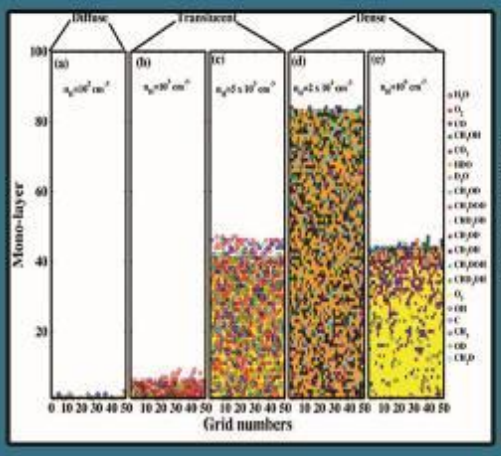


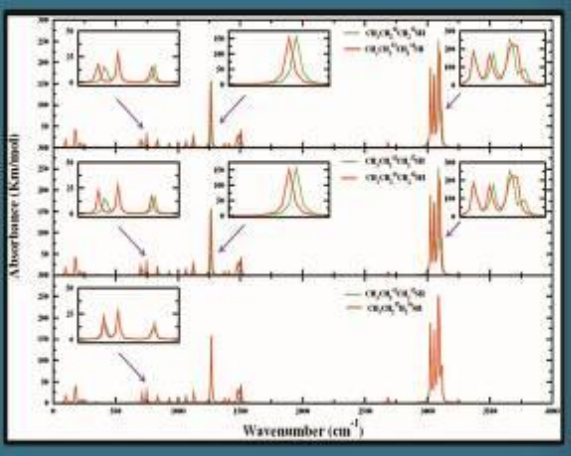
Image of a Two Component Accretion flow for radiation of emission seen from 50 Degree inclination angle (Left). Data from ICSP balloon missions during 2012 to 2016 showing anti-correlation between secondary cosmic ray counts at the Pfotzer maximum and the average daily sunspot number representing the solar activity (Right).



Balloon with payload after launch (Left). (1) Multilayer sieve collimator designed and built at ICSP for X- ray Detectors. (2) 5 inch diameter phoswich detector assembly for X-ray detection due to secondary cosmic rays and other extraterrestrial radiations onboard small balloon platform (Middle). ICSP scientist Dr. S. Sasmal who participated in the 35th Indian Scientific Expedition to Antarctica is standing in front of a couple of Electric Pole Antenna (Right).







Spectral Ageing Map of the Galaxy 3C284 in radio wave obtained from a GMRT observation (Left). Composition of grain mantle for various types of inter-stellar clouds (Middle). Isotopic variation of infrared spectra of 1-propanethiol as obtained by our simulation (Right).

INDIAN CENTRE FOR SPACE PHYSICS
ANNUAL REPORT
(2015-2016)

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Published by:
Indian Centre for Space Physics, Chalantika 43, Garia Station Road, Garia, Kolkata 700084

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Seminar Room: 24
Computer room: 25
Department of High Energy Radiation: 26
X-ray Laboratory: 27
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Front Cover: Images of activities of various Departments of ICSP. Top Left: Astrochemistry leading to origin of life; Top Right: Balloon borne science in near space of up to 42km; Middle Left: Very Low Frequency radiation detection and analysis of high energy phenomena; Middle Right: Black Hole Astrophysics. Middle Center: ICSP Head office; Bottom Left: IERC/ICSP in Medinipur (W); Bottom Right: New Campus gate on Eastern Bypas. **Back Cover:** Photographs taken by R. Khan using Meade 0.25m telescope of IERC/ICSP. Orion, Trifid, Lagoon, Horese-head nebulae and several galaxies including M51, M81, etc. could be seen. A picture of Venus transiting over sunspotted solar disk could be seen.

Report of the Governing Body

This is the Seventeenth Annual report of Indian Centre for Space Physics (ICSP). The Centre had a wonderful spell of academic activities in the year 2015-2016. ICSP pursued its goal to work in four niche areas to study all the aspects of the earth and its atmosphere, ionosphere, high energy astrophysics and Chemical evolutions of ISM etc.

In the field of astrobiology/astrochemistry our present scientists and past scholars are making their marks all over the world. Our past PhD student Dr. Kinsuk Acharyya, joined Physical Research Laboratory (PRL), Ahmedabad as a faculty and another PhD student D. Sahu joined PRL as a Post-doctoral fellow. Dr. L. Majumdar who had been our PhD student is doing exceptionally well while working at University of Bordeaux, France. Our leadership produced work on detection of precursors of pre-biotic molecules.

In the low-cost balloon programme, ICSP is recognized as a pioneer worldwide. This year, we also successfully sent a five inch diameter Phoswich X-ray detector to 41km height using a TIFR made polythene weather balloon. It brought very valuable data on cosmic rays, solar activities and pulsars. By combining our few years of results we see a clear trend of anti-correlation between the solar activity and the cosmic ray counts. We perfected a method by which even without pointing at a cosmic source we can isolate the photons emitted from it. We have applied for three patents in technological developments in this period.

In high energy Astrophysics division, we achieved a major success by estimating the masses of several black holes in binary systems using our theoretical model. We found evidences of very relativistic flows just outside the horizon where a line emission from iron atom is split into two in seven MAXI satellite discovered black hole candidates, we determined variation of flow parameters and spectral parameters in four of them. Our work also gives a very accurate estimation of the viscosity parameter in the accretion flow.

The ionospheric and earthquake research centre (IERC) at Sitapur was readied to include a roll-off roof facility to install 0.25m and 0.5m class telescopes. The guest rooms can accommodate about twenty students willing to engage in star watching and other study tour and thus would be a great facility of the State in future. In the past year, we have carried out a multi-receiver campaign to detect the VLF radio signal from Kolkata, Sitapur, Malda, Kochbeher, Agartala and Shillong during a solar eclipse in March, 2016. Dr. S. Sasmal who has been recently inducted as a faculty has obtained many important results in his Antarctica trip during December, 2015 to March, 2016. Dr. T. Basak and Dr. S. Pal joined our Centre as Project scientists, after having completed their tenures at Univ. of Electro-communications, Tokyo.

S.K. Maji and D. Sahu have submitted their Thesis. Dr. Santanu Mondal, our PhD student has joined University of Valparaiso, Chile. ICSP is grateful to International Centre for Theoretical Physics for support of a Ph.D. student from Nepal. S. Nagarkoti has successfully completed his second year of tenure at ICSP and became an SRF. The Government of West Bengal and the Central Government funding agencies, such as MoES, DST, ISRO and CSIR have been funding various projects and fellowships at ICSP. We sincerely thank them. I thank the ICSP office for timely compilation of the annual and Audit reports.

Prof. S.K. Chakrabarti, Honorary General Secretary
Indian Centre for Space Physics Kolkata: September 29, 2016

Governing Body (GB) of the Centre

Prof. B.B. Bhattacharyya, President
Prof. Sandip K. Chakrabarti, Secretary
Prof. S. Midya, Treasurer
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Dr. Sonali Chakrabarti, Member

Recommended Members of the Research Advisory Council (RAC)

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Prof. A. R. Rao, Tata Institute of Fundamental Research, Mumbai
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Secretary, State Council of Higher Education (ex-officio)
Prof. Ranjan Gupta, IUCAA, Member

Academic Council Members

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Dr. Dipak Debnath
Dr. Sujay Pal
Mr. Rajkumar Maiti (non-Member Secretary)
Dr. Ankan Das (Convenor)
Dr. Sabyasachi Pal
Mr. Debashis Bhowmick

In-Charge, Academic Affairs (Honorary)

Prof. Sandip K. Chakrabarti (Tel. : +91 33 24366003,
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Dr. Ankan Das (Tel. : +91 33 24366003 Extn: 22,
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Dr. Dipak Debnath (Tel.: +91 33 24366003 Extn: 26,
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Public Information Officer

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

In Charge of the Departments

Dr. Ankan Das	Astrochemistry / Astrobiology
Dr. Dipak Debnath	High Energy Astrophysics
Dr. Sujay Pal	Ionospheric Science
Mr. Debashis Bhowmick	Instrumentation for Space Exploration

Regular Faculty Members

Dr. Ankan Das	Assistant Professor-II
Dr. Dipak Debnath	Assistant Professor
Dr. Ritabrata Sarkar	Assistant Professor

Honorary Faculty Members

Dr. B. B. Bhattacharyya, Ex-ISM, Dhanbad	Emeritus Professor
Dr. S. K. Chakrabarti, SNBNCBS	In-Charge, Academic Affairs
Dr. S. Chakrabarti, M. M. Chandra College	Assoc. 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
Dr. 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

Project Scientists

Dr. Sabyasachi Pal (MoES) Dr. Sourav Palit (MoES) Dr. Sudipta Sasmal (MoES)
Dr. Partha Sarathi Pal (MoES)

Post Doctoral Fellow

Dr. Santanu Mondal (MoES) Dr. Sujay Pal (MoES)

Senior Research Fellows

Mr. Arka Chatterjee (MoES) Mr. Dipen Sahu (MoES) Mr. Dusmanta Patra (MoES)

Md. Aslam Ali Molla (MoES) Mr. Suman Chakraborty (MoES)

Junior Research Fellows

Mr. Arghajit Jana (ISRO) Mr. Prasanta Gorai (DST) Mr. Debjit Chatterjee (DST)

ICTP Junior Research Fellow

Mr. Shreeram Nagarkati (ICTP)

Visiting Research Fellows

Mr. Asit K. Choudhury Mr. Washimul Bari Mr. Amit Chowdhury
Mr. Surya K. Maji Mr. Dipak Sanki Mr. Sanjay Adak
Mr. Tilak B. Katoch Mr. Bakul Das

Part Time Research Scholars

Mr. Soujan Ghosh Mr. Milan Sil

Engineers / Laboratory Staff

Mr. Debashis Bhowmick	Hardware Engineer
Mr. Subhankar Chakraborty	Junior Engineer
Mr. Susanta Middya	Technical Assistant (MoES)
Mr. Arnab Bhattacharya	Junior Engineer
Mr. Hriday Roy	Laboratory Assistant
Mr. Samir Bhowmick	Technical Assistant (MoES)

Office Staff

Mr. Rajkumar Maiti	Accountant/ Office Assistant
Mr. Jyotisman Moitra	Computer Assistant
Mr. Ram Chandra Das	Office Attendant
Mr. Uttam Sardar	Office Helper

Security Staff

Mr. Barun Chakraborty

Research Facilities at the Head Quarter

Library: The library has well cataloged journals and conference proceedings in Astronomy, Astrophysics and Space sciences and an excellent collection of text books.

Internet: The Centre has dedicated lease-line internet with csp.res.in domain.

Computers: The Centre has modern high-speed computers and several servers which are connected through LAN/Wi-Fi and through the lease-line Internet.

Seminar room: The seminar room at ICSP is well equipped with modern amenities and wireless Internet.

Guest house: This facility is to provide lodging for residential scientists and visitors to stay overnight.

Laboratories: X-ray and VLF laboratories equipped with PCB making instrument, vacuum chamber, uninterrupted power supply and solar panels. Payloads for Balloon flights are fabricated and tested in this laboratory.

Facilities at other branches of the Centre:

IERC 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 computing and internet facilities, VLF antennas and receivers, small Radio Dish antenna; 0.25m Meade Optical Telescope. A 0.61m class telescope is being installed soon. It has a guest house to accommodate 20 students for skywatching and optical observations. Solar power for electricity and submersible pump for water supply keep this remote Centre running round the clock.

Balloon Facility at Bolpur, Birbhum: This Centre 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.

ICSP branch at English Bazar, Malda: 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.

Antenna at Kochbehar: This antenna is used to receive VLF data from transmitters around the globe.

ICSP new campus: Building of the new campus is planned in the land procured on lease on the Eastern Bypass.

Brief Profiles of the Scientists of the Centre

Dr. Achintya K. Chatterjee: He is the 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 Junior Research Fellow and is working in X-ray Astronomy.

Mr. Arka Chatterjee: He is an MoES project Senior Research Fellow in Black Hole Astrophysics. He is working on 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.

Mr. Asit Kumar Choudhury: He is an Asst. Teacher at the L.M.S.M. Institution, Malda and is an honorary Senior Research Fellow of ICSP. 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.

Md. Aslam Ali Molla: He is a Senior Research Fellow working in an MoES sponsored project. He is working on observational studies on Black Hole properties in X-Ray energy band.

Mr. Bakul Das: He is an Asst. Teacher at Kalimpong Govt. High School and is a part time visiting research fellow. He works on VLF signal and Earthquake correlational studies.

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 Parganas 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 a hardware engineer 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 First track Project Research Scholar and is working on theoretical studies in High energy astrophysics as a Junior Research Fellow.

Dr. Dipak Debnath: He is an Assistant Professor 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. Dipen Sahu: He is an MoES project Senior Research Fellow in Astrochemistry/ Astrobiology. He is working on deuterated species formation in star forming regions.

Mr. Dusmanta Patra: He is an MoES project Senior Research Fellow in Radio Astronomy and is working on Spectral ageing analysis of Giant radio galaxies using Very Large Array and Giant Meterwave 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.

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.

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 Junior Research Scholar in Astrochemistry/ Astrobiology and is working on the formation of various complex molecules in star forming regions.

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 with IERC Optical Telescope.

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.

Prof. S. K. Midya: He is a Professor and 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 a Project Scientist at ICSP. He is working on search for 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 a Senior Professor and HoD, Astrophysics & Cosmology of S.N. Bose National Centre for Basic Sciences and In-Charge of Academic activities and the General Secretary 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 balloon borne studies; ionospheric perturbations due to terrestrial and extra-terrestrial phenomena and their effects on VLF radio waves; Chemical Evolution of star forming regions.

Dr. Santanu Mondal: He is an MoES Post Doctoral Fellow. He is doing his research on effects of Comptonization on the properties of transonic accretion flows around Black Holes and satellite data analysis.

Dr. Sonali Chakrabarti: She is an Associate Professor at the Maharaja Manindra Chandra College and an honorary Associate 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.

Mr. Soujan Ghosh: He is a Part time Research Scholar working at IERC/Sitapur. He works on VLF radio data and its analysis.

Dr. Sourav Palit: He is an MoES Project Scientist at ICSP. He is involved in GEANT-4 simulations of solar-terrestrial interactions and interpretation of VLF data.

Mr. Sreeram Nagarkoti: He is an ICTP supported Junior Research Fellow. He is working on computation of effects of viscosity on outflow rates from accretion disks around black holes.

Dr. Sudipta Sasmal: He is an MoES Project Scientist working at ICSP. He is working on the study of earthquake precursors using VLF data. He is visiting Antarctica for data acquisition.

Dr. Sujay Pal: He is an MoES Post Doctoral Fellow at ICSP. He is involved in theoretical studies of various ionospheric disturbances through propagation of LF/VLF/ELF signal within the Earth-ionosphere wave-guide and its connection to Space-Weather phenomena and Earthquakes.

Mr. Suman Chakraborty: He is a Senior Research Fellow working under MoES project. He is working on LEP events, generation of AGW during Solar eclipse and CTIP Model.

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

Mr. Surya Maji: He is an Asst. Teaching in a School in W. Medinipur. He has submitted his Ph.D. thesis. He works on the effects of eclipse on VLF signals.

Dr. Sushanta K. Mondal: He is an honorary scientist of ICSP. He is an Assistant Professor at S.K.B.M. University, Purulia.

Dr. Tilak B. Katoch: He is an honorary Senior Research Fellow (SRF) and is working on the observation of solar flares by RT-2 satellite and X-rays sources by LAXPC instruments. He is a Scientist in X-ray Astronomy group of TIFR.

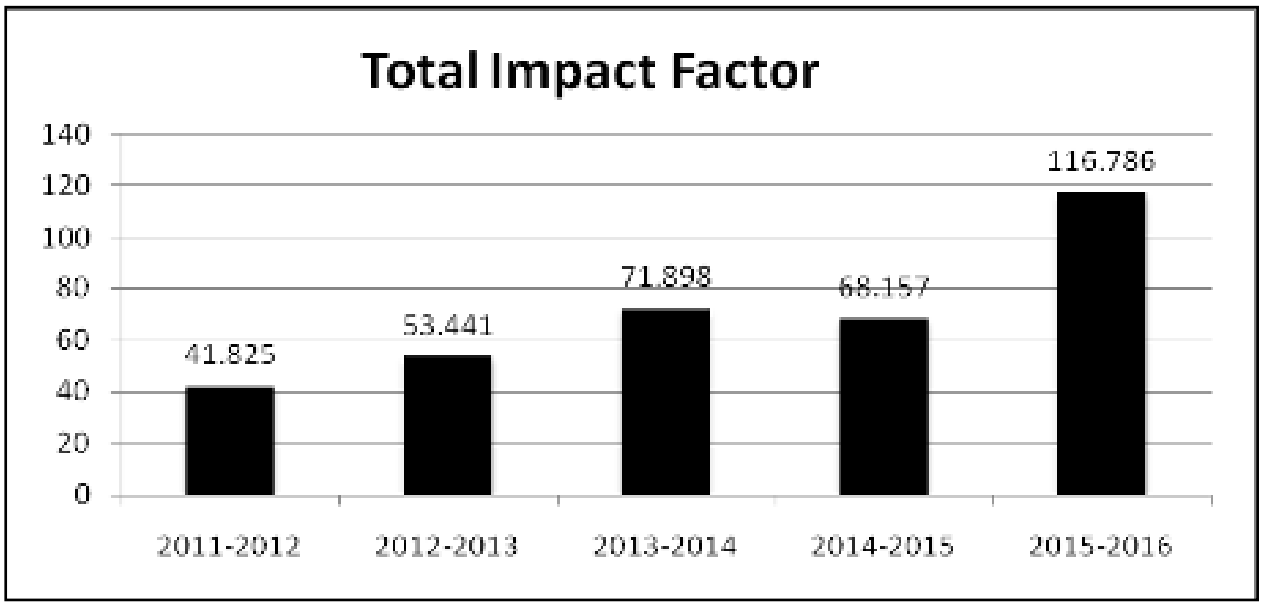
Dr. T. K. Das: He is an honorary Associate Professor of ICSP. His work is on the solar physics, especially on sunspots and classification of radio bursts. He also works on the geo-spot model of earthquakes, relationships between earthquakes and VLF etc.

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.

Impact Factor per Journal by ICSP scientists in 2015-2016:

Impact Factor 2015-2016				
Sl. No	**Journal Name**	**Impact Factor**	**No. Of publications**	**Total IF**
1	PhRvL	7.37	1	7.37
2	APJ	5.909	8	47.272
3	MNRAS	5.107	4	20.428
4	JGRA	3.318	1	3.318
5	JGR	3.318	1	3.318
6	ASI	2.96	4	11.84
7	AP&SS	2.263	4	9.052
8	SpWea	2.149	1	2.149
9	Ann. Geophys	1.74	1	1.74
10	JASTP	1.51	2	3.02
11	ASR	1.409	3	4.227
12	IND. J.PHYS.	1.166	1	1.166
13	New Astronomy	1.146	1	1.146
Cumulative Impact Factor				116.786

Impact Factor in last five years



Research Work Published/Accepted for Publication

Chakraborty, S., Palit, S., Ray, S., Chakrabarti, S. K., "Modeling of the lower ionospheric response and VLF signal modulation during a total solar eclipse using ionospheric chemistry and LWPC", ApSS, 2016, 361, 2.

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Departmental Progress Reports (2015-2016)

Department of Astrochemistry/Astrobiology

We focus on the formation of complex molecules during various stages of star formation. Based on the physical condition, chemical composition around a star-forming region is modeled and spectral properties of relevant complex Interstellar species are studied. Our department has two JRFs (Mr. Prasanta Gorai and Mr. Milan Sil) and one SRF (Mr. Dipen Sahu). Mr. Sahu is writing his Ph.D. Thesis and will submit it to the University of Calcutta for the evaluation. This year we published four papers in refereed journals. Dr. Ankan Das visited various National Institutes (PRL, Tezpur University) for presenting departmental research activities. Mr. Sahu visited KASI, South Korea under the Young Visitors Programme. Mr. Gorai visited IISc and PRL for collaborative work. Prof. Sandip K. Chakrabarti visited several scholarly places.

Ankan Das

(Dr. Ankan Das)
HOD, Astrochemistry/Astrobiology

Department of High Energy Astrophysics

We study Theoretical and observational aspects of black holes. We have six regular members (Dr. Dipak Debnath, Mr. Arka Chatterjee, Mr. Shreeram Nagarkoti, Md. Aslam Ali Molla, Mr. Arghajit Jana, and Mr. Debjit Chatterjee) and two visiting members (Dr. B. G. Dutta and Mr. Nirmal Saha). Regular scholars in this department are working on research topics on theoretical and observational aspects of black holes under different national and international project grants. Four scientific papers are published in high impact factor Journals and another four papers are in conference proceedings during 2015-2016. We participated in the National conference on Recent Trends of the Study of Compact Objects: Theory and Observation during May 6-8, 2015 at ARIES, Nainital.(Prof. S. K. Chakr abarti, Dr. D. Debnath, Dr. B. G. Dutta, Dr. P. S. Pal, Mr. Arka Chatterjee, Md. A. A. Molla, Mr. Shreeram Nagarkoti, Mr. Arghajit Jana); tin 14th Marcel Grossman meeting (Prof. S. K. Chakrabarti, Dr. D. Debnath and Dr. B. G. Dutta); to Hyderabad TIFR Balloon facility to attend a workshop on “TIMING & SPECTROSCOPY: WIDEBAND X-RAY ASTRONOMY” (Dr. D. Debanth, Dr. P. S. Pal) and presented our scientific research works.

Dipak Debnath

(Dr. Dipak Debnath)
HOD, High Energy Astrophysics

Department of Instrumentation for Space Exploration

Several Instrumentation and data analysis aspects of Balloon borne science are studied. VLF, Radio instruments and overall maintenance are also done by this department. There are total Six member (Mr. Debashis Bhowmick, Dr. Ritabrata Sarkar, Mr. Arnab Bhattacharya, Mr. Susanta Middya, Mr. Hriday Roy, Mr. Uttam Sardar) are working in this group. Fifteen (D75 to D89) successful balloon missions have been conducted in 2015-16. Three patents were applied (*874/KOL/2015, 875/KOL/2015, 876/KOL/2015*) and one scientific paper is published. Dr. Ritabrata Sarkar participated in India international Science Festival, IIT Delhi on December, 2015. S.K. Chakrabarti presented our results in the European Balloon Program conference in Tromso. We made VLF receivers for 35th Indian Antarctica expedition and 3rd VLF campaign of ICSP during solar eclipse. Two project students, one from RKMR College, Narendrapur and one from B. P. Poddar Engineering college submitted final year experimental projects from this department.

Debashis Bhowmick

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

Department of Ionospheric Sciences

Both theoretical and experimental studies on ionosphere and near-earth space including Ozone layer to magnetosphere were carried out at the fundamental level in this department. Some experimental setup for Ionospheric research are running at ICSP Kolkata, IERC Sitapur and the Malda branch. Ten members are working in this department. Six papers in highly reputed international journals were published in 2015-2016. Mr. Surya K. Maji successfully defended his pre-PhD viva-voce at Calcutta University. Dr. Sudipta Sasmal visited both the Indian Antarctic stations, Maitri and Bharati from December, 2015 to March 2016 for VLF-ionospheric research. He successfully performed VLF/LF experiments at both the stations and collected valuable ionospheric data. Dr. Pal and Dr. Basak participated in the URSI-Japan Radio Science Meeting, September-2015 at the Tokyo Institute of Technology, Japan. Dr. Basak also participated in the AGU Fall Meeting 2015, San Francisco, USA and 94th Research Recital meeting of the Society of Atmospheric Electricity of Japan, January 2016. Dr. Palit and Dr. Sasmal guided two M.Sc. project students.

Sujay Pal

(Dr. Sujay Pal)
HOD, Ionospheric Sciences

Members of Scientific Societies/Committees

Sandip K. Chakrabarti became a member of the following i) LOC and International Co-ordination Committee Member of 14th Marcel Grossman meeting (Rome, July, 2015). ii) Main Organizer COSPAR 41 (Istanbul) session E1.6 on Black Hole Astrophysics: Observational Evidence of Theoretical Models, iii) Deputy Organizer of C0.3 Session on Ionospheric Disturbances Observed through very Low Frequency Radio Waves, Iv) Deputy Organizer of PSB.1 session on Scientific Ballooning: Recent Development in Technology and Instrumentation V) Head of the Dept. of Astrophysics and Cosmology, SCREC General Secretary of the Governing body and In Charge of Indian Centre for Space Physics.

Ankan Das became a member of the Astrochemistry Society of India.

Ph.D. Degree Received

Santanu Mondal received Ph.D. Degree on **"**Spectral properties of accretion flows around black holes in presence of Comptonization and Mass Loss" (University of Calcutta).

Tilak B. Katoch received Ph.D. Degree on "Study of solar flares using Indian payloads Roentgen Telescope -2 (RT-2) on Board Coronas-Photon Satellite: instrumentation, Observation & data analysis" (Jadavpur University).

Ph.D. Thesis Submitted

Dipen Sahu submitted Ph.D. thesis on **"**Astrophysical Processes leading to deuterium enrichment of the interstellar medium" (University of Calcutta).

Course of Lectures offered by ICSP members

Ankan Das, Ritabrata Sarkar, and Dipak Debnath gave about 30 lectures to the 4th semester Physics post-graduate students of R. K. Mission Residential College (Autonomous) on High Energy Astrophysics and Cosmology as part of the Astronomy and Astrophysics Course. This is offered on a regular basis every year.

Participation in National / International Conferences & Symposia

Sandip K. Chakrabarti gave following oral presentations: **May, 2015:** "Whither TCAF?" Invited talk at "Recent Trends of Study of Compact Objects - Theory and Observations",in "Recent Trends in Compact Objects -II" conference at ARIES, Nainital. **June 2015:** "Unique high energy astrophysics experiment with weather balloons", at 22nd PAC Symposium at Tromso, Norway. **July 2015:** Chairman of "Accretion Processes on Black Holes" at the 14th Marcel Grossman meeting in Rome and invited talk on "Study of Accretion processes Around Black Holes becomes Science: Tell Tale Observational Signatures of Two Component Advective Flows". **Sept. 2015:** "Two Component Advective Flows: Theory and Observations" at the "Conference celebrating 100th Birth Anniversary of Prof. V.V. Sovolev at St. Petersburg. **Mar. 2016:** "Gravitational Waves and Black Holes" at 'Togetherness for Better Tomorrow' Forum, Kolkata.

Ankan Das gave oral presentations at "Astrochemistry of Pluto in New Horizons" at PRL, Ahmedabad, India, Chemical composition of the Interstellar medium, Tezpur University, India.

Dipak Debnath gave oral presentations at National conference on the topic of "Recent Trends in the Study of Compact Objects: Theory and Observation" (RETCO-II) during May 6-8, 2015 at

ARIES, Nainital; at Fourteenth Marcel Grossmann (MG14) meeting on "Recent Developments in Theoretical and Experimental General Relativity, Gravitation, and Relativistic Field Theory" from July 12-18, 2015 at University of Rome "La Sapienza", Rome, Italy; at ASTROSAT/LAXPC conference on "Timing & Spectroscopy : Wide-band X-ray Astronomy" at TIFR balloon facility, Hyderabad, India, during 12-14 January, 2016; at In Annual Review Meeting of ISRO-RESPOND projects at PRL, Ahmedabad during March 3-4, 2016 to defend project entitled "Study of timing properties of few out-bursting black hole candidates".

Ritabrata Sarkar gave oral presentation at **December, 2015:** Low Cost Exploration of Space by Indian Centre for Space Physics: Recent Technological Advancements; at India international Science Festival; IIT Delhi.

Sudipta Susmal gave oral Presentations at Study of long path radio wave propagation characteristics and theoretical simulation of ionospheric perturbations from Indian Antarctic station Bharati, National Workshop on Evaluation of Research Projects for Planning the XXXV Indian Scientific Expedition to Antarctica, 21-22 May, 2015, National Centre for Antarctic & Ocean Research, Headland Sada, Goa, India.; at VLF wave propagation characteristics as recorded from Antarctica, Scientific meeting in Antarctica in National Science Day, 28/02/2016, Maitri Station, Antarctica.

Sujay pal gave poster presentation in **September, 2015:** Atmosphere-ionosphere connection as revealed by network observations of VLF/LF radio signals in the URSI-Japan Radio Science Meeting, at the Tokyo Institute of Technology, Japan.

Santanu Mondal gave oral presentations in **May, 2015** on Recent Trends in the study of Compact Objects – Theory and Observation (RETCO-II), at ARIES, Nainital. **June/July, 2015:** Academic visit to TIFR, Mumbai. **Aug. Sep. 2015:** Compton Cooling and the signature of Quasi Periodic Oscillation frequency of few transient black hole candidates. He attended Radio Astronomy School, during Aug. 31-Sep. 11, 2015, NCRA-TIFR, Pune.

Arka Chatterjee presented a talk in **May, 2015:** Effects of Photon Bending on the Spectral and Timing Properties of Two Component Advective Flows at RETCO II, 2015, ARIES, Nainital on 6-8 May, 2015.

Prasanta Gorai Visited Dr. Sivaraman Bhala's FTIR lab and attended New Horizons seminar on 13th -17th **July, 2015**. He visited Prof . E. Arunan's FTMW laboratory during 26/12/15-7/1/2016.

Dushmanta Patra presented a talk in **May, 2015** at Multi-frequency observation of Galactic micro-quasar Cygnus X-3 during flare; at RETCO II, ARIES, Nainital. He attended Radio Astronomy School, 2015, Held 31st August- 11th September 2015 at NCRA, Pune, India.

Awards Received

Sandip K. Chakrabarti was awarded D.Sc. (Honoris Causa) from University of Gourbanga at the Convocation in December, 2015.

Sudipta Sasmal was selected as summer member of 35th Indian Scientific Expedition to Antarctica

Visits abroad from the Centre

Dipak Debnath visited University of Rome "La Sapienza", Rome, Italy. To attend The Fourteenth Marcel Grossmann (MG14) meeting in July, 2015.

Ritabrata Sarkar visited GAMMA 400 INFN, sezione di Trieste Trieste, Italy September 15 to October 4, 2015.

Dipen Sahu UST-GUAS radio astronomy winter school,10-13th February, 2015, Jeju Island, SOUTH KOREA.

Collaborative research & project work

Modeling of Interstellar Gas-Grain Chemistry and study the spectral properties of some complex Interstellar molecules, A. Das (ICSP), S.K. Chakrabarti (SNBNCBS and ICSP): Funded by Department of Science and Technology.

Abstract: Almost two hundred species have been discovered in the interstellar medium (gas and ice) and thousands of chemical species have been discovered in meteorites which are believed to be formed in proto-stellar phase. Surprisingly, reaction rate coefficients for the formation of several of these Interstellar gas phase as well as grain surface species, what to talk about amino acids seen in meteorites are till date unknown. Occasionally one takes approximate values of the reaction rates for modeling purposes, but these might yield misleading results. We perform Quantum Chemical simulation to study the spectral properties of several important Interstellar species to correlate different observational aspects. Armed with chemical abundances and spectral knowledge of complex molecules, we predict abundances of bio-molecules and their precursors.

Study of the spectral properties of few transient black hole candidates with Two Component Advective Flow model, D. Debnath (ICSP), S. K. Chakrabarti (SNBNCBS and ICSP), A. A. Molla (ICSP), A. Roy (ICSP), D. Chatterjee (ICSP).

Abstract: The main goal of this project is to study the spectral properties of the black hole candidates (BHCs) with two-component advective flow (TCAF) model and from there we want to get a clear picture about the mass accretion processes around a BHC. Chakrabarti and his collaborators have qualitatively argued that the TCAF model should fit well for various types (states) of black hole spectra, take from different spectral states of XTE J1550-564, H 1743-322, GX 339-4. In the present project, we are developing a software i.e., TCAF model fits file which will directly fit the observed data from NASA's archive as a local model in HeaSARC's spectral analysis software package XSPEC. From the spectral fit, one can also directly extract physical parameters related to the mass accretion flows around the BHCs: two-component (Keplerian and sub-Keplerian) flow rates, shock locations, shock strengths, possible mass of the BHCs and distance of the BHCs. Detailed accretion flow dynamics, classification of different spectral states, prediction of quasi-periodic oscillation (QPO) frequencies, unknown black hole mass, etc. will be explained in this project.

Study of timing properties of few outbursting black hole candidates, D. Debnath (ICSP), S. K. Chakrabarti (SNBNCBS and ICSP), A. Jana (ICSP).

Abstract: Main scientific objectives of the project are to quantify precisely how the time variation of spectra is taking place during the entire outburst phase, for each of the transient black hole candidates, such as GX 339-4, GRO J1655-40, H 1743-322, XTE J1550-564, XTE J1859+226 etc. during their outburst phases. Also to predict the origin of quasi-periodic oscillations (QPOs) by making detailed temporal and spectral studies of the properties of few transient X-ray binaries. If the QPOs are caused by oscillations of shocks, then, our goal would be to understand what causes the drifts of the shocks in order that the evolving frequencies may be explained. We also will work on prediction of the mass of unknown transient black hole candidates by the fitting results obtained from day-wise QPO frequency evolutions and constant normalization spectral fit with two-component advectie flow (TCAF) model as a local model in HeaSARC's spectral analysis software package in XSPEC.

M.Sc. project students guided by ICSP members

1. Dr. Ankan Das supervised Mr. Amaresh Das from Ramakrishna Mission Residential College (Auton.), Narendrapur, Kolkata, for their M.Sc project works entitled "Interstellar monohydric alcohols and their thiol analogues".

2. Dr. Ritabrata Sarkar supervised Rajkumar Santra of Ramkrishna Mission Residential College (Auton.), Narendrapur, Kolkata, for his M. Sc. project work entitled "Calibration and characterization of a Phoswich detector and detection of extraterrestrial radiation using it".

3. Dr. Sudipta Sasmal supervised Mr. Anjan Samanta from Panskura Banamali College, for his M.Sc project work entitled " Theoretical Simulation of Unusual Behavior of Very Low Frequency Signal using Long Wavelength Propagation Capability (LWPC) programme during the earthquake at Honsu, Japan on 11 March, 2011. "

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): D. Sahu, P. Gorai and M.Sil

The process of origin of life is not known. It is a big puzzle even to explain the origin of complex organic and potentially pre-biotic molecules in the interstellar medium (ISM). Work on the chemical evolution of pre-biotic molecules remains incomplete since the major obstacle is the lack of adequate knowledge of rate coefficients of various reactions which take place in interstellar conditions. We study the possibility of forming pre-biotic molecules in interstellar regions. Our study reveals that the synthesis of various pre-biotic molecules under interstellar circumstances is possible. Presence of amino acids and complex molecules in meteorites produced in the early stages of the formation of the solar system points to the major findings of our group in 2000 that they must be formed in ISM.It is now confirmed that methanol and ethanol are mainly produced on dust grains during the cold phase and evaporate from warm dust grains in latter stages of evolution. Following this trend, even higher order alcohols would be produced on interstellar grains. In the case of thiols, sulfur takes the place of oxygen in the hydroxyl group of an alcohol. Similar to their alcohol analogs, these thiols are mainly produced on the grain surface and are evaporated in suitable time. It is expected that the most stable conformers would be the most probable candidate for the astronomical detection in the ISM. In this attempt, here, before constructing our chemical model, we search for the various conformers of the monohydric alcohols and their thiols through relaxed potential energy surface (PES) scan of dihedral angles.

In order to realistically model the physical parameters, we consider a warm-up model. The initial phase of this model is the isothermal phase (T = 10 K) followed by a warm-up phase. Both phases have the same constant density (nH = 10^4 cm^{-3}) and a visual extinction of 10. The second phase starts with 10 K and ends at 200 K. We assumed that the isothermal phase lasts for 10^6 years and the warm-up phase for another 10^6 years. In the Figure (Middle left), we show time evolution of gas phase (solid curve) and ice phase (dotted curve) alcohols and their thiol analogs. Upper panel shows the isothermal phase and lower

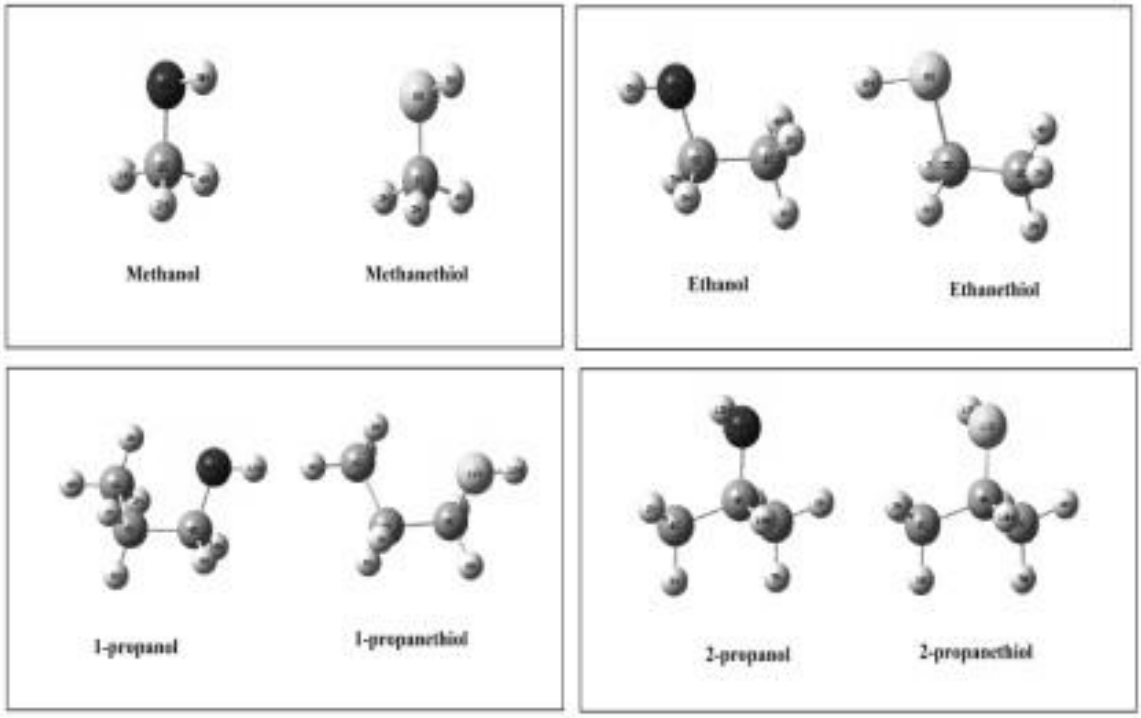


Figure: Most stable configuration of monohydric alcohols and their thiol analogs.

panel shows the warm-up phase. In the isothermal phase, it is clear that ice phase methanol, ethanol and methanethiol are efficiently produced. Some portions of these abundant ice phase species are readily transferred to the gas phase via various desorption mechanisms. At the beginning of the warm-up phase, ice phase production of ethanol, ethanethiol, 1-propanol and 1-propanethiol increases due to the increase in the mobility of the surface species involved in the reactions.

Below, we propose the formation of Uracil in two steps: 1st step is the addition of water with cytosine and 2nd step is the elimination of ammonia from the intermediate product.

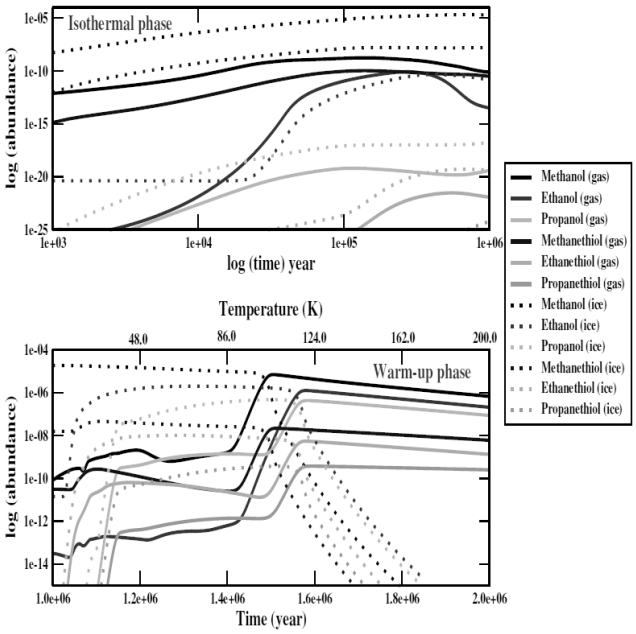


Figure: Time evolution of monohydric alcohols and their thiol analogs in isothermal and warm-up phase.

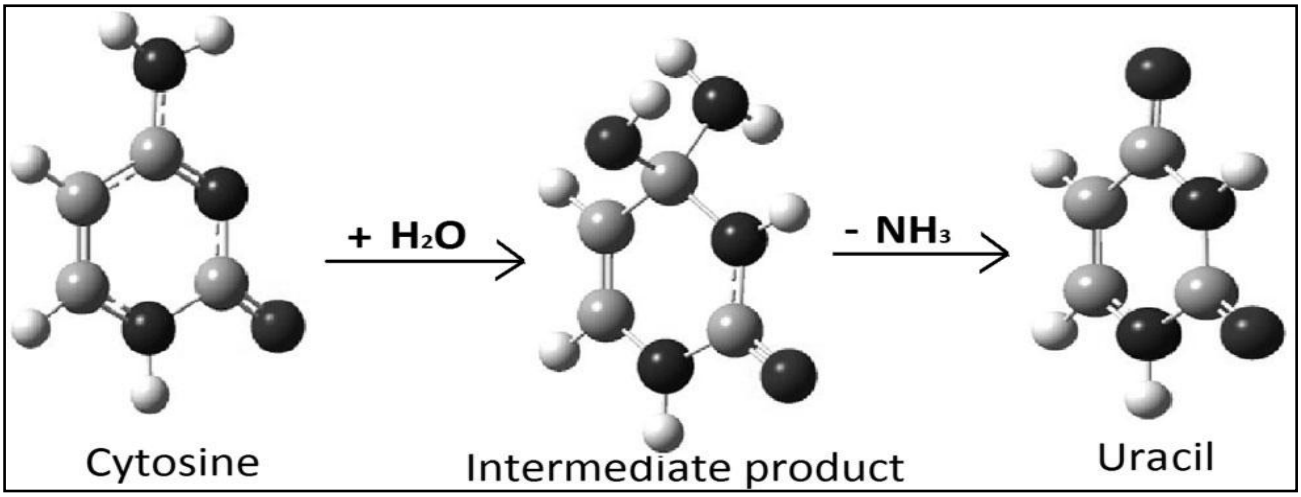


Figure: Uracil formation in two steps: 1st step is the addition of water with cytosine and 2nd step is the elimination of ammonia from the intermediate product.

Sources of High Energy Radiations



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



(L to R): Himadri Ghosh, A. Chatterjee, S. Nagarkoti

Black Hole environments are the sources of very high energy radiations as the matter which are attracted by the black holes can loss up to 40% of their rest mass in the form of radiation energy. This radiation has two clear components: black body type which is emitted from a viscous flow and the other is a power-law type emitted from a hot region sitting next to a viscous disk. Our group is the pioneer to advance the most successful solution of two component advective flow model where the viscous Keplerian disk is surrounded by a sub-Keplerian halo which may form a standing or oscillating shock wave. It has explained all the black hole candidate spectra so far across the states and also timing properties have come out of the spectral properties. We have also extracted masses of all the black hole candidates from spectral properties alone very satisfactorily.

There are thousands of stellar mass black holes in our own galaxy alone apart from one of about 4 million solar mass at the center of Milky Way, which is only 8 kilo parsec away from us. These radiations along with radiations emitted by neutron star/white dwarf accretion, supernovae outbursts, as well as energetic phenomena on the sun are affecting the upper atmosphere of the planet Earth. Under this hostile condition, the Earth's life form survives by the selective absorbance of its atmosphere. The radiation is known to ionize the atmosphere. It seeds the clouds and affects the climate of our planet. So, we will expand our expertise horizon to include these aspects.

Black Hole Astrophysics

We carry out theoretical studies of how matter is accreted into black holes, how matter is ejected from accretion disks in the form of jets and outflows, how radiation is emitted from these disks and outflows. Our interest is to focus on the effects of viscosity on the topology of the flow and emitted radiation. We are interested to find how the strong gravity close to a black hole affects the flow geometry. We also study how black holes focus photons to our side by bending the photon trajectory and cause deformation of the disk image, Doppler and gravitational redshifts and time-lags among various energy components.

Images and Spectral Properties of Two Component Advective Flows Around Black Holes: Effects of Photon Bending: In a black hole accretion process, Comptonization of photons is a very important phenomenon. Photons generated from the Keplerian disk are intercepted by the hot thick disk which represents CENtrifugal pressure supported BOundary Layer or CENBOL. First, we construct generalised relativistic thick disks for different thermodynamical parameters. Inside the thick disk, we compute Comptonization including the trajectory correction for photons due to space-time geometry of the black hole. Spectral difference between null geodesic Comptonization and flat space-time Comptonization are studied for different scenarios. In the next step, we have successfully connected the Comptonized photons to the observer to obtain energy dependent images of the system. The inclination angle dependent images are generated. We have computed the time of arrival of photons to the observer.

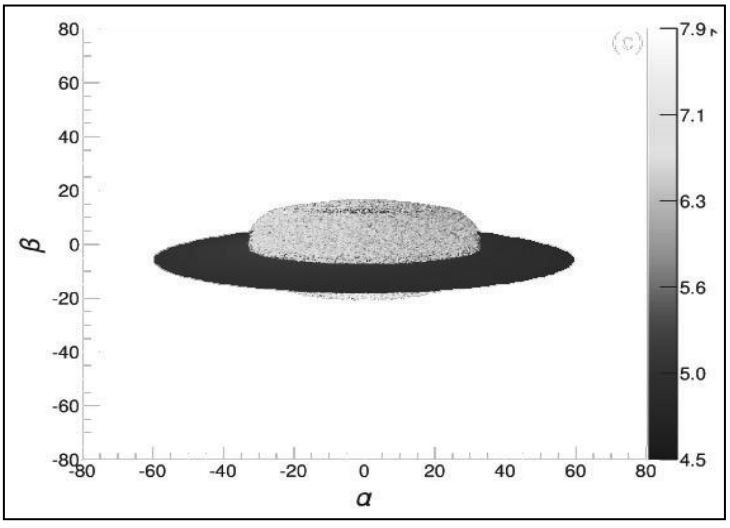


Figure: Image of a CENBOL (Tc ~ 300 keV) and Keplerian disk viewed at an inclination angle of 80 degree. Disk accretion rate is 10E-5.

Highest theoretical value of viscosity parameter (α):

It is well understood that for matter to accrete and finally fall into the black hole, angular momentum must be transported outwards. Viscosity is the agent which facilitates this phenomenon. Its contribution is represented by the viscosity parameter, α first introduced by Shakura & Sunyaev in 1973. We include effects of jets/outflows and then determine the highest value of α for which an accretion flow is allowed to have standing/dissipative shocks. We find that in absence of outflows, standing shocks can form at α as high as 0.3 (Nagarkoti & Chakrabarti, 2016) but dissipative shocks will form only up to α ~ 0.27. In presence of outflows, highest value of α allowing standing shocks is 0.2. Dissipative shocks are allowed for α as high as 0.175 and of course, this upper limit of α decreases with increasing amount of dissipation. It was also observed that the ratio of outflow rate to inflow rate could only reach as high as 15% (Nagarkoti & Chakrabarti, 2016, submitted).

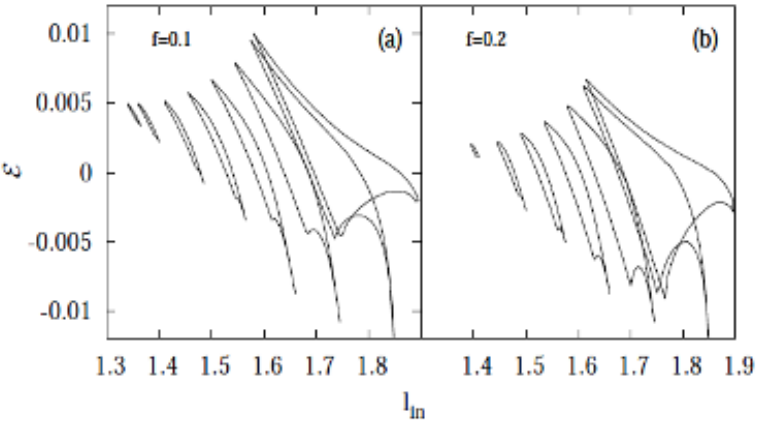


Figure: Parameter space allowing standing shock in presence of dissipation. In plot (a), dissipation factor f=0.1 and maximum viscosity α_{sup} = 0.27 and in (b) f=0.2 and α_{sup} = 0.25.

Resonance Condition: To Find Origin of Quasi-Periodic Oscillations (QPOs): There are many models available in literature to explain origin of low-frequency QPOs observed in harder spectral states of black hole X-ray binaries. Chakrabarti and his collaborators introduced shock oscillation model (SOM) (Molteni, Sponholtz & Chakrabarti, 1996; Chakrabarti et al. 2004; Garain et al. 2014) to find origin of these QPOs. According to SOM, QPOs are mainly due to resonance oscillation of the shock wave, when cooling time scale of the flow becomes comparable to the infall time scale. In Chakrabarti et al. (2015), we calculated ratio between these two time scales during the entire 2010 outburst phase of Galactic BHC H 1743-322. It was observed that QPOs are only observed when ratio becomes with in the 50% error limit, i.e., in between 0.5-1.5. If the ratio is outside this range, no signature of the QPOs are observed [Chakrabarti, Mondal & Debanth, 2015].

X-ray Astronomy

(L to R): D. Debnath, S. Mondal, A. K. Choudhury and S.K. Chakrabarti

(L to R): B.G. Dutta, A.A. Molla, A. Jana and D. Chatterjee

Evolution of Spectral and Timing Properties of MAXI J1836-194 during its 2011 Outburst: We studied entire X-ray outburst using RXTE/PCA observations. Low Frequency Quasi-periodic oscillations (LFQPOs) are observed sporadically, although a trend of increasing nature of the QPO frequency during rising phase and opposite nature during declining phase of the outburst were observed. We make a detailed study of the spectral properties using TCAF model fits in XSPEC. Depending upon nature of variations of Chakrabarti-Titarchuk TCAF solution fitted two component (Keplerian disk and sub-Keplerian halo) accretion rates, accretion rate ratio (ARR), and observed QPOs, we classified entire 2011 outburst of the source into two spectral states, namely, Hard (HS) and Hard-Intermediate (HIMS). These spectral states were observed in the sequence of HS(Rising) —> HIMS (Rising) —> HIMS (Declining) —>HS (Declining) [Jana, Debnath, Chakrabarti, Mondal & Molla, 2016]. Note the 10 day time lag between the days when the Keplerian flow and the sub-Keplerian flow became locally highest. This is in line with Chakrabarti-Titarchuk, 1995.

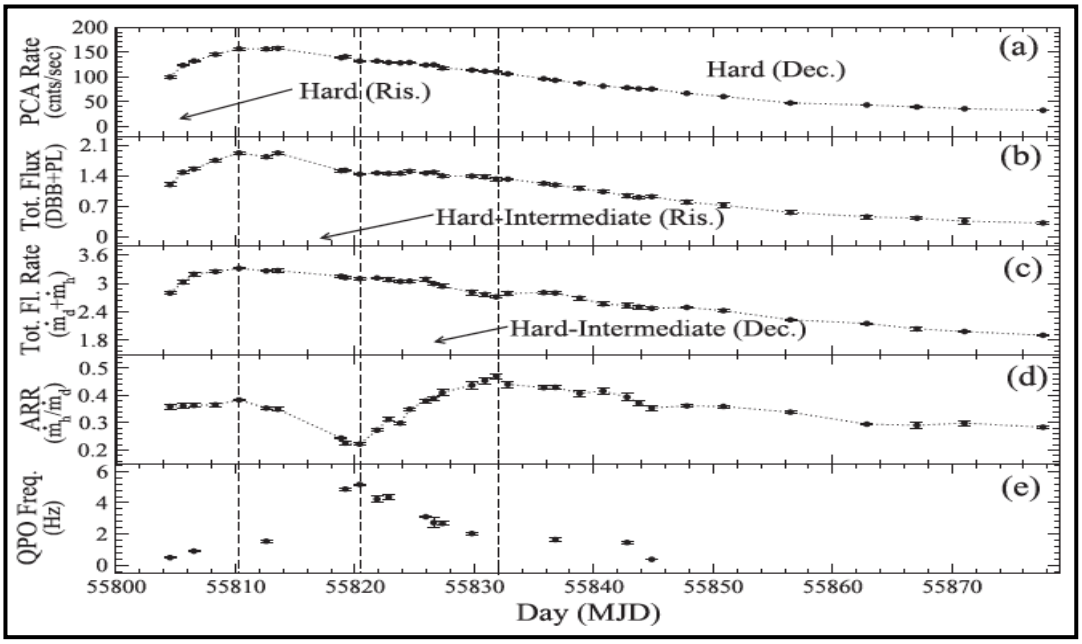


Figure: Variation of (a) 2–25 keV PCA count rates (cnts/s), (b) combined disk blackbody (DBB) and power-law (PL) model fitted total spectral flux in 2.5–25 keV range (in units of 10^{-9} erg cm^{-2} s^{-1}), (c) the TCAF model fitted otal flow (accretion) rate (sum of Keplerian disk and sub-Keplerian halo rates) in the 2.5–25 keV energy band, and (d) accretion rate ratio (ARR; ratio between halo and disk rates) with day (MJD) for the 2011 outburst of MAXI J1836-194 are shown. In the bottom panel (e), observed primary dominating QPO frequencies (in Hz) with day (MJD) are shown. The vertical dashed lines indicate transitions between different spectral states.

Accretion Rate Ratio Intensity Diagram (ARRID): A Correlation to Spectro-Temporal Properties: From a self-consistent understanding of the accretion flow, such as the TCAF solution, it is clear that the spectral and temporal properties must be correlated. During an outburst of a transient BHC, one can observe the general correlation, though, due to viscous effects as obtained from simulations, the curves in rising and declining phases are different and a hysteresis loop is seen. One can plot total photon counts from the light curves with the hardness ratios (HRs; ratio between high to low energy band photon counts), namely, hardness-intensity diagram (HID) or 'q'-diagram, where different branches are supposed to be correlated with different spectral states and other features (e.g., types of QPOs, Jets, etc). In TCAF model, where one can directly obtain rates of Keplerian and sub-Keplerian components and plot accretion rate ratio intensity diagram (ARRID), the plots are more physical. Transitions between spectral different states and their properties are more prominent (see, Figure). It clearly shows a hysteresis effect and different branches are associated with different spectral states. Though model independent, hardness intensity diagrams do not contain these precious information [Jana, Debnath, Chakrabarti, Mondal & Molla, 2016].

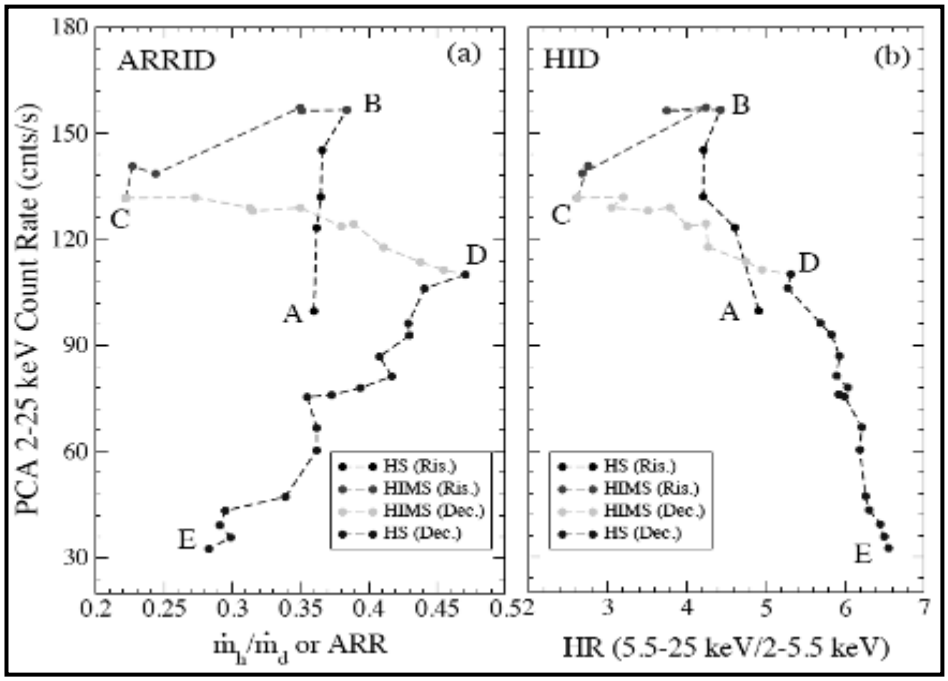


Figure: In left panel (a), shows ARRID, i.e., variation of PCU2 count rates in 2-25 keV energy band in terms of inverse accretion rate ratios during 2011 outburst of MAXI J1836-194. The right panel (b), shows HID, i.e., variation of PCU2 count rates in the same energy range with hardness- ratios (ratio between 5.5-25 keV photons with 2-5.5 keV photon counts per sec) during same outburst of MAXI J1836-194.

Mass Estimation of MAXI J1836-194 from TCAF Model fitted Constant Normalization Method: In usual dynamical methods of black hole mass measurement, the projected velocity of the companion and the binary period gives the mass function which is a complex combination of the masses of the components and the inclination angle. However, for the first time, by fitting the observational data (spectra) using TCAF model, we have predicted most probable range of the mass of the black hole candidate MAXI J1836-194. With this concept of constant normalization method, we got a most probable range of the mass of the Galactic black hole candidate MAXI J!836-194 as 7.5-11 M_Sun [Jana, Debnath, Chakrabarti, Mondal & Molla, 2016]

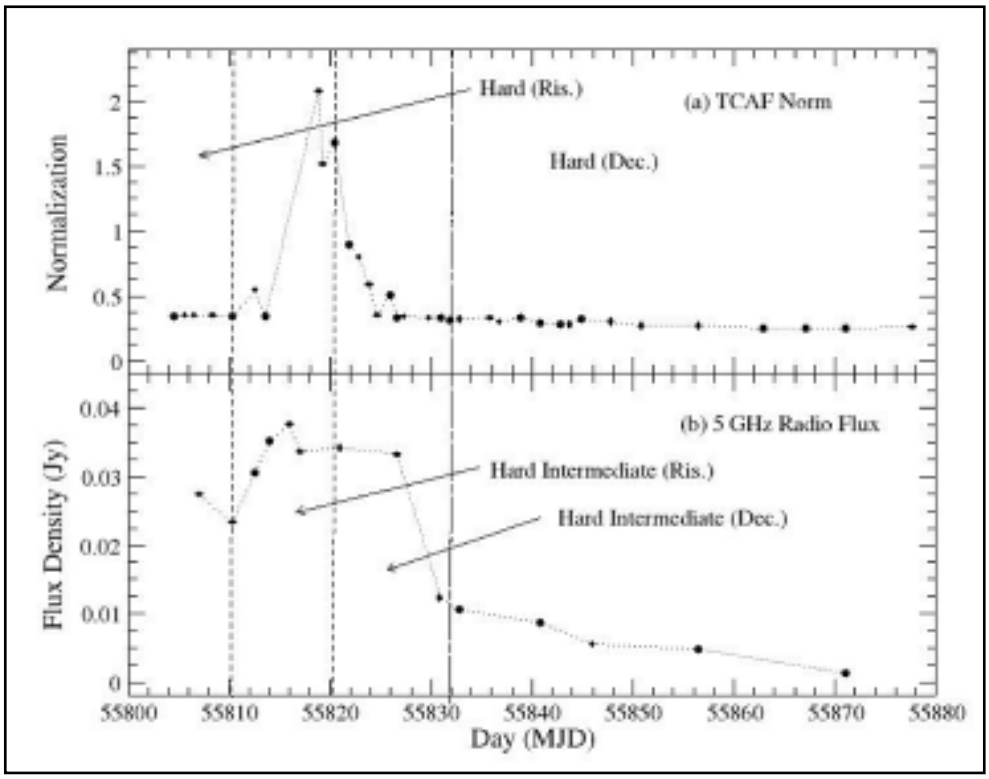


Figure: Top panel (a) shows TCAF model fitted normalization variation and bottom panel (b) shows radio flux variation with day (in MJD). It clearly indicates constant normalization variation throughout the outburst, except for five days from hard-intermediate spectral states, where high radio-flux were observed.

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): S. Middya, H. Roy, U. Sardar, R.C. Das

In the quest of low cost exploration of space, we have conducted several missions under the Dignity balloon mission of Indian Centre for Space Physics. In these missions we send light weight yet very sophisticated payload under 5 kg category featuring an X-ray/Gamma-ray or cosmic ray detector as the main instrument above the atmosphere with the help of a single or multiple rubber or plastic weather balloons or TIFR made polythene balloons. Budget required is very low since the payload is recoverable. We had to make several innovations to fulfill our goals, especially in the recovery sector and also identification of sources in the sky in the absence of pointing. With the help of the ancillary measurement sensors we measure the atmospheric parameters such as temperature, pressure, wind speed etc. up to a height of ~42 km which will be very helpful for atmospheric and meteorological purposes.

Design of a phoswich detector for improved background sensitivity during X-ray detection:

We have successfully used Phoswich detectors having two scintillator crystals of different pulse properties in communion with a single PMT for signal readout. One of the crystals is used as the primary and the second one is used as veto detector in anticoincidence with the primary. A picture of the detector with its front-end electronics and digital readout system is shown in a Figure in the front cover.

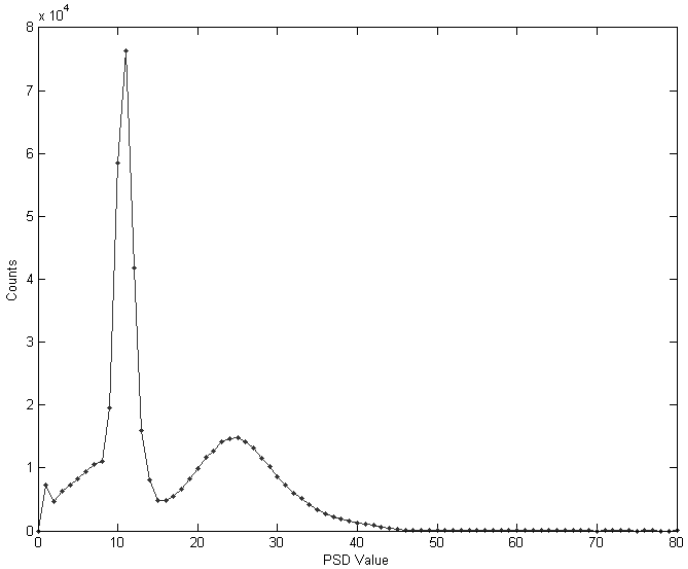


Figure: Pulse Shape Discriminator (PSD) plot is useful for discriminating the Photons coming from NaI(Tl) and CsI(Na) crystals. The region left to the minimum corresponds to NaI(Tl) and the right to the minimum is from the CsI(Na)

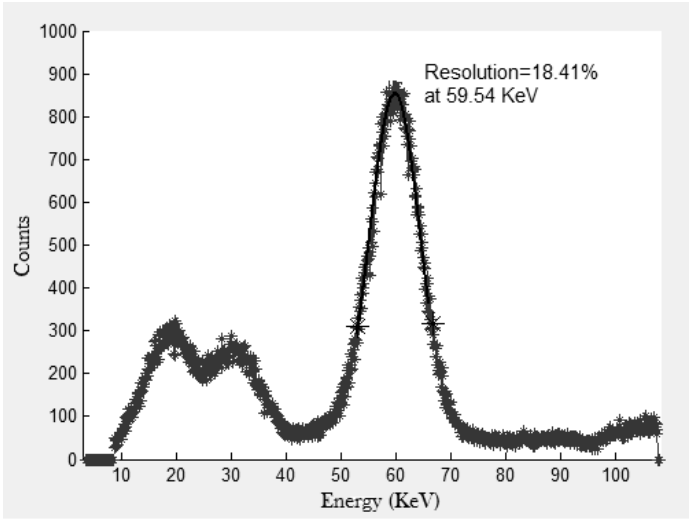


Figure: A sample Spectrum plot of the NaI(Tl) crystal data of Phoswich detector with Am241 radioactive source (calibrator).

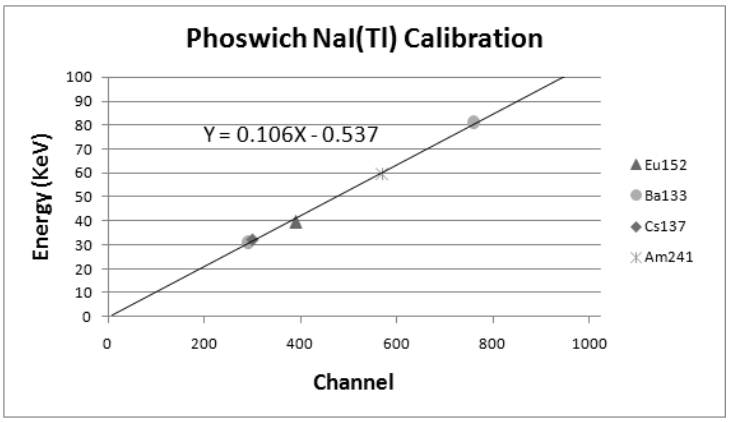


Figure: Channel-Energy calibration curve for NaI(Tl) crystal of Phoswich detector

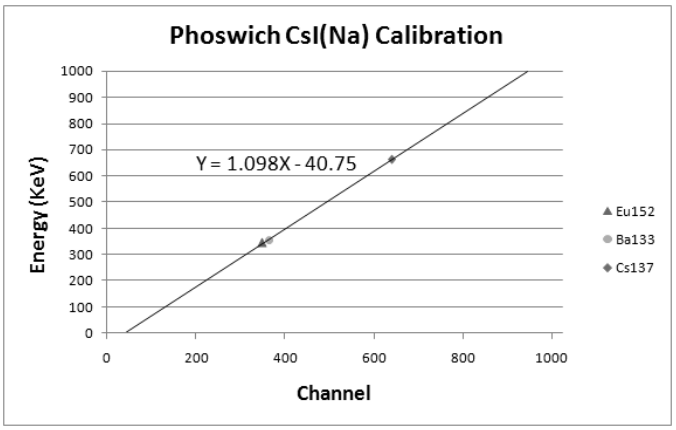


Figure: Channel-Energy calibration curve for CsI(Na) crystal of Phoswich detector

Design of a new kind of multiplate sieve collimator for the detector:

Since one of the most crucial and severe problem of source detection in X-ray astronomy is the signal to background ratio, collimator plays a very crucial role in detector design. However, we have a strict constraint on the weight of the collimator. For this reason, we came up with a new design scheme for the collimator using a number of plates with holes optimally distributed over it. The holes are aligned for all the plates and the plates are placed optimally depending on the FoV required in the experiment (front cover). The material used to construct the collimator also depends on mission requirement.

Spectrum of secondary radiation in the atmosphere due to cosmic-ray interaction

Along with the X-ray radiation from the extraterrestrial sources which is relevant when the payload is near the top of the atmosphere, we also monitor the secondary cosmic-ray in the atmosphere during the ascend and descend of the payloads. Use of the phoswich detector allowed us to receive more refined data free from the partial energy depositions.

Long term variation of the secondary cosmic ray at the Pfotzer maximum:

Counts of secondary cosmic-rays produced due to the interactions of primary cosmic-ray with the atmosphere changes with the altitude. Starting from the ground, the counts increase with altitude to attain a maximum value till around 16-17 km and then start to decrease beyond this altitude. This maximum in the secondary cosmic-ray profile with height is known as Pfotzer maximum which results due to the production vs. attenuation of the secondary rays. We have compared the secondary counts at the Pfotzer maximum from several missions to see the long term variation and we are particularly interested since the observation period covered the last solar maxima period. The result is shown in front cover page where we plotted the normalized count rate at Pfotzer maximum obtained in our experiment with sunspot number (averaged over 10 days) and the solar radio flux. We can see a clear anti-correlation between these parameters showing the evidence of the solar effect on the cosmic rays in earth's atmosphere.

Detection of radiation from the Crab pulsar at very low residual atmosphere:

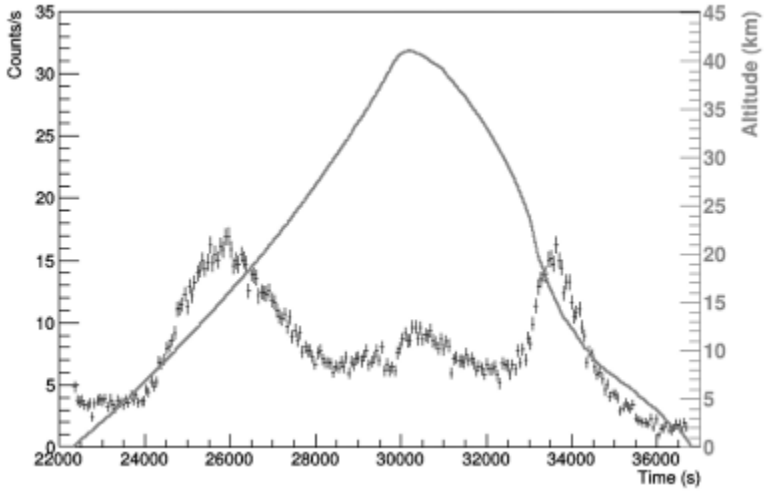


Figure: Excess of radiation (with error bar) at the highest altitude due to the Crab pulsar using Phoswich detector. Solid curve shows the height-altitude curve of the D93 mission.

In the past, we detected solar flare and extra-solar radiations at altitudes>30 km. This is possible since the residual atmosphere is thin and the background radiation due to the cosmic-ray interaction with the atmosphere is small. Recently, with phoswich detector above 40 km we detected crab pulsar. We plot the light curve of the detected X-ray data of the whole mission along with the payload altitude. We can clearly see the excess in the light curve around 30.5 ks UT which results from the radiation from Crab.

Patents filed by ICSP on Balloon technologies:

ICSP has filed applications for three important patents in the subject of weather balloon borne space science technology. These are:

1. ***Radio tracking system for flying platforms. (Appl. no. 874/KOL/2015)***
2. ***A multi-balloon launch system. (Appl. no. 875/KOL/2015)***
3. ***An orientation measurement unit for unguided instruments. (Appl. no. 876/KOL/2015)***

VLF Radio Observations and Modeling

Top (L to R): ***D. Bhowmick, S. Pal, S. Sasmal, S. Palit, S.K. Chakrabarti***
Bottom (L to R): A. Choudhury, B. Das, S. Chakraborty, S. Ray

Study of Seismo-Ionospheric Correlation

We have observed significant anomalies in VLF signal during the devastating Earthquake in Nepal on 12thMay (M=7.4) and 16thMay, 2015. The recorded VLF signal of frequency 22.2 kHz at IERC Sitapur, transmitted from JJI transmitter in Japan experienced a significant amplitude perturbation during the sunrise and sunset time. The sunrise and sunset terminators got shifted towards nighttime on three to four days before both the earthquakes. We successfully simulated this effect due to earthquake by LWPC simulation.

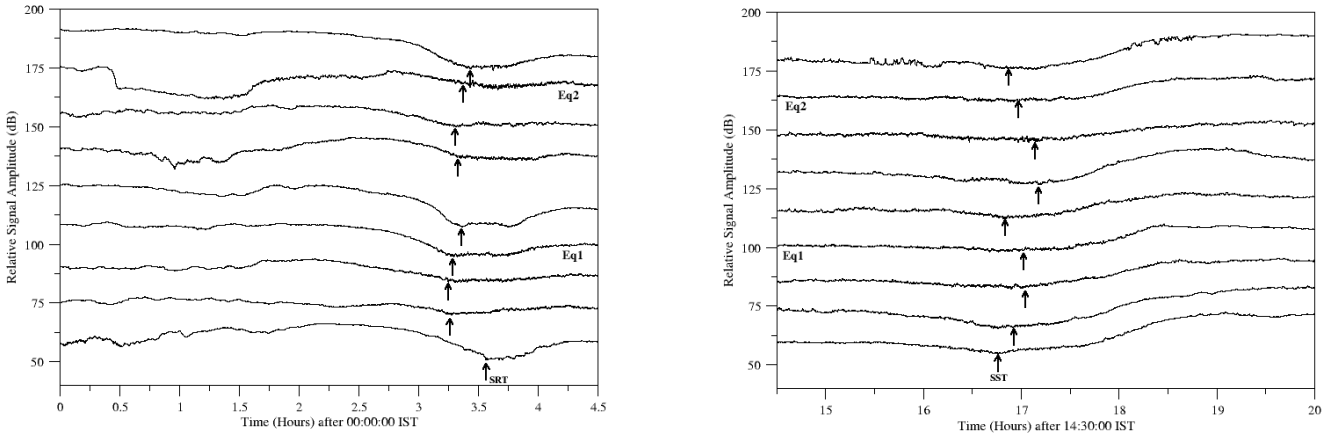


Figure: The shift of sunrise and sunset terminators (marked by arrows) before and during the earthquakes of 12th and 16th May, 2015 in Nepal.

We observed the possibilities of the presence of atmospheric gravity waves in the ionosphere which can be considered as an important factor in finding seismo-ionospheric correlations. We performed both FFT (Fast Fourier Transform) and wavelet analysis on the nighttime VLF signal and found significant presence of such waves (periods of almost 1 hour) on three days before the earthquake.

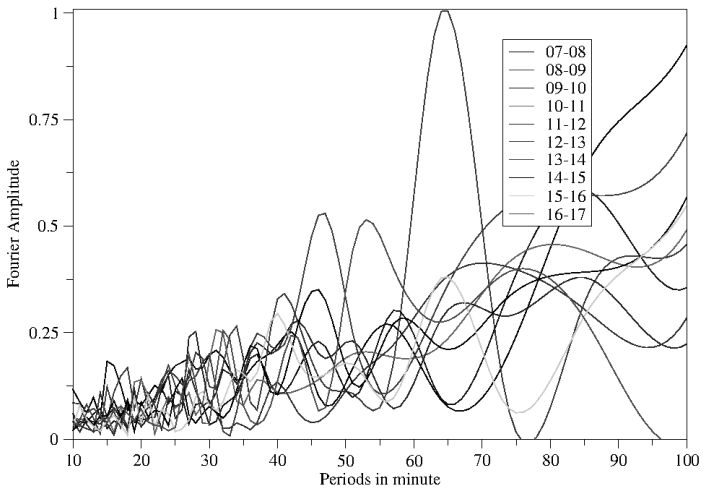


Figure: Normalized FFT spectrum of the VLF data from 7 to 17 May, 2015. Along X axis is the period of the waves in minutes and along Y axis is the normalized Fourier amplitude. Wave like structures with periods 65 minutes, 45 minutes and 55 minutes are evident on May 8, May 13 and May 16 respectively.

During this earthquake we also studied the tropospheric anomalies occurring before the earthquake. We studied the anomalies in Outgoing Long Wave Radiation (OLR) and observed singularities in Eddy field OLR curves around the earthquake epicenter 3 days prior to the earthquake day and disappearance of such singularities after the event. Such singularities can be associated with a large amount of energy released by an earthquake.

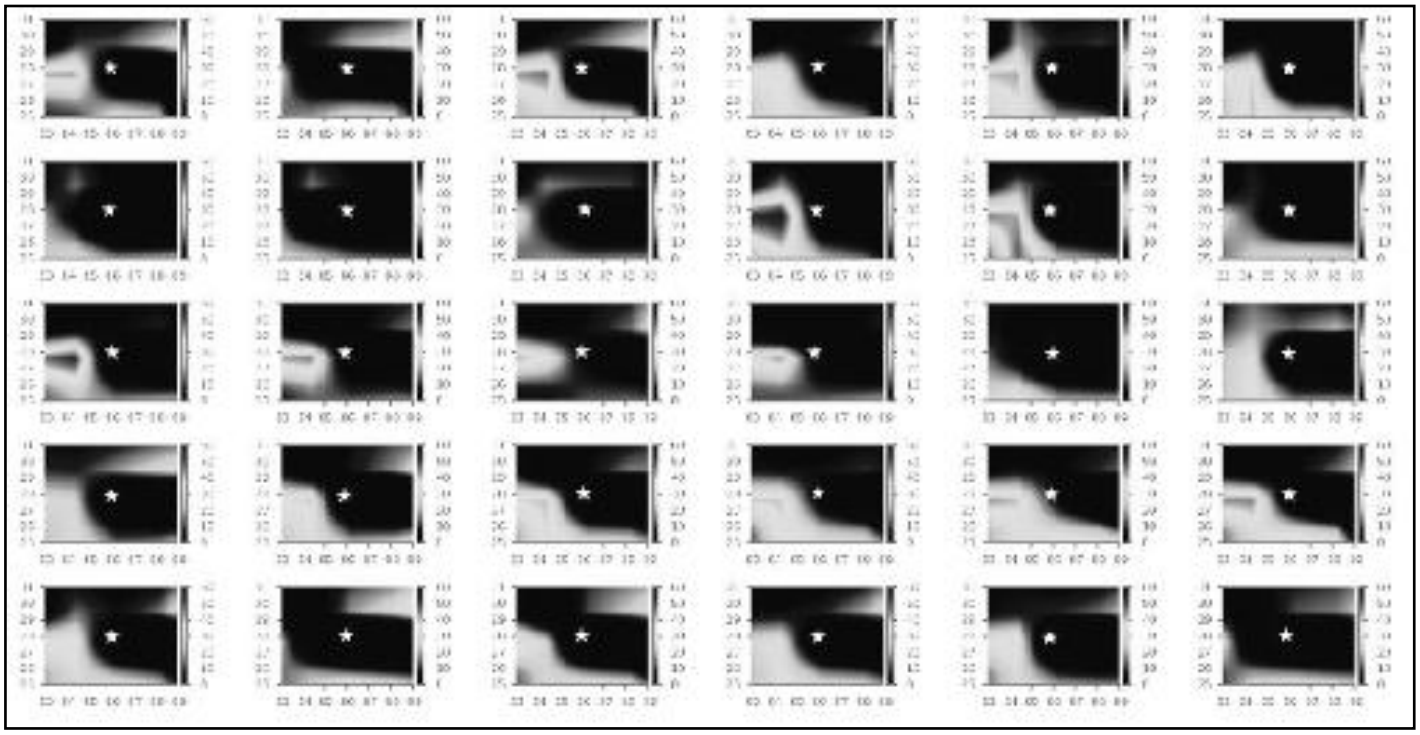


Figure: Eddy field OLR variations around the earthquake epicenter for the month of May (1-30) and from latitudes 25°N to 31°N and longitudes 83°E to 89°E. The epicenter is indicated by a white star. The color-bars represent the intensity of the field. Note intensification of Eddy Field around the earthquake and aftershock days.

Study of Stratosphere-ionosphere connection during Sudden Stratospheric Warming events

We reported persistent correlations between nighttime VLF amplitude and nighttime stratospheric parameters such as, temperature and total column Ozone for the mid-latitude VLF paths compared to low or high latitude paths.

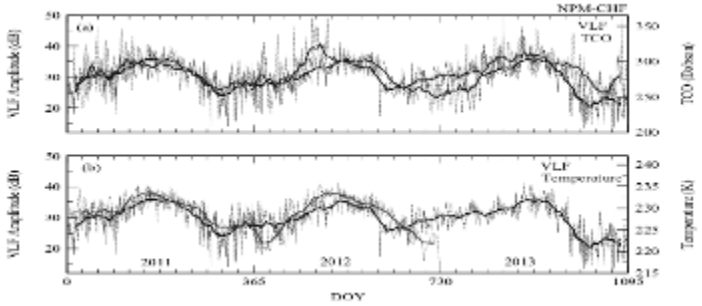


Figure: Variation of nighttime VLF amplitude (from January 2011 to December 2013) is compared with the TCO density (a) and stratospheric temperature at 31 km (b) for a mid-latitude propagation path.

We also observed for the first time significant increase or decrease of VLF/LF amplitude during the sudden stratospheric warming (SSW) event of 2009 for high to mid-latitude propagation paths.

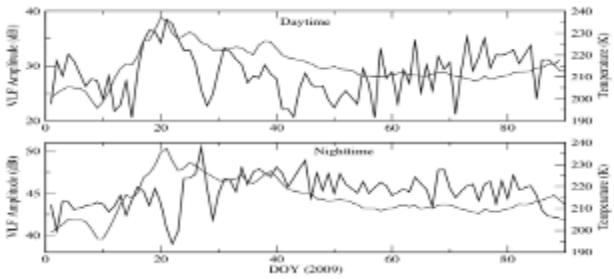


Figure: Daytime and nighttime average amplitude of high latitude LF signal from the NRK transmitter received at Kiel, Germany and the corresponding stratospheric temperature variation at 31 km.

Study of Effects due to Annular Solar Eclipse

We modeled the effects of the annular solar eclipse of May 20th 2012 (ASE-2012), using VLF-ionosphere interaction. We choose twelve propagation paths of UEC-VLF network. We noticed the observed VLF-anomalies from a dozen of receiving stations that, there is no linear correspondence of it with the degree of solar obscuration over the respective path. Both '+ve' and '-ve' types of VLF amplitude anomalies are observed, depending on the distance and 'geographical bearing angle' at the receiving site from the transmitter. Roughly, we can conclude that, we observed '+ve' VLF anomaly for the paths ≥ 1000 km paths and mixed type for the rest of the paths. We constructed a 3D model of ionosphere parameters and performed the correlation analysis between the simulated and observed VLF signal amplitudes.

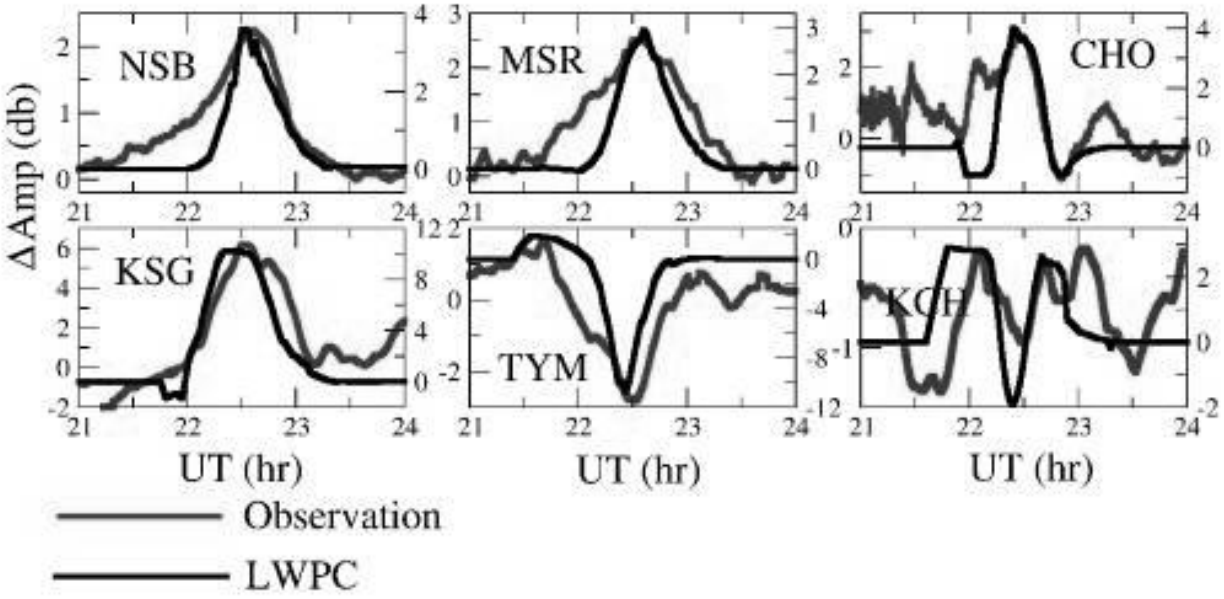


Figure: The differential VLF amplitude, observed (Delta A obs) (red) and LWPC computed (Delta A LWPC) for six VLF receiving stations respectively mentioned in the Figure for JJI 22.2kHz signal during 20th May 2012 Annular Solar Eclipse.

Study of Solar High Energetic Phenomena

We have investigated the influence the effect of Solar Energetic Proton (SEP) events and geomagnetic storm at low latitude area of the Earth. We analyzed the VLF signal amplitude between different transmitters such as, JJI, NWC etc. and the VLF receiver at IERC/ICSP, Sitapur for possible effects of such events. As expected we found some prominent effects of VLF amplitude modulation and electron density enhancement in JJI-IERC propagation path and very slight influence on NWC-IERC path. This study proves that though the solar energetic particles are generally believed to mainly affect the plasma properties at high latitude, some effect in mid and low latitude regions of the Earth can also be detectable.

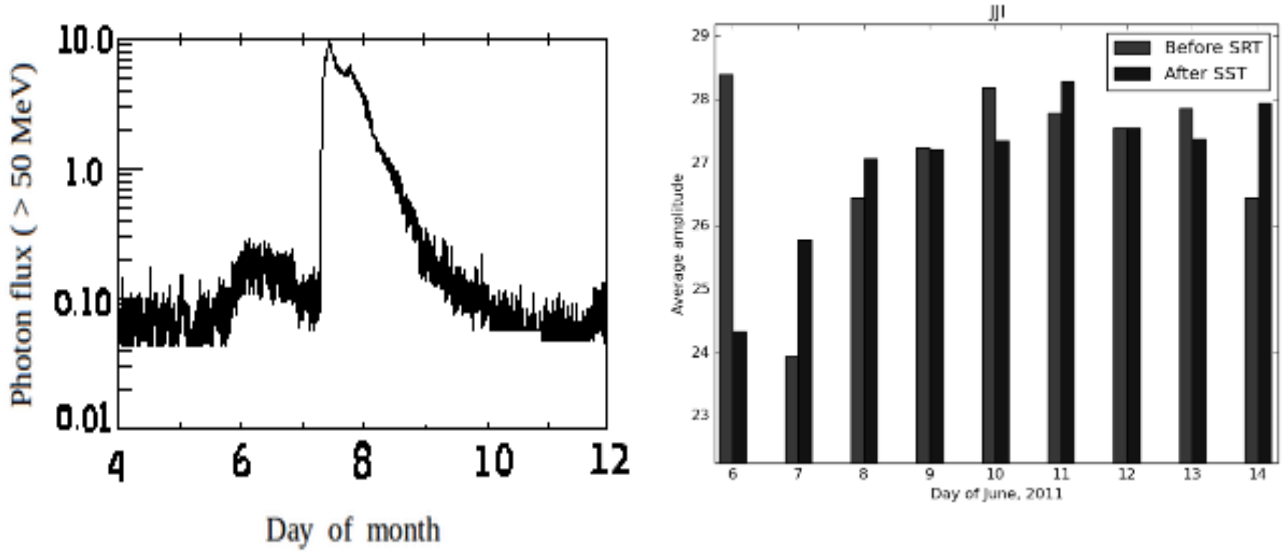


Figure: GOES proton flux during a solar storm in the month of June 2011 (Left). Average amplitude of VLF signal for one hour during the days of solar storm (Right).

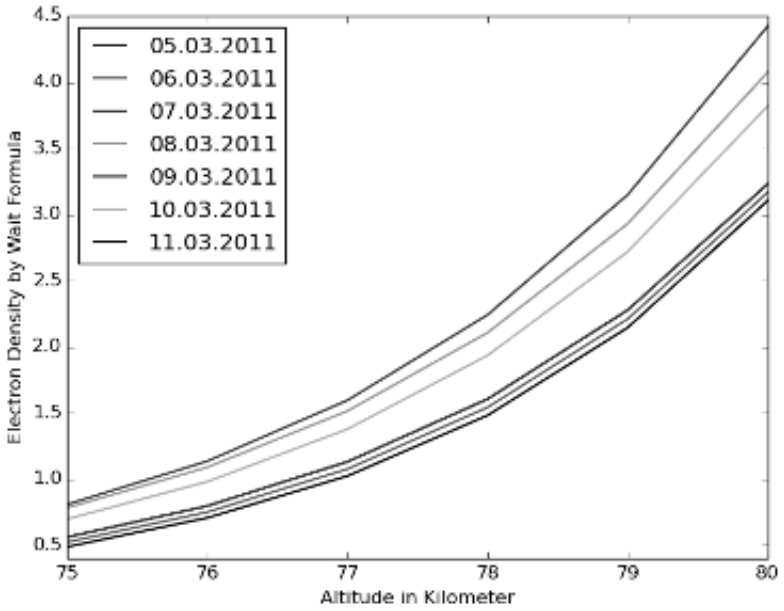


Figure: Recorded broadband (Left top) and narrowband signal (Left bottom) from VTX (18.2 kHz) and NWC (19.8 kHz) signal from Bharati. Solar flare recorded in amplitude (Right top) and phase (Right bottom) in VLF signal.

VLF Study in Antarctica

ICSP participated in the 35th Indian Scientific Expedition to Antarctica as summer member to observe the radio wave signal characteristics in Indian Permanent station Bharati. We installed electric field antenna and observed extremely quiet signal from different transmitter frequencies. We observed the signal attenuation effect due to Antarctic Ice mass and verify our previous theoretical findings. Also we observed several solar flares even though the sun was closer to the horizon. We successfully simulate the temporal and spatial properties of VLF signal using LWPC and Ion-chemistry model.

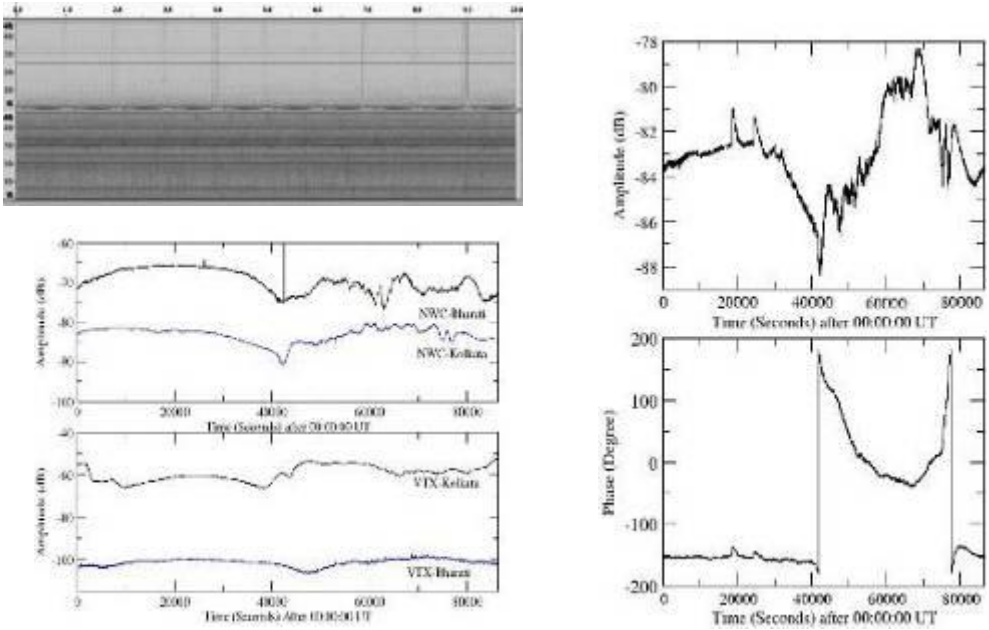


Figure: Broadband and narrowband data taken from Maitri and Bharati stations of Antarctica

Airglow/Ozone Depletion/Seismological effects

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

Airglow and Ozone depletion activities are lead 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. Prof. Midya has also found strong correlation between the ozone content and the day of the year. He showed that in pre-monsoon session, the Ozone content rises with the day of the year, while during the monsoon and in the post-monsoon sessions the trend is opposite. Efforts are made to model these theoretically. This group also works in Earthquake related study. They studied the Gutenberg-Richter parameter 'b' for epicentral regions of large earthquake in Japan, California, China, India, Chile, Italy, New Zealand and Sumatra. They reported a decreasing trend of 'b' before every major earthquake. After a major earthquake this parameter rises again.

Radio Astronomy

(L to R, top): **Sabyasachi Pal, Dusmanta Patra, Sanjoy Adak**

ICSP radio group has been engaged in observation with Giant Meterwave Radio Telescope (GMRT) and Jansky Very Large Array (JVLA) for more than a decade. Our scientists have discovered about a dozen of supernova remnants from Galactic plane survey at 330 MHz . We received GMRT observing time to confirm this findings and do study of spectral properties of these supernova remnants. A micro-quasar near the Galactic Centre region has been discovered also. Time is awarded by GMRT to observe variability, spectral properties and to measure the distance of the source. Spectral ageing analysis of many giant radio galaxies are going on. The analysis for the source 3C 35 and 3C 61.1 has been completed. An interesting 'C' shaped wide angle tale radio galaxy has been discovered. Also, a transient radio source close to a galactic micro-quasar has been discovered

The ionospheric and earthquake research centre (IERC)

(L to R, top): **Sabyasachi Pal, Sudipta Sasmal, Sujay Pal, Suman Chakrabarty and Rana Khan**
(L to R, Middle): **Amit Roy, Surya K. Maji, Dusmanta Patra, Dipak Sanki, Sanjoy Adak**
(L to R, Bottom): **S. Bhowmick, S. Ghosh**

At Sitapur, a remote village in W. Medinipur, silent revolution is taking place. Here, both the radio sky and optical sky are noise free. VLF antennas are placed here which monitor various stations continuously. Both SoftPAL and AWESOME receivers are working here. A 0.25m optical telescope (MEADE) is used to watch the sky (back cover photos). A 0.61m telescope will be placed here very soon. There are provisions of about 20 students/teachers who wish stay overnight for sky watching. College and High school students are invited, sky permitting, to use the facility to carry out small projects with the telescope and get familiar with the excitements of Astronomy.

Activities of the Indian Centre for Space Physics, Malda Branch



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

The Malda Branch of Indian Centre for Space Physics organized various types of scientific activities along with research work 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.

Achintya K Chatterjee, President of ICSP Malda Branch, was invited to present a scientific talk on "*Earthquake and Precautions* "– RKMVVM, MALDA, " W B Jnan o BijnanUtsav" 25th May, 2015. He attended BITM Workshop on Model Preparation as a Resource Person at Balurghat *17th* August, 2015. He also attended *BITM* Workshop on Model Preparation as a Resource Person at Malda 18th August, 2015. He participated the *Inter National Year of Light – Govt Teachers' Training College on 15th October, 2015.* He attended a seminar on after Higgs Boson as a anchor. He gave a talk on Gravitational Wave at state level seminar, GBU, 29th March, 2016.

Asit Choudhury, Secretary of ICSP and **Bakul Das** participated a live discussion on `Prediction of Earth Quake' organized by Malda Cable Network on 12.5.2015. It was telecast through the cable network covering four districts, namely, Malda, Uttar Dinajpur, Dakshin Dinajpur and Murshidabad.

Wasmul Bari and other ICSP members organized a sky watch programme on the roof of ICSP Malda Branch, Atul Market on 2.2.2016. About 100 students of different schools attended the programme.

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*
Mr. Nilmadhab Nandi, *Member*
Mr. Utpal Chatterjee, *Member*
Mr. Kankar Bandopadhyay, *Vice President*
Mr. Subhankar Das, *Treasurer*
Mr. Gobinda Chandra Mandal, *Member*
Mrs. Sutapa Chatterjee, *Member*

Office Staff at the Head quarter

Mr. Rajkumar Maiti (Accountant/ Office Assistant)

Mr.Jyotisman Moitra (Computer Assistant)

Mr. Ram Chandra Das (Office Attendant)

Mr. Uttam Sardar (Office Helper)

Independent Auditors' Report

To The Members of
Indian Centre for Space Physics

Report on the Financial Statements

We have audited the accompanying Financial Statements of **Indian Centre for Space Physics** ("the Institute")**,** which comprise the Balance Sheet as at March 31, 2016, the Statement of Income and Expenditure and the Cash Flow Statement for the year then ended, and a summary of significant accounting policies and other explanatory information.

Management's Responsibility for the Financial Statements

The Institutes' Management are responsible for the matters stated in section 134(5) of the Companies Act, 2013 ("the Act") with respect to the preparation of these financial statements that give a true and fair view of the financial position and financial performance of the Institute in accordance with the accounting principles generally accepted in India, including the Accounting Standards specified under Section 133 of the Act, read with Rule 7 of the Companies (Accounts) Rules, 2014. 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; designing, 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.

Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We have taken into account the provisions of the Act, the accounting and auditing standards and matters which are required to be included in the audit report under the provisions of the Act and the Rules made there under.

We conducted our audit in accordance with the Standards on Auditing specified under Section 143(10) of the Act and other applicable authoritative pronouncements issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and the disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material mis-statement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal financial control relevant to the Insitute's preparation of the financial statements that give a true and fair view in order to design audit procedures that are appropriate in the circumstances. An audit also includes evaluating the appropriateness of the accounting policies used and the reasonableness of the accounting estimates made by the Institute's Members, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion on the financial statements.

Opinion

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 Act in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India, of the state of affairs of the Institute as at 31st March, 2016 and its surplus and cash flows for the year ended on that date.

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, 2016 taken on record by the Board of Directors, none of the directors is disqualified as on March 31, 2016 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 Company 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 1st day of September, 2016.

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" or "the Company") as of 31st March, 2016 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 Company 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 company'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 Companies Act, 2013.

Auditors' Responsibility

Our responsibility is to express an opinion on the Company's internal financial controls over financial reporting 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 Companies Act, 2013, 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 internal financial controls system over financial reporting and their operating effectiveness. Our audit of internal financial controls over financial reporting included obtaining an understanding of internal financial controls over financial reporting, 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 qualified audit opinion on the Company's internal financial controls system over financial reporting.

Meaning of Internal Financial Controls over Financial Reporting

A company's internal financial control over financial reporting 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 company's internal financial control over financial reporting 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 company;

(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 company are being made only in accordance with authorizations of management and directors of the company; and

(3) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's 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 internal financial controls over financial reporting, 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 internal financial control over financial reporting 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 Company has, in all material respects, an adequate internal financial controls system over financial reporting and such internal financial controls over financial reporting were operating effectively as at 31st March, 2016, based on the internal control over financial reporting criteria established by the Company 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 1st day of September, 2016.

INDIAN CENTRE FOR SPACE PHYSICS

43 Chalantika, Garia Station Road

Kolkata - 700 084

Balance Sheet as at 31st March, 2016

Funds and Liabilities	Note	As at 31st March 2016	As at 31st March 2015
		(Rs.)	(Rs.)
Capital Fund			
Life Membership Fees	**1**	23,000	23,000
Reserves and Surplus	**2**	10,915,616	9,918,939
		10,938,616	9,941,939
Current Liabilities	**3**	343,410	2,096,220
		343,410	2,096,220
Total		**11,282,026**	**12,038,159**
Assets			
Non-current Assets			
Fixed Assets	**4**		
Tangible		4,051,690	4,103,077
Intangible		92,894	-
		4,144,584	4,103,077
Current Assets			
Cash and Bank Balances	**5**	6,973,255	7,816,021
Short-term Loans and Advances	**6**	164,188	119,061
		7,137,443	7,935,082
Total		**11,282,026**	**12,038,159**
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, 1st day of September, 2016.

For and on behalf of Board of Directors

Sd./- S.K.Chakrabarti
(Honorary Secretary, Indian Centre for Space Physics)

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

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

INDIAN CENTRE FOR SPACE PHYSICS

43 Chalantika, Garia Station Road

Kolkata - 700 084

Statement of Income and Expenditure for the Year Ended 31st March, 2016

Particulars	Note	Year ended 31st March 2016 (Rs.)	Year ended 31st March 2015 (Rs.)
INCOME			
Grants Received	**7**	11,671,525	14,437,670
Other Income	**8**	891,508	660,189
		12,563,033	**15,097,859**
EXPENDITURE			
Employee Benefits Expense	**9**	4,422,670	3,732,336
Depreciation & Amortisation Expenses	**4**	838,442	1,182,949
Other Expenses	**10**	6,181,414	10,167,019
		11,442,526	**15,082,304**
Earlier Year Tax		(123,830)	-
Excess of Income over Expenditure for the year		**996,677**	**15,555**
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, 1st day of September, 2016.

For and on behalf of Board of Directors

Sd./- S.K.Chakrabarti

(Honorary Secretary, Indian Centre for Space Physics)

Sd./- S.Midya

(Honorary Treasurer, Indian Centre for Space Physics)

Sd./- B.B.Bhattacharyya

(Honorary President, Indian Centre for Space Physics)

INDIAN CENTRE FOR SPACE PHYSICS

Chalantika 43, Garia Station Road

Kolkata - 700 084

Cash Flow Statements for the year ended 31st March' 2016

	Year Ended March 31, 2016 (Rs.)	Year Ended March 31, 2015 (Rs.)
A. Cash Flow From Operating Activities:		
Excess of Income over Expenditure	996,677	15,555
Adjustment for:		
Depreciation	838,442	1,182,949
Operating Profit Before Working Capital Changes	1,835,119	1,198,504
Adjustment for:		
Current Assets	(45,127)	(108,311)
Current Liabilities and Provisions	(1,752,809)	(63,510)
Change in Working Capital	(1,797,936)	(171,821)
Cash Flow From Operations	37,182	1,026,683
Net Cash Generated by Operating Activities (A)	**37,182**	**1,026,683**
B. Cash Flow From Investing Activities		
(Purchase of Fixed Assets)	(879,949)	(68,490)
(Investment in)/Maturity of Fixed Deposits	569,695	(2,117,919)
Cash Flow From Investing Activities (B)	**(310,254)**	**(2,186,409)**
C. Cash Flow From Financing Activities		
Membership Fees Received	-	6,500
Cash Flow From Financing Activities (C)	**-**	**6,500**
D. Net Increase/(Decrease) in Cash and Cash Equivalents (A+B+C)	(273,071)	(1,153,226)
E. Opening Balance of Cash and Cash Equivalents	954,985	2,108,211
F. Closing Balance of Cash and Cash Equivalents (D+E)	**681,914**	**954,985**

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, 1st day of September, 2016.

Sd./- S.K.Chakrabarti
(Honorary Secretary, Indian Centre for Space Physics)

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

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

INDIAN CENTRE FOR SPACE PHYSICS

43 Chalantika, Garia Station Road

Kolkata- 700084

Notes to Financial Statements

Particulars		31.03.2016 (Rs.)		31.03.2015 (Rs.)
Note-1				
Life Membership Fees				
Life Membership Fees		23,000		23,000
[`500/- for Forty Six members]				
		23,000		**23,000**
Note-2				
Reserves and Surplus				
Opening Balance		9,918,939		11,386,383
Add: Excess of Income over Expenditure		996,677		15,555
(Less: Adjustment relating to Fixed Assets)		-		(1,482,999)
[Refer Note 4]				
		10,915,616		**9,918,939**
Note-3				
Current Liabilities				
Unutilised Grants *				
EMJDP, Italy		13,155		23,459
MoES, Delhi		-		1,907,544
DST-FTYS, Delhi		128,727		-
ICTP, Italy		54,137		118,368
ISRO Projects, Bangalore		133,591		35,449
Other Payables				
Liabilities for Expenses		13,800		11,400
*** Refer Note-11 below**		**343,410**		**2,096,220**
Note-4				
Fixed Assets - Refer Next Page				
Note-5				
Cash & Bank Balances				
Cash & Cash Equivalents				
Cash in hand	14,768		14,330	
Axis Bank Ltd.	656,792		931,609	
Central Co-operative Bank Ltd.	10,354	681,914	9,046	954,985
Other Bank Balances				
Fixed Deposits with Banks		6,291,341		6,861,036
		6,973,255		**7,816,021**
Note-6				
Short-term Loans and Advances				
Security Deposits		5,100		5,100
Advance to Employees		7,000		6,000
Balance with Revenue Authorities		102,979		39,230
Advances recoverable in cash or in kind or for		49,109		68,731
		164,188		**119,061**

Note-7

Grant Received

Grant-in-Aid	11,671,525	14,437,670
	11,671,525	**14,437,670**

Note-8

Other Income

Guest House Rent	18,900	52,400
Interest on Fixed Deposits	632,564	606,478
Interest on Bank Deposits	366	-
Misc. Income	239,678	1,311
	891,508	**660,189**

Note-9

Employee Benefits Expense

Salaries & Stipend	4,112,814	3,537,603
Contribution to Pension Fund	309,856	194,733
	4,422,670	**3,732,336**

Note-10

Other Expenses

Fund draw for Project Expenses	4,888,524	6,699,067
Office Expenses	286,394	2,716,531
Statutory Audit Fees	11,500	11,400
Postage	26,122	2,378
Travelling & Conveyance	293,123	240,197
Telephone, Fax & Internet	78,250	73,288
Printing & Stationary	129,988	39,342
Professional Fees	52,177	8,000
Rent & Electricity	409,955	373,110
Miscellaneous Expenses	5,381	3,706
	6,181,414	**10,167,019**

Note-11

Details of Grants Utilised

Particulars	**Opening**	**Funds Received**	**Funds Utilised**	**Balance Unutilised**
EMJDP, Italy	23,459	-	10,304	13,155
CSIR PROJECT, Delhi	(1,133)	73,505	73,997	(1,625)
West Bengal Government	-	6,588,490	6,588,490	-
MoES, Delhi	1,907,544	3,090,560	4,869,377	128,727
DST-FTYS, Delhi	(67,598)	900,000	879,886	(47,484)
ICTP, Italy	118,368	400,970	465,200	54,137
ISRO Projects, Bangalore	35,449	618,000	519,858	133,591
	2,016,089	**11,671,525**	**13,407,112**	**280,501**

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 u/s 8 (originally known as u/s 25 of the Companies Act, 1956) of the Companies Act, 2013 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 have 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 Benefit

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 periodical duration subject to their good performance. Being an Autonomus 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 year's figures have been regrouped/reclassified wherever necessary to correspond with the current year's classification/disclosure.

INDIAN CENTRE FOR SPACE PHYSICS

Chalantika 43, Garia Station Road

Kolkata - 700 084

Amount in Rs.

Note-4

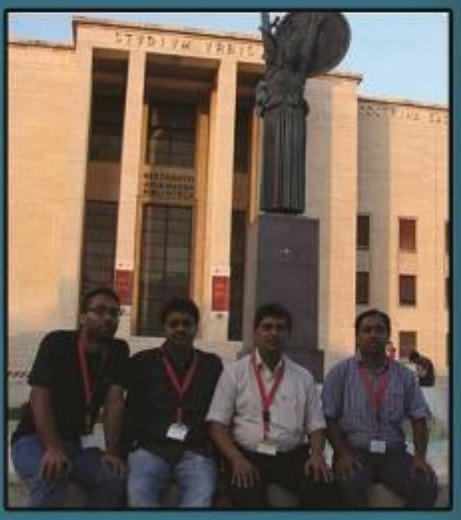
Fixed Assets

Particulars	Gross Block				Depreciation				Net Block	
	As on 01.04.15	Addition during the year	Sale during the year	As on 31.03.16	As on 01.04.15	During the year	Adjustment*	As on 31.03.16	As on 31.03.16	As on 31.03.15
Tangible										
Computers	1,484,844	55,548	-	1,540,392	1,368,367	69,822	-	1,438,189	102,203	116,477
Furniture	123,371	-	-	123,371	117,203	-	-	117,203	6,168	6,168
Office Equipment	53,758	-	-	53,758	51,072	-	-	51,072	2,686	2,686
Scientific Equipment	3,743,634	-	-	3,743,634	1,631,799	552,651	-	2,184,450	1,559,185	2,111,836
Boundary Wall	1,338,020	-	-	1,338,020	133,287	64,074	-	197,361	1,140,659	1,204,733
Land * #	-	-	-	-	-	-	-	-	-	-
Expansion of laboratory	-	708,283	-	708,283	-	-	-	-	708,283	-
Development of land	308,380	-	-	308,380	-	-	-	-	308,380	308,380
Car	161,794	-	-	161,794	84,818	41,774	-	126,592	35,202	76,976
Books	76,045	-	-	76,045	68,984	2,135	-	71,119	4,926	7,061
Electrical Items	432,740	-	-	432,740	163,980	84,762	-	248,742	183,998	268,760
Current Year	**7,722,586**	**763,831**	-	**8,486,417**	**3,619,509**	**815,218**	-	**4,434,727**	**4,051,690**	**4,103,077**
Intangible										
Software	-	116,118	-	116,118	-	23,224	-	23,224	92,894	-
Current Year		**116,118**	-	**116,118**	-	**23,224**	-	**23,224**	**92,894**	-
Current Year Total	**7,722,586**	**879,949**	-	**8,602,535**	**3,619,509**	**838,442**	-	**4,457,950**	**4,144,584**	**4,103,077**
Previous Year Total	**7,654,096**	**68,490**	-	**7,722,586**	**953,561**	**1,182,949**	**1,482,999**	**3,619,509**	**4,103,077**	**6,700,535**

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

0.25 acres from private donation.

Prof. Sandip K. Chakrabarti awarded DSc. (Honoris Causa) from University of Gourbanga at the Convocation in December, 2015 (Left). Dr. Santanu Mondal received his Ph.D. certificate from the Vice-Chancellor of Calcutta University (Right).



Dr. Dipak Debnath, Dr. Partha Sarathi Pal and Dr. Tilak B. Katoch at TIFR Balloon Facility, Hyderabad (Left). A group of ICSP scientists participated RETCO-II conference at ARIES, Nainital (Middle). Dr. Chandra Bahadur Singh, Dr. Broja Gopal Dutta, Prof. Sandip K. Chakrabarti and Dr. Dipak Debnath participated MG14 in Rome, Italy (Right).

The entrance gate of ICSP on eastern bypass where new buildings are planned (Left). The laboratory building at IERC/ICSP Sitapur (Right).