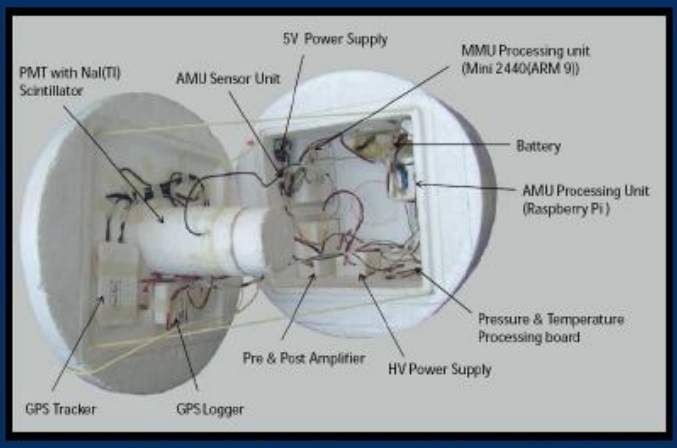
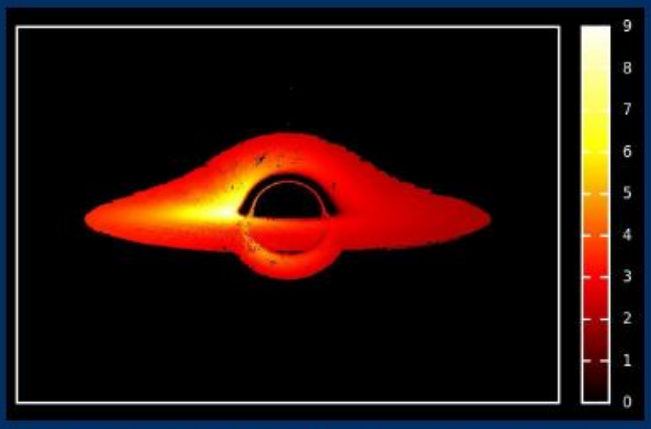
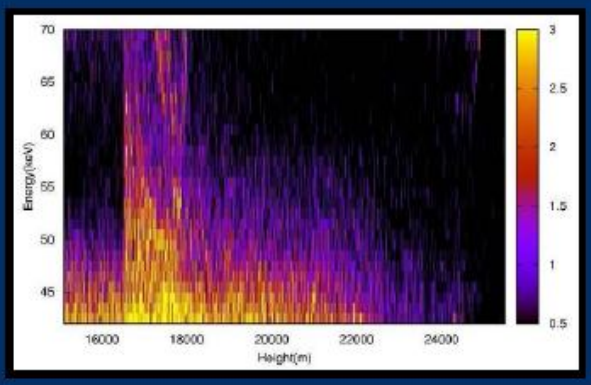
Indian Centre for Space Physics

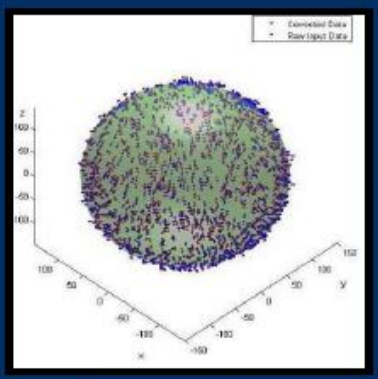
Annual Report
(2013-2014)



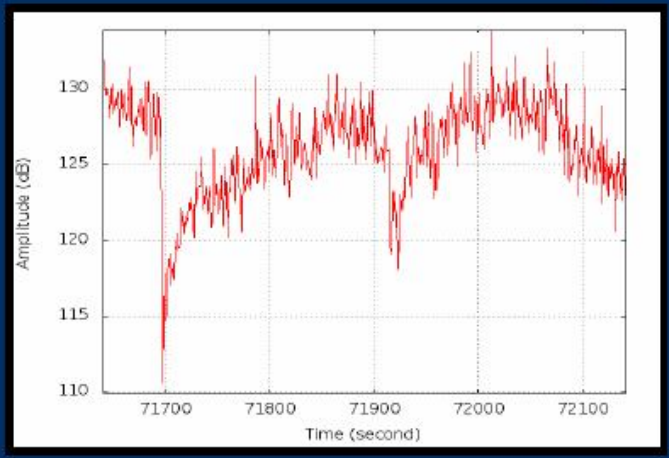


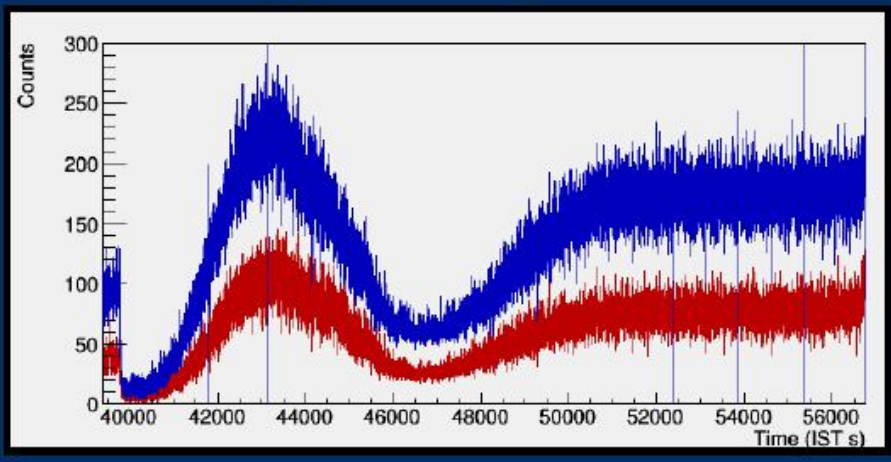
A typical balloon borne payload with its components (Left). This is how a Keplerian Disk around a black hole would look in a X-ray camera: White/Yellow in harder X-rays and Red in softer X-rays (Right).



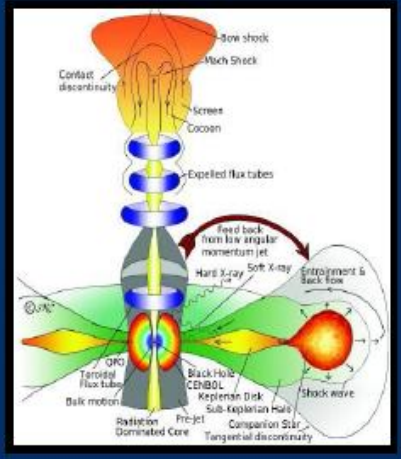


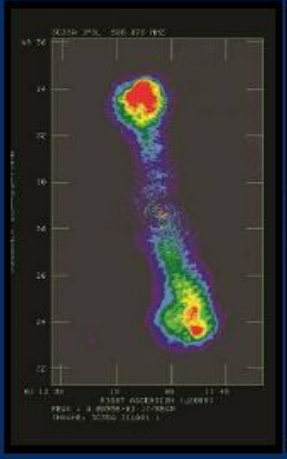
A dynamical spectrum of a strong solar flare detected in our D37 mission (Left). Magnetometer calibration (Middle). A pole antenna used for VLF data at Kochbehar (Right).

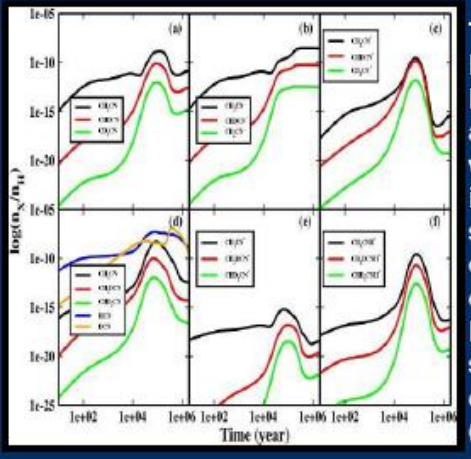




A couple of LEP events detected by our IERC campus antennas (Left). Light curves obtained from a typical double balloon launch showing Pfotzer maximum in the ascending phase and constant count at a given height when orbiter floats it constant height in the descending phase (red: up to 130keV, blue: all counts) (Right).







Two Component Advective Flow solution around a black hole on which the black hole astrophysics group is working. Observational data is being matched with this solution (Left). GMRT image of 3C35A at 610MHz taken by our Scientists (Middle). Evolution of some Deuterated species formation in a collapsing interstellar cloud (Right).

INDIAN CENTRE FOR SPACE PHYSICS
ANNUAL REPORT
(2013-2014)

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Computer room: 25
Department of High Energy Radiation: 26
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Front Cover: Superposed photos of the earth taken from a camera on board a balloon borne mission and the sky at Ionospheric and Earthquake Research Center of ICSP taken by Mr. R. Khan using ICSP 10" telescope.
Back Cover: Estimated location of the Gamma Ray Burst GRB 131024C discovered by ICSP Dignity 45 Mission as seen on this skychart drawn using Stellarium programme. The light curve and the spectrum are also shown

Report of the Governing Body

This is the Fifteenth Annual report of our Centre. The Center is rapidly progressing in the four major directions which have been its prime focus of research activities, namely, astrochemistry/astrobiology; ionospheric science and earthquake precursor studies, theoretical studies of sources of high energy radiation and balloon borne studies of space weather and high energy phenomena. All these topics bridge the gap between the Earth and the Universe. Our goal has been to investigate Earth as A Planet and not as The Planet.

The balloon flight programme has been very active in the 2013-2014, since 25 Missions were carried out with several payloads of up to 4.9 kilograms. Many solar flares have been caught in X-rays and gamma rays. A Gamma Ray Burst (GRB 131024C) was discovered (back cover of this report) and excess radiations were detected on several occasions at a height of 16-17km which are indicative of possible nuclear tests. ICSP pioneered a technique with double balloon configuration where the payload floats with the orbiter is left in the orbit by a launcher (booster). This enabled us to obtain very long duration data. The payloads are returned back to the earth by parachutes. Malda branch members assisted us in recovering one such payload from Godda of Jharkhand. Important results were presented in European Balloon and Rocket Programme conference in Switzerland.

Computation of abundances of complex pre-biotic molecules in interstellar space has been a goal since inception of the Center and its founders first asked the question: Can DNA constituents be formed during collapsing cloud and star forming region? We are happy to report that we have a strong group of scientists answering precisely this question. If required, reaction cross-sections required to form complex molecules are also computed by quantum chemical method and are deposited for world wide use in various databanks. Collaborations with scientists in various countries have started in full swing in order to study hydro-chemical evolution in presence of magnetic fields. Several projects have been written.

In the field of ionospheric science, a numerical procedure combining Geant4 simulation and LWPC code which treats the Earth as a gigantic detector, yielded exciting results were obtained on the sluggishness of any high energy radiation impinging on the atmosphere, such as solar flares and gamma ray bursts. Very Low Frequency signals testifying Lightning induced Electron Precipitation (LEP) events are regularly observed in our IERC, Sitapur (Midnapur) and Coochbehar Centres. VLF data obtained by our scientists at Maitri station has been analyzed satisfactorily. Several papers showing correlations between VLF signal anomaly and earthquakes have been completed.

Theoretical studies on sources of high energy radiation include finding in spectral and temporal properties of X-rays produced close to compact objects such as black holes. The theoretical solution from this group has now been successfully implemented in NASA's most used XSPEC programme so that others may also use this 'only Indian' solution in analyzing X-ray results of any compact object.

As usual, ICSP trained many students, both at MSc level and PhD level last year. Ten students from various colleges carried out their M. Sc. projects at ICSP. A Nepalese citizen named Chandra Bahadur Singh (ICTP Fellow) received his PhD degree (Jadavpur University) and has joined University of Sao Paolo (Brazil) as a Post Doctoral Fellow. We received funds to recruit one more Nepalese citizen in our PhD programme. Our students Sujay Pal, Sudipta Sasmal, Partha S. Pal, Sourav Palit have received PhD degree. Liton Majumdar, Suman Ray and Sushanta Mondal have submitted PhD thesis.
The Malda branch of ICSP has been very active and its scientists Dr. Achintya Chatterjee, Mr. Asit Kumar Choudhury, Mr. Wasim Bari have been doing a commendable job. Similarly, Mr. Bakul Das has been receiving excellent VLF data regularly at Coochbehar using an Electric pole antenna.
The Government of West Bengal and the Central Government funding agencies, such as MoES, DST, ISRO and CSIR have been funding various projects of ICSP. We sincerely thank them for all the encouraging support. I thank computer assistant Mr. Jyotisman Moitra for designing the cover page.

Prof. S.K. Chakrabarti, Honorary General Secretary
Indian Centre for Space Physics Kolkata: September 21, 2014

Governing Body (GB) of the Centre

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Prof. Sandip K. Chakrabarti, Secretary
Mr. P. Bandyopadhyay, Treasurer
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Dr. Ankan Das (Convenor)
Dr. Sabyasachi Pal
Mr. Debashis Bhowmick

In-Charge, Academic Affairs (Honorary)

Prof. Sandip K. Chakrabarti (Tel. : +91 33 24366003 / 24622153,
Email: sandip@csp.res.in / sandipchakrabarti9@gmail.com)

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Dr. Dipak Debnath (Tel.: +91 33 24366003 / 24622153 Extn: 26,
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Public Information Officer

Mr. Rajkumar Maiti (Tel.: +91 33 24366003 / 24622153 Extn: 23,
Email: rajkumar@csp.res.in / rajkumarmaiti24@gmail.com)

In Charge of the Departments

Ankan Das	Department of Astrochemistry / Astrobiology
Dipak Debnath	Department of High Energy Astrophysics
Sujay Pal	Ionospheric Science
Debashis Bhowmick	X-ray Laboratory

Faculty Members

Dr. Ankan Das	Assistant Professor
Dr. D. Debnath	Assistant Professor
Dr. Ritabrata Sarkar	Assistant Professor

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Dr. S. K. Chakrabarti, SNBNCBS	In-Charge, Academic Affairs
Dr. S. Chakrabarti, M. M. Chandra College	Hony. Assoc. Professor
Dr. S. C. Chakravarty, EX-ISRO	Hony. Senior Professor
Dr. A. K. Chatterjee, Malda College	Hony. Scientist
Dr. R. Chattopadhyay, Haripal Instituion	Hony. Scientist
Dr. T. K. Das, Narasimha Dutta College	Hony. Assoc. Professor
Dr. P. K. Jana, Panipukur B.Ed. College	Hony. Scientist
Dr. M. M. Majumdar, DPI	Hony. Scientist
Dr. S. K. Midya, Calcutta University	Hony. Assoc. Professor
Dr. G. Tarafdar, Barasat Govt. College	Hony. Scientist

Project Scientists

Dr. Sabyasachi Pal (MoES) Dr. Sourav Palit (MoES) Dr. Sujay Pal (MoES)
Dr. Sudipta Sasmal (MoES) Mr. Liton Majumdar (MoES)

Post Doctoral Fellows

Dr. Himadri Ghosh (MoES)

Senior Research Fellows

Mr. Santanu Mondal (CSIR)

Junior Research Fellows

Mr. Rajdeep Saha (DST)
Mr. Dipen Sahu (ISRO)
Mr. Arka Chatterjee (MoES)
Mr. Dusmanta Patra (MoES)
Mr. Shounak Ghosh (MoES)
Md. Aslam Ali Molla (DST)
Mr. Suman Chakraborty (MoES)

ICTP Senior Research Fellow

Mr. Chandra Bahadur Singh (ICTP)

Visiting Research Fellows

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

Engineers / Laboratory Staff

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

Office Staff




Mr. Rajkumar Maiti (Accountant/ Office Assistant)
Mr.Jyotisman Moitra (Computer Assistant)
Mr. Ram Chandra Das (Office Helper)
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 512 Kbps 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 uninterrupted power supply and solar panels.

Facilities at other branches of the Centre:

IERC at Sitapur: The Ionospheric and Earthquake Research Centre (IERC) for studying VLF, radio and optical astronomy was inaugurated at Sitapur, Paschim Medinipur, West Bengal on 22nd January 2012. It has computing and internet facilities, VLF antennas and receivers, Radio Dish antenna; 10" Meade Optical Telescope and Two element interferometer. It has a guest house. Solar power for electricity and submersible pump for water supply keep this remote Centre running round the clock.

Balloon Facility at Bolpur: 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.

ICSP branch at Malda: The 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 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 data from various transmitters around the globe.

Brief Profiles of the Scientists of the Centre

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.

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. Wasim ul Bari: He is a Teacher in Malda and is an honorary Junior Research Fellow at ICSP, Malda branch. He works on VLF studies of ionosphere and also data analysis of NASA/ISRO satellites.

Mr. K. Chakrabarti: He is an Associate Professor at Hooghly Mahsin College and is an honorary Senior Research fellow of ICSP. He is working on similarities of accretion flows around black holes and fluid dynamics in a converging-diverging duct.

Mr. K. K. Chakrabarti: He was the Director of Positional Astronomy Center. His field of interest is the cause of Cyclonic activities. He is in the Research Advisory Committee.

Prof. Sandip K. Chakrabarti: He is a Senior Professor and HoD, Astrophysics & Cosmology of S.N. Bose National Centre for Basic Sciences and an honorary Professor, 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 very low frequency radio waves; Chemical Evolution of star forming regions.

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. Subhankar Chakraborty: He is a junior hardware engineer at ICSP and is involved in ICSP activities for software developments for balloon experiments.

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

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. R. Chattopadhyay: He is a Teacher at Haripal G. D. Institution. His research work includes Airglow and Ozone depletion.

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

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

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

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.

Dr. Dipak Debnath: He is an Assistant Professor and HoD of High Energy Astrophysics Department of the ICSP. His main research interest is observational and theoretical studies of properties of transient stellar mass black hole candidates during their outbursts.

Dr. Broja G. Dutta: He is an Assistant Professor at Y. S. Palpara College, Purba Medinipur and has completed his Ph.D. as a "Teacher Fellow" at ICSP under "Faculty Improvement Programme" of UGC. He is working on the data analysis of X-ray emission from accretion disks around black holes.

Dr. Himadri Ghosh: He is a post-doctoral research fellow at ICSP. He is working on analytical modeling and numerical simulations of physics around black holes. He is also working on evolution of spectra during star formation.

Mr. Sounak Ghosh: He is a Junior Research Fellow working under MoES project He is working on observational studies on cosmic sources of high energy radiation in X-Ray energy band.

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.

Mr. Tilak C. Katoch: He is an honorary Senior Research Fellow (SRF) and is working on the observation of solar flares by RT-2 satellites. He is a Technical staff in X-ray Astronomy group of TIFR.

Mr. R. Khan: He is a Teacher of Bidhan Nagar Govt. High School and is involved in activities of the ICSP observatories. He is in charge of the training with IERC Optical Telescope.

Mr. Surya Maji: He is a Teaching in a school and an honorary Senior Research Fellow at IERC/ICSP. He works on the effects of eclipse on VLF signals.

Mr. Liton Majumdar: He is a Project Scientist (MoES) in Astrochemistry/Astrobiology. He is working on quantum chemical calculation of reaction cross sections and the evolution of complex molecules in star forming regions.

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.

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

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

Mr. Santanu Mondal: He is a CSIR Senior Research 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. Sushanta K. Mondal: He is a visiting scientist of VLF group. He is an Assistant Professor at S.K.B.M. University, Purulia.

Mr. Pikesh Pal: He is a Junior Research Fellow posted at IERC of ICSP working in an MoES project. He is working on the earthquake prediction studies using VLF signal amplitude and phase anomalies.

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.

Dr. Sujay Pal: He is a project-scientist 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.

Dr. Sourav Palit: He is a project-scientist at ICSP. He is involved on GEANT-4 simulations of solar-terrestrial interactions and interpretation of VLF data.

Mr. Suman Ray: He is working as a honorary visiting scientist. He is in the VLF group and is working on the earthquake related anomalies of VLF signals.

Dr. Chandra B. Singh: He is an ICTP supported Senior Research Fellow. He is working on computation of outflow rates from accretion disks around black holes.

Mr. Rajdeep Saha: He is a DST project research scholar and is working on theoretical studies in Astrochemistry/Astrobiology as a Junior Research Fellow.

Mr. Dipen Sahu: He is an ISRO-RESPOND project research scholar in Astrochemistry/ Astrobiology and is working on deuterated species formation in star forming regions.

Dr. Ritabrata Sarkar: He is an Assistant Professor at ICSP. He is mainly analyzing the data of balloon borne experiments which includes corrections due to atmosphere and instrumental effects.

Dr. Sudipta Sasmal: He is a Project Scientist working at ICSP. He is working on the study of earthquake precursors using VLF data.

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

Research Work Published/Accepted for Publication

Basak, T., Chakrabarti, S.K., 2013, “Effective recombination coefficient and solar zenith angle effects on low-latitude D-region ionosphere evaluated from VLF signal amplitude and its time delay during X-ray solar flares”, Ap & SS, 348, 315.

Chakrabarti, S. K., Bhowmick, D., Chakraborty, S., Palit, S., Mondal, S. K., Bhattacharya, A., Midya., S., Chakrabarti., S., "Study of properties of cosmic rays and solar X-ray flares by balloon borne experiments" Indian Journal of Physics (in press).

Chakrabarti, **S. K.,** 2013, "Golden Jubilee Year of Stanley Miller Experiment and Chemical Evolution and Origin of Life", AIP conference proceedings No. 1543 on 'Chemical Evolution of Star Forming Regions and Origin of Life' (AIP: New York).

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Chandra, I., Sirothia, S., Wadadekar, Y., Pal, **S.,** "High redshift radio galaxies from DEEP2 Fields", Proceedings of The Metre wavelength Sky: Celebrating 50 years of radio astronomy at TIFR and 10 years of GMRT. The conference was held in NCRA-TIFR, Pune (9-13 December 2013).

Choudhury, A. K. and **Chatterjee, A. K. ,** "Monitoring of Sudden Ionospheric Disturbances with Very Low Frequency Signal", by ICSP Malda Branch authored by has been published in Ind. J. Mul. Acad. Res. 1, 2014, 31-37 (ISSN No. - 2347-9884).

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Das, A., Chakrabarti, S. K., Acharyya, K., Chakrabarti, **S.,** 2013, "Methanol formation around the star forming region", AIP conference proceedings No. 1543 on 'Chemical Evolution of Star Forming Regions and Origin of Life' (AIP: New York).

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Debnath, D., Chakrabarti, S.K., Nandi, A., 2013, "Evolution of the temporal and the Spectral Properties in 2010 and 2011 outbursts of H 1743-322", Advances of Space Research, 52, 2143.

Debnath, D., Chakrabarti, S. K., Mondal, S., 2013, "Proc. of Recent Trends in the Study of Compact Objects: Theory and Observation", at IIT Guwahati, Assam, India, ASI Conference Series, Ed. Das, S., Nandi, A. & Chattopadhyay, I., vol. 8, p.85.

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Debnath, D., Chakrabarti, S. K., & Santanu Mondal, “Implementation of Two Component Advective Flow Solution in XSPEC”, 2014, MNRAS (In Press).

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Books and In Books

"First International Conference on Chemical Evolution of Star Forming Region and Origin of Life" (ASTROCHEM2012) Eds. **S.K. Chakrabarti, K. Acharya and A. Das** (AIP, New York).

"ICSP Detections of Anomalous VLF Radio Wave Signal Prior to Major Earthquakes"**, S. K. Chakrabarti, S. Sasmal, S. Ray in "Earthquake Prediction Studies Seismo Electromagnetics"** Ed. M. Hayakawa, Terrapub, 2013.

Members of Scientific Societies/Committees

Sandip K. Chakrabarti became a member of the following i) International coordination committee of "13th Marcel Grossman Conference on General Relativity and Cosmology", Stockholm, July, 2012; ii) Scientific Advisory Committee: "Recent Trends of Compact Objects (RETCO)", Guwahati, March, 2013; iii) Editorial Board member: Indian Journal of Physics and Bulletin of Astronomical Society of India; v) Scientific Organizers of Three sessions in COSPAR 2012 General Assembly (C0.4, E1.2, F3.5), Mysore, July, 2012. He is also the Head of i) Dept. of Astrophysics and Cosmology; ii) Academic and Research Advisory Committee (ARPAC); iii) Departmental Research Committee (DRC); iv) Consultative Advisory Committee (CAC); v) Students' curriculum and Research Evaluation Committee (SCREC); vi) Library and several other committees of the S. N. Bose National Centre for Basic Sciences, Kolkata. He is the In Charge, Academic Affairs and General Secretary of the Governing Body; and the Chairman of the Academic Council of the Centre.

Ph.D. Degree Received

Sourav Palit received PhD degree on Study of Some X-ray imaging Devices in X-ray Astronomy (Jadavpur University)

Sudipta Sasmal received PhD degree on Study of Terrestrial and Solar Energetic Phenomena through propagation characteristics of Very Low Frequency (VLF) Waves (Jadavpur University)

Sujay Pal received PhD degree on Numerical Modelling of VLF Radio Wave Propagation through Earth-Ionosphere Waveguide and its Application to Sudden Ionospheric Disturbances (University of Calcutta)

Chandra Bahadur Singh received PhD degree on Numerical Modeling of VLF Radio Wave Propagation through Earth-Ionosphere Waveguide and its Application to Sudden Ionospheric Disturbances (Jadavpur University).

Ph.D. Thesis Submitted

Suman Ray submitted PhD thesis on "Study of Very Low Frequency (VLF) Radio Wave Propagation in Earth-Ionosphere Wave-Guide and its Applications for Possible Correlations of VLF Signal Anomalies with Seismicity" (University of Calcutta).

Liton Majumdar submitted PhD thesis on **"**Hydrodynamics and Evolving Composition of the Collapsing Interstellar Clouds" (University of Calcutta).

Sushanta K. Mondal submitted PhD thesis on "Study of High Energy Phenomena in the Universe using Earth's ionosphere as a detector" (Jadavpur University).

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: **June, 2013:** "*Latest Developments of the Black Hole Accretion Flow Dynamics", Two Lectures at* ICRANET, Pescara Italy, "*Low Cost Balloon flight programme of Indian Centre for Space Physics" at 21st conference on the European balloon and rocket programme,* Thun, Switzerland"; **September 2013:** "*Predictability of Two Component Advective Flow Solution" An Invited Talk at the conference on 'Accretion of Black Holes' at International Centre, Goa* "; **January 2014:** Two talks on "*Earth as a Gigantic detector: GEANT4/LWPC simulation of X-ray detection and comparison with observation" and "Propagation Effects of VLF signals in Earth-Ionosphere waveguide during the eclipses of July 2009 and January, 2010"* and two posters on "*Effective recombination coefficient and solar zenith angle effects on low-latitude D-region ionosphere evaluated from VLF signal amplitude and its time delay during X-ray solar flares' and 'Study of Precursors of Earthquakes from Indian Centre for Space Physics"* at VERSIM-6 conference at the University of Otago, New Zealand;

March 2014: An invited talk on "Comptonization in Black Hole Accretion and Zeldovich's contribution"at National Academy of Science, Minsk, Belarus.

Ankan Das gave oral presentations on *"Chemical composition of the Interstellar Molecular cloud*," **November, 2013**, PRL, Ahmedabad; on *"Chemical composition of the interstellar dust and deuterium enrichment of the ISM*" in "Light Scattering techniques and application to Astronomy and other areas", 19-21st , **November, 2013**, S. N. Bose National Centre for Basic Sciences, Kolkata; on "*Deuterium enrichment of the ISM",* Respond review meeting, **February 2014** PRL Ahmedabad; on "*Origin of Life*", Golden Jubilee Celebration Panchberia Sunrise Club, Panchberia, Midnapore(W), in **January, 2014**, at Khukurdaha, Midnapur (W), West Bengal.

Dipak Debnath gave oral presentations on "*Study of the Timing and Spectral properties of H 1743-322 using XMM Newton data (Observation Id: 055411020)*" at International workshop on "*COSPAR Capacity Building Workshop on High Energy Astrophysics*" at Xuyi Observatory Station (XOS), Jiangsu Province, China, **September, 2013**.

Liton Majumdar gave oral presentations on "Role of interstellar dusts towards the chemical enrichment of the ISM", "Light Scattering Techniques and Application to Astronomy and other Areas" in S.N.Bose National Centre for Basic Sciences, Kolkata, **November, 2013**. He and **Dr. A. Das** visited PRL, Ahmedabad for performing an experiment on IR spectroscopic studies of various interstellar molecules on cold astrochemical dust analogs at Low temperature Astrochemistry Lab in Nov, 2013.

Santanu Mondal attended an workshop on *"High-Energy Astrophysics": An Advanced School for Asian Astronomers, A COSPAR Capacity Building Workshop and gave an oral presentation on "X-Ray Spectrum of the Black Hole Candidate Swift J1753.5-0127 Using XMM-Newton Data" at Xuyi Observatory Station, Jiangsu, China in* ***September 2013***.

Arka Chatterjee gave an oral presentation on *"spectral study of H 1743-322 with TCAF: Determination of Mass Using LFQPO Technique, at "Accretion onto a Black Hole" conference at TIFR Goa,* ***November 2013***.

Suman Ray presented a talk on "Study of ionospheric behaviour during total solar eclipse of July 2009 using the Characteristic of Very Low Frequency (VLF) signals'', Physical Research Laboratory (PRL), Ahmedabad, **February, 2014**.

Sabyasachi Pal and **Dushmanta Patra**, visited National Centre for Radio Astrophysics, Tata Institute of Fundamental Research in connection with observation with GMRT.

Conference organized

An Internal workshop "Recent Progress in VLF/Radio", was organized at IERC, Sitapur, 29th December 2013 by Dr. Sabyasachi Pal.

Visits abroad from the Centre

Sandip K. Chakrabarti made academic visits to International Centre for Relativistic Astrophysics, Pescara (Italy) and Thun (Switzerland) in **June, 2013**; University of Otago and University of Christchurch (New Zealand) in **January, 2014** and National Academy of Sciences, Minsk (Belarus) in **March, 2013**.

Dipak Debnath and **Santanu Mondal** visited Xuyi Observatory (China) to attend a capacity building workshop in **September 2013**.

Ritabrata Sarkar joined back ICSP after spending two years at INFN, Trieste (Italy).

Major visitors to the Centre

Professor Dinshaw Balsara (University of Notre Dame, USA) interacted with the scientists of the Centre and gave a seminar on MHD simulations in Astrophysics (January, 2014).

Collaborative research & project work

Study of the Interstellar process leading to the deuterium enrichment, A. Das (ICSP), S.K. Chakrabarti (SNBNCBS and ICSP), D. Sahu (ICSP): Funded by RESPOND (ISRO)

Abstract: Magnetic fields control star formation rate in ISM. To have an idea about strength of magnetic field, it is essential to extract an information about degree of ionization of ISM. In this project, we are trying to explore various possibilities to co-relate deuterium fractionation with degree of ionization of ISM. Armed with degree of ionization, we want to construct a hydro-chemical model to study chemical evolution under these circumstances. Moreover, spectral properties of several deuterated molecules will be theoretically explored by quantum chemical simulation.

M.Sc. projects guided by ICSP members

1. **Dr. Dipak Debnath** supervised Subhasish Saha and Iman Barik of Ramakrishna Mission Residential College (Auton.), Narendrapur, Kolkata, for their M.Sc. project works entitled "Spectral property study of H 1743-322 during its early phase of 2003 outburst" and "Temporal property study of H 1743-322 during early phase of 2003 outburst" respectively.

2. **Dr. Sujay Pal** supervised Bikash Dolai and Pranay Bera of Contai P.K. College in an M. Sc. project work titled "Remote Sensing of Planetary Wave Type Oscillations (PWTOs) in the mesosphere-ionosphere system using the Very Low Frequency transmitter data".

3. **Dr. Sudipta Sasmal** supervised Mr. Debkumar and Mr. Soumen Mazumder from P. K. College, Contai, Midnapore (E), for their M.Sc project titled " Study of Seismo-Ionospheric Correlations using Anomalous Characteristics of Very Low Frequency (VLF) Wave Propagation for Different Propagation Path."

4. **Dr. Sourav Palit** supervised Suvankar Manna and Koushik Sanfui of Ramakrishna Mission Residential College (Auton.), Narendrapur, Kolkata, for their M.Sc. project works entitled "Effect of Solar flare on lower ionospheric and VLF propagation, finding reflection height" and "Solar flare effect on lower ionosphere, analysis of peak time delay in electron density" respectively.

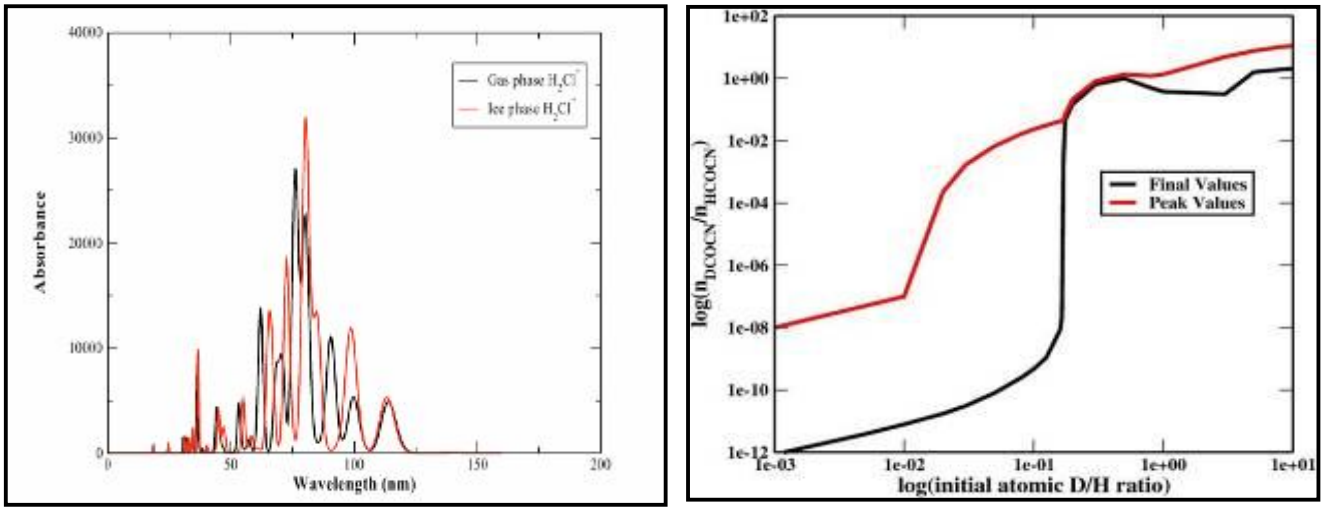
5. **Dr. Ankan Das** supervised Prasanta Gorai and Soumyadip Mondal of Ramakrishna Mission Residential College (Auton.), Narendrapur, Kolkata, for their M.Sc. project works on "Correlattion of Ionization Degree of Interstellar Medium with Deuterium enrichment of Interstellar ions and using CASSIS spectrum analyzer for calculating various spectral aspects of these interstellar ions" and "Study the chemical evolution and spectral properties of HCO+ and HCN which are found to be coexistent in molecular clouds and have systematic line width differences" respectively.

Astrobiology/Astrochemistry

Top: (L to R): A.Das, S.Chakrabarti and S.K.Chakrabarti
Bottom: (L to R): L. Majumdar, R.Saha, and D.Sahu

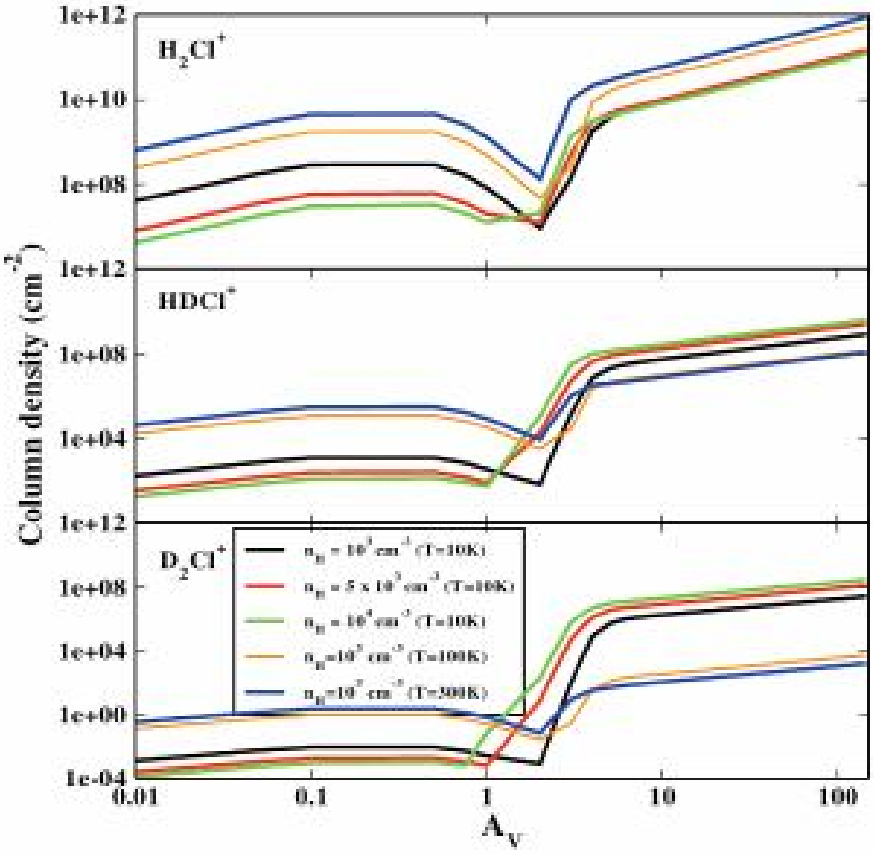
Indian Centre for Space Physics concentrates on a very important aspect of Earth system science by seeking an answer to questions: how generic is the Earth as a habitable planet? Why Earth was suitable for life form? Can complex bio-molecules, which are pre-cursors to lives, be formed in other proto-stellar systems? Can we quantify how much amount of complex molecules could be formed? Can the age of these proto-stellar systems be determined from the amount of deuterated species in which Hydrogen atom in molecules are replaced by Deuterium?

To this effect, our major work so far has been to compute chemical evolutions of over 600 species which make an interstellar medium which a star with a proto-disk is being formed. In this venture we have developed three sophisticated codes: (i) A time dependent hydrodynamic code to follow the collapse of clouds into a proto-star; (ii) A Monte-Carlo simulation to produce lighter molecules through grain phase chemistry and (iii) A chemical evolution code in the gas phase to track time dependence of the mass fractions of various species. For these, we require cross-sections of various reactions and these are computed using quantum calculations using Gaussian Software. Another aspect we are looking at is the intensity of rotational/vibrational lines emitted from a cloud. We also comparing our predicted results with observed results, wherever available. Comparisons with experimental results are being done as well.

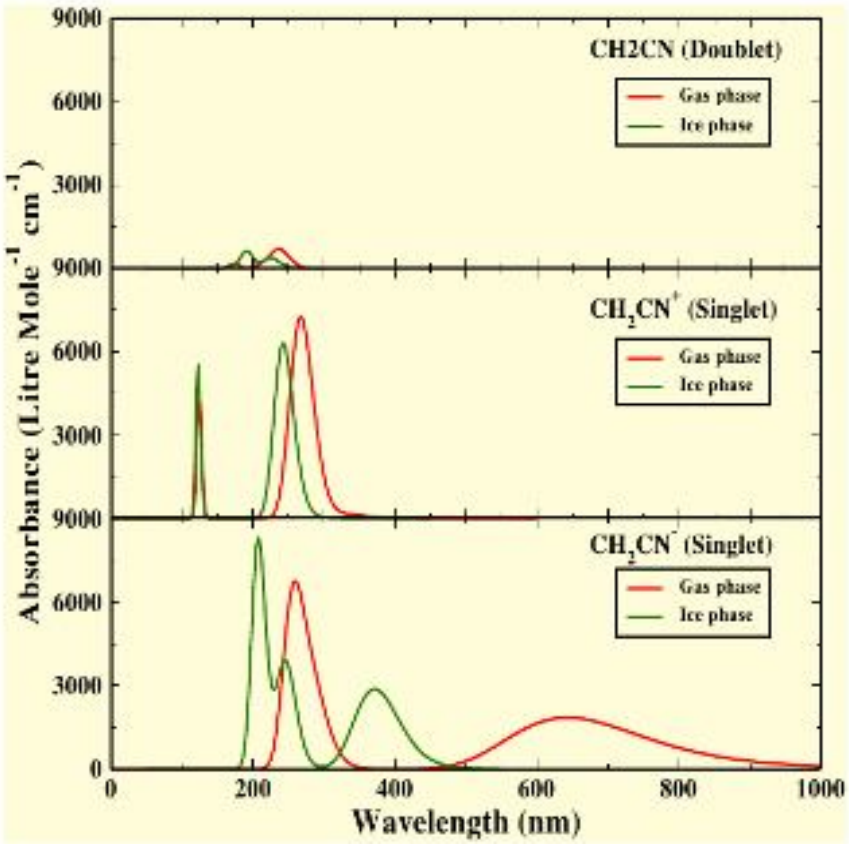


Electronic adsorption spectrum of H_2Cl+ in gas phase and in ice phase (left). Deuterium fractionation of HCOCN as a function of the initial atomic D/H ratio (right).

Cyanomethyl anions CH_2CN^- are thought to be carriers of many poorly characterized diffuse interstellar bands. We study spectroscopic characteristics of various forms of CH_2CN, including its deuterated counterparts in the interstellar medium and predict the column densities of such species in dark cloud conditions (L. Majumdar, A. Das and S.K. Chakrabarti). We explore the probability of detecting H_2Cl+ (chloronium) including its deuterated counterparts (HDCl+ and D_2Cl+) in the interstellar medium (L. Majumdar, A. Das and S.K. Chakrabarti). We explored also formation of cyanoformaldehyde and its deuterated counterpart to study how the abundance ratio changes with the initial D/H ratio (A. Das, L. Majumdar, S.K. Chakrabarti and R. Saha).



Variation of peak column densities of various forms of Choloronium with visual extinction parameter.



Electronic absorption spectra Of CH2CN,CH_2CN^+ and CH_2CN^- for their most stable spin configuration in gas phase and in ice phase.

Sources of High Energy Radiations



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



(L to R): A.Chatterjee, S.Mondal, Aslam A.Molla

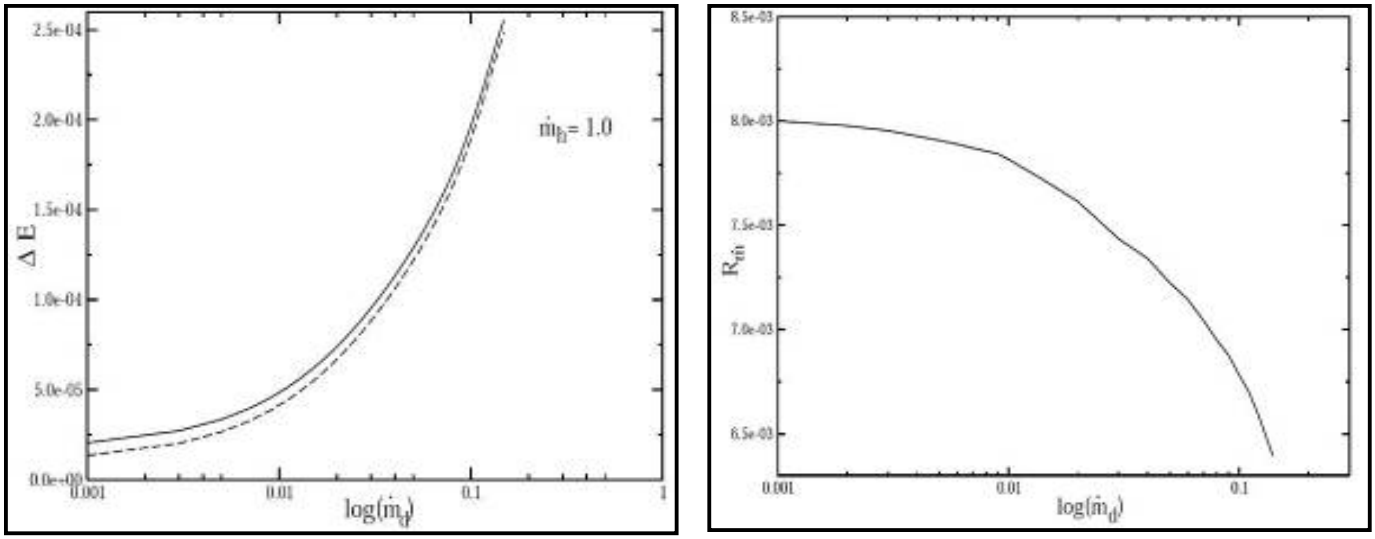
Earth is constantly bombarded with high energy X-rays and Cosmic rays since its formation 4.6 Billion years ago. Under this hostile condition, the Earth's life form survives by the selective absorbance of its atmosphere. The radiation is known to ionize the atmosphere. It seeds the clouds and affects the climate of our planet. We have a dedicated team to study various types of sources of radiation, model them, carry out numerical simulations and fits our models with satellite observations. The strongest X-ray source which affects the Earth most is the Sun and its effects are mostly studied by us using balloon borne equipment and very low frequency (VLF) radio waves discussed later. Here we present the nature of radiations from Black holes, several of which are known to exist in our own galaxy,

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. We are very much interested in finding how the strong gravity close to a black hole affects the flow geometry. We also study how black hole focus photons to our side by bending the photon trajectory.

We study effects of cooling on the formation of centrifugal pressure supported shocks. We find that the shock moves towards a black hole as the post-shock region is cooled down. We also find out how the outflow rate is affected by such cooling.

Before matter enters into a black hole, it starts radiating and also starts losing matter due to centrifugal and radiative forces. In a self-consistent solution, we have been able to compute this radiation energy and the ratio of outflow rate to inflow rate as a function of the rate of the Keplerian accretion disk (S. Mondal, D. Debnath and S.K. Chakrabarti).



Energy loss in the CENBOL in X-rays (Left) and the ratio of the outflow rate to inflow rate (Right) as a function of the Keplerian accretion rate. Radiation loss increases for increased inverse Comptonization and the CENBOL cools down. This also reduces the outflow rate.

Implementation of Two Component Advective Flow (TCAF) model into XSPEC:

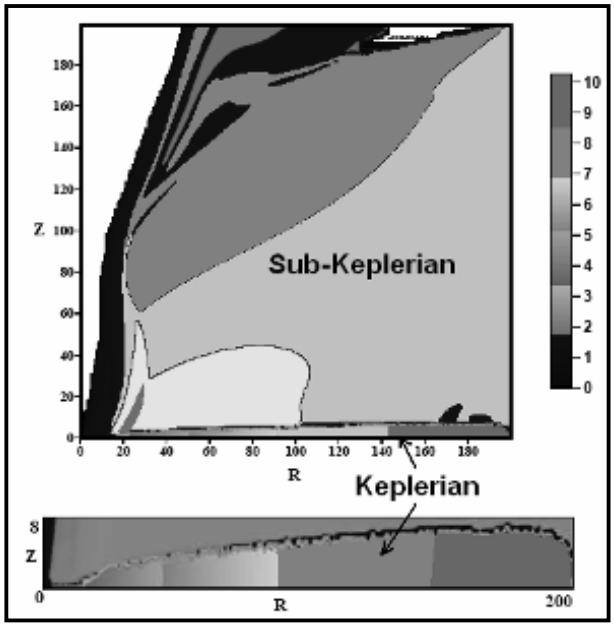
We have been able to successfully implement the Two Component Advective Flow solution of our group into NASA's XSPEC software so that the X-ray spectra of any black hole may be fitted by this very physical model. After a fit, accretion rates of the Keplerian and sub-Keplerian accretion rates, size of the CENBOL and the shock strength were obtained. So far in other models, one could only compute average temperature and optical depth of the Compton cloud. From the shock location (CENBOL Size) and shock strength, we are in a position to compute the QPO frequencies also. This is the first time that the spectral and temporal properties of a black hole observation can be explained by the same model through a single fit (D. Debnath, S. Mondal, and S. K. Chakrabarti).

Time dependent image variation of a black hole accretion disk: Coupled Monte Carlo – TVD simulation with gravitational photon bending

Radiations emitted from an accreting black hole are focused in a strong gravitation field before reaching the observers. We have coupled a photon bending code recently developed by us with Monte Carlo code tracking each photon as it is scattered by the CENBOL electrons and with a TVD code which studies the formation of the disk. An example of how an accretion disk is distorted in presence of photon bending and emits different radiations from different segments is shown on inside cover page (A. Chatterjee, S. K. Chakrabarti and H. Ghosh).

Time dependent simulation of matter with viscosity and radiative transfer:

So far workers believe that a binary companion star can only supply Keplerian matter. However if that is the case, then the biggest problems are: (a) One must remove all the angular for the matter to enter into a black hole; (b) One cannot explain most of the observations of the radiation from black hole accretion disks; (c) One cannot explain high speed jets and outflows from the accretion flows. The most attractive alternative solution is that most of the matter actually comes as a mixture of Keplerian and sub-Keplerian (low-angular momentum flow) and their rates mostly guided by the amount of viscosity available. This so-called Chakrabarti-Titarchuk Two Component Advective Flow (TCAF) solution can explain all the observational aspects, including formation of jets,



Automatic formation of a Keplerian disk on the equatorial plane in presence of sub-Keplerian flow and viscosity (left).

QPOs, spectral and temporal properties of radiations emitted from the disk etc. If we do numerical simulations even with a totally sub-Keplerian flow and some viscosity which is higher on the equatorial plane, we see clearly how a Keplerian disk is formed on the equatorial plane by transporting angular momentum to the sub-Keplerian halo. Keplerian component being cold and dense, the fast moving sub-Keplerian flow does not disrupt it even with Kelvin Helmholtz instability (S.K. Chakrabarti, S Garain and K. Giri).

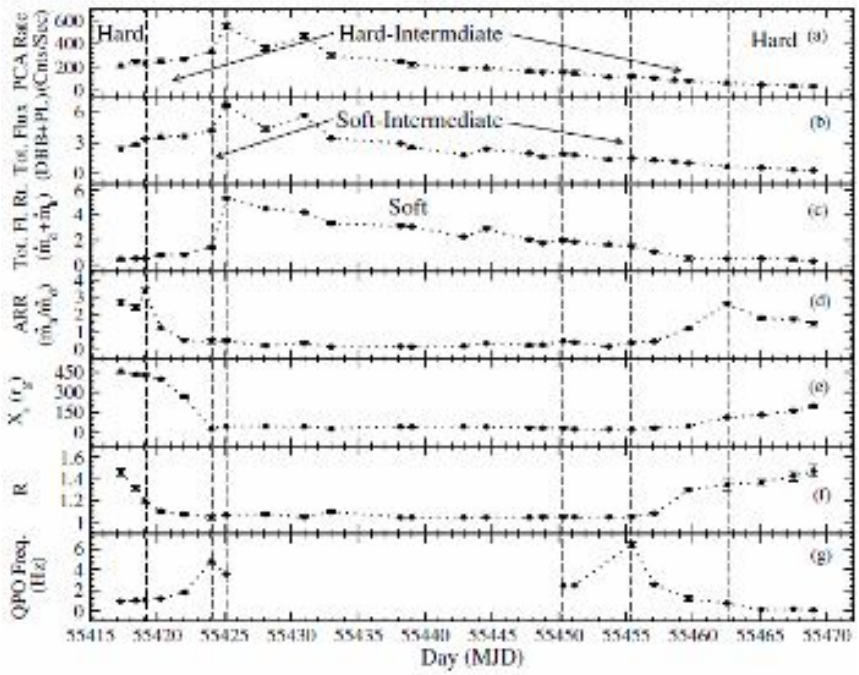
X-ray Astronomy

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

Unlike the activities in black hole astrophysics, the X-ray Astronomy group is involved in fitting observational results with various models. It also analyses results and interprets them in terms of physical processes. Our major activity has been to implement TCAF solution into XSPEC and fit observational data with this solution. Our solutions give physical parameters of the flow directly.

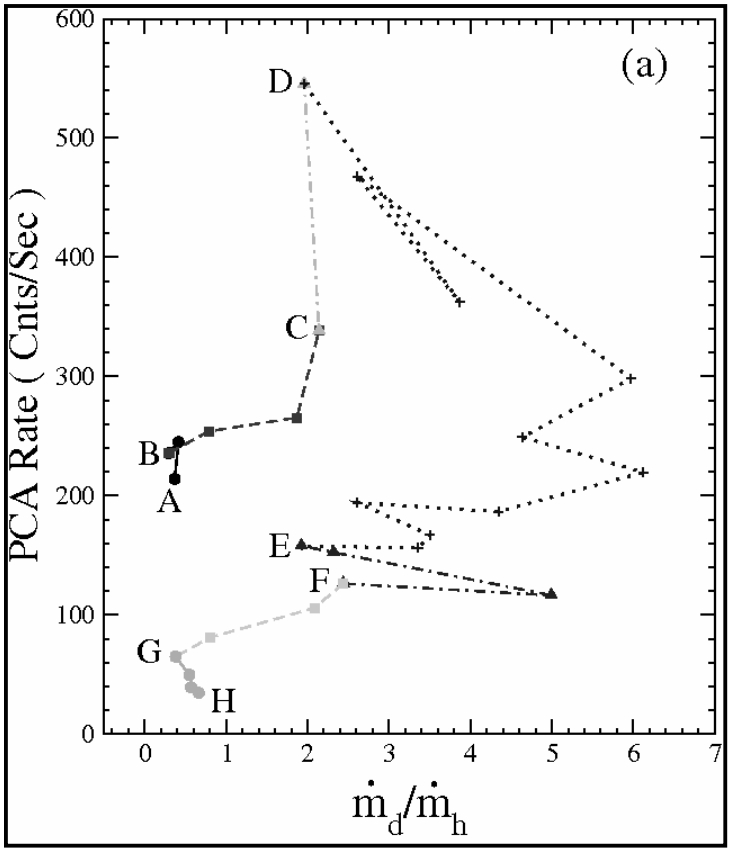
Evolution of spectral and timing properties of outbursting source H 1743-322:

We fit RXTE PCA spectral data **H 7143-322** during its 2010 outburst with TCAF solution for the entire data set and find how the physical quantities such as the accretion rates of the disk and the halo change. We also compare our TCAF model fitted spectral results with that of the combined disk black body and power-law model fitted results (Debnath, Chakrabarti & Nandi, 2013). We found more physical reason to classify spectral states during the outburst based on variation of accretion rate ratio (ARR; ratio between TCAF model fitted sub-Keplerian halo to Keplerian disk rates) and nature of QPOs (if observed). We also studied variation of shock parameters (location and strength) during the entire phase of the outburst. During the transition from hard to hard-intermediate or vise-verse, ARR is observed in a local maxima of the rising or the declining phase of the outburst. (S. Mondal, D. Debnath and S.K. Chakrabarti).



Variation of PCA count rate, total flux (DBB+PL), total flow rate, Accretion Rate Ratio (ARR) , shock location, compression ration and observed QPO frequencies during 2010 outburst of H 1743-322 as a function of day number.

Evolution of Spectral states during outbursts of H1743-322 in a cyclic order as observed in Inverse ARR-Intensity diagram :

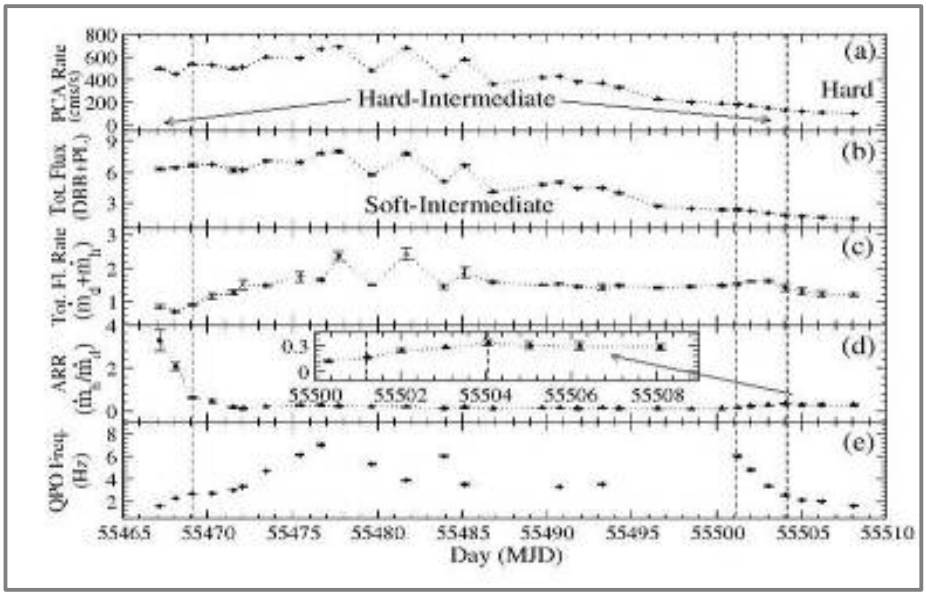


We fitted the data of the outburst source H 1743-322 with TCAF solution and obtained its flow parameters. Most interestingly, We find that as the spectra goes through *hard (AB) → hard-intermediate (BC) → soft-intermediate (CD) → soft(DE) → soft-intermediate (EF) → hard-intermediate (FG) → hard* states (GH), the Count rate variation with the ratio of the accretion rates (disk rate/halo rate) makes a loop clearly showing a hysteresis effect (see Figure, Left). The path traced during the rising phase of the outburst (AD) is different from the declining phase of the outburst (EH) (S. Mondal, D. Debnath, S. K. Chakrabarti).

Variation of the PCA rate with the accretion rate ratio in the outburst source H 1743-322.

Evolution of spectral and timing properties of outbursting source MAXI J150-152:

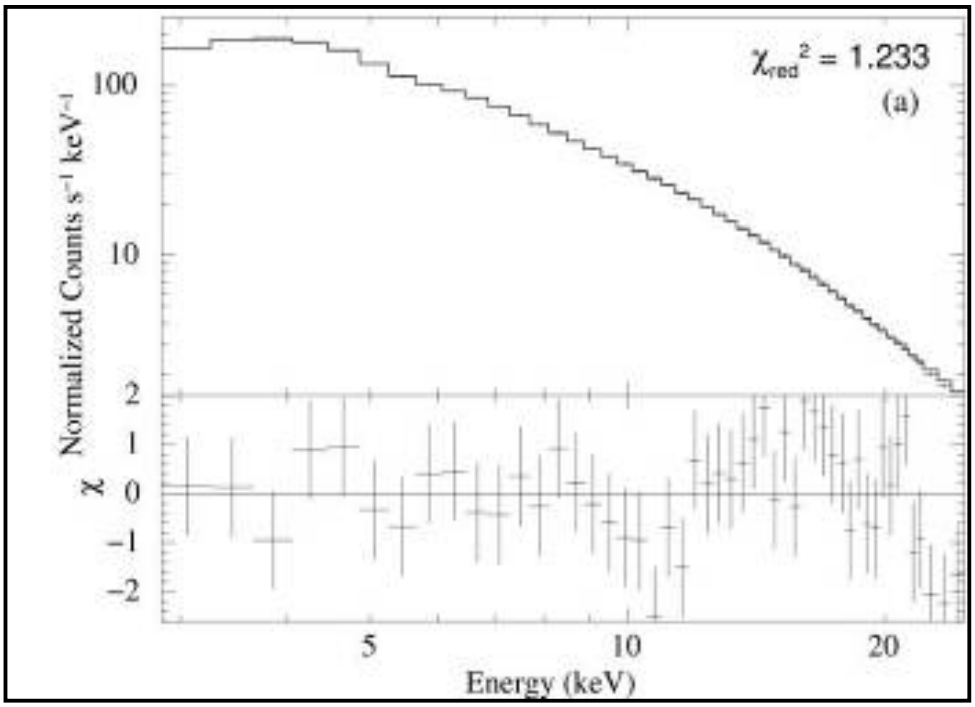
We fit the spectral data **MAXIJ159-152** with TCAF solution for the entire data set and find how the physical quantities such as the accretion rates of the disk and the halo change. The object was not caught in the hard state in the rising phase, so we could analyze only hard-intermediate and soft-intermediate states in the rising phase and soft-intermediate, hard-intermediate, and hard states in the declining phase. We that the QPO frequency rises steadily in the rising phase and goes down in the declining phase as in other outbursting sources. The ARR ratio is weakly maximum on the say the object changed from hard-intermediate to hard state (A.A. Molla, D. Debnath and S.K. Chakrabarti).



Variation of total flow rate, total flux (DBB+PL), Accretion Rate Ratio (ARR) , QPO of MAXI J159-152 as a function of day number.

Extracting parameters of black hole accretion disks using TCAF solution:

A detailed knowledge about the physical parameters in outbursting black holes emerges by fitting data using Two Component Advective Flow (TCAF) solution. In this solution, the source of the soft photons is still the Keplerian disk while the puffed up region of the centrifugal pressure dominated inner part of the low angular momentum flow (including outflows that are emitted from this region) behaves as a Compton cloud. Our fits are generally excellent. In soft states one requires a single component flow since in soft states the Compton cloud is totally cooled down (D. Debnath, S. Mondal, S.K. Chakrabarti)



TCAF model fitted 2.5−25 keV RXTE PCA spectrum of Galactic transient BHC GX 339-4 (Obs. ID = 95409-01-14-04; MJD = 55300). The value of the model fitted reduced χ^2 is written inside.

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

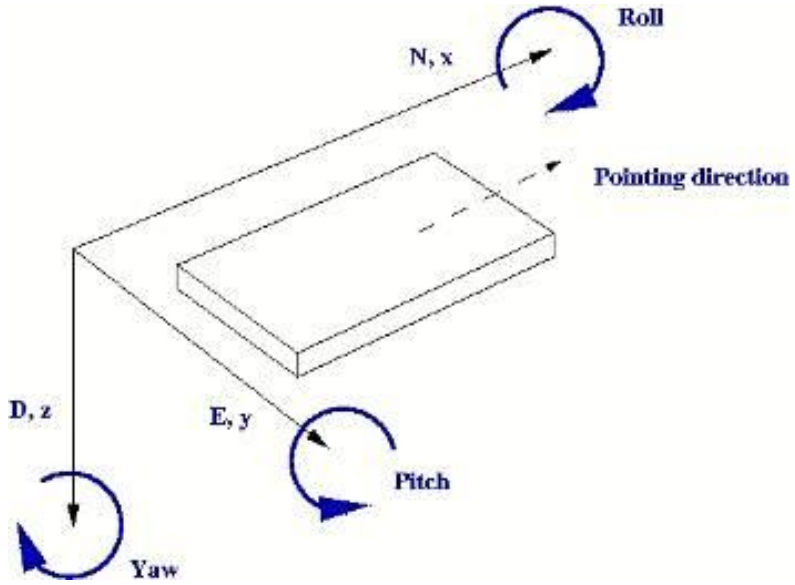
(L to R): S.K.Chakrabarti, D.Bhowmick, S.Chakraborty, R.Sarkar

(L to R): S.Palit, A.Bhattacharya, S.Middya, H.Roy

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

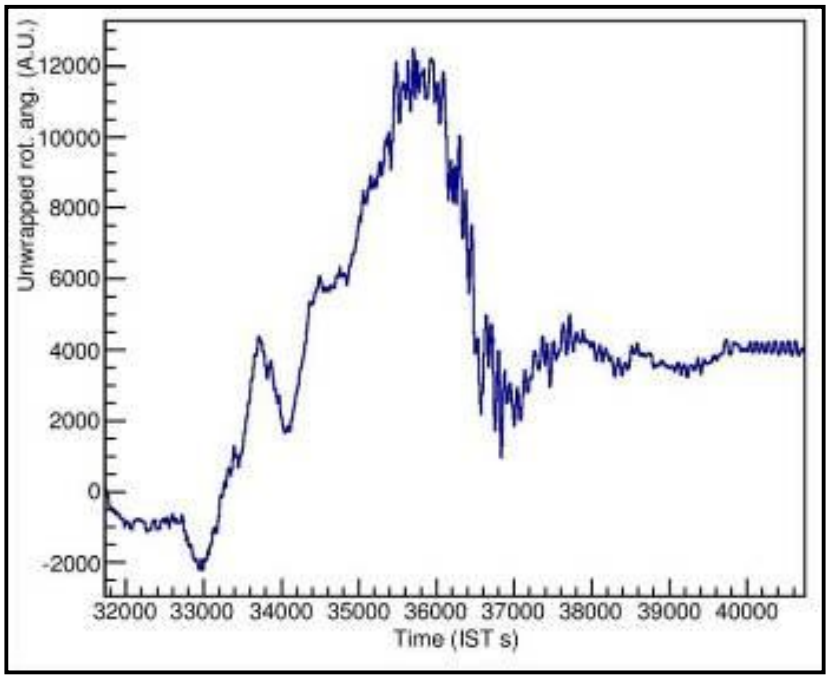
Indian Centre for Space Physics has been conducting a very successful indigenous program to fly instruments to near space (up to 40 km altitude) using low cost rubber balloons. These balloons burst at about 35-40km altitude and the instruments are returned back by parachutes. So far, a total of 63 Dignity Series Missions have been launched and a wealth of knowledge has been acquired in the subject of low energy cosmic rays, Solar radiation (front inside cover), radiation from other celestial high energy sources, wind patterns at high altitudes, stability of the payload attitudes as a function of height etc. Each payload contains an Inertial measurement unit, a science instrument, one or more video camera, GPS tracker and GPS units apart from power supplies.

Attitude measurements in a balloon flight



In order to find the direction in which the main instrument is pointing at a given moment we send 9 degrees of freedom measurement units which contain accelerometer, gyroscope and magnetometer. From this data we obtain RA/DEC of observed systems. This also provides us a with measure of the stability of the balloon borne platform.

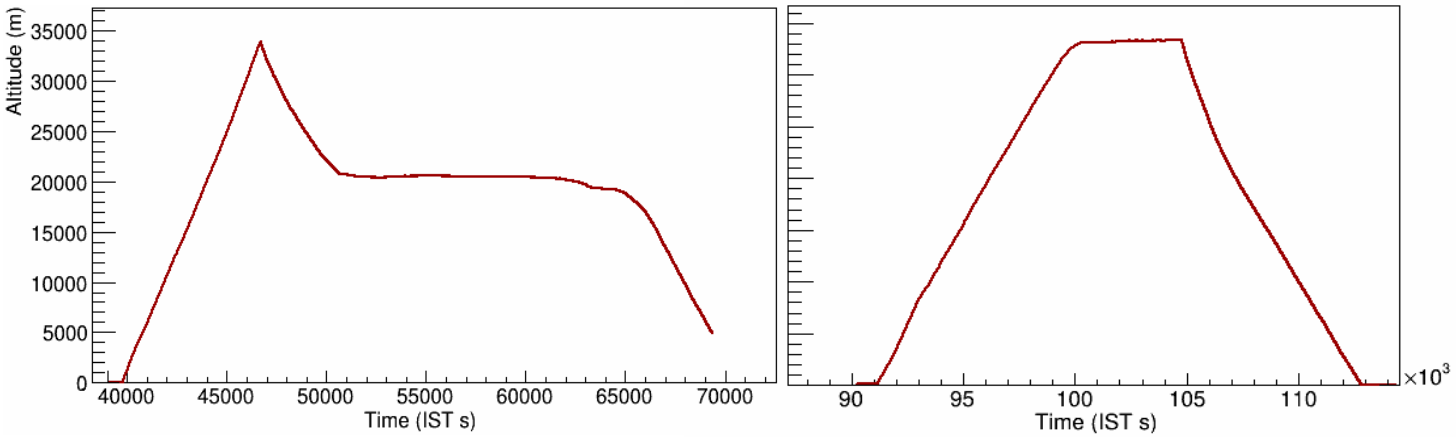
(Left) The procedure to obtain instantaneous azimuth and altitude of the pointing direction.



(***Left) Variation of the unwrapped rotational angle as measured by our Inertial measurement unit as a function of time from launch till the burst of the balloon. Almost 40 minutes of the final leg of the journey, the rotational motion is very slow.***

Achievement of constant height flights without valve or ballasts

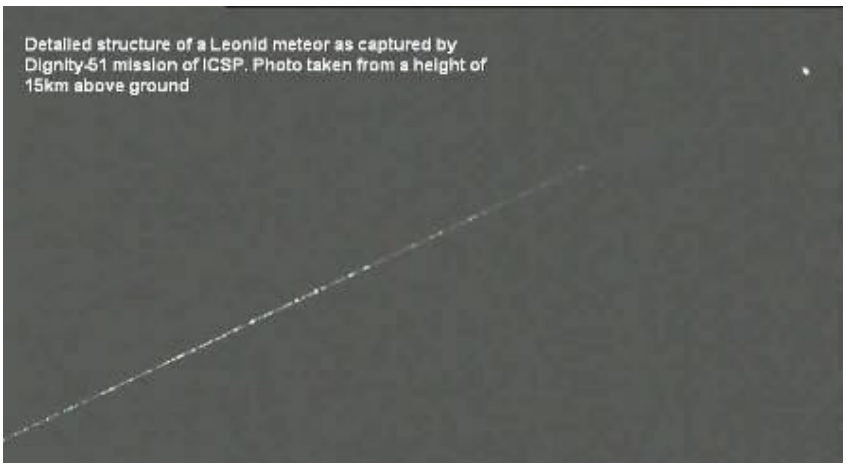
ICSP has pioneered a way in which two balloons are launched together with a single payload. In this booster-orbiter configuration, both the balloons may remain at neutral equilibrium (below, right) with the payload as a given height (in ascending phase), or booster may burst and the orbiter may keep a constant height (in the descending phase). Thus for several hours data could be procured. An example of light curve of the secondary cosmic rays at low energy (<120 keV, red) and at all energy channels blue) is given in the inside of the front cover. While descending the payload continued its trip for a few hours at a height of 21km (below left).



Typical examples of payloads at a constant height for several hours can be seen in these two Height-time plots. (Left) Payload staying at a height of 21km after the booster bursts and orbiter remains in neutral equilibrium at about 21km height. (Right) The payload remains at a height of about 34km for about 1.5 hours before starting to descend.

Tracking meteor showers from balloon heights

ICSP balloon flights obtained unique view of meteor showers from near space. On November 17th , 2013, night in D51 mission we sent video cameras and a 4" Optical telescope. We captured several Leonid meteor tracks with extreme detail, particularly the entering particle's rapid disintegration. The photo below obtained from two video frames shows variation of intensity due to disintegration of the mini-meteorite along the path. Note that the track ends with a tiny explosion (sudden brightened spot on the top-right corner).

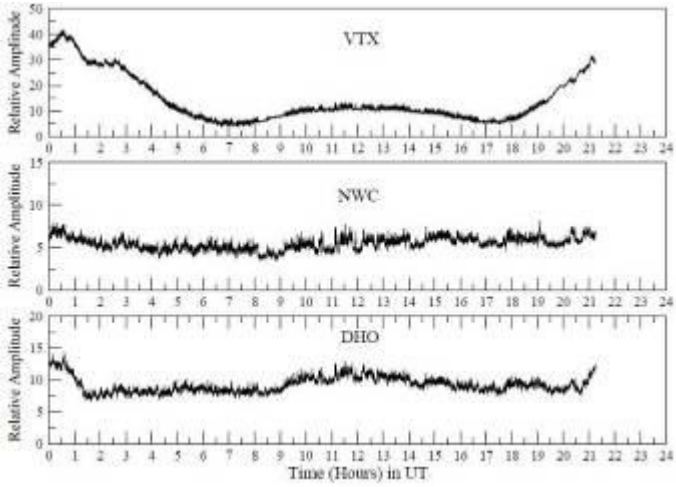


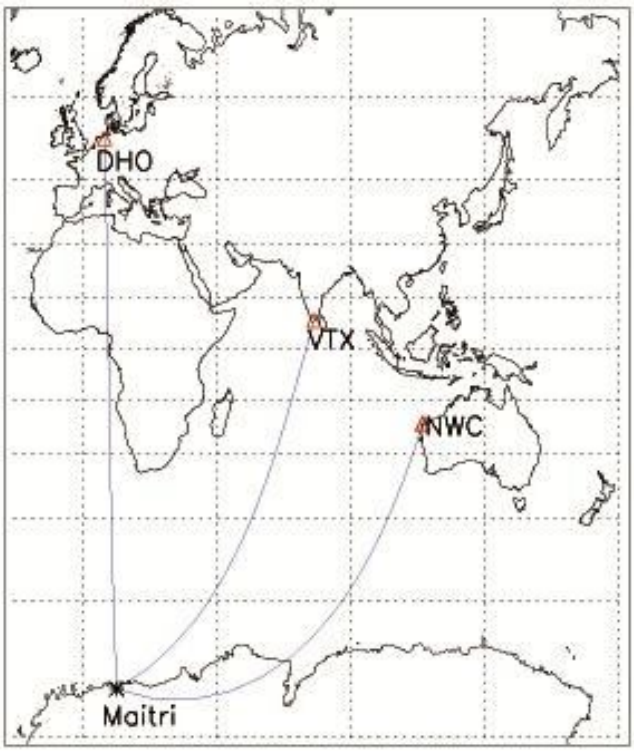
A Leonid meteor track obtained combining two video frames during our Dignity-51 mission. The altitude of the payload was 15km. Note the terminal explosion at the top right.

VLF Radio Observations and Modeling

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

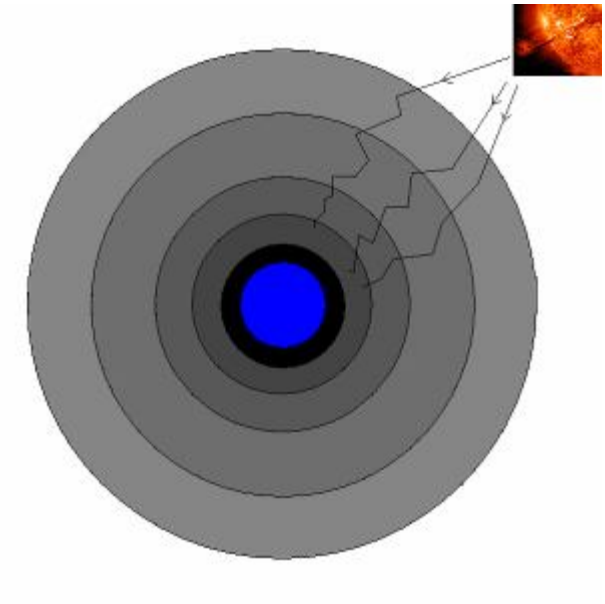
Our group is the largest group working on the propagation effects of Very Low Frequency (VLF) Radio waves in India contributing to a large number of topics on the study of ionospheric





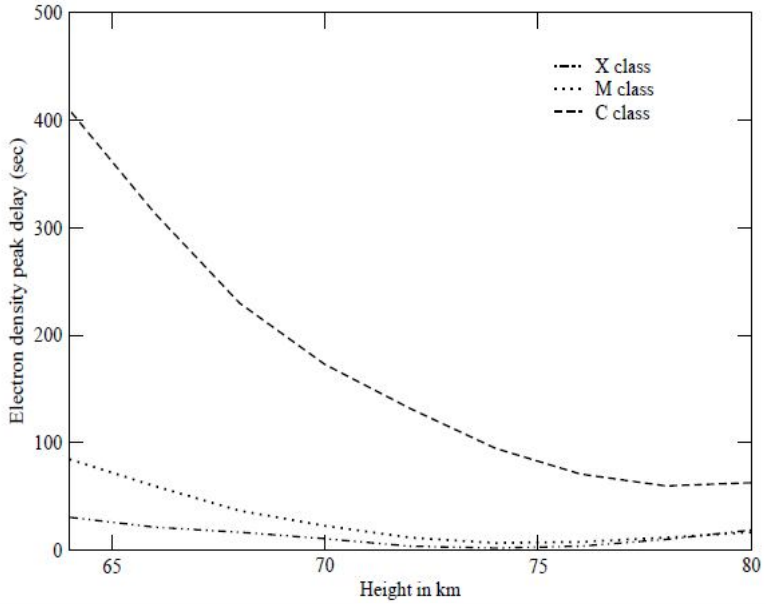
VLF narrowband signals received by our scientists from the Maitri station in Antarctica (above). Radio propagation path in the Earth-ionosphere waveguide from three transmitters (right). NWC and DHO paths are over the landmass causing a huge attenuation of their signals.

perturbations over whole India and their modeling. The perturbations could be due to Solar flares, earthquakes, solar eclipses, gamma ray bursts, lightning induced electron precipitations, Atmospheric gravity waves, etc. We have several receiving antennas all over the eastern India.

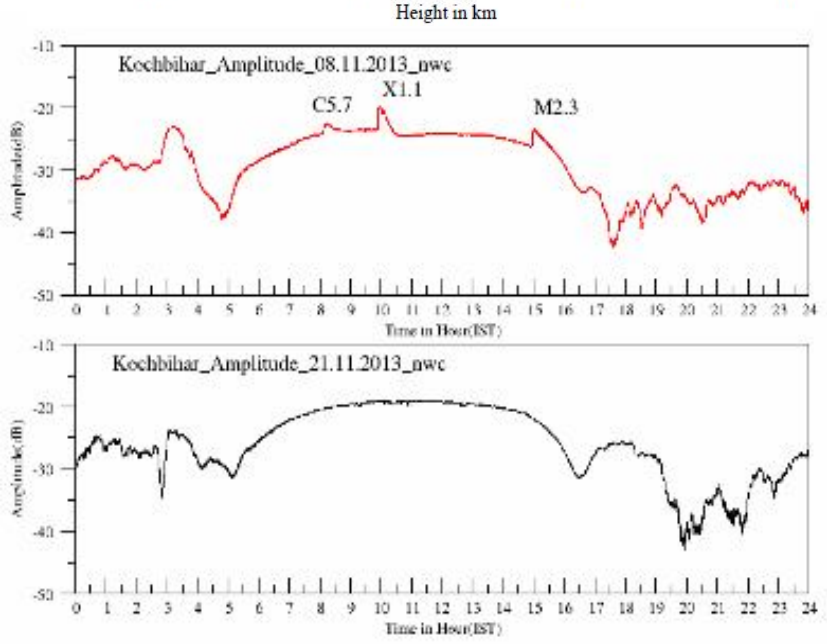


In campaign modes we often go to all over India with several receivers and antennas. To particularly study precursory effects of earthquakes, we have opened a new branch named Ionospheric and Earthquake research Centre (IERC) in Midnapur district. The activities of IERC would be discussed later.

We treat the Earth's vast ionosphere as a gigantic detector hanging in space on which hostile radiations from the sun and other celestial objects impinge incessantly. We pioneered a method in which the radiation from an event is simulated to interact with the ionosphere and then the computed altitude variation of electron density is used in conjunction with LWPC code to predict what the corresponding VLF signal perturbation would be. This is then compared with the observed VLF signal. The same method has now been used to compute the sluggishness or time delay between the observed signal and incident solar flare for flares of various intensities (S. Palit, T. Basak, S. Mondal, S. Pal, S.K. Chakrabarti).

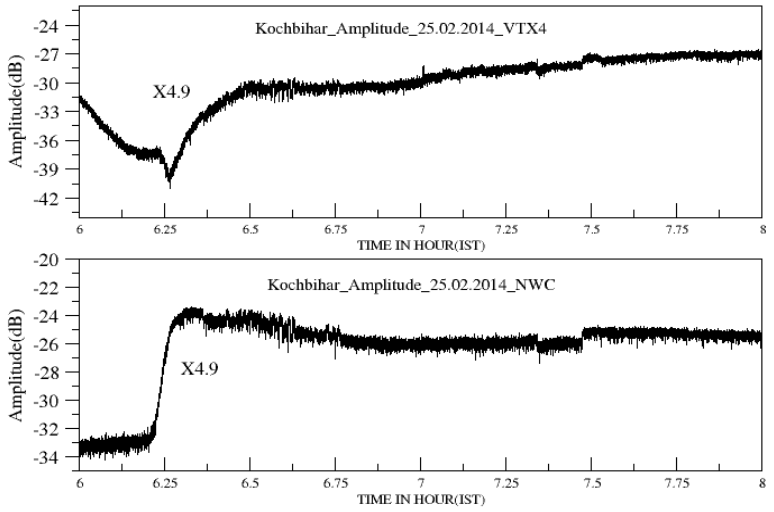


Procedure of generating theoretical electron density distribution using GEANT4 code (Upper Left) is illustrated where the ionosphere is divided into several concentric spherical shells and Monte Carlo method is used to see how an incident photon in absorbed. Time delay between the observed peak of a flare and the computed peak of electron density as a function of height for various classes of flares. Clearly, stronger flares cause prompter response (Lower Left).



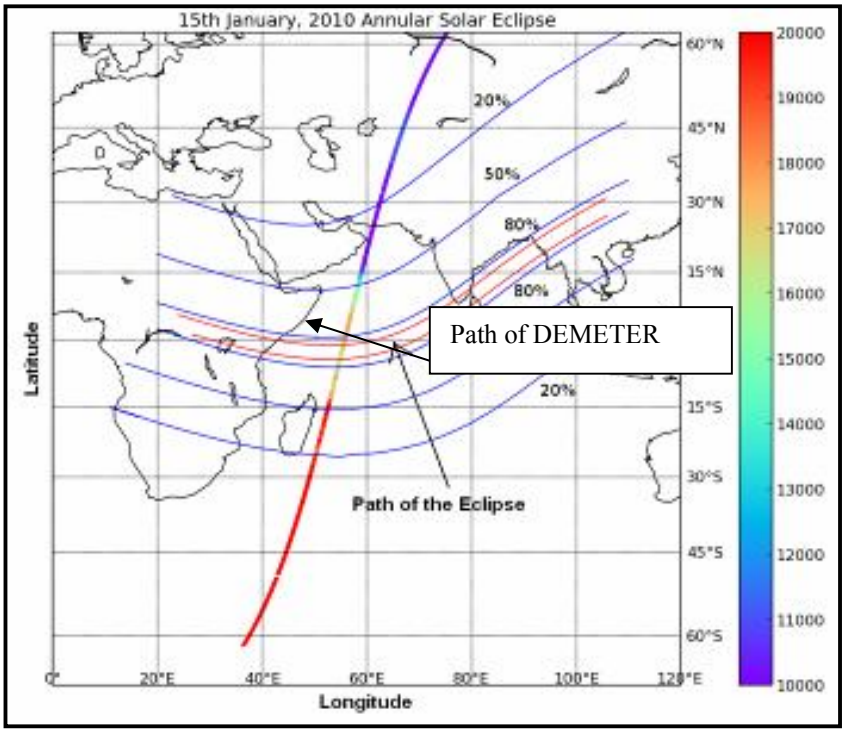
A large number of projects are being executed by the ICSP VLF scientists. Our Kochbihar based scientist Mr. B. Das has erected a very long electric pole antenna in order to receive distance VLF signal. We also receive perturbation of signal phase due to solar flares and other high energy events [B. Das, S.K. Chakrabarti, S. Sasmal].

Examples of solar flares (C, X, and M types) observed from Kochbihar station in the signal of NWC (19.8KHz) transmitted at about 6000km away (Upper panel). Data of a quiet day (Lower panel).

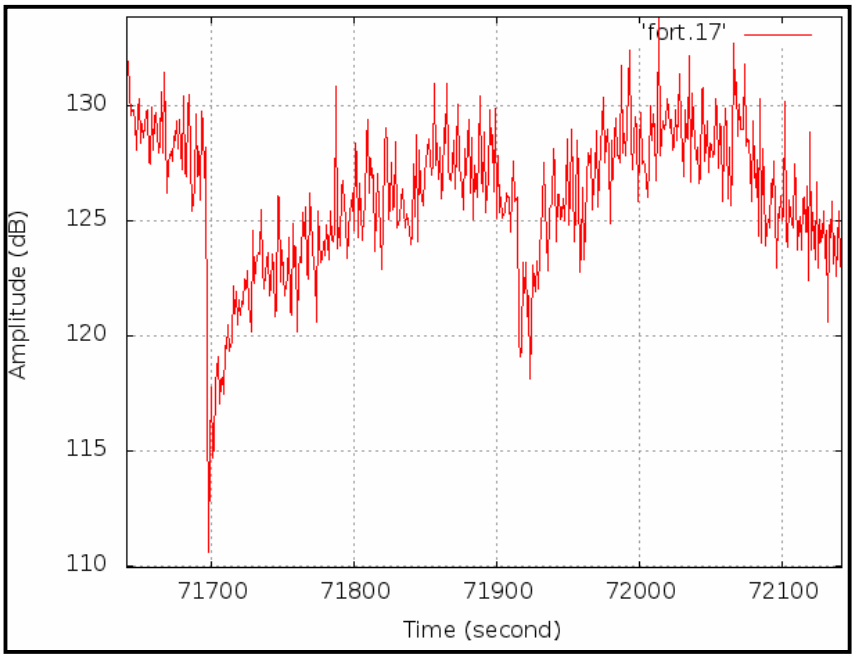


Depending on the propagation path, the interference among various wave modes can cause the VLF amplitude to be enhanced or attenuated. In the Figure on the left , we see this for an X4.9 flare, the signal at peak time is attenuated and then it started to go up when the VTX-Kochbihar raw data is plotted (Upper). However, for the NWC-Kochbihar propagation path, the signal is enhanced from the beginning of the flare. We are now solving this case using GEANT4 simulation/LWPC code [B. Das, S. Palit, S.K. Chakrabarti].

ICSP has been monitoring VLF radio signals from various stations since 2002. Data was received and analyzed for two solar eclipses. Most importantly, it has taken a pioneering role in detecting relations among ionospheric anomalies and seismic phenomena. Our earlier reports have discussed our continuing efforts in Earthquake prediction studies, atmospheric gravity waves etc. Apart from these work, the current year saw our effort to decipher DEMETER satellite data during eclipses when we also observed from ground. Results clearly indicated variation of ion density over the annularity region as seen by a satellite. [S. Maji, S.K. Chakrabarti].



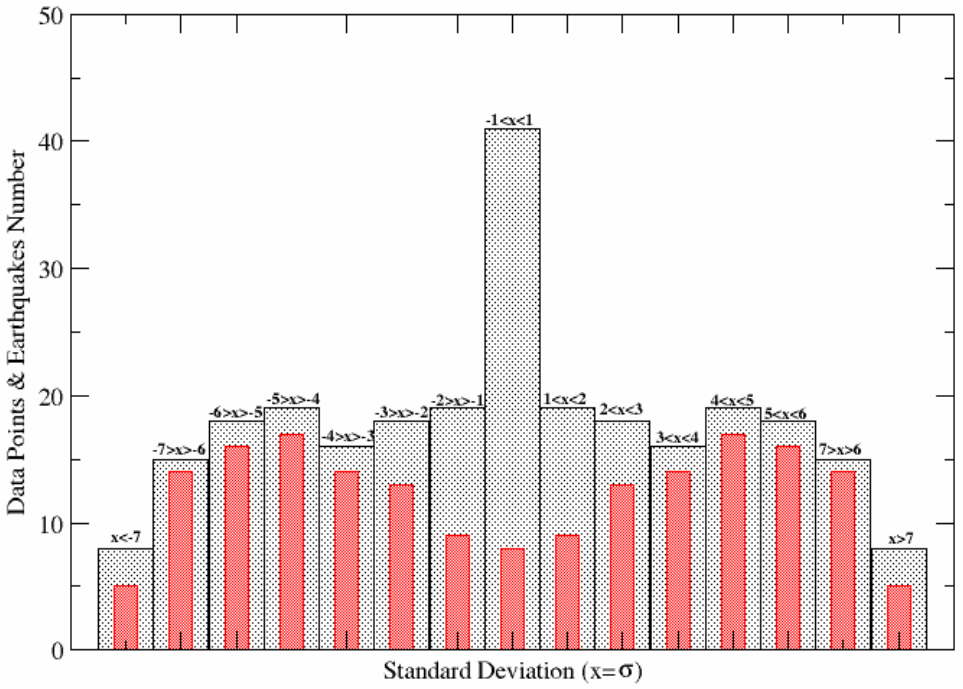
Path of DEMETER satellite is superimposed on the world map on which the path of annularity and partial eclipse of January 15th, 2010 is also drawn. The color code indicates electron density as measured by the satellite. Clear anomaly on the path of annularity is seen.



Lightning induced electron precipitation (LEP) causes a typical type of atmospheric perturbation which manifests itself in the VLF signal in a very specific way. ICSP monitors these LEP events and models them using our own Monte Carlo approach.

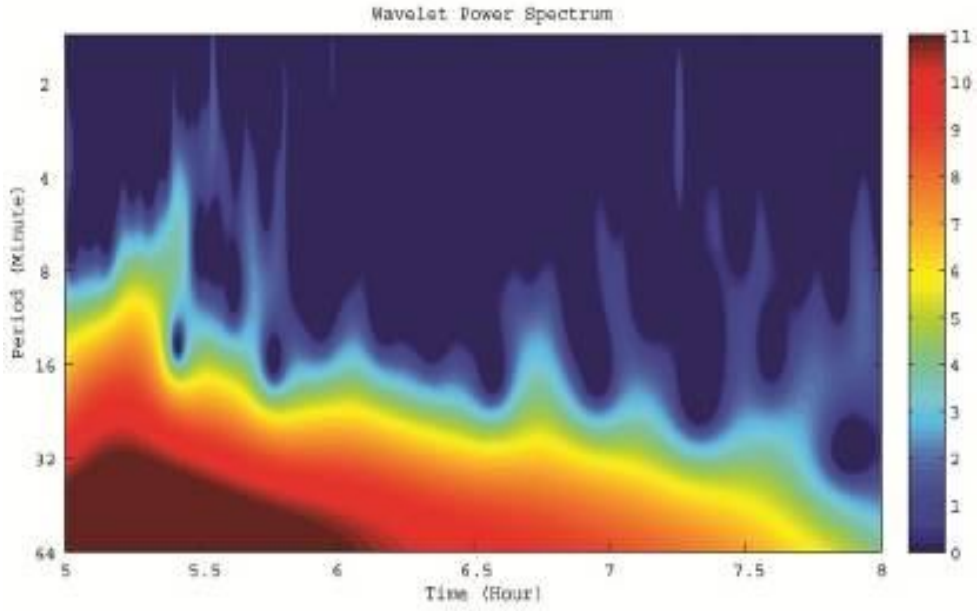
Two successive LEP events observed at ICSP monitoring stations (Left).

We have successfully observed anomalous features in VLF signal amplitude prior to seismic events using different methodologies and have computed the correlation between the anomalies and the seismic magnitudes. This year we have applied our computation to the phase of VLF signal using the terminator time method. We have observed the phase of the VLF signal is well correlated with seismic events and the shift of the terminator time in phase is maximum on two days prior to seismic events. The result clearly indicates that those days for which the value of VLF day-length (grey histograms) is anomalously high (>±3σ) those days (red histograms) are seismically active [Pal, Sasmal & Chakrabarti, 2014].



Correlation between the anomalous VLF day-length due to shift of terminator time with earthquake day.

We have observed the presence of Atmospheric Gravity Wave (AGW) during the total solar eclipse in July, 2009.The figure shows the wavelet power spectrum of the VLF amplitude deviation due to the total solar eclipse at Salt Lake having maximum obscuration 89.9 %. The presence of strong wave periods during the maximum solar eclipse phase shows the excitement of atmospheric gravity waves generated due to the movement of moon's shadow on Earth's atmosphere during eclipse [Pal, Chakraborty & Chakrabarti, 2014].

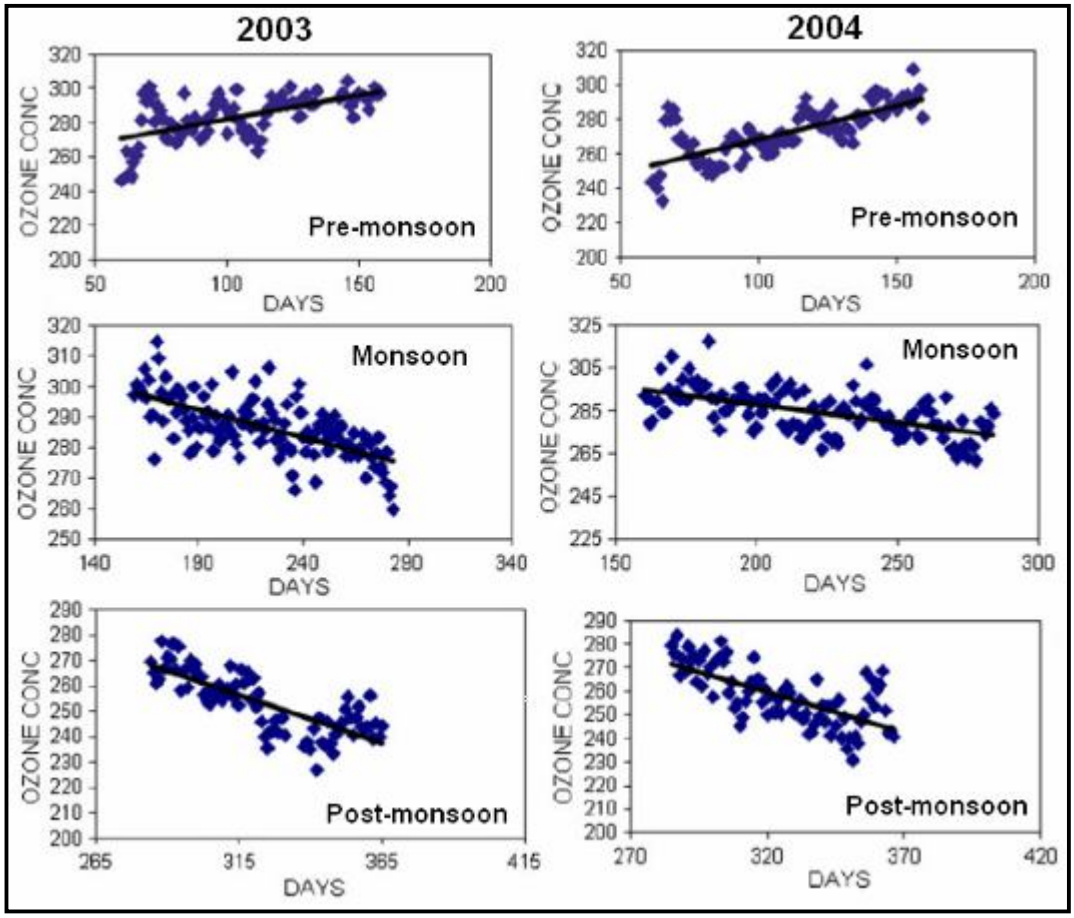


Atmospheric gravity wave generated during total solar eclipse.

Airglow and Ozone Depletion studies

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

Airglow and Ozone depletion activities are conducted mostly by the visiting and honorary scientists of ICSP. The work is 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. In a study which spanned for several years, 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.



Correlations between ozone content and the day of the year for 2003 and 2004 which clearly show that the ozone content rises with time in the pre-monsoon session while it is the opposite in the post-monsoon season.

Radio Astronomy



(L to R, top): **S.Pal, D.Patra, S.Adak**

ICSP radio group has been engaged in observation with GMRT for more than a decade. The work is continuing. Dr. Pal along with Dr. Subhashis Roy of GMRT discovered one of youngest supernovae in Radio waves, third such object in our galaxy in about 400 years. Other works involve finding intensity distribution and spatial variation of spectral index at low frequencies from 200kHz to ~600kHz range.

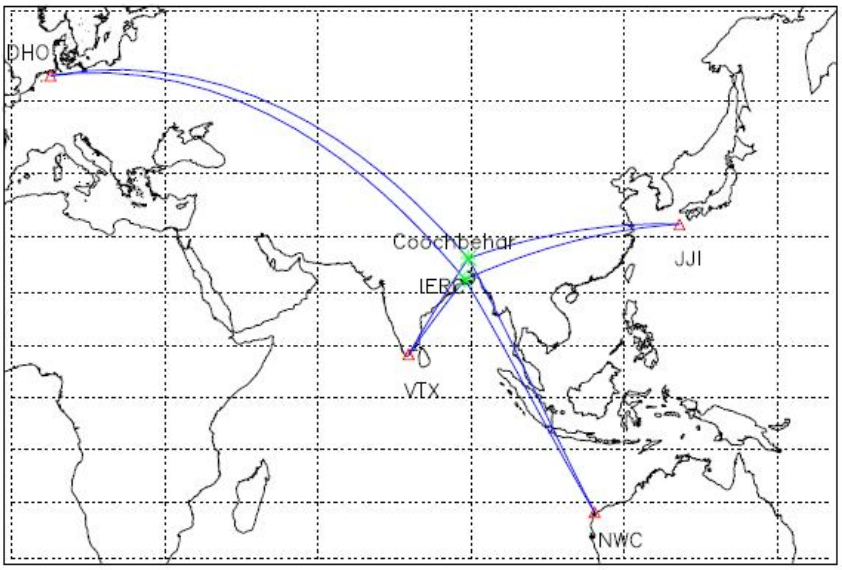
The ionospheric and earthquake research centre (IERC)

(L to R, top): **Sabyasachi Pal, Sudipta Sasmal, Sujay Pal, Pikesh Pal and Rana Khan**
(L to R, bottom): **Amit Roy, Surya K.Maji, Dusmanta Patra, Dipak Sanki, Sanjoy Adak**

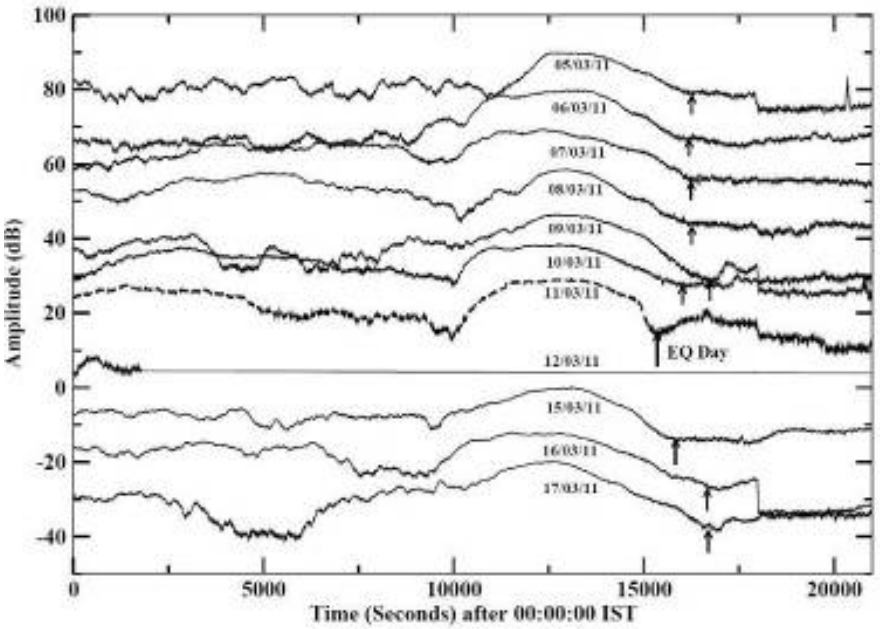
In order to receive quiet Radio signals and to have clear night skies for optical observation, ICSP decided to open a campus at a remote village, about 100km away from the head office. The centre is located at Sitapur, Paschim Medinipur, West Bengal, India. VLF antennas with SoftPAL and AWESOME receivers, two element interferometer, etc. are installed there. A ten inch optical telescope (MEADE) is used to study the night sky.

Seismo-Ionospheric Correlation

Since the conventional seismology has not been successful in short term prediction of any short term, ICSP has been looking for correlations among seismic events and VLF signal anomaly. ICSP found three types of anomalies. Both statistical analysis and case by case analysis have convincingly shown that the effect is real. However, to establish this as science and to provide theoretical understanding of the correlation, ICSP scientists are installing an array of VLF antennas all over India. This is expected to provide much better short term prediction than what the conventional seismologists. (S. Sasmal, S. Ray, S.K. Chakrabarti).



Propagation paths of VLF radio signals from various transmitters. We showed that the paths passing closer to the epicenters showed more anomalies.



Seismo-ionospheric correlation has been studied for NWC-IERC baseline and it has been observed that for longer propagation paths the correlation between the signal anomaly and earthquake magnitude can be established with respect to receiving point instead of the first reflection point for this path.

Sunrise terminator time shifts before an earthquake in Japan.

Activities of the Indian Centre for Space Physics, Malda Branch



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

Established in 2000, this branch continues to study Ionospheric response to high energy radiation with an antenna and a receiver. It also analyzes several satellite data on galactic black hole candidates. It regularly conducts popular and semi popular lectures. Several papers have been published from this branch. Two scientists are working towards PhD on a part time basis.

ICSP Malda Branch was invited to conduct a Quiz Contest organized jointly by UNESCO and SSM, Malda, at Shyam Sukhi Valika Vidya Niketan, Gazole, Malda. Asit K Choudhury and Washimul Bari conducted the Quiz successfully. Achintya K Chatterjee, President of ICSP Malda Branch, was invited to present a scientific talk in the Golden Jubilee Celebration of Government Teachers' Training College, Malda. About 100 students witnessed the Mars Encounter event through ICSP's telescope in a sky watch programme jointly organized by ICSP, Malda Branch and LMSM High School.

ICSP Malda branch members. Asit K Choudhury and Washimul Bari recovered payloads of ICSP balloon from a remote village named Sabejora at a distance of 30 km from the district town of Godda in Jharkhand. The payloads recorded data of about seven hours of flight.

A scientific paper titled ***Monitoring of Sudden Ionospheric Disturbances with Very Low Frequency Signal by ICSP Malda Branch*** authored by Asit K Choudhury and Achintya K Chatterjee has been published in ***Ind. J. Mul. Acad. Res.*** 1 (January 2014) 31-37 (ISSN No. - 2347-9884).

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*

All Work and No Play .....

As in the past, ICSP scientists and non-scientific staff members had a tour to Henry Island and Bakkhali on the Bay of Bengal for two days for a refreshing change.

Some of the students, faculties and working staff at Bakkhali beach

P.K. Chakraborty and Associates
Chartered Accountants
F/52, Bapujinagar, P.O. Regent Estate,
Kolkata 700 092, Phone: 033 2412 5244

AUDITOR'S REPORT TO THE MEMBERS

1. We have audited the attached Balance Sheet of Indian Centre for Space Physics, 43, Chalantika, Garia Station Road, Kolkata 700 084 as at March 31, 2014 and also the Income and Expenditure, Account for the year ended on that date annexed thereto. These financial statements are the responsibilities of the Company's management. Our responsibility is to express an opinion on these financial statements based on our audit.

2. We conducted our audit in accordance with auditing standards generally accepted in India. Those Standards require that we plan and perform the audit to obtain a reasonable assurance about whether the financial statements are free from material misstatement. An audit includes examining, on a test basis, evidence supporting, the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by the management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion and report that: -

   a) We have 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 Indian Centre for Space Physics so far as appears from our examinations of these books.

   c) The Balance Sheet and Income and Expenditure Account dealt in this report are in agreement with the books of accounts.

   d) In our opinion, the Balance Sheet and Income and Expenditure Accounts comply with the Accounting Standards referred to in Sec. 211 (3c) of the Company's Act 1956, to the extent applicable.

   e) An income which was wrongly adjusted in the previous year, is rectified and included in this accounting year.

   f) On the basis of our information and explanations given to us and representations received from the committee of management, we report that no committee member is disqualified from being appointed as committee member of the Centre under clause (g) or sub-section (i) of Section 274 of the Companies Act 1956.

   g) In our opinion and to the best of our information and according to the explanation given to us, the said accounts read with the notes thereon give a free and fair view in conformity with the accounting principles generally accepted in India.

      i. In the case of Balance Sheet of the state of affairs of the Centre as at March 31 2014 and

      ii. In the case of Income and Expenditure Account of the surplus of the Centre for the year ended on that date.

P.K. Chakravorty & Associates
Chartered Accountant

P.K. Chakravorty, Proprietor
M.No. 5170I
Place: Kolkata
Date: 21st Sept'2014
F/52, Bapuji Nagar, PO: Regent Estate
Kolkata 700 092

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

Sd./- P. Bandyopadhyay
Honorary Treasurer, Indian Centre for Space Physics

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

P.K. Chakraborty and Associates
Chartered Accountants
F/52, Bapujinagar, P.O. Regent Estate,
Kolkata 700 092, Phone: 033 2412 5244

ANNEXURE TO THE AUDITOR'S REPORT

Referred to in Paragraph 1 of our Report of even date

1. The Centre has not taken any loan from Companies, Firms or Other parties listed in the register maintained under Section 301 of the Companies Act, 1956. There are no Companies under the same management.
2. The Centre has not given any loans/advance to parties/companies during the year.
3. The Centre has not accepted any deposit from public during the year.
4. The Provident Fund Act is not applicable to the Centre.
5. Other clauses of manufacturing other companies (auditor's report) order issues by Company Law Board in terms of Section 227 (4A) of the Companies Act 1956 are not applicable in this case.

P.K. Chakravorty & Associates
Chartered Accountant

(P.K. Chakravorty)
Proprietor
M.No. 5170I

F/52, Bapuji Nagar, PO: Regent Estate
Kolkata 700 092

Place: Kolkata
Date: 21st Sept'2014

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

Sd./- P. Bandyopadhyay
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

BALANCE SHEET AS AT 31.03.2014

		As on 31.03.2014	As on 31.03.2013
SOURCE OF FUNDS	Schedule	**Amount (Rs.)**	**Amount (Rs.)**
Capital Funds	1	11402883.00	11240398.00
Loan Funds	2	0.00	0.00
TOTAL		**11402883.00**	**11240398.00**
APPLICATION OF FUNDS			
Fixed Assets			
Gross Block	3	7654096.04	7485311.48
Less: Depreciation		953560.67	864793.06
Net Block		**6700535.00**	**6620518.00**
Current Assets,Loans & Advances:			
Security Deposit		5100.00	5100.00
Cash & Bank Balances	4	6851328.00	7997620.00
Dues from funding agencies	4A	5650.00	0.00
Total		**6862078.00**	**8002720.00**
Less: Current Liabilities	5	142921.00	191210.00
Less: Unspent during the year	9	2016809.00	3191630.00
Net Current Assets		**4702348.00**	**4619880.00**
Miscellaneous Expenditure			
to the extent not written off	6	0.00	0.00
		11402883.00	**11240398.00**

Schedules referred to above from an integral part of the Balance Sheet As per our Annexed Report of even date

P.K. Chakravorty & Associates
Chartered Accountant

(P.K.Chakraborty)
Proprietor
Date: 21st Sept. 2014
Place: Kolkata

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

Sd./- P.Bandyopadhyay
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

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2014

	Schedule	As on 31.03.2014 Amount(Rs.)	As on 31.03.2013 Amount(Rs.)
INCOME			
Income	7	10880118.00	12125359.00
		10880118.00	**12125359.00**
EXPENDITURE			
Administrative & Other Expenses	8	10703173.00	8891801.00
Preliminary Expenses written off		0	0.00
Depreciation		14460.50	75923.21
		10717633.00	**8967724.00**
Excess of Income Over Expenditure		**162485.00**	**3157635.00**
Surplus(Deficit) brought forward from the earlier year		11223898.00	**8066263.00**
Balance transferred to the Balance Sheet		**11386383.00**	**11223898.00**
Notes on Account	10		
Significant Accounting Policies	11		

Schedules referred to above from an integral part of the Balance Sheet
As per our Annexed Report of even date

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Place: Kolkata
Date: 21st Sept. 2014

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INDIAN CENTRE FOR SPACE PHYSICS 43 Chalantika, Garia Station Road Kolkata- 700084		
	As on 31.03.2014	As on 31.03.2013
	Amount (Rs.)	Amount (Rs.)
Schedule -1 **Capital Fund**		
Life Membership Fees	16500.00	16500.00
Prior period adjustment	0.00	0.00
Balance Transferred from Income & Expenditure Account	11386383.00	11223898.00
TOTAL	**11402883.00**	**11240398.00**
Schedule -2 **Loan Fund**		
Loan from Directors	0.00	0.00
TOTAL	**0.00**	**0.00**
Schedule-4 **Cash & Bank Balances**		
Cash in hand	8399.00	73274.00
Fixed Deposit at Axis Bank, Salt Lake	4743117.00	0.00
Axis Bank Ltd, Salt Lake, Sector-III	2091305.92	7912429.65
Malda Dist. Central Co-op Bank Ltd.	8506.00	11916.00
TOTAL	**6851328.00**	**7997620.00**
Schedule-4A **Loans & Advances**		
Advance to Employees	4000.00	0.00
CSIR Fellows	1650.00	0.00
TOTAL	**5650.00**	**0.00**
Schedule-5 **Current Liabilities**		
Audit Fees	4000.00	1300.00
Liability for Projects	138921.00	189910.00
TOTAL	**142921.00**	**191210.00**
Schedule-6 **Miscellaneous Expenditure**		
Preliminary & Pre-operative Expenses	0.00	0.00
TOTAL	**0.00**	**0.00**
Schedule-7 **Income**		
Grant-In-Aid	8996199.65	10838022.00
Overhead recovery from project	121000.00	30000.00
Recovery from project	82195.56	0.00
Other Receipts	444743.00	205440
Guest House Rent	48900.00	94500.00
Interest & other Income	1171880.00	647618.00
Misc. Income	15200.00	309779.32
TOTAL	**10880118.00**	**12125359.00**

Schedule-8		
Administrative & Other Expenses		
Fund draw for Project Expenses	5414541.00	390968.00
Salaries/ Stipend	3066635.00	6427725.00
Office Expenses	1426781.26	672608.46
Postage	2276.00	330.00
Travelling & Conveyance	214744.00	461726.00
Telephone, Fax & Internet	65914.00	64661.00
Stationary, Consumables & Printing	83501.00	181291.90
Filing Fees	4800.00	30567.50
Bank Charges	0.00	393.26
Rent & Electricity	233914.00	229884.00
ICSP Development	0.00	290602.00
TDS / Porfession Tax	187755.00	136209.00
Miscellaneous Expenses	2312.00	3535.00
Audit Fees(For Statutory Audit)	0.00	1300.00
TOTAL	**10703173.00**	**8891801.00**
Schedule-9		
Unspent During the Year		
DST Projects	0.00	192400.00
EMJDP	23459.32	98161.32
CSIR PROJECT	2.00	47857.00
MoES	691152.00	2833212.00
DST-FTYS	428689.00	0.00
ICTP	417567.65	0.00
ISRO Projects	455939.00	20000.00
Total unspent (committed) during the year	**2016809.00**	**3191630.00**

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INDIAN CENTRE FOR SPACE PHYSICS

Chalantika 43, Garia Station Road, Kolkata 700 084

Schedule – 10 **NOTES TO ACCOUNTS**

1. This is a Company limited by Guarantee and Liabilities of each member will be as per the provisions specified by the Memorandum of Association.

2. Loan from Directors represent preliminary expenses incurred at the time of incorporation as well as pre-operative expenses incurred time to time.

3. Accounts have been regrouped and re-arranged wherever necessary.

Schedule – 11 **SIGNIFICANT ACCOUNTING POLICIES**

BASIS OF ACCOUNTING

a) The Company prepares its account on accrual basis, except otherwise stated in accordance with normally accepted accounting policies.

b) Donations and Annual membership fees received from patrons are treated as revenue receipts and life-member-ship fees as capital receipts.

c) Preliminary expenses and deferred Revenue Expenditure are chargeable in 10 years and 3 years respectively.

FIXED ASSETS

Fixed Assets are stated at cost including installation expenses if any.

DEPRECIATION

Depreciation on fixed assets has been provided on straight-line method at the rates specified in Schedule XIV of the Companies Act, 1956.

P.K. Chakravorty & Associates
Chartered Accountant

(P.K. Chakravorty)
Proprietor
M.No. 5170I

F/52, Bapuji Nagar, PO: Regent Estate
Kolkata 700 092

Place: Kolkata

Date: 21st Sept'2014

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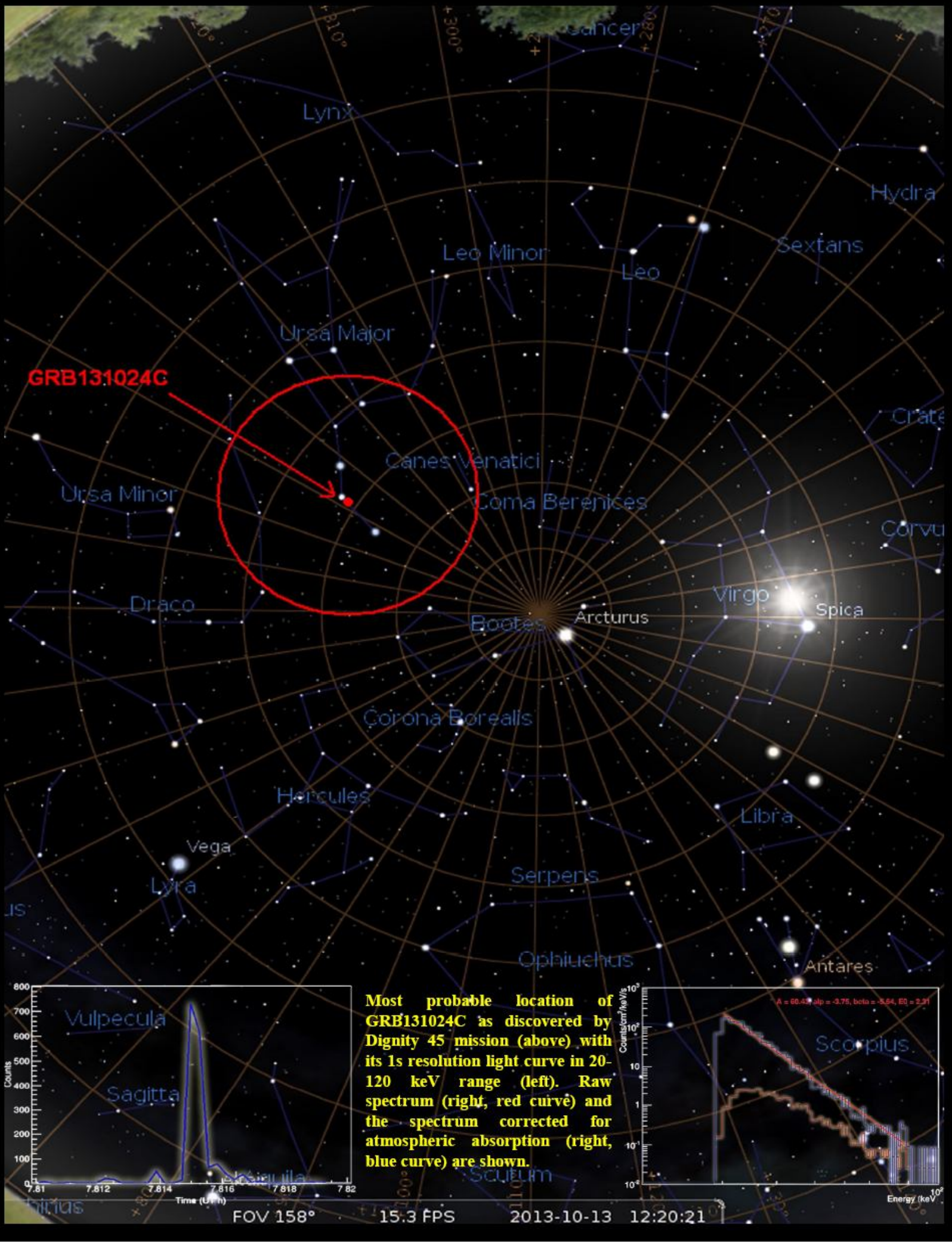
Scientists A. Das [L] and L. Majumdar [R] flanking N. Meson (UK) and B. Sivaraman (PRL) at a VAMDC conference at PRL (Left). Preparing for a double balloon launch (Right).

ICSP scientists with Prof. D. Balsara (USA) (Left). Discussion with Prof. Balsara at the Seminar room (Right).

Some M.Sc. Project students with their Instructors (Left). Dr. A. Das received 'Tomare Selaam' award from R-Plus Channel for scientific achievements (Middle). M.Sc. students Debkumar and Soumen presenting a poster based on their ICSP project at a conference in Odisha (Right).



Most probable location of GRB131024C as discovered by Dignity 45 mission (above) with its 1s resolution light curve in 20-120 keV range (left). Raw spectrum (right, red curve) and the spectrum corrected for atmospheric absorption (right, blue curve) are shown.