Annual Report

(2011-2012)

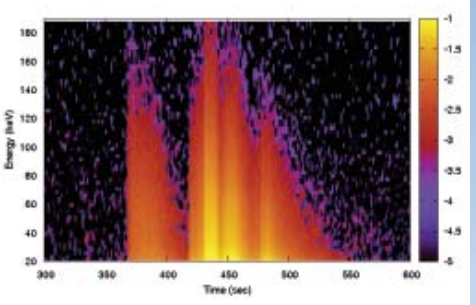
Indian Centre for Space Physics

Inauguration of the Ionospheric and Earthquake Research Centre (IERC) of Indian Centre for Space Physics at Sitapur village, Paschim Medinipur, West Bengal. (L) Inauguration ceremony. (R) Data acquisition began with the click of the mouse by the President, Prof. B. B. Bhattacharyya.

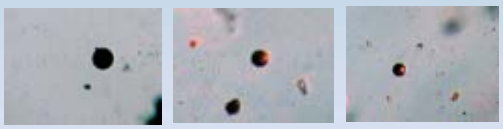
Photomultiplier tubes with NaI scintillators and lead shielding/ collimator are being tested before integrating with payload (Top left and middle). Thick lead shieldings for muon detection (Top right).

A telescope is prepared to take photographs during balloon flights (L).

The balloon team readies a two kilo category balloon for sending a payload to a height of ~ 40km altitude (R).



Dynamic spectrum of the GRB 090618 observed through RT-2/S payload. The first episode is the signature of the formation of a black hole.



Microscope images of the micro-meteorites collected from various heights for analysis of their composition (L).

INDIAN CENTRE FOR SPACE PHYSICS

ANNUAL REPORT
(2011-2012)

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Front Cover: This extraordinary photograph of Orion nebula region was taken by ICSP scientist Mr. R. Khan from the terrace of the Ionospheric and Earthquake Research Centre/ICSP, Sitapur, W. Medinipur using a 10 inch Meade Telescope.

Report of the Governing Body

This is the Thirteenth Annual report of our Centre. As usual, ICSP activities are steadily growing. The new branch in Paschim Medinipur, namely, Ionospheric and Earthquake Research Centre (IERC) was inaugurated by the President and is now functioning well. Several VLF antennas and receivers are operating from there. Small sized radio antennas are also being installed. Not only this site is free from radio noise, the night sky is very good for optical observations. Our 10 inch optical telescope has been able to obtain superb pictures of celestial bodies from this site as can be appreciated in the cover of this issue.

ICSP is doing pioneering work in the field of conducting space research using weather balloons. Several successful balloon flights were carried out and for the first time, spectrum of the Sun was also obtained using single and multiple balloon flights. Lead collimated/shielded, photomultiplier tubes with NaI scintillators were the main detectors. Muon detectors also obtained muon data as a function of height. The attitude of the payload were computed using onboard gyroscope, accelerometers and magnetometers at each moment.

In addition to the VLF activities and the balloon programme, our contributions in AstrobiologyAstrochemistry and black hole astrophysics have been very encouraging. Several papers were written in both the topics. Quantum chemical calculations were made to obtain reaction cross-sections at extreme conditions of interstellar medium. New students have joined the group also.

Along with the Govt. of West Bengal, the Central Government funding agencies, such as the Department of Earth Sciences has also supported our research programme. New grant to hire several project scientists, post-doctoral fellows and research scholars has been received. We thank them for their continuous support.

Several scientists attended and presented valuable findings at National and International conferences in India and abroad. A student from Nepal is working at our Centre as an ICTP (Italy) Senior Research Fellow. He has submitted his PhD thesis to Jadavpur University. ICSP is a consortium member of Erasmus Mundus Joint Doctorate (EMJD) programme which is coordinated by University of Nice, France.

ICSP has been playing a major role in helping M.Sc. students from the nearby colleges. Last year, six students from various colleges carried out their M.Sc. projects at ICSP. ICSP also conducted Astrophysics course at RKMR (autonomous) college. Five ICSP students are completing their thesis to the Universities for PhD degree in the coming year.

The Malda branch of ICSP is also active. The Malda branch scientists are completing several works on VLF astronomy and X-ray Astronomy. They have delivered several lectures to popularize space science in the district of Malda.

I thank Dr. D. Debnath and Mr. Rajkumar Maiti for helping with the compilation of the data related to this Annual report.

Prof. S.K. Chakrabarti, Honorary General Secretary
Indian Centre for Space Physics Kolkata: September 29, 2012

Governing Body (GB) of the Centre

Dr. B.B. Bhattacharyya, *President*
Dr. Jogendra N. Chakravorty, *Vice President*
Dr. Sandip K. Chakrabarti, *Secretary*
Dr. Dipak Bhaumik, *Treasurer*
Dr. Sonali Chakrabarti, *Member*
Dr. S. C. Chakravarty, *Member*
Dr. A. R. Rao, *Member*
Mr. Gurusaran Das Gupta, *Member*
Dr. Asish Das Gupta, *Member (Nominated by Calcutta University)*
Dr. P. K. Das Poddar, *Member (Nominated by Calcutta University)*

Members of the Research Advisory Council (RAC)

Prof. S. N. Ghosh, FNA, Ex Allahabad Univ. & Calcutta Univ. (Chairman)
Prof. J. N. Chakravorty, Indian Centre for Space Physics
Prof. A.R. Rao, Tata Institute of Fundamental Research, Mumbai
Mr. K. K. Chakraborty, Ex-Director, Positional Astronomy Centre
Prof. A.M. Basu, Jadavpur University, Kolkata
Prof. S.K. Chakrabarti, S.N. Bose Nat'l Centre for Basic Sciences, Kolkata & ICSP
Prof. D.C.V. Mallick, Indian Institute of Astrophysics, Bangalore
Prof. S. Ananthakrishnan, Ex-Senior Prof., GMRT, Pune
Prof. D. J. Saikia, National Center for Radio Astronomy, Pune
Prof. B. G. Ananda Rao, Physical Research Laboratory, Ahmedabad
Prof. P. J. Wiita, Georgia State University, USA

Faculty Members

Dr. Ankan Das	Assistant-Professor
Dr. D. Debnath	Scientist -B
Dr. Ritabrata Sarkar	Assistant-Professor
Mr. D. Bhowmick	Hardware Engineer
Mr. S. Chakraborty	Junior Engineer

Honorary Faculty Members

Dr. B. B. Bhattacharyya, Ex-ISM, Dhanbad	(Hony. Emeritus Professsor)
Dr. S. Chakrabarti, M. M. Chandra College	(Hony. Assoc. Professor)
Dr. S. K. Chakrabarti, SNBNCBS	(In Charge, Academic Affairs)
Dr. S. C. Chakravarty, Ex-ISRO	(Hony. Senior Professor)
Dr. J. N. Chakravorty, ICSP	(Hony. 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 BEd College	(Hony. Scientist)
Dr. M. M. Majumdar, DPI	(Hony. Scientist)
Dr. S. K. Midya, Serampore College	(Hony. Assoc. Professor)
Dr. S. Mondal, RKMR College	(Hony. Scientist)
Dr. G. Tarafdar (Barasat Govt. College)	(Hony. Scientist)

Research Scholars

Mr. Santanu Mondal (CSIR) Mr. Partha S. Pal (CSIR) Mr. Kumaresh Chakrabarti
Mr. Sudipta Sasmal (ISRO) Mr. Wasim ul Bari Mr. Surya K. Maji
Mr. Tilak Kotoch (ISRO) Mr. Sushanta K. Mondal (CSIR) Mr. Asit K. Choudhury
Mr. Sourav Palit (CSIR) Mr. Suman Ray (ISRO) Mr. Dipen Sahu (ISRO)
Mr. Liton Majumdar (DST) Mr. Rajdeep Saha (DST)

ICTP Senior Research Fellow

Mr. Chandra Bahadur Singh

Engineers

Mr. Debashis Bhaumick
Mr. Subhankar Chakraborty

Administrative Section

Mr. Rajkumar Maity

(Accountant/ Office Assistant)

Mr. Hriday Roy

(Laboratory Assistant)

Mr. Ram Chandra Das

(Office Helper)

Mr. Uttam Sardar

(Office Helper)

Security

Mr. Barun Chakraborty

Research Facilities at the Centre

ICSP Head Office in Kolkata:

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

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.

ICSP branch at Sitapur: The Ionospheric and Earthquake Research Centre (IERC) for studying VLF and radio astronomy was inaugurated at Sitapur, Paschim Medinipur, West Bengal on 22nd January 2012. It has computing and internet facilities.

ICSP branch at Bolpur: This Centre is used only during balloon flights twice per year for a period of about two months.

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.

Brief Profiles of the Scientists of the Centre

Prof. Bimalendu B. Bhattacharyya: He is the President of the governing body of ICSP. He was an ex-Director of Indian School of Mines, Dhanbad. He is presently an Emeritus Professor (Hony.) of the Centre. His field of specialization is the study of deep crustal structure on earth from magneto-telluric data.

Prof. Sandip K. Chakrabarti: He is a Senior Professor and Dean (Academic Program) of the S.N. Bose National Centre for Basic Sciences and the 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; ionospheric perturbations due to terrestrial and extra-terrestrial phenomena and their effects on very low frequency radio waves; Chemical Evolution of star forming region.

Dr. Sonali Chakrabarti: She is an Assistant 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 computing the possibility to produce high resolution millimeter and microwave grating instruments.

Dr. Ankan Das: He is an Assistant-Professor at ICSP. He is also the dean (academic affairs) of the centre. His main research interest is in the formation of bio-molecules in star forming region. He does time dependent hydrodynamic and chemical evolutions.

Dr. Dipak Debnath: He is a Scientist-B at ICSP. His main research interest is observational

and theoretical studies of the properties of transient stellar mass black hole candidates (during their outbursts. He is implementing Two-Component Advective Flow (TCAF) model for a better fit of black hole spectra and include it into NASA's standard spectrum fit software package XSPEC.

Mr. Debashis Bhowmick: He is a hardware engineer at ICSP and is the X-ray laboratory in Charge which oversees the activities related to VLF and balloon experiments.

Mr. Subhankar Chakraborty: He is a junior hardware engineer at ICSP and is involved in software and instrumentation work related to balloon activities.

Dr. Ritabrata Sarkar: He is an Assistant-Professor at ICSP. He is working on simulations leading to atmospheric corrections to data from balloon experiments.

Mr. Tilak C. Kotoch: He is a Senior Research Fellow (SRF) working on the Solar activity. Presently, he is finishing the Ph.D. Thesis.

Mr. Liton Majumdar: He is a DST project research Fellow at ICSP and is working on theoretical studies in Astrochemistry/Astrobiology.

Mr. Rajdeep Saha: He is a DST project research Fellow at ICSP and is working on theoretical studies in Astrochemistry/Astrobiology.

Mr. Dipen Sahu: He is an ISRO-RESPOND project research Fellow at ICSP and has started working on theoretical studies in Astrochemistry/Astrobiology as a Junior Research Fellow.

Mr. Partha Sarathi Pal: He is a CSIR senior research fellow working at ICSP. He is working on spectral and timing properties of Black hole Astrophysics.

Mr. Santanu Mondal: He is a CSIR Senior Research Fellow working at ICSP. He is doing his research incorporating Comptonization in the Transonic flows around black holes in the context of two component advective flow model.

Mr. Sudipta Sasmal: He is a Senior Research Fellow working at ICSP under ISRO RESPOND project. He is working on earthquake predictions using VLF data.

Mr. Sushanta K. Mondal: He is a CSIR Senior Research Fellow and working on radio and VLF studies of very high energy gamma ray activities in space.

Mr. Sourav Palit: He is a CSIR Senior Research Fellow, working at ICSP. He is working on theoretical and experimental study X-ray imaging with Fresnel Zone plates. He is also involved on GEANT-4 simulations of ionospheric study.

Mr. Suman Ray: He is working as a part time Junior Research Fellow in an ISRO project. He is in VLF group and is working on the earthquake related perturbations on VLF signals. He is also working on eclipse data.

Mr. Surya Maji: He is a school teacher and a part time Junior Research Fellow at ICSP. He works on the effect of eclipse on VLF signals.

Mr. M. M. Samanta: He is a teacher of B.M. Institution, Tarakeswar and is an honorary Senior Research Fellow (SRF) of ICSP. His field of interest is time dependent accretion

around black holes.

Mr. Chandra B. Singh: He is an ICTP Senior Research Fellow. He is working on computation of the outflows rates from accretion disks around Black holes.

Dr. Broja G. Dutta: He is a teacher of 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. Dipak Bhaumick: He is an Ex-Reader at the Ramakrishna Mission Residential College, Narendrapur and an honorary scientist and Treasurer of the Governing Body of the Centre. His interest lies in the airglow, reaction properties of molecules in the upper atmosphere and also VLF research.

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 Malda Branch of Indian Centre for Space Physics.

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

Mr. K. Chakrabarti: He is a selection grade Assistant Professor in 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 Astronomical Society of India. His field of interest is the cause of Cyclonic activities. He is in the Advisory Committee.

Dr. T. K. Das: He is a 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. 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. R. Khan: He is a teacher of Bidhan Nagar Govt. High School and is involved in activities of the ICSP observatories. He uses ICSP optical telescope for imaging celestial objects.

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

Dr. G. Tarafdar: He is an honorary scientist of the Center. He is permanently with Barasat Govt. College.

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

Indian Centre for Space Physics.

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.

Research Work Published or Accepted for Publication

Papers in Journals and Proceedings

Chattopadhyay I. & Chakrabarti, S.K., "Effects of the composition on transonic properties of accretion flows around black holes", 2011, IJMPD, 20, 1597

Chakrabarti, S.K. "Fundamental Concepts in Transonic Flow Paradigm of Black Hole Astrophysics", 2012, IJMPD, 20, 1723

Chakrabarti, S.K., Bhowmick, D. , Sarkar, R., Mondal, S. & Sen, A., "High energy Astrophysics using Rubber Balloons, 2011, Proc. 20th European Space Agency Symposium, p. 581 (ESA)

Chakrabarti, S. K., Pal, S., Sasmal, S., Mondal, S. K., Ray, S., Basak, T., & Maji, S., "VLF observational results of total eclipse of 22nd July, 2009 by ICSP team", Proceedings of 2011 URSI General Assembly and Scientific Symposium, 13th to 20th August, 2011, Istanbul, Turkey, 2011, 978-1-4244-6051-9/11/26.00 2011 IEEE.

Chakrabarti, S. K., Pal, S.. Sasmal, S., Mondal, S. K., Ray, S., & Basak, T., "Results of VLF campaigns in Summer and Winter in Indian Subcontinent", Proceedings of 2011 URSI General Assembly and Scientific Symposium, 13th to 20th August, 2011, Istanbul, Turkey, 2011, 978-1-4244-6051-9/11/26.00 2011 IEEE.

Das, A., & Chakrabarti, S. K., "Composition and Evolution of Interstellar Grain Mantle under the effect of Photodissociation", 2011, MNRAS, 418, 545

Das, A., & Chakrabarti, S. K., "Composition of Grain Mantle; A Monte Carlo Study", 2011, v.280, p.399

Das, A., Majumdar, L., Chakrabarti, S. K., & Chakrabarti, S., "Study of the formation of proto-stars by a two dimensional hydrodynamic simulation and the chemical evolution during these process", 2012, New Astronomy (Submitted)

Debnath, D., Chakrabarti, S. K., & Nandi, A., "Evolution of QPO frequency and Spectral state in 2010 & 2011 outbursts of H 1743-322", 2012, New Astronomy (Submitted)

Debnath, D., Nandi, A., Chakrabarti, S. K., Kotoch, T. B., & Rao, A. R., "Nature of GRBs observed by RT-2 onboard CORONAS-PHOTON Satellite", 2012, BASI (in press)

Ghosh, H., Garain, S. K., Giri, K., & Chakrabarti, S. K., "Effect of Compton Cooling on the Hydrodynamic and the Spectral Properties of a Two Component Accretion Flow around a Black Hole", 2011, MNRAS, 416, 959

Ghosh, H., Garain, S. K., Giri K., & Chakrabarti, S. K., "Monte-Carlo Simulations of Comptonization Process in a Two Component Accretion Flow around a Black Hole in Presence of an Outflow", 2012, Proc. XII Marcel Grossman Conference, p. 985 (World

Scientific Publishiers Co.)

Giri, K. & Chakrabarti, S. K., "Hydrodynamic simulations of viscous accretion flows around black holes, 2012, MNRAS 421, 666

Majumdar, L., Das, A., Chakrabarti, S. K., & Chakrabarti, S., "Chemical Evolution around star forming region: A time dependent study", 2011, Proc. IAU Symposium, v. 280, p.400

Majumdar, L., Das, A., Chakrabarti, S. K., & Chakrabarti, S., "Study the chemical evolution and spectral signatures of some interstellar precursor molecules of adenine, glycine & alanine", 2012, New Astronomy (Submitted)

Majumdar, L., Das, A., Chakrabarti, S. K., & Chakrabarti, S., "Hydro-chemical study of the evolution of interstellar pre-biotic molecules during the collapse of molecular clouds", 2012, Astronomy and Astrophysics (Submitted)

Nandi, A., Debnath, D., Mandal, S., & Chakrabarti, S. K., "Accretion flow dynamics during the evolution of timing and spectral properties of GX 339-4 in 2010-11 outburst", 2012, A&A, 542, 56

Pal, S., Basak, T., Chakrabarti, S.K., & Mondal, S. K., "Modeling of sub-ionospheric VLF signal perturbation associated with total solar sclipse, 2009 in Indian subcontinent:, 2012, Advances in Space Research, 50, 196-204

Pal, S., Basak, T., & Chakrabarti, S.K., "Advances in Geosciences, Solar Terrestrial (ST)", Vol. 27. Edited by Marc Duldig. Singapore: World Scientific, 2011, p.1

Pal, P. S., Chakrabarti, S. K., & Nandi, A., "Evidence of variation of the accretion flow geometry in GRS 1915+105 from IXAE and RXTE data", 2011, IJMPD, 20, 2281

Pal, P.S., Chakrabarti, S.K., & Nandi, A., "Sequencing the Variability Classes of GRS 1915+105, 2012, Proc. XII Marcel Grossman Conference, p. 969 (World Scientific Publishiers Co.)

Rao, A. R., Malkar, J. P., Hingar, M. K., Agrawal, V. K., Chakrabarti, S. K., Nandi, A., Debnath, D., Kotoch, T. B., Sarkar, R., Chidambaram, T. R., Vinod, P., Sreekumar, S., Kotov, Y. D., Buslov, A. S., Yurov, V. N., Tyshkevich, V. G., Arkhangelskij, A. I., Zyatkov, "Onboard performance of the RT-2 detectors", 2011, SoSyR, 45, 123-134

Ray, S., Chakrabarti, S. K., Mondal, S., & Sasmal, S., "Correlation between night time VLF amplitude fluctuations and effective magnitudes of earthquakes in Indian sub-continent" 2011, Nat. Hazards and Earth Syst. Science, 11, 2699

Ray, S., Chakrabarti, S. K., & Sasmal, S., "Precursory Effects in the night time VLF signal Amplitude for the 18th Jan. 2011 Pakistan Earthquake", 2012, Ind. J. Physics, 86, 85

Ray, S., & Chakrabarti, S. K., "Precursor of earthquake using night time VLF amplitude", 2011, IEEE Conf. Publication, DOI 10.1109/URSIGASS.2011.6051045

Ray, S., Chakrabarti, S. K., & Choudhury, A. K., "Anomalous behaviours of the VLF signals before earthquakes for VTX-Malda propagation path", 2011, IEEE Conf. Publication, DOI 10.1109/URSIGASS.2011.6051047.

Ruffini, R., Izzo, L., Penacchioni, A. V., Bianco, C. L., Caito, L., Chakrabarti, S. K., &

Nandi, **A., "**GRB 090618: a possible case of multiple GRB?", Proceedings of the 25th Texas Symposium on Relativistic Astrophysics. Frank M. Rieger (Chair), Christopher van Eldik and Werner Hofmann (Eds.), p. 101

Sasmal, S., Chakrabarti, S. K. & Chakrabarti, S., "Studies of the Correlation Between Ionospheric Anomalies and Seismic Activities in the Indian Subcontinent", Proceedings of 2011 URSI General Assembly and Scientific Symposium, 13th to 20th August, 2011, Istanbul, Turkey, 2011, 978-1-4244- 6051-9/11 2011 IEEE.

Sasmal, S., Chakrabarti, S. K., Pal, S., & Basak, T., "A comparative study of VLF signals from several transmitters around the world as observed from Maitri station, Antarctica", Proceedings of 2011 URSI General Assembly and Scientific Symposium, 13th to 20th August, 2011, Istanbul, Turkey, 2011, 978-1-4244-6051-9/11 2011 IEEE.

Singh, C. B. & Chakrabarti, S. K., "Model dependence of outflow rates from an accretion disk in presence of a dissipative standing shock", 2011, IJMPD, 20, 2507

In Books

S. K. Chakrabarti, S. Sasmal, S. Ray, Short Term Earthquake Prediction using VLF observations: An ICSP initiative in Indian Sub-continent, Frontier of Earthquake Prediction, 2011, Ed. by M. Hayakawa, Nihon-senmon-Tosho Pub. Comp.

Members of Scientific Societies/Committees

Sandip K. Chakrabarti became a member of the following ***External Committees***: i) International Advisory committee: International Conference on Astrophysics and Cosmology, Kathmandu; ii) International Coordination committee Member: 13th Marcel Grossman meeting on General Relativity and Gravitation, Stockholm; iii) In Charge, Aacdemic Affairs and General Secretary of teh Governing Body of Indian Centre for Space Physics; Editorial Board member: Indian Journal of Physics; Bulletin of Astronomical Society of India. He also became a member and of the following ***Internal Committee*** of S. N. Bose National Centre for basic Sciences: i) Head of the Dept. (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.

Awards / Recognitions received:

Sandip K. Chakrabarti received "***Mitra Mandir***" award for his Eminent Personalities of India medalion (2012)

Ankan Das became "***Adjunct Professor"*** at Ilia State University Georgia, 2011-2012.

Students registered for Ph.D. Degree

Suman Ray and Santanu Mondal registered with Calcutta University for PhD Degree.

Ph.D. Thesis Submitted

Chandra Bahadur Singh has submitted his Ph.D. Thesis entitled "*Analytical studies of origin of outflows from accretion disks around black holes*" to Jadavpur University, Kolkata.

Course of Lectures offered by ICSP members

Sandip K. Chakrabarti, Ankan Das, Dipak Debnath, and J.N. Chakravorty gave a series of about 40 lectures to the Physics post-graduate students of R. K. Mission Residential College on High Energy Astrophysics and Cosmology in 2011 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, 2011:** two lectures on "*Astrophysical flows around black holes*" at Erasmus Mundus Joint Doctorate Programme, University of Nice; **May, 2011:** "*High Energy Astrophysics with weather balloons*" at the 20th ESA conference on "Balloons and Rockets" in Heyres, France; **August, 2011:** "*Perturbation of the GW signals from a binary system in presence of an accretion flow*" at the Lijiang conference on Gravitation wave Astronomy; **August, 2011:** "*Earthquakes and VLF signal anomalies*" at the URSI conference in Istambul; **September, 2011:** "*Excitements in Astrophysics*" at the National Council of Science Museums; **March, 2012:** Invited talks on "*Accretion Processes around Black Holes and Physics of Jets*" and "*Chemical Evolution of the Universe and the Origin of Life*" at the "International Conference on Astrophysics and Cosmology", Kathmandu.

Ankan Das presented a talk to defend ISRO respond project titled "*Study of the Interstellar processes leading to the deuterium enrichment*", at ISRO Respond meeting, PRL, Ahmedabad, from 29th - 31st March, 2011; presented a talk on "*Chemical composition of the interstellar grain mantle under the effect of physical parameters*" at International conference on Interstellar Dust, Molecules and Chemistry (IDMC-2011), November 22-25, 2011, IUCAA, Pune and presented two posters in IAU 280 symposium, 29th May-3rd June 2011, Toledo, Spain.

Dipak Debnath attended the workshop on "Role of Telescopes in Modern Astronomy Research" from November 7 - 8, 2011 at S.N. Bose National Centre for Basic Sciences, Kolkata, India; presented a lecture on summary of his research work at S.N. Bose National Centre for Basic Sciences, Kolkata, India on 26th December 2011.

Liton Majumdar presented a poster "*Chemical evolution around star forming region : A time dependent study*" in IAU 280 symposium, 29th May-3rd June 2011, Toledo, Spain; a poster on "*Hydrodynamic simulation coupled to chemical evolution in the star forming regions*" in IDMC 2011, 22nd to 29th Nov, 2011, IUCAA, Pune, India; a poster on "*Formation of bio-molecules in interstellar space: A hydro-chemical study*" in Gaussian Workshop 2012, 2nd to 6th Jan, 2012, CLRI & IIT Madras, India.

Chandra B. Singh presented a talk on "*Study of Origin of Outflows from Accretion disks around Black holes*" at International Conference on Astronomy and Cosmology, Tribhuvan University, Kathmandu, March 19-21, 2012.

Partha Sarathi Pal presented a talk on "Study of Origin of Outflows from Accretion disks around Black holes", International Conference on Astronomy and Cosmology, Tribhuvan

University, Kathmandu, March 19-21, 2012.

Santanu Mondal attended the workshop on "Role of Telescopes in Modern Astronomy Research" from November 7 - 8, 2011 at S.N. Bose National Centre for Basic Sciences, Kolkata, India; presented a talk on "Spectral properties of accretion flows around black holes in presence of Comptonization" at S.N. Bose National Centre for Basic Sciences, Kolkata, India on 26th December 2011.

Sudipta Sasmal presented four posters on "*Studies of the Correlation Between Ionospheric Anomalies and Seismic Activities in the Indian Subcontinent*", "*A comparative study of VLF signals from several transmitters around the world as observed from Maitri station, Antarctica*", "*Results of VLF Campaigns in Summer and Winter in Indian Subcontinent*" and "*VLF Observational Results of Total Eclipse of 22nd July, 2009 by ICSP Team"* at XXXth URSI General Assembly and Scientific Symposium of International Union of Radio Science, Istanbul, Turkey, 13th to 20th August, 2011; presented a talk on "*Study of Ionospheric Anomalies Related to Earthquakes*" and a poster on "*Anomalous fluctuation of the night time VLF amplitude before earthquakes*" at International conference on "Advancing VLF Science through the Global AWESOME Network" at Neelam's The Grand, Goa, India, 28th November to 1st December, 2011.

Suman Ray presented two posters on "*Precursor of earthquake using night time VLF amplitude*" and "*Anomalous behaviors of the VLF signals before earthquakes for VTX-Malda propagation path"* at XXXth URSI General Assembly and Scientific Symposium of International Union of Radio Science, Istanbul, Turkey, 13th to 20th August, 2011; a poster on "*Anomalous fluctuations of the night time VLF amplitude before earthquakes*" at International conference on "Advancing VLF Science through the Global AWESOME Network" at Neelam's The Grand, Goa, India, 28th November to 1st December, 2011.

Surya Maji presented a poster on "*VLF Observation of a Solar Flare by Lunar Occultation during Annular Solar Eclipse of January 15th, 2010*" at International conference on "Advancing VLF Science through the Global AWESOME Network" at Neelam's The Grand, Goa, India, 28th November to 1st December, 2011.

Sushanta Mondal gave an oral presentation on "*First VLF detection of ionospheric disturbances due to Soft Gamma ray Repeater SGR J1550-5418*" at XXXth URSI General Assembly and Scientific Symposium of International Union of Radio Science, Istanbul, Turkey, 13th to 20th August, 2011; a poster presentation on "*Very Low Frequency Detection of Ionospheric Disturbances due to GRB 090424*" t International conference on "Advancing VLF Science through the Global AWESOME Network" at Neelam's The Grand, Goa, India, 28th November to 1st December, 2011.

Workshop / Seminars etc. organized :

Sandip K. Chakrabarti organized as the chairman of the conference: "Role of Small Telescopes in Modern Astronomy", Nov. 7-8, 2011, was held at SNBNCBS.

Visits abroad from the Centre

Sandip K. Chakrabarti visited University of Nice (May, 2011) as an Adjunct Faculty of the International Relativistic Astrophysics PhD (IRAP-PhD) programme; attended the 20th ESA conference (May, 2011) on "Balloons and Rockets" in Heyres, France; attended the Lijiang conference (August, 2011) on Gravitation wave Astronomy; attended the XXXth URSI General Assembly and Scientific Symposium (August, 2011) of International Union of Radio

Science, Istanbul, Turkey; attended "International Conference on Astrophysics and Cosmology", Kathmandu (March, 2012).

Sudipta Sasmal, Suman Ray and Sushanta Mondal attended XXXth URSI General Assembly and Scientific Symposium (August, 2011) of International Union of Radio Science, Istanbul, Turkey.

Ankan Das and Liton Majumdar attended the IAU 280 symposium, 29th May-3rd June 2011, Toledo, Spain.

Ritabrata Sarkar visited INFN, Trieste, Italy as an Post-Doctoral Research Fellow.

Visitors to the Centre

Prof. Tomaso Belloni, from Milan Observatory, Italy, visited the Centre and presented a lecture on recent development of observational studies of black hole X-ray binaries.

Dr. Bhalamurugan Sivaraman of TIFR gave a talk on the laboratory experiments to determine the spectral properties of interstellar molecules.

A team of students from Maharaja Manindra Chandra College was shown some of the objects in the night sky using the ten inch Meade telescope from the terrace of ICSP.

Collaborative research & project work

Time dependent evolution of gas/grain chemistry, S. Chakrabarti (MMC and ICSP), S.K. Chakrabarti (SNBNCBS and ICSP), L. Majumdar (ICSP), R. Saha (ICSP): Funded by Department of Science and Technology (March 2010 – March 2013).

Abstract: We carry out time dependent simulations of the collapsing molecular clouds and at the same time carry out the Monte-Carlo simulations on grains and simulations of chemical evolutions. We compare with observational results.

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

Effects of Solar Eclipse on the VLF signals: Funded by RESPOND (ISRO) project

Abstract: In July, 2009 and January, 2010, the Solar eclipses were observed from Indian subcontinent. We study the perturbations of the ionosphere by these natural processes through the observations of the VLF signals. Several students have been working in this project: S. Ray (ICSP), S. Maji (ICSP), S. Sasmal (ICSP).

M.Sc. projects guided by ICSP members

1. **Dr. Ankan Das** supervised Mr. Chandan Mahapatra of Ramakrishna Mission Residential College, Narendrapur, Kolkata, for his M.Sc. project work entitled "*A quantum chemical simulation to study the spectral and chemical parameters of Interstellar Formamide*".

2. **Dr. Dipak Debnath** supervised Mr. Soumik Banerjee of Ramakrishna Mission Residential College, Narendrapur, Kolkata, for his M.Sc. project work entitled "*X-ray temporal variability study of H 1743-322 during its 2007-08 outburst*".

3. **Mr. Sushanta Modal** supervised Mr. Siddhartha Ray and Mr. Ashin Hazra of Ramakrishna Mission Residential College, Narendrapur, Kolkata, for their M.Sc. project works entitled "*Designing Directional Yagi-Uda Antenna for 467 MHz and 2.4 GHz*" and "*Search for Gamma Ray Burst and Soft Gamma Ray Repeaters in Very Low Frequency data*" respectively.

4. **Mr. Debashis Bhowmick and Mr. Sourav Palit** jointly supervised Mr. Arpan Das and Mr. Tuhin Pal of Ramakrishna Mission Residential College, Narendrapur, Kolkata, for their M.Sc. project works entitled "Calibration of MEMS based inertial navigation system and finding attitude of a moving object" and "Modelling the ascent of a weather balloon and finding air drag coefficient at balloon heights" respectively.

Media Coverages

ICSP activities have been highlighted in several media, in Newspapers and Television channels. Both Indian and Bangladeshi newspapers covered several news on the landing and recovery of the balloon payloads.

Summary of Research Activities of the Scientists at the Centre

Astrobiology/Astrochemistry

Astrochemistry/astrobiology is a multi-disciplinary research activity. It involves the understanding of the star formation (hydrodynamics coupled to radiative transfer) and at the same time the changes in the chemical composition of this region (knowledge of reaction cross-sections among the reactive species under extreme condition). Our premise has always been that the complex pre-biotic molecules must have been formed during the start forming region first and then were brought to the planets through comets and meteorites when the planet settled down. If the planet is in the habitable zone, then the pre-biotic molecules would further evolve to produce life. In fact, our first work in this topic was “Can DNA molecules form in star forming regions?” The possibility is being investigated by many groups throughout the world since then.

A complete answer requires simultaneous study of hydrodynamics of the collapsing gas, the grain chemistry inside the gas, the chemical evolution of the collapsing matter and most importantly, the study of the energetics of possible reactions. These are the main activities of the astrobiology and astro-chemistry department of ICSP.

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

Chemical evolution around the star forming regions: Gas–grain interaction plays a major role towards the chemical evolution around the star forming regions. We performed several model calculations to mimic the exact chemical processes during the collapsing phase of the proto-stars. Moreover, we performed several theoretical calculations to predict the spectral signature of some of the precursors of bio-molecules (A. Das, L. Majumdar, S. K. Chakrabarti and S. Chakrabarti).

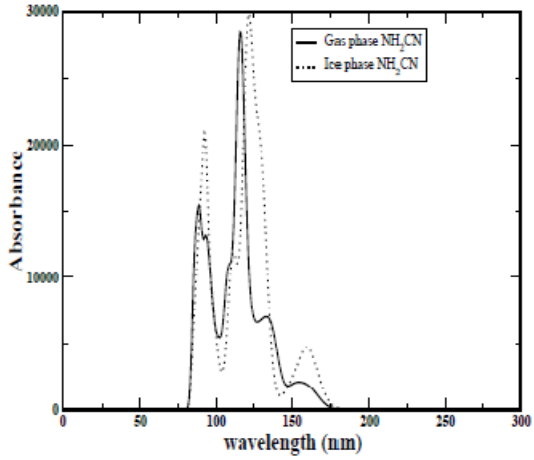


Fig. 1: Electronic absorption spectra of NH_2CN, which is a precursor molecule of Adenine.

Hydro-Chemical modeling to study the chemical evolution and spectral analysis of some pre-biotic molecules: We explored the possibility of the formation of various pre-biotic molecules during the collapsing phase of a proto-star. Our main goal was to compute the abundances with realistic reaction rates and with the grain chemistry taken into account. We observed that not only the reaction rates were important, the presence or absence of the grains made a significant difference of several orders of magnitude in the final abundances of most of the pre-biotic molecules. Despite the high abundances of the neutral species, it is noted that in most of the cases, the radical-radical/radical-molecular reactions are dominating over the neutral-neutral reaction pathways. The reason behind this is that the neutral-neutral reactions very often possess high activation barrier energies, whereas in most of the radical-radical and radical-radical/radical-molecular reactions are found to be barrier less in nature (L. Majumdar, A. Das, S. Chakrabarti & S. K. Chakrabarti).

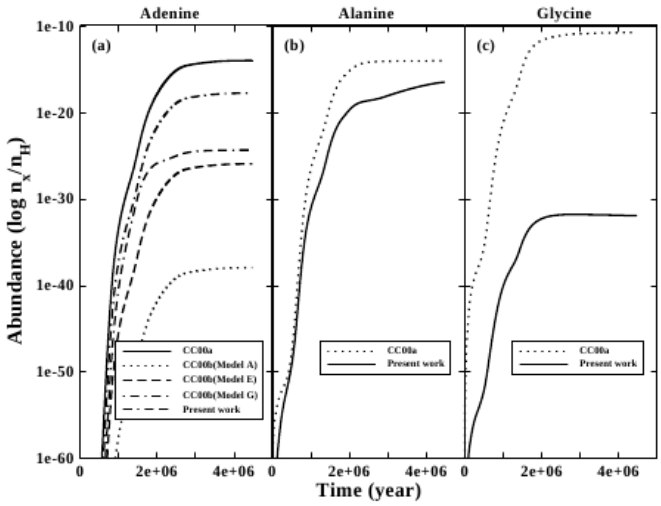


Fig. 2: Comparison of the calculated abundances of (a) adenine, (b) alanine and (c) glycine using various prescriptions.

Black hole Astrophysics

(L - R): D. Debnath, C. B. Singh, S. Mandal and S. K. Chakrabarti

Black Hole astrophysics basically consists of the theoretical studies of how matter is accreted into the 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 and what is the time dependence of the spectrum of radiation. All these types of works are done at ICSP.

Computation of outflow rates and its dependence on flow models in a black environment in presence of a dissipative standing shock: Solutions of black hole accretion flows with axi-symmetric shocks are obtained self-consistently when the dissipation at the post-shock flow is taken into account. The outflow rate from the post-shock region is computed self-consistently. Since the spectrally soft states are generally believed to be caused by the dominance of the soft photons and almost total loss of thermal energy of the Compton cloud by inverse Comptonization, a spectrally soft state should have less outflows. A spectrally harder state will have a stronger outflow, but the result depends on the compression ratio and the adopted model. Other important result is that the model independence of the transonic properties of the flow does not hold in presence of the loss of the energy (radiation) and mass (outflow).

In models of vertical equilibrium and conical flow, the parameter space is reduced as the cooling rate is increased. However in the case of constant height flow model, the parameter space initially increases with the cooling process but starts to decrease with a further increase in cooling. However in all the flow models, the parameter space disappears completely above a critical amount of cooling. This indicates that the spectrally soft states might not have a significant amount of outflows from the accretion disk. This property is well established by observations (C. B. Singh and S. K. Chakrabarti).

Transonic flow solution in presence of Comptonization:

Here we are coupling both the hydrodynamic and radiative transfer processes occurring in accretion flows. We try to show the spectral properties and spectral index variation of the radiation coming from the accretion flow around a black hole as well as the parametric space behavior of the flow in presence of Compton cooling. In presence of cooling the shock moves towards the black hole and the spectrum becomes softer.

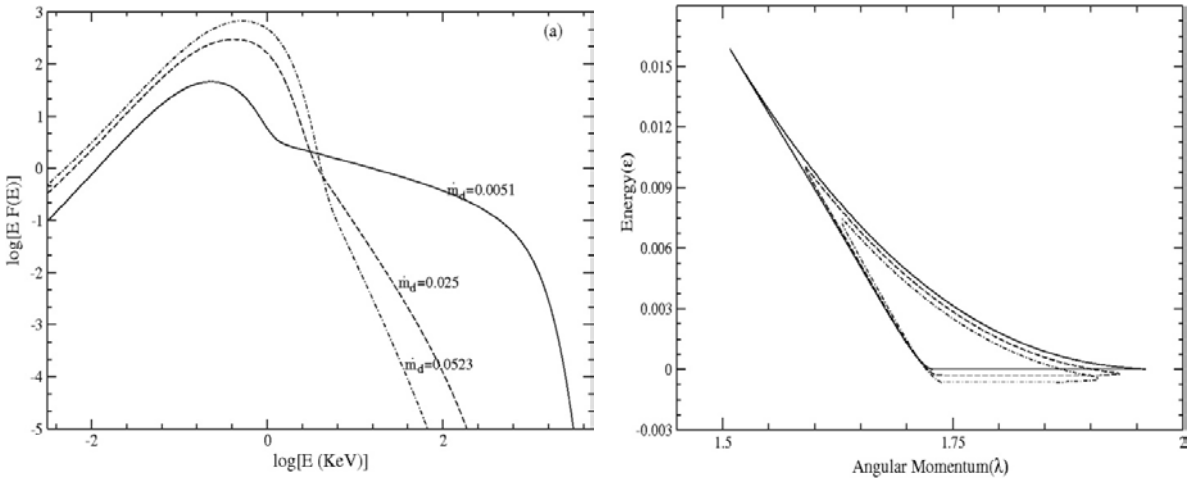


Fig 3: Left panel shows the variation of the spectrum when disk rate is increased and right panel shows the variation of the parametric space in which shock can be produced when cooling rate is increased.

Matter from the companion becomes Keplerian and sub-Keplerian component depending on the viscous processes. The Keplerian flow produces soft photons which is scattered by the hot electrons in the post-shock CENBOL (Centrifugal pressure supported Boundary Layer) region. In each scattering, the soft photon absorbs energy from the electrons via inverse Compton scattering process which in turns cools down the CENBOL. As the accretion rate increases, no of soft photons increases, so the cooling of the CENBOL increases. As a result, the shock or the CENBOL boundary moves inward towards the black hole. This shift has been studied. At the same time, we also see that the spectral index becomes larger. i.e., the spectrum becomes softer. In our study, we consider the mass of the black hole to be 5 solar mass and outer boundary is kept at 500 r_g. In the Figure below we have shown the variation of the spectrum and corresponding variation in the parametric space (S.K. Chakrabarti and S. Mondal).

Inclusion of Two Component Advective Flow (TCAF) model into XSPEC: It has been long understood that the black hole spectral properties cannot be explained by a single Keplerian disk component, and one necessarily requires a Keplerian component and a Compton cloud. Such simplified phenomenological models are already in XSPEC. We make an effort to include a model named TCAF developed by Chakrabarti and his collaborator since mid 1990s based on theoretical solutions of viscous transonic flows), where the Compton cloud is replaced by a low angular momentum flow. This flow becomes hot close to the black hole where the centrifugal pressure starts dominating and an accretion shock may or may not form depending on whether or not the shock condition is satisfied. The jets are also produced from this hot region. The low angular momentum flow, be it in the CENBOL or in the jet, collectively behaves like the Compton cloud.

We are creating a first user-friendly version of TCAF model for XSPEC, which can directly extract accretion flow parameters such as two component (Keplerian and Sub-Keplerian) mass accretion rates, shock locations, shock strengths etc. From the spectral fit with this model, we can also extract other parameters such as the unknown black hole mass and distance related to the accreting black hole candidate. The work is in progress (D. Debnath, S. Mondal and S. K. Chakrabarti).

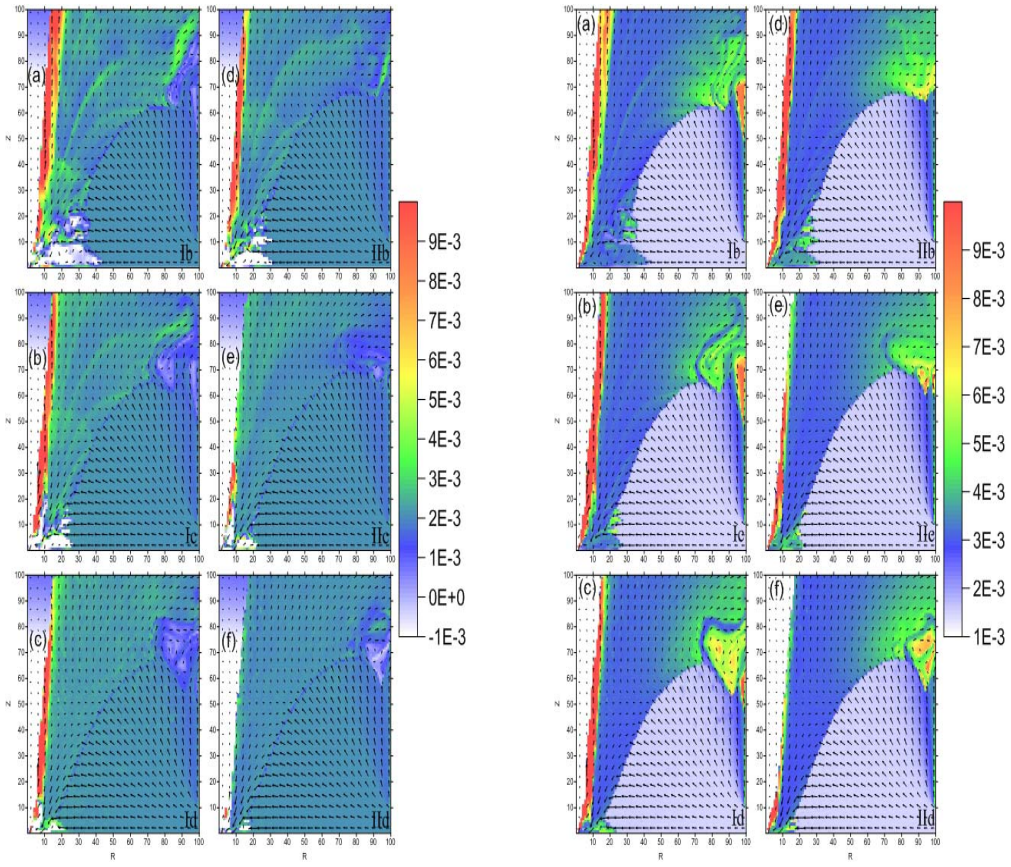


Fig. 4: A typical Monte Carlo grid where soft photons from Keplerian disks(on the X-axis) are intercepted by the sub-Keplerian haloand the outflow and are inverse Comptonized. The left panel is for flow energy and the right panel is for entropy. For each panel, the left and the right columns are for specific angular momentum 1.73 and 1.76 respectively. Rows from top to bottom are for Keplerian disk rates 0.5, 1 and 1.5 respectively.

We have coupled radiative transfer with time dependent flows and computed spectral feature variation with time. Our goal had been to study the formation of jets from CENBOL and how the outflow rate is affected by the cooling of the CENBOL. A typical Monte-Carlo grid is shown in Fig. 4. We show that the outflow rate is reduced due to the excess cooling of the base of the jet, i.e., CENBOL, when the Keplerian rate rises (S. Garain [SNBNCBS], S.K. Chakrabarti, H. Ghosh)

Black hole astrophysics as an Engineering problem:

Visiting scientists: (L to R): K. Chakrabarti, M. M. Majumdar, M. M. Samanta

In Schwarzschild geometry and Kerr geometry we have shown that the accretion problem can be treated as an engineering problem with flows passing through converging and diverging ducts. However, these studies were made for non-viscous flows. A significant progress has been made for the viscous isothermal flow. This work is in progress (K. K. Chakrabarti, M. M. Majumdar and S.K. Chakrabarti).

X-ray Astronomy

(L to R): D. Debnath, P.S. Pal and A. K. Choudhury

Evolution of the Timing and the Spectral properties during outbursts of transient black hole candidates:

Evolution of the accretion flow dynamics and mass flow rates causes evolution of timing and spectral properties during the outburst phases of transient black hole candidates (BHCs). In our recent study on 2010-11 outburst of GX 339-4 and 2010 & 2011 outbursts of H 1743-322, using archival X-ray data of NASA satellite RXTE, we found that depending upon the variation of mass flow rates of Keplerian and sub-Keplerian, mainly four different spectral states (hard, hard-intermediate, soft-intermediate and soft) are observed during the outburst phases of the BHCs. It was also found that these four basic spectral form a hysteresis loop in the sequence: *hard → hard-intermediate → soft-intermediate → soft → soft-intermediate → hard-intermediate → hard.* (D. Debnath, S. K. Chakrabarti & A. Nandi).

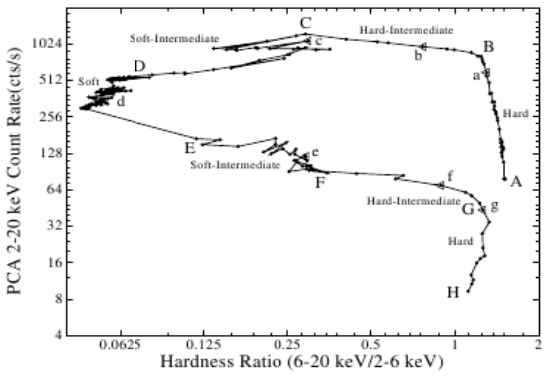


Fig 5: The hardness-intensity diagram observed during the 2010-11 outburst of GX 339-4. All the four basic spectral states form a hysteresis loop.

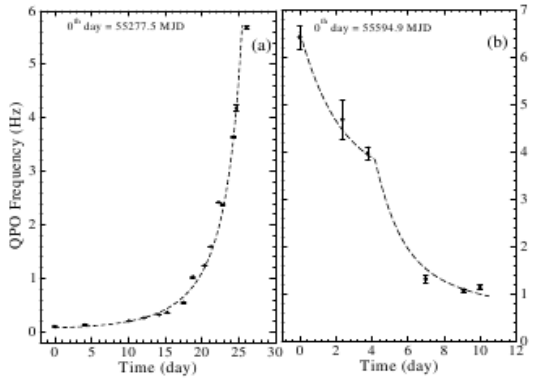


Fig 6: Left panel: shows variation of the QPO frequencies with time (in day) during (a) the rising and (b) the declining phases of the 2010-11 outburst of GX339-4. The dotted curves are the solutions from the oscillating and propagating shocks. While in (a), the shock appears to be drifting at a constant speed (~10 m/s) towards the black hole, in (b), the shock moves away from the black hole in two different ways. During the initial ~4.2 days, the shock moved away with a slow rate of acceleration (~20 cm/s/day), after which it moved away with a high acceleration (~175 cm/s/day). Right panel: shows the variation in the shock locations (dashed curve) and compression ratios R (dotted-dashed curve) with time (in days) during (a) the rising and (b) the declining phases of the 2010-11 outburst of GX 339-4.

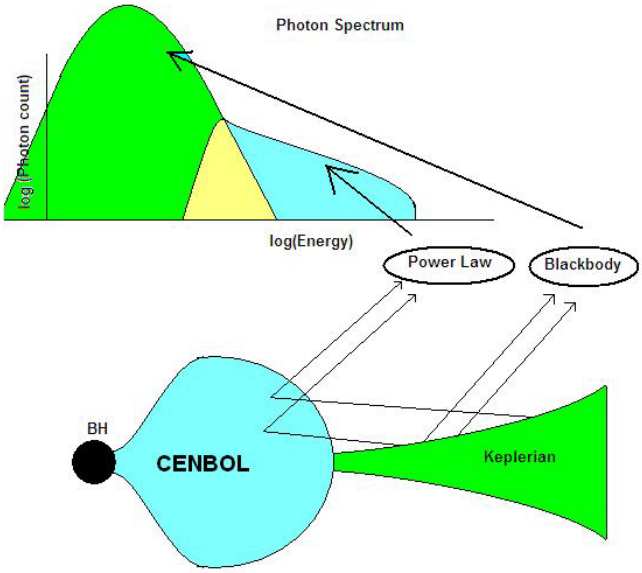


Fig. 7: The flow geometry (left, bottom) and the spectral components (left, top). The power-law component is generated from the Comptonization of the black body photons intercepted by the sub-Keplerian CENBOL. The ratio of power-law and black body photons thus decide the optical depth of the CENBOL.

Dynamic geometry variation of accretion disk around compact objects:

Here we study the time dependent geometry variation of the Compton cloud around a black hole candidate GRS 1915+105 using RXTE data. We introduce a parameter named as Comptonizing Efficiency (CE) which is defined to be the ratio between the photons in the power law component and the black body component. Since the power law component is produced by the soft photons intercepted by the Compton cloud, the CE is directly related to the size of the Compton cloud (geometry) and the optical depth (accretion rate in the low angular momentum component).

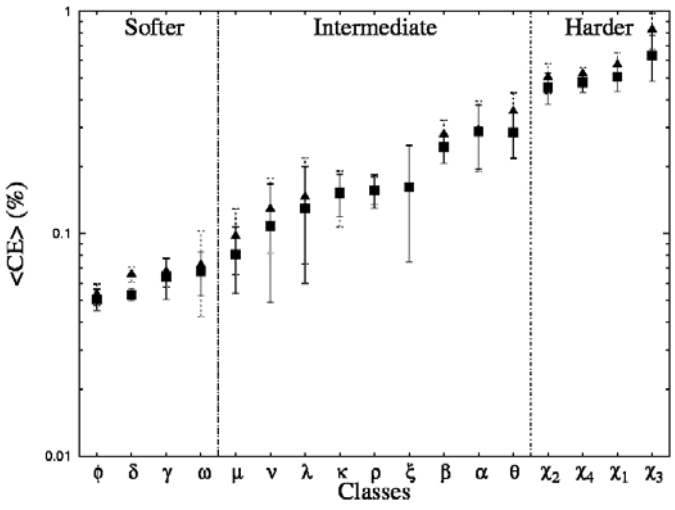


Fig. 8: The Comptonizing Efficiency of all the classes of GRS1915+105 are arranged in an increasing order. The class transition of this object, whenever available, is also seen in the same order.

X-ray/gamma ray Experiments

(L – R): D. Bhaumick, S. Chakraborty, S. Palit, R. Sarkar, and S.K. Chakrabarti

(L - R): D. Debnath, T. B. Katoch, R.C. Das, H. Roy, and U. Sardar

RT-2 observation of Solar Flare, Gamma-Ray Bursts and Transient Events

RT-2 is an Indo-Russian collaborative experiment, consists of three scientific payloads and one electronics payload. The RT-2 payloads were a part of the Russian CORONAS-PHOTON satellite, and it was launched to its polar orbit on January 30, 2009. The main goal of the experiment was to make a detailed temporal, spectral and spatial study of our nearest star Sun in hard X-ray and low-energy Gamma-ray (~ 13 keV – 1 MeV).

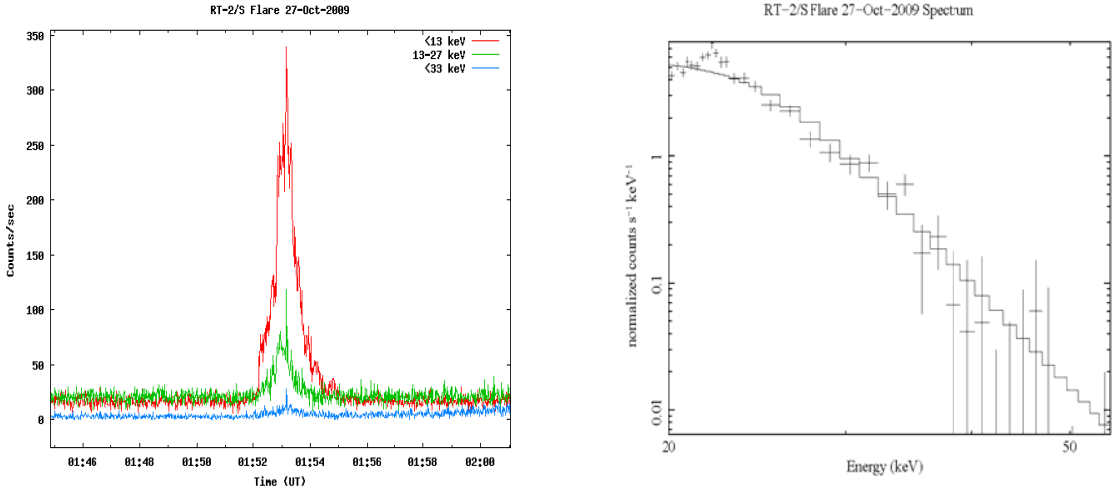


Fig. 9: (Left) RT-2/S light curve of 8th July 2009 solar flare in three different energy bands. (Right) RT-2/S spectrum in 13-55 keV band is fitted with a combination of thermal (black body) and nonthermal (power-law)components.

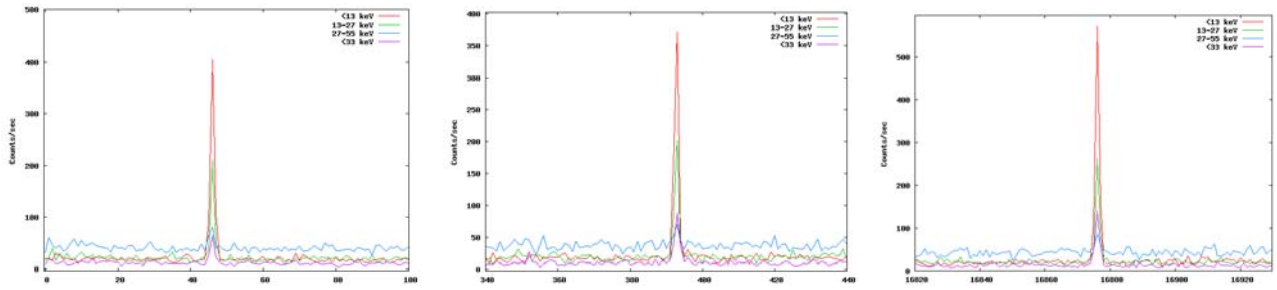
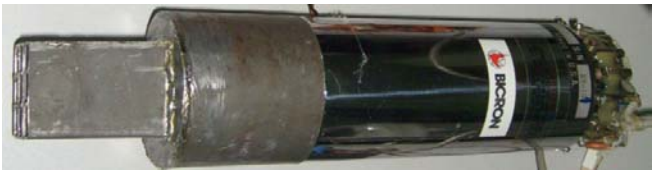


Fig 10: RT-2/S light curves in four different spectral bands for transient events observed on 23th Jul, 12th Aug, and 28th Sep 2009.

So far, we observed 22 solar flares (SFs), 4 Gamma-Ray Bursts (GRBs) and 3 transient events (TEs) not yet identified. In C2.7 class solar flare of 5th July, 2009, we observe quasi-periodic pulsations of period ~ 12s in various energy bands (RT-2 teams of ICSP, TIFR and VSSC).

Instrumentations for future space missions:

We fabricated several X-ray spectrum measuring instruments for future space missions. These instruments have been tested and the expected behavior with height, in case of balloon borne missions, has been characterized.



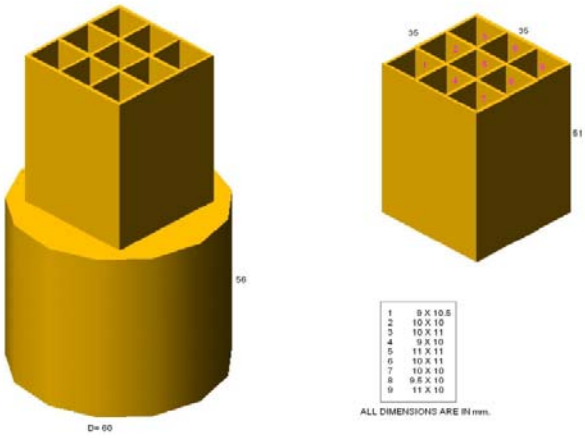


Fig 11: (Left) Bicron made PMT with a lead shield around the NaI scintillator and a collimator (10^o x 10^o). (Right) The model of the shield and collimator for GEANT4 simulations.

Figure 12 (below) shows the energy resolution of the detector. In the range we are interested, the resolution vary from ~ 23% at low energies to ~ 7% at high energies.

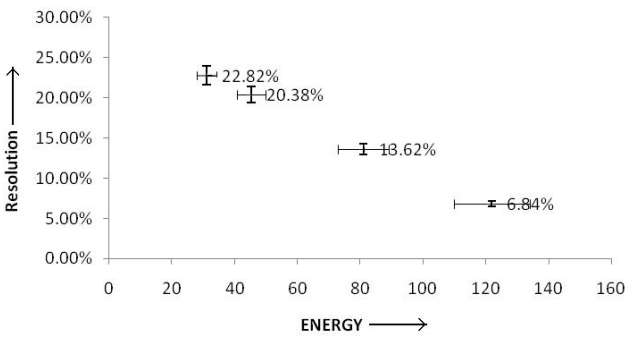


Fig 12: Energy resolution as a function of energy in the Bicron detector with a NaI scintillator.

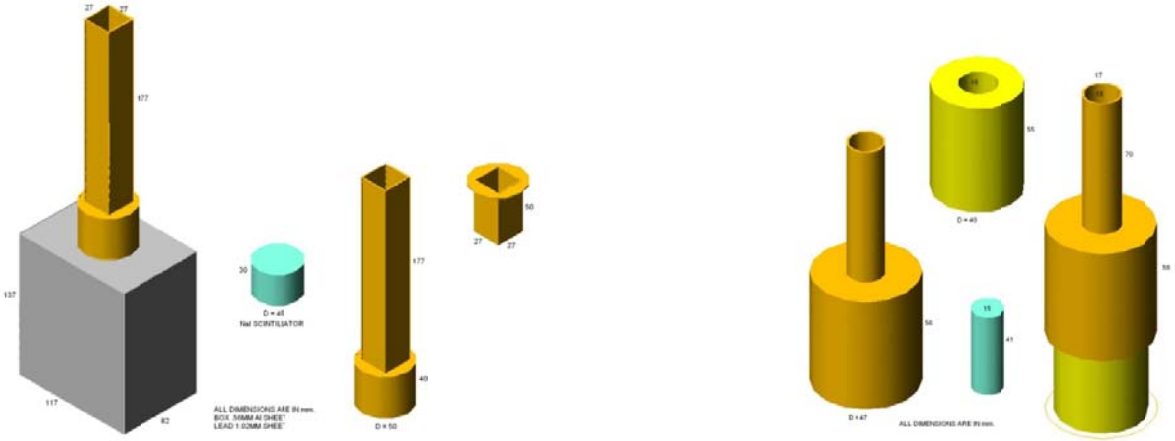


Fig 13: Implementation of GEANT4 simulation in the Hamamatsu PMT with NaI scintillator for X-ray spectrum (Left) and the lead shielding for the muon detector (Right).

Radio and VLF Astronomy

ICSP has been monitoring VLF signals from various stations since 2002. It is engaged in modeling the signals over different propagation paths. It is specialized in detecting and interpreting anomalous VLF signals generated by high energy processes in the sun, gamma-ray bursts, soft-gamma-ray repeaters etc. Two solar eclipses have been covered. Most importantly, it has taken a pioneering role in detecting the relations among the ionospheric anomalies and the seismic phenomena. The group has a large number of Gyrator-III receivers and antenna systems which were made by ICSP. It has two AWESOME receivers and antenna systems and one SOFTPAL receiver/Antenna system. The data is received from several stations. Typically, NWC, VTX, JJI stations are monitored.

Top (L to R): ***S. Sasmal, S. Mondal, S. Ray, D. Bhoumick, S.K. Chakrabarti***
Bottom (L to R): S. Chakrabarti, S. Maji, A. K. Choudhury

Solar flares from IERC/ICSP, Sitapur

Extraordinarily noise-free data is being procured from multiple stations using SOFTPAL receiver. It uses a pole antenna to obtain the electric component. Figure 14 shows the VLF amplitude variation in a typical day which included solar flares. Data from NWC (Australia, 19.8 kHz) and JJI (Japan, 20.2kHz) transmitters are shown.

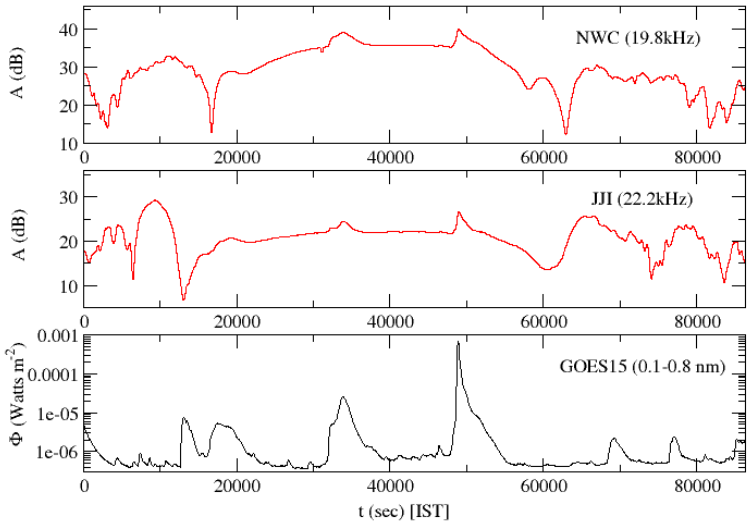


Fig. 14: VLF amplitude of NWC and JJI stations on 9th August 2011 as obtained at IERC/ICSP. Two flares could be seen. For comparison, the X-ray data from GOES satellite is also shown in the lower panel.

Studies of the seismo-ionospheric correlation:

Studies of the precursory effects of 18th January 2011 Pakistan earthquake:

We have analyzed day-wise data of 2007 for VTX-Kolkata propagation path and found that, for the most of the cases, the night time VLF signal amplitude become anomalous for three days before the earthquake. On 18th January 2011, an earthquake of magnitude 7.4 occurred at South-Western Pakistan. The night time VLF signals around two weeks centered on the earthquake day are studied to find precursory effects during the earthquake. We found that the amplitude of the night time VLF signals are anomalous four days before the earthquake. Using the terminator shift method for this Pakistan earthquake, we also found that the precursory effects are more prominent for the propagation paths which are closer to the epicenter of the earthquake. This indicates that it may be possible to predict the location of the future earthquake by analyzing the VLF signal for multiple propagation paths (S. Ray, S. K. Chakrabarti, S. Sasmal).

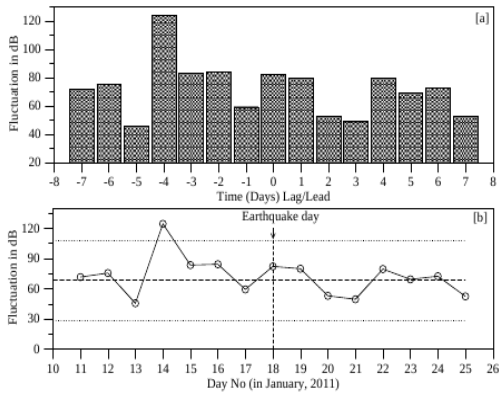


Fig 15 : (a) The night time VLF amplitude fluctuations for two weeks centered on 18th January, 2011. The Peak appears four days before the event. (b) The amplitude of the nighttime VLF fluctuations (open circles) are plotted as a function of day no. The dashed curve represents the average nighttime fluctuations while the dotted curves represent the ±3σ (σ is the standard deviation) lines. The vertical line is the earthquake day. The fluctuation four days before the event crossed the 3σ line.

We studied the seismo-ionospheric correlation with data obtained from the new ICSP receiving station Ionospheric and Earthquake Research Centre (IERC), Sitapur. We use the NWC transmitter of Australia, which transmits at the frequency of 19.8 kHz. A definite co-relation exits and the value the deviation is maximum on two days before the earthquake for terminator shift method. For for DLPT/DLDT method, the peak is one day before the earthquake.

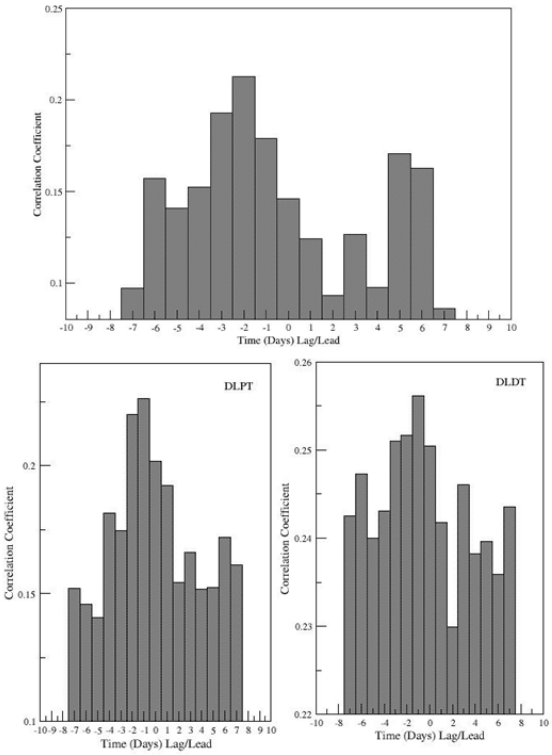


Fig. 16: The correlation between the effective magnitude of the earthquake at the midpoint between the transmitter and the receiver and in the (I) deviation of the VLF day length (upper panel), (II) with the DLPT (lower left panel) and with the DLDT (lower right panel) from the average value. The earthquake occurs on the '0th' day. The peak is maximum 2 days before seismic event for the VLF day length method. The peak for DLPT and DLDT occurs almost one to two day prior to the seismic event.

Study of the solar eclipses on the ionosphere

Theoretical models were developed to explain the observed deviation of the VLF signals during the total solar eclipse in July 2009. Our receivers all around India detected both positive and negative changes in amplitude. In Fig. 17 we show the comparison of the model prediction of the deviation (solid curve) along with the observed deviation (circles) at different places in India. During the January 15th, 2010 annular eclipse also our antennas received very clear data (annual report 2010-2011). While the solar disk was blocked by the moon, a solar flare occurred behind the moon and was seen only partially. This historic event was also analyzed by our team and the variation of the electron density in the ionosphere was computed.

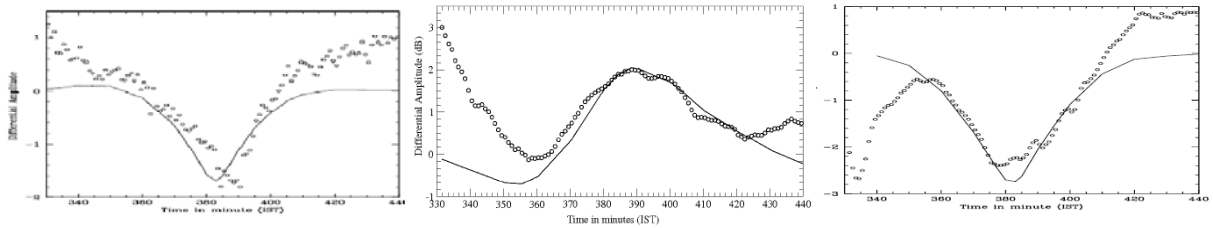


Fig. 17: Comparisons between the observed deviation and the theoretically predicted deviations of the VLF signal (VTX) amplitude on July 22nd 2009, as received in Kathmandu (left), Kolkata (middle) and Raiganj (right) respectively.

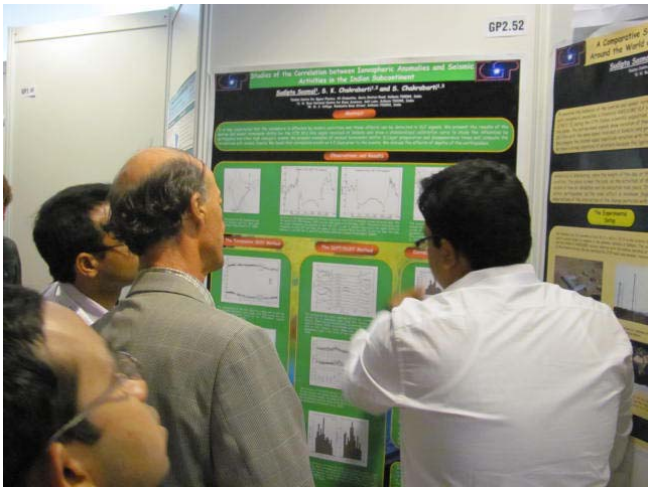


Fig. 18: Presentations of ICSP scientists at the URSI General Assembly conference, Istanbul, Turkey. (Left) S. Mondal giving a talk on the GRB detection by VLF. (Right) Scientists gather around S. Sasmal's (right) presentation on Earthquake prediction by VLF signal anomaly.

Balloon borne experiments

ICSP has been doing pioneering experiments in near space environment (~36-40km) last few years. Dignity XIV-XX missions were sent in this year which obtained cosmic rays, muons, X-rays and gamma rays from the sun using Geiger counters, shielded Geiger counters and X-ray detectors (PMTs with BGO crystals) respectively. The data is being processed. In Figs. 19 and 20 we show a typical time variation of the altitude of a payload and the typical trajectory pattern using GPS data on a Google map. The Dignity-20 (D-20) mission data has been used.

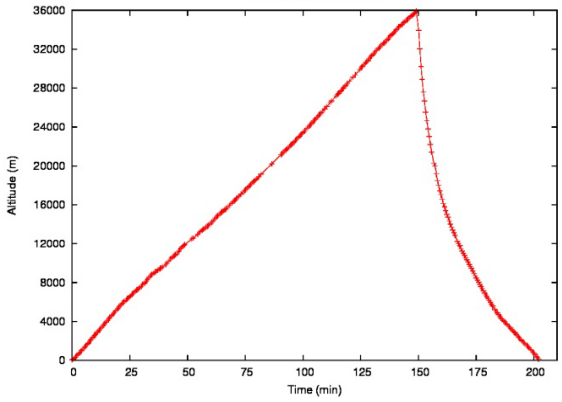


Fig. 19: Typical profile of the ascent and descent of a balloon. In this Dignity-20 mission the burst happened at 36km. The ascent took about 150 minutes and the descent took about 50 minutes (left).

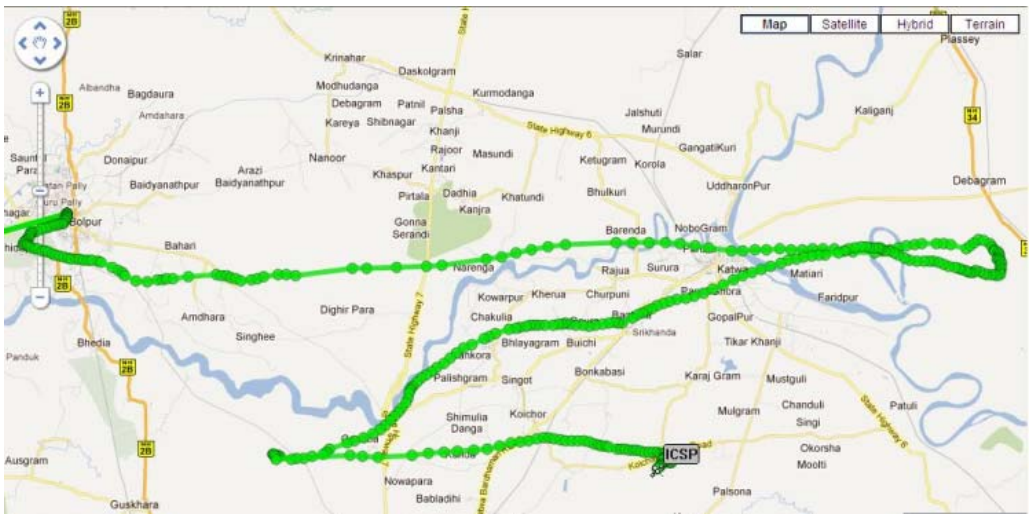


Fig. 20: Typical trajectory of a balloon between lift-off and landing. Here Dignity-20 mission trajectory is shown on a Google map from the GPS data.

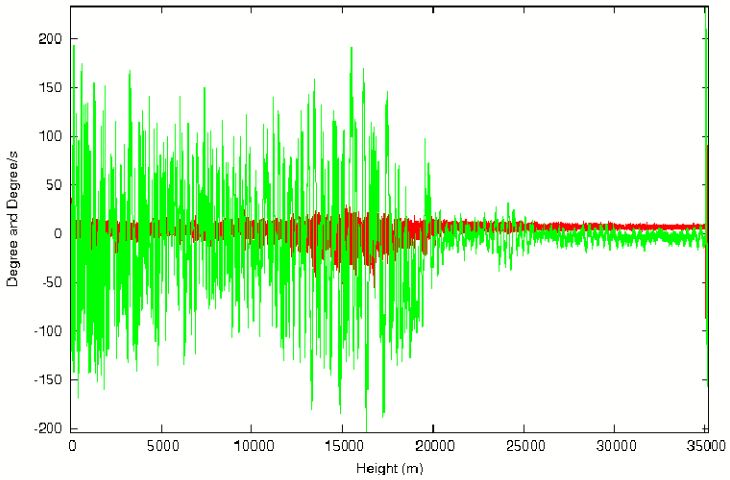


Fig. 21: The nature of the tilt of the payload and the angular velocity as a function of height in the D-20 mission. Clearly, the pointing accuracy is higher beyond an altitude of 25km.

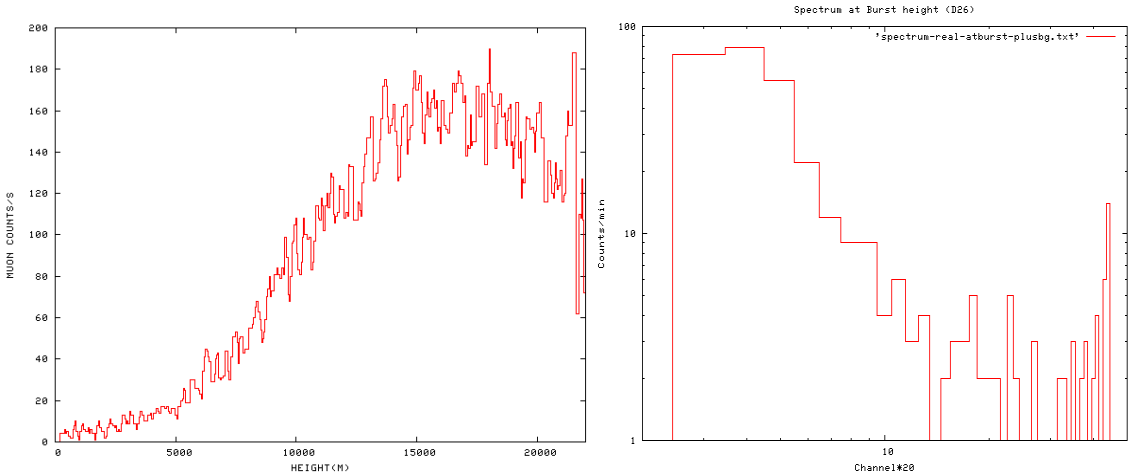


Fig. 22: Raw data showing distribution of Muon count rate in D17 mission as a function of height (Left). Raw data showing photon spectrum of the Sun as obtained in D20 mission.

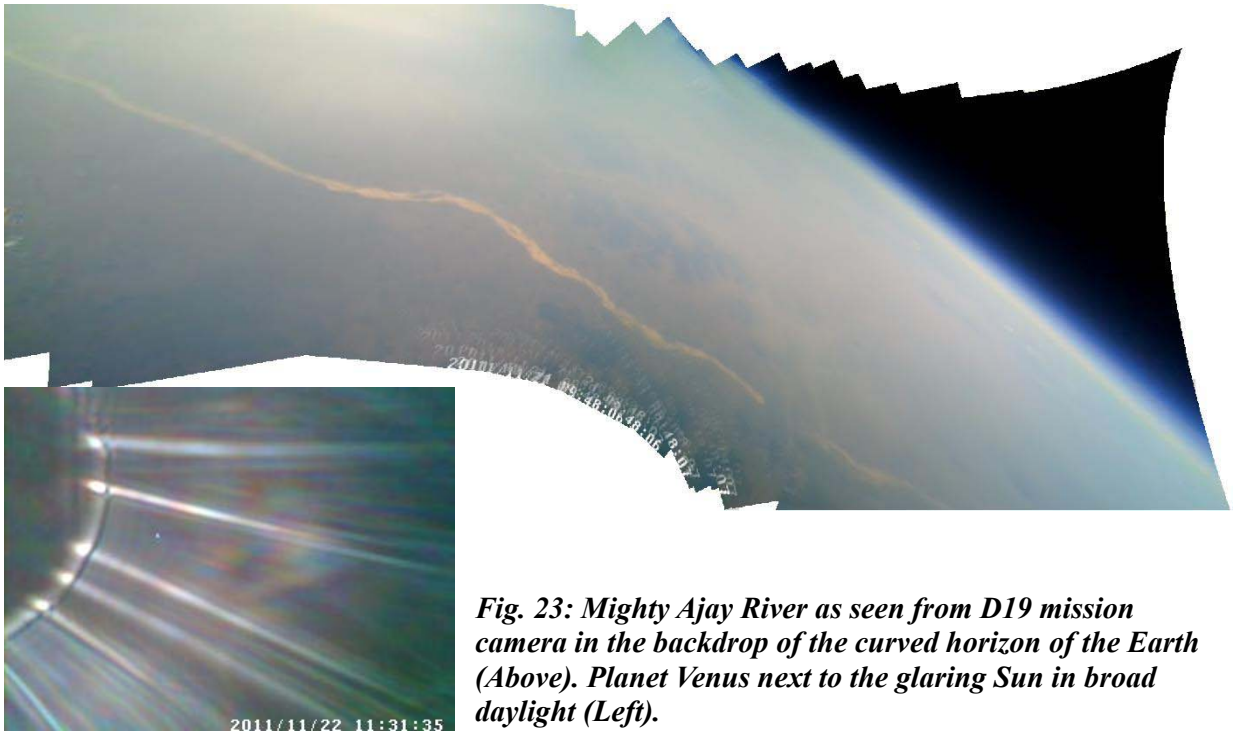


Fig. 23: Mighty Ajay River as seen from D19 mission camera in the backdrop of the curved horizon of the Earth (Above). Planet Venus next to the glaring Sun in broad daylight (Left).

ICSP Teaching Programme & Service to University/Colleges

ICSP has been contributing to human resource development by nurturing college and school teachers to continue research works. Indeed, many of its visiting research fellows and honorary scientists are from University/college/school sectors. Several papers in international Journals were published by these scientists and many are working towards their Ph.D. degree. ICSP is recognized by Calcutta University, a premiere University of the country. One college teacher has received PhD for his work at ICSP under the Faculty Improvement Programme (FIP) and several teachers have registered for PhD work.

ICSP is developing its teaching programme for the MSc and Post-MSc students. Last several years its course on Astrophysics and Cosmology is taken by R.K.M.R. College (Autonomous) students. Its scientists also gave series of lectures as a part of course at nearby Institutes.

Each year ICSP receives several M.Sc. students who wish to complete their mandatory project course. In 2011-2012, five such Physics postgraduate students carried out their project which are on various advanced topics of Ionosphere, Interstellar space, Stars, Gamma ray bursts (GRBs), Solar flares, etc.

Collaborative work: Airglow and Ozone Depletion studies

(From L to R) J.N. Chakravorty, D. Bhaumik, S.K. Midya, R. Chattopadhyay and P.K. Jana

Airglow and Ozone depletion activities are conducted mostly by the visiting and honorary scientists of ICSP. The activity includes the study of the effects of solar parameters on the airglow emission lines. Other work includes the study of variation of Ozone over India and Antarctica. It is recently shown that sharp depletion of absolute humidity may be one possible method of predicting Nor'wester. The relationship between the airglow and VLF data is being studied.

Since ICSP conducts balloon experiments, in near future, study of altitude variation of various gas components would be carried out.

Activities of the Indian Centre for Space Physics, Malda Branch

The Malda Branch of Indian Centre for Space Physics organized various types of scientific activities along with research work since its inception in 2000. 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 instrument from Indian satellite IRS-P3 and RXTE. Several scientific papers on class transitions and earthquake have been published in this year. A. K. Choudhury attended the VLF workshop at ICSP, Stanford-AWESOME meeting at Sharjah, UAE and VELFRATO-10 meeting on VLF. A. Chatterjee, N.M. Nandy attended VELFRATO-10 meeting and presented talks. The Malda branch organized a one day symposium in 2010 at Malda College Auditorium where several lectures (Near Space experience of ICSP by S.K. Chakrabarti; Antarctica trip experience by S. Sasmal) were presented.

Some of the members participated in the VLF campaigns, all the workshops, annual general body meetings etc. They also provided necessary supports during the balloon experiments in July, 2009, when the total solar eclipse took place.

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*

The ionospheric and earthquake research centre (IERC)

In order to receive quiet Radio signals in kHz to GHz range, 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. Before the construction of the campus building, data from this region was studied for about one year and was found to be very useful in the study of the solar and stellar flares, anomalies associated with earthquakes etc. Already half a dozen papers have been completed on the basis of the data from this area. The centre is located at Sitapur, Paschim Medinipur, West Bengal, India. It was formally inaugurated on 22nd January, 2012 by the President of the Governing Body, Prof. Bimalendu Bhattarcharyya. Small telescope (10 inch Meade) has been put hear for imaging the sky and the study of variable stars. Small sized radio antennas are also being installed. About one hundred visitors were present during inauguration.

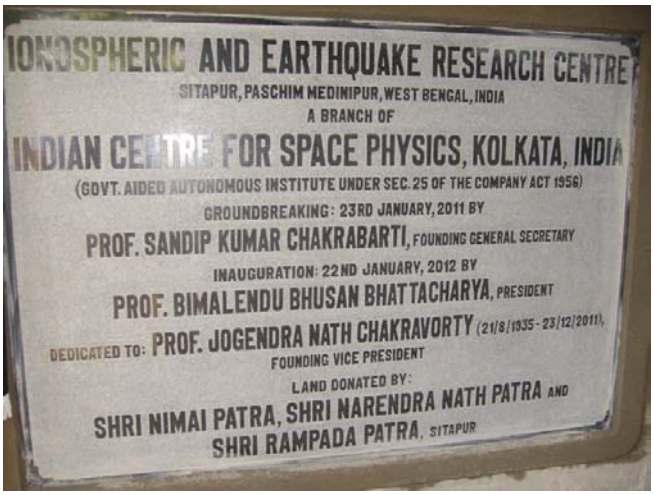


Fig. 24: The Inaugural stone on the front of IERC building

Fig. 25: The IERC building at Sitapur, West Medinipur

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, 2012 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 omitted in the previous year, which is adjusted 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 2012 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: 22nd Sept'2012
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: 22nd Sept'2012

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 31.03.2012

SOURCE OF FUNDS	Schedule	As on 31.03.2012 Amount (Rs.)	As on 31.03.2011 Amount (Rs.)
Capital Funds	1	14628627.00	5209573.00
Loan Funds	2	0.00	67446.00
TOTAL		**14628627.00**	**5277019.00**
APPLICATION OF FUNDS			
Fixed Assets			
Gross Block	3	6483776.00	2232659.00
Less: Depreciation		1390021.00	741960.00
Net Block		**5093755.00**	**1490699.00**
Current Assets,Loans & Advances:			
Security Deposit		5100.00	5100.00
Cash & Bank Balances	4	10062167.00	4627121.00
Dues from funding agencies	4A	159666.00	78582.00
Total		**10226933.00**	**4710803.00**
Less: Current Liabilities	5	340598.00	628717.00
Less: Unspent during the year	9	351463.00	295766.00
Net Current Assets		**9534872.00**	**3786320.00**
Miscellaneous Expenditure			
to the extent not written off	6	0.00	0.00
		14628627.00	**5277019.00**

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
Place: Kolkata
Date: 22nd Sept. 2012

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 2012

	Schedule	As on 31.03.2012 Amount(Rs.)	As on 31.03.2011 Amount(Rs.)
INCOME			
Income	7	15277578.00	5759210.00
		15277578.00	**5759210.00**
EXPENDITURE			
Administrative & Other Expenses	8	6478727.00	4339171.00
Preliminary Expences written off		0	0.00
Depreciation		648061.00	230225.00
		7126788.00	**4569396.00**
Excess of Income Over Expenditure		**8150790.00**	**1189814.00**
Surplus(Deficit) brought forward from the earlier year		5193073.00	**4003259.00**
Balance transffered to the Balance Sheet		**13343863.00**	**5193073.00**
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

P.K. Chakravorty & Associates
Chartered Accountant

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

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

(P.K.Chakraborty)
Proprietor
Place: Kolkata
Date: 22nd Sept. 2012

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

INDIAN CENTRE FOR SPACE PHYSICS 43 Chalantika, Garia Station Road Kolkata- 700084		
	As on 31.03.2012	**As on 31.03.2011**
	Amount (Rs.)	**Amount (Rs.)**
Schedule -1		
Capital Fund		
Life Membership Fees	16500.00	16500.00
Prior period adjustment	1268264.00	
Balance Transferred from Income & Expenditure Account	13343863.00	5193073.00
TOTAL	**14628627.00**	**5209573.00**
Schedule -2		
Loan Fund		
Loan from Directors	0.00	67446.00
TOTAL	**0.00**	**67446.00**
Schedule-4		
Cash & Bank Balances		
Cash in hand	29270.70	351.20
Fixed Deposit at Axis Bank, Salt Lake	9974328.00	4080323.00
Axis Bank Ltd, Salt Lake, Sector-III	48233.00	536513.66
Malda Dist. Central Co-op Bank Ltd.	10335.00	9933.00
TOTAL	**10062167.00**	**4627121.00**
Schedule-4A		
Loans & Advances		
ICTP Fellow	0.00	36118
ISRO fellow	0.00	0
Advance to Employees	138303.00	18388.00
CSIR Fellows	21363.00	24076.00
TOTAL	**159666.00**	**78582.00**
Schedule-5		
-		
Current Liabilities		
Audit Fees	0.00	7500.00
Liability for Projects	340598.00	621217.00
TOTAL	**340598.00**	**628717.00**
Schedule-6		
Miscellaneous Expenditure		
Preliminary & Pre-operative Expenses	0.00	0.00
TOTAL	**0.00**	**0.00**
Schedule-7		
Income		
Grant-In-Aid	12280882.00	5203990.00
Overhead recovery from project	230000.00	70000.00
Equipment recovery from project	2207826.00	0.00
Guest House Rent	70539.00	70050.00
Interest & other Income (Prev. yr. Adj.)	485331.00	413170.00
Misc. Income	3000.00	2000.00
TOTAL	**15277578.00**	**5759210.00**

Schedule-8 **Administrative & Other Expenses**		
Fund draw for Project Expenses	3157849.00	349923.00
Salaries	1873554.00	2635209.00
Office Expenses& refunds	516288.34	296185.73
Postage	776.00	4121.00
Travelling & Conveyance	114542.00	89908.00
Telephone, Fax & Internet	114370.00	107247.00
Stationary,Consumables & Printing	56369.50	66313.00
Filing Fees	15640.00	2440.00
Bank Charges	219.27	941.27
Rent & Electricity	173657.00	153389.00
ICSP Development	53135.00	603670.00
TDS	57823.00	26975.00
Provision for expenses	340598.00	0.00
Miscellaneous Expenses	1906.00	2349.00
Audit Fees(For Statutory Audit)	2000.00	500.00
TOTAL	**6478727.00**	**4339171.00**
Schedule-9 **Unspent During the Year**		
DST Projects	123492.00	241162.00
ISRO Projects	227971.00	54604.00
Total unspent (committed) during the year	**351463.00**	**295766.00**

P.K. Chakravorty & Associates Chartered Accountant	Sd./- S.K.Chakrabarti Honorary Secretary, Indian Centre for Space Physics
	Sd./- P.Bandyopadhyay Honorary Treasurer, Indian Centre for Space Physics
(P.K.Chakraborty) Proprietor Place: Kolkata Date: 22nd Sept. 2012	Sd./- B.B.Bhattacharyya Honorary President, Indian Centre for Space Physics

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 chargable 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: 22nd Sept'2012

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

Sd./- P.Bandyopadhyay
Honorary Treasurer, Indain 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

Receipts & Payments accounts for the year ended 31st March'2012

RECEIPTS		PAYMENTS	
Particulars	**Amount**	**Particulars**	**Amount**
Op. Cash Balance	351.00		
Op. Balance (Axis Bank)	1,805,324.00	Salary	3929469.00
Op. Balance (Malda Bank)	9,933.00	Office Expenses	642317.00
	-	Postage	3658.00
GRANT RECEIVED DURING THE YR.	-	Travelling & Conveyance	135398.00
Interest received from Malda Bank	402.00	Telephone, Fax & Internet	112707.00
Deposit during the year in Malda Bank	-	Stationary,Consumables & Printing	144051.00
Deposit during the year in Axis Bank	11,426,822.00	Filing Fees	15590.00
		Bank Charges	219.00
Misc. Income	3,000.00	Rent & Electricity	173645.00
Guest house Rent Received	60,339.00	ICSP Development	474861.00
Loan/Adv./Sal recovery	120,000.00	Misc. Exp.	1918.00
Loan recovery	9194.00	Trf. to fixed deposit	5500000.00
DD Cancelled	78,266.00	Loan refund to director	67446.00
Inter Bank Transfer	195,000.00	P.Y Liability	1225150.00
		Inter Bank Transfer	195000.00
		Adv. to employee	138187.00
		TDS	42000.00
		DD	78266.00
		EQUIP	338785.00
		Cl. Balance(Axis)	450359.00
		Cl. balance Malda bank	10335.00
		Cl. Cash Balance	29270.00
Total	**13,708,631.00**		**13,708,631.00**

P.K. Chakravorty & Associates
Chartered Accountant

(P.K. Chakravorty)
Proprietor
M.No. 5170I
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, Indain Centre for Space Physics

Place: Kolkata
Date: 22nd Sept'2012

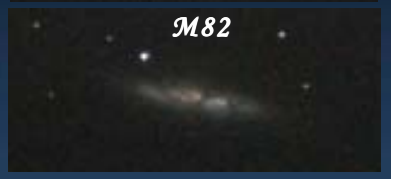
Sd./- B.B.Bhattacharyya
Honorary President, Indian Centre for Space Physics

(Top left) S.K. Chakrabarti and his PhD students with Prof. Kip S. Thorne, Caltech, during later's Kolkata visit. VLF workers of ICSP and SNBNCBS at the Stanford-AWESOME Goa conference (Top right) and at the URSI General Assembly, Istanbul (Bottom right). Dr. T. Belloni of Italy giving a talk on black holes at ICSP seminar hall (Bottom left).

S.K. Chakrabarti with Nobel Laureate Prof. R. Giacconi at an Erasmus Mundus Joint Doctorate programme meeting in Italy (Left).

Ph.D. student Mr. Liton Majumdar (Centre) with the trainers at a Gaussian Workshop, Chennai (Right).

Students from R.K. M.R. College (flanked by A. Das and S. Mondal) who completed their MSc projects at ICSP (left). Students from Maharaja Manindra Chandra College at a skywatching session at ICSP (extreme left).



Some celestial objects photographed at IERC./ICSP by our observer Mr. R. Khan with Centre's 10 inch Meade telescope

Himalayan range (L) and the Bay of Bengal (R) under black sky near Earth's horizon as photographed from a height of 40km near Bolpur (L).