Annual Report (2012-2013)

Indian Centre for Space Physics



Double Balloon after launch (left)



Altitude variation of wind velocity measured in several balloon flights (above)



Payloads for balloon flights: Collimator, Sun tracker, GM counters, Hamamatsu and Bicron made crystal detectors, and the Proportional Counter



This Horse-head nebula and surrounding star forming region was photographed by Mr. R. Khan using our 10" Meade telescope at IERC, Sitapur.



Cytosine to Uracil (Left), electron distribution during solar eclipse (Middle), Earthquake Alert System (Right)

Youngest supernovae

in our galaxy discovered by ICSP scientist Dr. S. Pal (Left), Venus transit photo taken from IERC, Sitapur (Middle), A picture of sun behind parachute during descend of a payload (Right).

INDIAN CENTRE FOR SPACE PHYSICS ANNUAL REPORT (2012-2013)

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Front Cover: A video frame of cloudy earth surface taken from an ICSP payload at around 40km altitude. Superposed on it are Orbiter & Booster balloons on their way up. **Back Cover:** Burst of the Booster balloon while the payloads float with the Orbiter

Report of the Governing Body

This is the fourteenth Annual report of our Centre. As before, it is making its mark in all four major directions 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.

Major progress has been made in its balloon flight programme where several payloads of up to 3.5 kilograms were launched in eleven missions to near space by balloons and several solar X-ray flares have been detected. ICSP also pioneered a technique with double balloon configuration where one balloon (orbiter) is left in the orbit by a launcher (booster). Studies of deuterated species to ascertain ages of molecular clouds have been made and proposals to observe them using International IR observatories are initiated.

An extraordinary success is achieved in the field of ionospheric science. A numerical procedure, based on the use of the Geant4 simulation and LWPC code was developed to treat the Earth as a gigantic radiation detector and response of the ionosphere by any extraneous high energy radiation, such as solar flares, was obtained. Resulting VLF signal amplitude was found to match with predicted variation very satisfactorily.

Several scientists have joined ICSP in 2012-2013: Dr. Sabyasachi Pal joined IERC, Sitapur campus of ICSP in Radio Astronomy activities. Mr. Sujay Pal has joined the VLF group. Dr. Himadri Ghosh has joined the high energy Astrophysics group. Several students have also joined the Centre.

A two-element radio interferometer was installed in Sitapur with the help of Indian Institute of Astrophysics. In order to reduce the cost of electricity, both the head quarter as well as IERC, Sitapur have installed a total of 3.5kW solar panels.

ICSP participated very enthusiastically the centenary celebration of Indian Science Congress in January, 2013. ICSP stall was visited by thousands of people every day. It was awarded the trophy of the most innovative stall of the event. Several ICSP scientists presented their results in international conferences, such as General Assembly of COSPAR in Mysore, General Assembly of International Astronomical Union in Beijing, 13th Marcel Grossman Meeting in Stockholm and a conference on the 'Recent Trends of Compact Objects' at IIT/Guwahati, Assam. Our faculty Dr. R. Sarkar continued to work with the PAMELA satellite team at INFN, Trieste, Italy.

ICSP has been playing a major role in training scientists from nearby colleges. Six students from various colleges carried out their M. Sc. projects at ICSP. A Nepalese citizen Chandra Bahadur Singh has completed his research and submitted his PhD Thesis. Our other students Sujay Pal, Sudipta Sasmal and Partha Sarathi Pal have also submitted their PhD thesis.

The ICSP, Malda branch has been very active and its scientist Mr. Asit Kumar Choudhury has registered for PhD degree.

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. Our Centre sincerely thanks them for all the encouraging supports.

Supports of Dr. D. Debnath for helping with the compilation of this report and of computer assistant Mr. Jyotisman Moitra for designing the cover pages are acknowledged.

Prof. S.K. Chakrabarti, Honorary General Secretary Indian Centre for Space Physics

Kolkata: September 29, 2013

Governing Body (GB) of the Centre

Prof. B.B. Bhattacharyya, President Prof. Sandip K. Chakrabarti, Secretary Mr. P. Bandyopadhyay, Treasurer Dr. Sonali Chakrabarti, Member Dr. S. C. Chakravarty, Member Prof. A. R. Rao, Member Prof. Arun K. Tiwari, Member Mr. Gurusaran Das Gupta, Member

Members of the Research Advisory Council (RAC)

Prof. S. N. Ghosh, FNA, Ex Allahabad Univ. & Calcutta Univ. (Chairman)
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

Academic Council Members

Prof. Sandip K. Chakrabarti (Chairman) Dr. Dipak Debnath Mr. Sujay Pal Mr. Rajkumar Maiti (Member Secretary) Dr. Ankan Das (Convenor)

Dr. Sabyasachi Pal

Mr. Debashis Bhowmick

In-Charge, Academic Affairs (Honorary)

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

Dean (Academic) and Finance Officer (Acting)

Dr. Ankan Das (Tel. : +91 33 24366003 / 24622153 Extn: 22, Email: <u>ankan@csp.res.in</u> / <u>ankan.das@gmail.com</u>)

Administrative Officer (Acting)

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

In Charge of the Departments

Ankan Das Dipak Debnath Sujay Pal Sabyasachi Pal Debashis Bhowmick Department of Astrochemistry / Astrobiology Department of High Energy Astrophysics Ionospheric Science Ionospheric and Earthquake Research Centre, Sitapur X-ray Laboratory

Faculty Members

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

Honorary Faculty Members

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

Project Scientists

Dr. Sabyasachi Pal (MoES)	Mr. Sourav Palit (MoES)	Mr. Sujay Pal (MoES)
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Post-doctoral Research Fellows

Dr. Himadri Ghosh (MoES) Mr. Sudipta Sasmal (MoES)

Senior Research Fellows

Mr. Santanu Mondal (CSIR)	Mr. Liton Majumdar (DST)	Mr. Sushanta K. Mondal (CSIR)
Mr. Partha S. Pal (CSIR)	Mr. Tilak Katoch	Mr. Suman Ray (ISRO)

Junior Research Fellows

Mr. Rajdeep Saha (DST)Mr. Dipen Sahu (ISRO)Mr. Arka Chatterjee (MoES)Mr. Dusmanta Patra (MoES)Mr. Ritamay Bhunia (MoES)Mr. Prasun Sarkar (MoES)Mr. Debshankar Bhattacharya (MoES)

ICTP Senior Research Fellow

Mr. Chandra Bahadur Singh

Visiting Research Scholars

Mr. Kumaresh Chakrabarti Mr. Asit K. Choudhury Mr. Surya K. Maji Mr. Dipak Sanki Mr. Wasim ul Bari Mr. Amit Chowdhury

Engineers / Laboratory Staff

Mr. Debashis Bhowmick Mr. Subhankar Chakraborty Mr. Susanta Midya Mr. Arnab Bhattacharya Mr. Hriday Roy Hardware Engineer Junior Engineer Technical Assistant (MoES) Technical Assistant (MoES) 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 <u>csp.res.in</u> 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 lonospheric 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, Two element interferometers and a guest house. Solar power for electricity and submersible pump for water supply keep this remote Centre running.

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.

Brief Profiles of the Scientists of the Centre

Prof. Bimalendu B. Bhattacharyya: He is the President of the Governing Body and a 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.

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.

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. 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. Ritabrata Sarkar: He is an Assistant Professor at ICSP. He is working on GEANT4 simulation part for balloon experiment. Currently he is on leave for an assignment with the PAMELA satellite team working at INFN, Trieste, Italy.

Dr. Sabyasachi Pal: He is a project-scientist at ICSP. He is also in-charge of IERC, Sitapur branch. 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. He is developing radio astronomy observatory at IERC.

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

Mr. Sourav Palit: He is a project-scientist at ICSP. He is involved on GEANT-4 simulations of ionospheric study and ICSP balloon experiments.

Mr. 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.

Mr. Sudipta Sasmal: He is a post-doctoral research fellow working at ICSP. He is working on the study of earthquake precursors using VLF data.

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. Tilak C. Katoch: He is a honorary Senior Research Fellow (SRF) and is working on the observation of solar flares by RT-2 satellites.

Mr. Liton Majumdar: He is a DST project senior research scholar in Astrochemistry/ Astrobiology. He is working on quantum chemical calculation of reaction cross sections and the evolution of complex molecules in star forming regions.

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.

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.

Mr. Suman Ray: He is working as a Junior Research Fellow in an ISRO project. He is in the VLF group and is working on the earthquake related anomalies of VLF signals.

Mr. Surya Maji: He is a school teacher and an honorary Junior Research Fellow at ICSP. He works on the effects of eclipse on VLF signals.

Mr. 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. Partha Sarathi Pal: He is a CSIR supported Senior Research Fellow. He is working on spectral and timing properties of radiations from disks around black holes.

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

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. 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 the 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 as 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.

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. 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 is in charge of the training with IERC Optical Telescope.

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 Calcutta University and an honorary Professor of ICSP. He works on Airglow experiments and Ozone depletion problem.

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

Mr. Asit Kumar Choudhury: He is a Teacher at the L.M.S.M. Institution, Malda and is a 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 Refereed Journals and Conference Proceedings

Bari, W. Md., Chatterjee, A. K., "Class Transition during 2008 outburst of 4U 1630-47", 2012, *Ind. J. Phys.*, In press.

Basak, T., Chakrabarti, S. K., "On the nature of time-delay in lower ionospheric response time during solar flares", 2012, *COSPAR publication*, **39**, 107.

Bhaumik, D., Chakraborty, J. N., Midya S. K., 2012 "Evening twilight emission of Li 6708A[°] at Calcutta", *J.Pure and Appl.Phys.* In Press.

Chakrabarti, S. K., Mondal, S. K., Sasmal, S., Pal, S., Basak, T., Chakrabarti, S., Bhowmick, D., Ray, S., Maji, S. K., Nandi, A., et al., "VLF signals in summer and winter in the Indian sub-continent using multi-station campaigns", 2012, *InJPh*, 86, 323.

Chakrabarti, S. K., Pal, S., Sasmal, S., Mondal, S. K., Ray, S., Basak, T., Maji, S. K., Khadka, B., Bhowmick, D., Chowdhury, A. K., "VLF campaign during the total eclipse of July 22nd, 2009: Observational results and interpretations", 2012, *Jour. Atmos. Sol. Terres. Phys.*, **86**, 65.

Chakrabarti, S. K., "Towards the most complete solution of black hole accretion and outflows for the spectral and the timing studies", 2012, *COSPAR publication*, **39**, 292.

Chakrabarti, S. K., Das, A., Majumdar, L., Chakrabarti, S., "A 2D hydrodynamic simulation coupled with the chemical evolution to study the physics and Chemistry of the ISM ", 2012, *COSPAR publication*, **39**, 28.

Chakrabarti, S. K., Das, A., Majumdar, L., Chakrabarti, S., "Synthesis of prebiotic molecules and origin of life", 2012, *COSPAR publication*, **39**, 289.

Chakrabarti, S. K., Mondal, S. K., Palit, S., Sarkar, R., Bhowmick, D., "Balloon Programme of Indian Centre for Space Physics, Kolkata", 2012, *COSPAR publication*, **39**, 290.

Chakrabarti, S. K., Pal, P. S., "Dynamical Evolution of Spectral and Timing Properties of Compact Objects: Some Examples", 2012, *International Journal of Modern Physics Conference Series*, **12**, 68-79.

Chattopadhyay, I., Garain, S. K., Ghosh, H., "How Plasma Composition Affects the Relativistic Flows and the Emergent Spectra", 2012, Proc. of *International Conference on Astrophysics & Cosmology*, Kirtipur, Nepal (in press).

Chattopadhyay, I., Mandal, S., Ghosh, H., Garain, S. K, Ryu, D., "Effect of Equation of State and Composition on Relativistic Flows", 2012, *ASI Conference Series*, Eds. S. B. Pandey, V. V. Sokolov & Yu A. Shchekinov, **5**, 81.

Das, G. K., Roy, S. N., Midya, S. K., "A Climatological feature of temperature and heavy rainfall events over Kolkata and its impact on human being", 2012, *Mausam* 63(4) 615-622.

Das, A., Chakrabarti, S. K., "A Monte Carlo Study to Explore the Composition of the Grain Mantle", 2012, *COSPAR publication*, **39**, 398.

Das, A., Chakrabarti, S. K., "Chemical Composition of Interstellar Dust: A Monte Carlo Study", 2012, *COSPAR publication*, **39**, 399.

Das, A., Majumdar, L., Chakrabarti, S. K., Chakrabarti, S., "Chemical evolution during the process of proto-star formation by considering a two dimensional hydrodynamic model", 2013, *New Astronomy*, 23, 118.

Das, G K, Midya, S. K., Debnath, G. C., Roy, S. N., "The relationship between geopotential height and movement & landfall of tropical cyclone in the Bay of Bengal region", 2012, *Mausam* 63(3) 469-474.

Debnath, D., Nandi, A., Chakrabarti, S.K., "A comparative study of the timing and the spectral properties during two similar outbursts of 2010 2011 of H 1743-322", 2012, *COSPAR*, **39**, 431.

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, *ASI Conference Series*, **5**, 91.

Debnath, D., Chakrabarti, S. K., Mondal, S., "Extracting Flow parameters of H 1743-322 during early phase of its 2010 outburst using Two Component Advective Flow model", 2013, *ASI Conference Series* In press.

Debnath, D., Chakrabarti, S. K., "Properties of the propagating oscillatory shock wave in the accretion flows around few transient black hole candidates during their X-ray outbursts", 2013, *MG13 Conference Proceedings* In press,

Debnath, D., Nandi, A., Chakrabarti, S. K., "A comparative study of the timing and the spectral properties during two recent outbursts (2010 & 2011) of H 1743-322", 2013, *MG13 Conference Proceedings* In press.

Ganda, S.C., Midya S. K., "Comparison of Long Term Rainfall Trends on Urban and Nonurban Regions of Indian Land Mass and Its Probable Implication", 2012, *J Ind Geo. Union.* **16(2)** 37-40.

Garain, S. K., Ghosh, H., Chakrabarti, S. K., "Effects of Compton Cooling on Outflow in a Twocomponent Accretion Flow around a Black Hole: Results of a Coupled Monte Carlo Total Variation Diminishing Simulation", 2012, *ApJ*, **758**, 114.

Garain, S. K., Chakrabarti, S. K., Ghosh, H., "Effects of Compton Cooling on the Hydrodynamic and Spectral Properties of a Two Component Accretion Flow around a Black Hole", 2012, *cosp*, **39**, 589.

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", 2013, *MG13 Conference Proceedings* In press.

Giri, K., Chakrabarti, S. K., "Numerical simulations of a Two Component Advective flow for the study of the spectral and timing properties of BHs and NSs", in 39th COSPAR Scien. Assem., **39**, 622, 2012

Izzo, L., Ruffini, R., Penacchioni, A. V., Bianco, C. L., Caito, L., Chakrabarti, S. K., Rueda, J. A., Nandi, A., Patricelli, B., "A double component in GRB 090618: a proto-black hole and a genuinely long gamma-ray burst, Astron. Astrophys.", *543A*, **10**, 2012

Jana, P. K., Sarkar, D., Saha, D. K., Midya, S. K., "Effect of cloud occurrences on tropospheric ozone over Alipore (22.52°N, 88.33°E), India". 2012, *J. Earth System Sci.*, **121(3)** 711-722.

Jana, P. K., S. Goswami, S. K., Midya, "Short-term tropospheric ozone trend in India". 2012 *Ind.J,Phys.* 86(11) 951-960

Jana. P. K., S. Goswami, S. K., Midya, "Relation between tropospheric and stratospheric ozone at Thumba (8.5° N, 77°E) and Bangalore (13°N, 77.5°E), India and its effect on environment", 2012 *Ind.J,Phys.* **86(9)** 769-775

Lynn, K., Singh, R., Chakrabarti, S. K., Veenadhari, B., More, C., Brundell, J., "Non-reciprocity observed by the VLF reception of NWC (19.8 kHz) over trans-equatorial east-west paths to India with reception over a non-equatorial west-east path of similar length to Dunedin, New Zealand", 2012, *COSPAR* **39**, 1128.

Maji, S. K., Chakrabarti, S. K., Mondal, S. K., "Unique Observation of a Solar Flare by Lunar Occultation During the 2010 Annular Solar Eclipse Through Ionospheric Disturbances of VLF Signals", 2012, *Earth Moon & Planets*, **108**, 243

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, *Res. Astron. Astrophys.*, **12**, 1613.

Majumdar, L., Das, A., Chakrabarti, S. K., Chakrabarti, S., "Chemical evolution and spectroscopy of some complex molecules which could be treated as the precursor of some bio-molecules in the interstellar medium", 2013, *Proc. IAU Sym.* **292**, 250.

Majumdar, L., Das, A, Chakrabarti, S. K., Chakrabarti, S., "Study the chemical evolution and spectral signatures of some interstellar precursor molecules of adenine, glycine and alanine", 2013, *New Astronomy*, **20**, 15.

Majumdar, L., Chakrabarti, S. K., Das, A., Chakrabarti, S., "A quantum chemical approach to set a guideline for the observation of different pre-biotic molecules in the interstellar space", 2012, *COSPAR*, **39**, 1154.

Majumdar, L., Chakrabarti, S. K., Das, A., Chakrabarti, S., "Formation of some of the bases of DNA in the interstellar space during the molecular cloud collapse", 2012, COSPAR, 39, 1153.

Majumdar, L., Chakrabarti, S. K., Das, A., Chakrabarti, S., "Spectral signature and chemical evolution of some complex molecules which could be treated as the precursor of some bio-molecules in the ISM", 2012, *COSPAR*, **39**, 1152.

Midya, S. K., Das, G. K., Sarkar, A., "The relationship between wet component of atmospheric refractivity and movement & landfall of tropical cyclone in the Bay of Bengal region",2013, *Meterology and Atmos.Phys.(Germany)* DOI 10.1007/s00703-013-0266-4

Midya, S.K., Dey, S. S., Chakraborty, B., "Variation of TOC (Total Ozone Column) during tropical cyclone over Bay of Bengal and Arabian Sea". 2012, *Meteorology and Atmos. Phys.(Germany)* 117, 63-71.

Midya, S.K., Ghosh, D., "Associating an ionospheric parameter with major earthquake occurrence throughout the world". 2013, *J. Earth System Sci.*, In Press

Midya, S. K., Goswami, S., "Seasonal Variation of daily total column ozone (TCO) and its depletion and formation role on surface temperature over Ahmedabad (23001'N, 72039'E)", 2013, *Ind. J. Phys.* In Press

Midya, S. K., Ghosh, D., Das, G.K., Sarkar, H., "Study of atmospheric refractivity prior to squall onset and its strong association with surface temperature and relative humidity over Kolkata (22°34'N, 88°22'E)", 2013, *Ind. J. Phys.* DOI 10.1007/s12648-013-0304-6

Midya, S. K., Panda, P., "Study of major earthquakes (Magnitude \geq 6 Richter Scale) with Cp index during the period 2001-2007". 2013, *The Pacific Journal of Science and Technology (Akamai)* **14** (1) 586-592.

Midya, S. K., Sarkar, H., Sarkar, S., Maity, D., Ghosh, M., "Sharp Decrease of Attenuation of 183.31GHz Water Molecule Absorption Line Associated with Nor'wester over Kolkata- may be one possible method of forcasting Nor'wester". 2012, *Mausam* 63(2), 219-222.

Midya, S. K., T. Mukherjee, Dey, S.S, Das, G. K., "Variation of total column ozone (TCO) during the time of landfall of tropical cyclone in extratropical region". 2012, *PJST (Akamai)* 13 (1) 123-130

Midya, S. K., Saha, U., Sarkar, D., Jana, P. K., "Inter-relation amongst the different Atmospheric parameters to estimate Summer Monsoon Rainfall over Gangetic West Bengal: A Multiple Linear Regression Approach". 2012, *The Pacific Journal of Science and Technology (Akamai)* 13 (1) 131-143.

Midya, S.K., Sarkar, H., Manna, A., "Variation of daily ozone with surface temperature over Kolkata". 2012, *AJMBES* **3** (4). In Press

Midya, **S.K.**, **Goswami**, **S.**, **H. Sarkar**, "Seasonal variation of Daily Total Column Ozone (TCO) and its Formation and Depletion Role on Surface Temperature and Average Rainfall over Dibrugarh, India (27°28'N,94°54'E)". 2012 , *The Pacific Journal of Science and Technology (Akamai)* **13** (1) 689-699.

Mondal, S. K., Chakrabarti, S. K., Sasmal, S., "Very Low Frequency Detection of the Soft Gamma ray Repeater SGR J1550-5418", 2012, *COSPAR*, **39**, 1269.

Mondal, S., Chakrabarti, S. K., Das, R., "A New Photometric Survey Design for Detection of Transiting Extrasolar Planets", 2012, *COSPAR*, **39**, 1268.

Mondal, S.K., Chakrabarti, S. K., Sasmal, S., "Detection of ionospheric perturbation due to a soft gamma ray repeater SGR J1550-5418 by very low frequency radio waves", 2012, *Astrophysics and Space Science*, **341**, 259.

Mondal, S., Chakrabarti, S. K., "Spectral properties of Two Component Advective Flows with standing shocks in presence of Comptonization.", 2013, *MNRAS*, 431, 1044.

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

Nandi, A., Chakrabarti, S. K., "Ejection mechanism for the disappearance of inner accretion disk of Black Holes: A theoretical study with observational signatures", 2012, *COSPAR*, **39**, 1336.

Nwankwo, V. U. J., Chakrabarti, S. K., Sasmal, S., "Daily Variation of Very Low Frequency (VLF) Signal Amplitude and Phase from North-West Cape (19.8kHz) to Kolkata", 2012, *COSPAR*, **39**, 1385.

Nwankwo, V. U. J., Chakrabarti, S. K., "Computation and Prediction of plasma drag on Orbiting Satellites due to Space Environmental Perturbation by Coronal Mass Ejections (CMEs), 2012, *COSPAR*, **39**, 1384.

Palit, S., Basak, T., Mondal, S. K., Pal, S., Chakrabarti, S. K., "Modeling of the Very Low Frequency (VLF) radio wave signal profile due to solar flares using the GEANT4 Monte Carlo simulation coupled with ionospheric chemistry", 2013, *Atmos. Chem. Phys. Disc*, **13**, 6007.

Pal, S., Maji, S. K., Chakrabarti, S. K., "First ever VLF monitoring of the lunar occultation of a solar flare during the 2010 annular solar eclipse and its effects on the D-region electron density profile", 2012, *Planetary and Space Science*, **73**, 310.

Pal, P. S., Chakrabarti, S.K., Nandi, A., "Sequencing the Variability Classes of GRS 1915+105", 2012, *MG12 Conference Proceeding*, 969.

Pal, S., Chakrabarti, S. K., Mondal, S. K., "Modeling of sub-ionospheric VLF signal perturbations associated with total solar eclipse, 2009 in Indian subcontinent", 2012, *Advances. Space Res.*, **50**, 196.

Pal, S., Roy, S., Hyman, S., D., Lazio, T. J. W., Ray, P. S., Kassim, N. E., "Summary of transient radio source search program near Galactic Center", 2013, *ASI Conference Series*, In press.

Ray, S., Chakrabarti, S. K., "Unusual Shifts in Terminator Times of the VLF Signals before the Pakistan Earthquake (M=7.4), Occurred on 19th Jan.", 2011., 2012, *COSPAR*, 1595, 2012

Ray, S., Chakrabarti, S. K., Sasmal, S., Mondal, S. K., "Unusual Fluctuations of the Nighttime VLF Signal Amplitude before Seismic Events", 2012, *COSPAR*, **39**, 1594.

Roy, S., Pal, S., "Observations and discoveries of supernova remnants with GMRT", 2013, *Supernova environmental impacts Proceedings IAU Symposium* No. 296, Alak Ray & Dick McCray (eds.)

Ruffini, R., et al., "Canonical GRBs: the long, the disguised short and the short, and their cosmic distances", 2012, COSPAR, 39, 1628.

Sasmal, S., Chakrabarti, S. K., "Case Studies of Seismic Events and Comparison with VLF Signal and Satellite Data", 2012, *COSPAR*, **39**, 1690.

Sasmal, S., Chakrabarti, S. K., Mondal, S. K., Ray, S., "Study the Broadband Very Low Frequency Data Received from Different Places and Observe the Possible Ionospheric Events", 2012, *COSPAR*, **39**, 1689.

Sasmal, S., Chakrabarti, S. K., Chakrabarti, S., Ray, S., "Study the Seismo-Ionospheric Correlations in the Indian Sub-Continent using Very Low Frequency (VLF) Signal Characteristics", 2012, *COSPAR*, **39**, 1688.

Saha, R., Chakrabarti, S. K., Das, A., Majumdar, L., Chakrabarti, S., "Effect of photo-dissociation on the composition of the grain mantle", 2012, *COSPAR*, **39**, 1647.

Saha, U., Midya, S. K., Sarkar, G. K. Das, "Sharp Depletion of Absolute Humidity associated with Squall over Kolkata (22°34'N, 88°26'E): A Possible Method of Forecasting Squall", 2012, *The Pacific Journal of Science and Technology (Akamai)* **13** (1) 683-688.

Sarkar, H., Midya, S. K., Goswami, S., "A Comparative Study of Integrated Water Vapor (IWV) and of Attenuation of 94 GHz Signal from Radiometer and Radiosonde Observations during Monsoon Period over Kolkata, India", 2012, *The Pacific Journal of Science and Technology (Akamai)* **13** (1) 197-201.

<u>In Books</u>

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 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.

Ankan Das (Convenor), Dipak Debnath, Sabyasachi Pal, Debashis Bhowmick, Sujay Pal, Rajkumar Maiti became members of the Academic Council of the Centre.

Ph.D. Degree Received

Partha Sarathi Pal has received Ph.D. degree in Physics for his Thesis entitled "*Time Dependent X-Ray Data from Flows Around Stellar Mass Black Holes and Their Implications*" from Calcutta University, Kolkata.

Ph.D. Thesis Submitted

Partha Sarathi Pal submitted his Ph.D. Thesis entitled "*Time Dependent X-Ray Data from Flows Around Stellar Mass Black Holes and Their Implications*" to Calcutta University, Kolkata.

Sudipta Sasmal submitted his Ph.D. Thesis entitled "Study of Terrestrial and Solar Energetic Phenomena through propagation characteristics of Very Low Frequency (VLF) Waves" to Jadavpur University, Kolkata.

Sujay Pal has submitted his Ph.D. Thesis entitled "Numerical Modelling of VLF Radio Wave Propagation through Earth-Ionosphere Waveguide and its Application to Sudden Ionospheric Disturbances" to Calcutta University, Kolkata.

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 and **Dipak Debnath** gave a series of about 20 lectures to the 4th semester 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: **July, 2012:** "Synthesis of prebiotic molecules and origin of life", "Very Low Frequency Radio wave monitoring programme of ICSP, Kolkata", "Towards the most complete Solution of black hole accretion and outflows for the spectral and timing studies", "Balloon Programme of ICSP", "Canonical GRBs: the long, the disguised short and the short, and their cosmic distances" at 39th COSPAR Assembly, Mysore; "State-of-the-Art Accretion flow Solution around a black hole: An end in sight?" at the 13th Marcel Grossman meeting, at Stockholm University, Sweden; **August 2012:** "My Experiment with Astrophysics" at Bose Colloquium at S. N. Bose National Centre for Basic Sciences, Kolkata; **March, 2013:** "Chemical Evolution of the Universe and the Origin of Life": public lectures at IIT-Guwahati and "Astrofest" at Cotton College University; **March 2013:** "Interpretation of spectral and temporal behaviour of black hole candidates from transonic flow solution of accretion flows" at "Recent Trends of Compact Objects" conference at IIT/Guwahati.

Ankan Das gave oral presentations on "A Monte Carlo Study to Explore the Composition of the Grain Mantle" and on "Chemical Composition of Interstellar Dust: A Monte Carlo Study" in B0.5 session of the 39th COSPAR Scientific Assembly in July 2012 at Mysore, India; on "Monte Carlo Simulation for the formation of interstellar grain mantle" 10-13th July, 2012, ASTROCHEM 2012, S. N. Bose National Centre for Basic Sciences, Kolkata, India; on "Deuterium enrichment of the ISM" in International Workshop on Chemical Evolution and Origin of Life, 21st –23rd March, 2013, IIT Roorkee, India. He also presented a poster on "Composition of Grain Mantle; A Monte Carlo Study" at the XXVIIIth IAU General Assembly, 20th May - 31st August 2012, Beijing, China.

Dipak Debnath gave oral presentations on "Properties of the propagating oscillatory shock wave in the accretion flows around few transient black hole candidates during their X-ray outburstst" the 13th Marcel Grossman (MG13) conference in July 2012 at Stockholm University, Sweden; on "A comparative study of the timing and the spectral properties during" two similar outbursts of 2010 & 2011 of H 1743-322" at 39th COSPAR Scientific Assembly in July 2012 at Mysore, India; on "Extracting Flow parameters of H 1743-322 during its 2010 outburst using Two Component Advective Flow model" at National Conference on Recent Trends in the Study of Compact Objects (RETCO) in March 2013 at IIT, Guwahati, India. He also presented one poster on "A comparative study of the timing and the spectral properties during two recent outbursts (2010 & 2011) of H 1743-322" at SO1 MG13 meeting. Stockholm. and four posters on "Propagating Oscillatory Shock (POS) model for explaining QPO evolutions of some transient black hole candidates", "Study of the timing and the spectral properties during the 2010-11 outburst of black hole candidate GX 339-4", "Possible ASTROSAT observation of disappearance of accretion shocks behind the horizon in outburst sources" at the 39th COSPAR Scientific Assembly, Mysore, India.

Liton Majumdar gave oral presentations on "*Quantum chemical approach to study the spectral properties of some important precursor of bio-molecules*" at ASTROCHEM conference from 10-13 July 2012 at S. N. Bose National Centre for Basic Sciences, Kolkata, India; on *"Formation of some of the bases of DNA in the interstellar space during the molecular cloud collapse"* and on "*A quantum chemical approach to set a guideline for the observation of different pre-biotic molecules in the ISM*" at 39th COSPAR Scientific Assembly, July 2012 in Mysore, India; on "*Guidelines for astronomical detections of new complex molecules in the Interstellar Medium*" at a conference on Chemical Evolution and Origin of life, 2013 at IIT Roorkee, India. He also 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, 2013. He presented a poster on "*Chemical evolution and Spectroscopy of some complex molecules which could be treated as the precursor of some bio-molecules in the Interstellar Medium*" at the XXVIIIth IAU General Assembly, in August, 2012, Beijing, China.

Santanu Mondal presented a poster on "Spectral properties of accretion flows around black holes in presence of Comptonization" at the 39th COSPAR Scientific Assembly in July, 2012 at Mysore.. He also presented a talk on "Spectral properties of Two Component Advective Flows around black holes with standing shock in presence of Comptonization" at a National conference on "Recent trends in the study of Compact Objects: Theory and Observation (RETCO)" in March, 2013 at IIT Guwahati, India.

Arka Chatterjee presented a poster on *"Visualization of Black Holes with Accretion Disk"* at a National conference on *"Recent trends in the study of Compact Objects: Theory and Observation (RETCO)"* in March, 2013 at IIT Guwahati, India.

Himadri Ghiosh presented talks on "*Numerical Studies of the Hydrodynamic, Spectral and Timing Properties of a Two-Component Accretion Flow around a Black Hole*" at Black Hole Universe 2012 conference at Bamberg, Germany, June, 2012; on "*Monte Carlo Simulation of the Advective Inflow and Outflow around a Black Hole*" at Max Planck Institute for Kernphysik, Germany, June, 2012; on "*Effects of Compton Cooling on the Hydrodynamic, Spectral and Timing Properties of a Two-Component Accretion Flow around a Black Hole*" at the 13th Marcel Grossman (MG13) meeting in July, 2012 at Stockholm University, Sweden; on "*Compton Cooling and its Effects of a Coupled Monte Carlo TVD Simulation*" at a National conference on "Recent trends in the study of Compact Objects: Theory and Observation (RETCO)" in March, 2013 at IIT Guwahati, India. He also presented a poster on "*Numerical studies of timing and spectral properties of shocked two component accretion flow around a black hole in presence of Compton cooling*" at the 39th COSPAR Scientific Assembly, July, 2012 at Mysore.

Partha Sarathi Pal presented a talk on *"A study of the Variation of Geometry of Accretion Flows of Compact Objects through Timing and Spectral Analysis of Their Outbursts"* at a national conference on "Recent trends in the study of Compact Objects: Theory and Observation (RETCO)" in March, 2013 at IIT Guwahati, India.

Sudipta Sasmal gave three oral presentations on "Study the Seismo-Ionospheric Correlations in the Indian Subcontinent Using Very Low Frequency (VLF) Signal Characteristics", "Study the Broadband Very Low Frequency (VLF) Received from Different Places and Observe the Possible Ionospheric Events" and "Case Studies of Seismic Events and Comparison with Very Low Frequency (VLF) and Satellite Data" at the 39th COSPAR Scientific Assembly in July, 2012 at Mysore, India. In the same conference, he also presented two posters on "Ionospheric Anomaly During Seismic Activities Observed from NWC-Sitapur Baseline", and on "Calibration of the VLF Signals for VTX-MALDA Propagation Path: Correlation Between Ionospheric Anomaly and Seismic Activities". **Sushanta Mondal** gave oral presentations on "Very low frequency detection of the Soft Gamma ray Repeater SGRJ1550-5418", and on "Unique observation of a solar flare by lunar occultation during the 2010 annular solar eclipse through ionospheric disturbances in VLF waves" at the 39th COSPAR Scientific Assembly in July, 2012 at Mysore.

Suman Ray gave two oral presentations on "Unusual fluctuation of nighttime VLF signal amplitude before seismic events", "Unusual Shifts in Terminator Times of the VLF Signals before the Pakistan Earthquake (M=7.4), Occurred on 19th Jan., 2011" and a poster on "Calibration of the VLF Signals for VTX-Malda Propagation Path : Correlation between lonospheric Anomaly and Seismic Events" at the 39th COSPAR Scientific Assembly in July 2012 at Mysore. He also presented a talk to defend ISRO respond project titled "Study of ionospheric behaviour during total solar eclipse of July 2009 using the Characteristic of Very Low Frequency (VLF) signals" at ISRO Respond meeting, PRL, Ahmedabad, 2013.

Sujay Pal gave oral presentations on "Modeling of sub-ionospheric VLF signal perturbations associated with total solar eclipse 2009, in Indian sub-continent" at the 39th COSPAR Scientific Assembly in July, 2012 at Mysore; and on "Numerical modeling of VLF radio wave propagation through Earth-Ionosphere wave guide and its application to Sudden Ionospheric Disturbances" for his pre-Ph.D. Seminar at Calcutta University. He also presented two posters on "First Ever VLF Monitoring of Lunar Occultation of a Solar Flare during the 2010 Annular Solar Eclipse and its effects on the D-region Electron Density Profile" and on "Multi-satellite observation of Lunar Occultation of X-ray emission from a Solar Flare during the 2010 Annular Solar Eclipse" at the 39th COSPAR Scientific Assembly in July, 2012 at Mysore.

Rajdeep Saha gave oral presentations on *"Formation of different nucleo-bases during formation of protostar in support of RNA world hypothesis"*, at Chemical evolution and the Origin of life, IIT Roorkee, 21-23rd March, 2013; and on *"Effect of photo-dissociation on the composition of grain mantle"*, at the 39th COSPAR Scientific Assembly in July 2012 at Mysore. He also presented one poster on *"Effect of photo-dissociation on the composition of grain mantle"*, at ASTROCHEM-2012, SNBNCBS, Kolkata, 10-13th July, 2012.

Dipen Sahu presented a talk on "*Developing a 2D hydrodynamic code to study the formation of Protostar*", at IIT Roorkee, in March, 2013.

Workshops / Seminars / Conferences etc. organized :

Sandip K. Chakrabarti and **Ankan Das** co-organized a conference on "Chemical Evolution of Star Forming Region and Origin of Life" in July, 2012 at SNBNCBS with joint convener Dr. K. Acharyya of SNBNCBS.

Sandip K. Chakrabarti, Main Scientific Organizer (MSO) and **Anuj Nandi**, Deputy Organizer (DO) jointly organized the session E1.2 (Title: *Spectral and Timing Properties of Black Holes and Neutron Stars*) of the 39th COSPAR Scientific Assembly from 14 - 22 July 2012 at Mysore, India.

Sandip K. Chakrabarti (MSO) and **Sudipta Sasmal** (DO) jointly organized the session C0.4 (Title: Ionospheric Disturbances Observed Through Very Low Frequency Radio Waves) of the 39th COSPAR Scientific Assembly from 14 - 22 July 2012 at Mysore, India.

Ankan Das (MSO) and **Sandip K. Chakrabarti** (DO) jointly organized the session F3.5 (Title: *Chemical Evolution of Star Forming Regions: Observations, Experiment and Theory*) of the 39th COSPAR Scientific Assembly from 14 - 22 July 2012 at Mysore, India.

Visits abroad from the Centre

Sandip K. Chakrabarti visited Stockholm University, Sweden for the 13th Marcel Grossman meeting (July 2012).

Ankan Das attended the XXVIIIth IAU General Assembly, 20th May - 31st August 2012, Beijing, China.

Dipak Debnath attended the 13th Marcel Grossman (MG13) meeting from July 1 - 7, 2012 at Stockholm University, Sweden.

Himadri Ghosh visited Max Planck Institute for Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg, Germany, to Prof. Felix A. Aharonian, June, 2012; and Stockholm University, Sweden for the 13th Marcel Grossman (MG13) meeting from July 1 - 7, 2012.

Liton Majumdar attended the XXVIIIth IAU General Assembly, 20th May - 31st August 2012, Beijing, China.

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

Visitors to the Centre

Several Scientists including Prof. S.K. Ghosh (NCRA, Pune), Prof. R. Sekhar (PRL, Ahmedabad), Prof. T. Chandrasekhar (PRL, Ahmedabad), Dr. S. Roy (NCRA, Pune); Dr. Samir Mandal (IISST, Trivandrum), Prof. A. R. Rao (TIFR) visited 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).

<u>Abstract:</u> 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.

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

<u>Abstract:</u> 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.

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

S. Samsal, S. Ray, S. Maji, S.K. Chakrabarti

<u>Abstract:</u> 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 observations of VLF signals. Several students have been working in this project: S. Ray (ICSP), S. Maji (ICSP), S. Sasmal (ICSP).

M.Sc. or other projects guided by ICSP members

- 1. **Dr. Dipak Debnath** supervised Koushik Pan of Ramakrishna Mission Residential College, (Auton.) Narendrapur, Kolkata, for his M.Sc. project work entitled "*Temporal variability study* of 4U 1630-47 during its 2007-08 outburst".
- Mr. Sujay Pal supervised Suman Chakraborty and Partha Pradip Panja of Ramakrishna Mission Residential College (Auton.), Narendrapur, Kolkata, for their M.Sc. project works entitled "Study of Atmospheric Gravity Waves during Solar Eclipse from VLF data" and "Dependence of Solar Flare Induced Sub-Ionospheric VLF Signal Perturbations with Solar Zenith Angle" respectively.
- 3. **Mr. Sudipta Sasmal** supervised Jeet Dutta, Krishnendu Das and Pikesh Pal of Ramakrishna Mission Residential College (Auton.), Narendrapur, Kolkata, for their M.Sc. project works entitled "Study the Anomalous behaviour of VLF Signal during Earthquake by D-Layer Preparation Time (DLPT) and D-Layer Destruction Time (DLDT) Method", "Study the unusual behaviour of VLF Signal during Earthquakes by analysis of the Sunrise and Sunset Terminator time" and "Study the effects of Seismic Activities in the VLF Signal" respectively.
- 4. **Mr. Sourav Palit** supervised Prabir Midya of Ramakrishna Mission Residential College (Auton.), Narendrapur, Kolkata, for his M.Sc. project work entitled "Computation of Ionization rates due to Solar radiations in Earth's Atmosphere".

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

In this department, the main focus is given to find out if the complex molecules which form life could be formed in star forming region and proto-stellar clouds. Chakrabarti and Chakrabarti, in 2000, for the first time actually computed the abundances of Adenine in ISM. 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, grain chemistry inside the gas, chemical evolution of collapsing matter and most importantly, study of energetics of possible reactions. Since then our efforts have been to simulate hydro-chemical models including gas and grain, with more accurate reaction cross-sections and with varied number of species. We believe that these complex molecules were brought to planets through comets and meteorites. If the planet is in the habitable zone, then pre-biotic molecules would further evolve to produce life. Thus, we believe that life has evolved quite independently throughout the Universe.

After the formation of the complex molecules in space, the next biggest challenge is to observe them accurately. Dating from the mid-twentieth century, the technique of rotational spectroscopy is a powerful tool for observing these molecules. Work in millimeter and sub millimeter wavelength range allows study of small to medium-sized molecules, and has been a particularly useful technique for detection of new chemical species, Indeed, for gas-phase molecules, rotational spectroscopy remains the most accurate and reliable source for structural information. In the field of Astrochemistry, use of rotational spectroscopy is vital. Radio-astronomical detection has been responsible for detection of more than 170 chemical species in the interstellar medium. The theoretical prediction of rotational spectra involves two tasks, namely (a) determination of the required spectroscopic parameters and (b) simulation of spectra based on given set of spectroscopic parameters. An accurate determination of these requires a quantum-mechanical treatment of the molecular system under consideration, Besides, infrared and UV-VIS spectroscopy are also used to explore several new complex species in interstellar medium.

All these works are going on in our group to motivate observers to search for these new complex molecules in ISM.



Study of the formation Cyanoformaldehyde and one of its isotopomer DCOCN in the ISM:

Cyanoformaldehyde (HCOCN) molecule has recently been suspected towards the Sagittarius B2(N) by Green Bank telescope, though a confirmation of this observation has not yet been made. To this effect, we carried out quantum chemical simulation to find out different spectral parameters of HCOCN for the transition in electronic, infrared and rotational modes. This type of studies are expected to assist observers to look for these species in and around various molecular clouds (A. Das, L. Majumdar, S.K. Chakrabarti, R. Saha, S. Chakrabarti).

Emission lines of Cyanoformalihyde and its join isotopomer in ice and gas phases

Black Hole Astrophysics



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



(L to R): H. Ghosh, and A. Chatterjee

This group concentrates on 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 and what the time dependence of spectrum of radiation is. Theoretical studies include the analytical, numerical simulations and Monte Carlo simulations of photon-electron interactions.

<u>Self-consistent transonic flow solution with standing shocks in presence of Comptonization:</u>

Here we couple both Hydrodynamic and Radiative Transfer Processes occurring in accretion flows. We show spectral properties and spectral index variation of the radiation coming from



black hole accretion disks as well as parametric space behavior of the flow in presence of Compton cooling.

Matters from the companion becomes Keplerian and sub-Keplerian on the basis of their angular momentum. Keplerian flow produces low energy soft photons which are scattered by hot electrons in the CENBOL (CENtrifugal pressure supported BOundary Layer) region produced by the low angular momentum sub-Keplerian flow. We also study shifting of the shock location due to the Compton cooling effects (left Figure) (S.K. Chakrabarti and S. Mondal).

Figure on the left shows the softening of emitted spectrum.

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

It has been long understood that 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 (e.g., disk blackbody for thermal part and power-law for non-thermal component of black hole spectra) are already in NASA's spectral analysis software package XSPEC. Here, we

make an effort to include a model named TCAF developed by Chakrabarti and his collaborator in mid-90s based on theoretical solutions of viscous transonic flows, where the Compton cloud is replaced by a low angular momentum flow which 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 according to the TCAF model. The low angular momentum flow, be it in the CENBOL or in the jet, collectively behave like a Compton cloud. We have been able to create an user-friendly version of TCAF model FITs file for XSPEC, which can directly extract accretion flow parameters such as two component (Keplerian and Sub-Keplerian) mass accretion rates, shock parameters (location and strength of the shock wave). 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. We found that model fits well with acceptable values of reduced chi-square for hard and intermediate (hard-intermediate, soft-intermediate) state spectra (D. Debnath, S. Mondal, and S. K. Chakrabarti).

Coupled Monte Carlo – TVD simulation for black hole accretion:

We apply coupled Monte Carlo – TVD code to an accretion flow with considerable amount of sub-Keplerian angular momentum. In this case, a strong shock is produced and a percentage of matter from the post-shock region leaves the system as outflow/jet. We investigate effects of cooling of the Compton cloud on the outflow formation rate in an accretion disk around a black hole. We show that as a result of Comptonization of the Compton cloud, the cloud becomes cooler with the increase in the Keplerian disk rate. As the resultant thermal pressure is reduced, the post-shock region collapses and the outflow rate is also reduced. Since the hard radiation is produced from the post-shock region, and the spectral slope increases with the reduction of electron temperature, the cooling produces softer spectrum. We thus find a direct correlation between spectral states and outflow rates of an accreting black hole (S. Garain [SNBNCBS], H. Ghosh [ICSP] & S.K. Chakrabarti[SNBNCBS & ICSP]).

Previously, it was found that the shock location oscillates with time. It has been shown in the context of bremsstrahlung cooling by Chakrabarti and his collaborators that this shock oscillation gives rise to the Quasi Periodic Oscillation (QPO). We verify this claim by doing numerical simulation using our code where Compton cooling is present. Assuming that the general structure of an accretion disk is a Two Component Advective Flow (TCAF), we numerically simulate light curves emitted from an accretion disk for different accretion rates and find how QPO frequencies vary. We find that the QPO frequency increases and the spectrum becomes softer as we increase Keplerian disk rate. However, the spectrum becomes harder if we increase sub-Keplerian accretion rate. We find that an earlier prediction that QPOs occur when infall time scale roughly matches with cooling time scale, originally obtained



using a power-law cooling, remains valid even for Compton cooling. Our findings agree with the general observations of QPOs (S. Garain [SNBNCBS], H. Ghosh [ICSP] & S.K. Chakrabarti).

<u>Time dependent simulation of matter with</u> viscosity and radiative transfer:

Viscosity transports angular momentum allowing matter to fall into a black hole. However, when viscosity decreases as one moves away from the equatorial plane, the Keplerian disk is formed at the equatorial plane and is surrounded by low angular momentum, sub-Keplerian, matter. This centrifugal pressure supported boundary layer, or CENBOL is produced. This is shown by numerical simulations

(S.K. Chakrabarti and K. Giri [SNBNCBS]).

Figure above shows the formation of Keplerian disk on the equatorial plane and the CENBOL

Black hole astrophysics as an Engineering problem:



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

We have shown that the accretion around black holes can be thought of as an engineering problem with flows passing through converging and diverging ducts. Recently, we made a significant progress in the case when the flow is viscous and isothermal (K. K. Chakrabarti, M. M. Majumdar and S.K. Chakrabarti).

X-ray Astronomy



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



(L to R): A. Chatterjee, P.S. Pal

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

Evolutions of accretion flow dynamics and mass flow rates cause evolution of timing and spectral properties during outburst phases of transient black hole candidates (BHCs). In our recent study on 2010 & 2011 outbursts of H 1743-322, we found that mainly four different spectral states (hard, hard-intermediate, soft-intermediate and soft) are observed during the outburst phases of the BHCs. During outbursts of GX 339-4 & H 1743-322, it was also found that these four basic spectral states form a hysteresis loop in the sequence: hard \rightarrow hard-intermediate \rightarrow soft-intermediate \rightarrow soft-intermediate \rightarrow hard-intermediate \rightarrow hard (D. Debnath, S. K. Chakrabarti & A. Nandi [ISRO]).

Similar to the 2005 outburst of GRO J1655-40 and 1998 outburst of XTE J1550-564), during rising and declining phases of 2010 & 2011 outbursts of H 1743-322, evolution of QPO frequencies were also observed. We found that same propagating oscillatory shock (POS) model holds good to explain the evolution. We can obtain accretion flow parameters such as instantaneous shock locations, shock velocity and shock strength etc. Also, from comparative study on timing and spectral properties of recent two successive evolutions of H 1743-322 it was found nature (profile light curves, evolutions of QPO frequency, spectral evolutions, etc.) of these two successive outbursts, which continued for around two months each, are very similar (D. Debnath, S. K. Chakrabarti & A. Nandi [ISRO]).



Variation of QPO frequencies with time (in day) during rising phases of (a) 2010 and (b) 2011 outbursts of H 1743-322 (left). Variation of QPO frequencies with time (in day) during decline phases of (a) 2010 and (b) 2011 outbursts of H 1743-322.

X-ray/Gamma Ray Experiments and Balloon borne Astronomy



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

X-ray Detection using Proportional Counter

We developed the readout system of a large area proportional counter for conducting space based experiments. The effective area of the Proportional counter is 140Sq.cm.



Large Area proportional counter with 40° X 40° collimator (left)). Calibration of the detector at room temperature (right). Energy Range of the Detector is set at 21KeV to 125 KeV suitable for balloon borne study of black hole candidates.



Energy Calibration curve of the proportional counter

X-ray Spectrometer using (3"Bicron) with NaI Scintillator

We developed the readout circuit with high speed data acquisition (ARM9) system and completed a payload containing a large area 3" diameter Bicron made PMT with Nal scintillator. The effective area of this detector is 45.4 cm. This is to be flown to near space from ICSP balloon facility at Bolpur.





(L to R) 3" Bicron detector with Nal Scintillator, collimator for the Bicron detector and Calibration.

(Below, L to R): Channel vs energy calibration for the Bicron detector. Emission characteristics of lead collimator also appears at 77keV.



Geiger Counters in coincidence mode



We developed Geiger counter in coincidence mode. We took two sets of four numbers of identical GM counters in each series. These two series are connected in coincidence mode at a distance of 230mm to get acollimation of $24^{\circ}X40^{\circ}$. This is for a future balloon borne mission.

Eight Geiger tubes in coincidence mode.

Development of a Sun tracker for balloon borne measurements



Sun tracker to direct a payload to the sun (Left). Test is conducted with a tethered balloon (Right).

ICSP developed a sun-sensor to direct the payload to the sun or in any other object during a flight. This is being tested with various payloads which require such assistance. This is for a future mission.

Muon Detection

In an earlier report, Cosmic ray data obtained by Geiger counter was presented. Here we present the detection of muon with height. The muon count becomes zero above 30km. For muon detection we used 1.5cm thick lead shielding all around the Geiger tube.



Muon Counts as a function of time since liftoff on the way up and way down.

Achievement of long duration flights: ICSP way

ICSP has developed a unique capability of floating payload for a long period of time (in principle, 5-24 hours) without using any valve to leak out excess gas to stop bursting or dropping ballasts in order to maintain a minimal height as is the practice for larger balloons. This is achieved by a so-called booster-orbiter configuration where the lifts of the balloons are adjusted in such a way that only the booster bursts at, say, H_b letting the orbiter to slowly come down to an equilibrium height H_o where the neutral buoyancy is achieved.



Booster-orbiter configuration principle of ICSP to float the payload for a long time.

Data of a long duration flight (D26) where we obtained the data of Cosmic rays, temperature, pressure and accelerometers for about 12 hours.



Raw light curves of the three flares in hard Xrays observed in D33 mission as compared with 3-25keV GOES satellite light curve. Softer X-ray component of 3-20keV was invisible to D33 due to absorption of air (L).

Our balloon programme has successfully obtained spectrum of several solar flares in this Solar maximum. This indicates the use of our programme for space weather studies. We present the raw light curves (3s average of the raw data) of three solar flares of D33 Mission which are observed when the balloon was at heights of 25km, 28km and 32-34km respectively. The data

is compared with the GOES (3-25keV) data. The general timings of the flare match perfectly. However, since our instrument was not sensitive in 3-20keV at such a low height, we see only the hard components. The long downward spikes in our data are produced when the sun was not in the field of view of the X-ray detector. At lower altitude the spectrum would have more hard photons due to blockage of softer photons by the remaining atmosphere. As the height of the instrument goes up, more and more soft photons would dominate the spectrum (as the injected solar spectrum itself is dominated by low energy X-rays arising of thermal



bremsstrahlung) and the observed spectrum would also be close to the emitted spectrum. We also show the channel-energy flux for these flares (the whole of the first flare data and 60s data at the rising phase of the other two flares). We find that the inner most flare observed at 25km extends to harder X-rays and the detected energies of the flares progressively become softer and brighter.



Radio and VLF Astronomy



Top (L to R): Sabyasachi Pal, D. Bhowmick, Sujay Pal, S. Palit, S.K. Chakrabarti, Middle (L to R): S. Maji, S. Mondal, S. Ray, A. K. Choudhury, S. Sasmal, Bottom (L to R): D. Patra, R. Bhunia, D. Bhattacharyya, P. Sarkar, B. Mishra, W. Bari, D. Sanki, A. Choudhuri ICSP radio group has been engaged in observation with GMRT for more than a decade. The work is still continuing. At the same time a facility is being built at the IERC campus, Sitapur where several dish antennas are expected to be installed over the next years. Right now major work has been done by the project scientist Dr. Sabyasachi Pal and his group. Recently, 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. More such discovery are anticipated as the expected number of such objects is supposed to be about 12.

In low frequency domain, ICSP has been monitoring Very Low Frequency (VLF) radio signals from various stations since 2002. It is engaged in modeling 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 ionospheric anomalies and 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 taken from various stations in India.

Seismo-lonospheric Correlation

An automatic file transfer protocol has been developed which is the part of the automatic seismic alert system. This is capable to transfer data from several location using the Virtual Private Networking (VPN) technology. A schematic diagram on how it is operating is shown below.



Schematic diagram of the automatic file transfer protocol and the seismic alert system developed at ICSP

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.

Atmospheric Gravity Waves in VLF data during solar eclipse

The presence of Atmospheric Gravity Waves in VLF data during solar eclipse has been detected. Using the Fourier transformation of VLF data during solar eclipse period peaks in several frequencies has been observed. To identify the occurrence times of the peaks, the wavelet analysis method has been used which allows to resolve the Fourier spectra in both time-frequency domain. It has been found enhanced fluctuations of wavelet power with periods ranging from ~10 minutes to 1 hour around the time of maximum eclipse phase. This might indicate the presence of atmospheric waves phenomena at VLF reflection height (D-region and lower E-region) during the solar eclipse period. These waves are the atmospheric gravity waves, generated within the whole atmosphere from the temperature gradient created by the movement of the lunar shadow along the eclipse totality belt (Sujay Pal et al.).



Wavelet power spectrum (left) of the VLF amplitude deviation due to solar eclipse of July 22, 2009 at Kathmandu. Note the wave activities around the time of maximum eclipse phase (~6:30 IST) with periods ranging from ~10 minutes to 1 hour in the power spectrum.

Study of the ionospheric perturbation due to seismic events by analyzing the VLF signal :

VLF signals for four different propagation paths during the Pakistan earthquake which occurred on 18th Jan., 2011 are analyzed. These four propagation paths are DHO-IERC (Sitapur), VTX-Pune, VTX-Kolkata and NWC-IERC (Sitapur). A significant shift of the 'sunrise terminator time' (SRT) for DHO-IERC and VTX-Pune paths is observed. For DHO-IERC path,



Sunrise terminator time shifts before an earthquake.

the SRT of VLF signals shifted towards night time three days before the earthquake day and in case of VTX-Pune path it shifted towards night time just one day before the earthquake day. For VTX-Kolkata path, the shift of SRT is four days before the earthquake day, but here the shift is not so strong, somewhere between 2σ and 3σ line. For the other two paths, namely, DHO-IERC and VTX-Pune, the terminator shifts crossed the 3σ line. We found no significant shifts of SRT for NWC-IERC propagation path. Higher deviation in VTX-Pune and DHO-IERC paths as compared to VTX-ICSP path could be due to formers proximity to the epicentre. Similarly, DHO-IERC path is over the epicentre while that of NWC-IERC path is away from the epicenter. This could be the reason why precursory effect is present in the VLF signals for DHO-IERC and VTX-Pune path but no effect is found for NWC-IERC path. The Figure shows the Sun rise terminator time (SRT) as a function of day no., around 9th Jan, 2009 on which day an earthquake of magnitude 5.5 occurred is plotted. Note that the SRT of the VLF signals crossed the 3 σ line two days before the earthquake. This anomalous shift of the SRT can be treated as the precursor effect of the earthquake.

Ab Initio Calculation of Ionospheric perturbations

X-ray photons emitted during solar flares cause ionization in the lower ionosphere (60 to 100 km) in excess of what is expected to occur due to a quiet sun. Very low frequency (VLF) radio wave signals reflected from the D-region of the ionosphere are affected by this excess ionization. We reproduce deviation in VLF signal strength during solar flares by numerical modeling. We use GEANT4 Monte Carlo simulation code to compute the rate of ionization due to M-class flare and X-class flare. The output of the simulation is then used in a simplified ionospheric chemistry model to calculate time variation of electron density at different altitudes in the D-region of the ionosphere. Resulting electron density variation profile is then self-



consistently used in the LWPC code to obtain the time variation of the change in VLF signal. We did the modeling of the VLF signal along (Australia) to **IERC/ICSP** NWC (India) propagation path and compared the results with observations. The agreement is found to be very satisfactory (S. Palit, Т. Basak [SNBNCBS], S. Mondal, S. Pal. S.K. Chakrabarti [SNBNCBS & ICSP]).

A comparison between the predicted result from our ab initio calculation and actual VLF signal perturbation observed during an X-class flare.

Airglow and Ozone Depletion studies



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

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. It is recently shown that sharp depletion of absolute humidity may be one possible method of predicting Nor'wester. Study of atmospheric refractivity prior to squall onset, seasonal variation of daily total column ozone, short-term tropospheric ozone trend in India etc. are studied by this group.

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 source, sudden atmospheric disturbance, lightnings and earthquakes. Some students are engaged in analysis of data obtained from RXTE. Several scientific papers on class transitions and earthquakes have been published. Members of the Malda branch have taken active role in coordinating Venus transit event on 6.6.2012 in Malda, Murshidabad, North and South Dinajpur. They organized live telecast of Venus transit in collaboration with Malda Cable Network. Several sky watching programmes were also organized on different dates throughout the year. Wasim Bari and A. K. Chatterjee continued their work on data analysis of black holes. A.K. Choudhury has registered for Ph.D. degree.

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. Kankar Bandopadhyay, Vice President
Mr. Asit K. Choudhury, Secretary	Mr. Subhankar Das, Treasurer
Mr. Zahirul Islam, Member	Mr. Gobinda Chandra Mandal, Member
Mr. Nilmadhab Nandi, <i>Member</i>	Mrs. Sutapa Chatterjee, Member
Mr. Utpal Chatterjee, Member	

The ionospheric and earthquake research centre (IERC)



(L to R): S. Pal (Radio Astronomer), R. Khan (Optical Astronomer)

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. The centre is located at Sitapur, Paschim Medinipur, West Bengal, India. Two element interferometer has been installed here by Dr. Sabyasachi Pal. This project was supported by Prof. Siraj Hasan, Ex-Director of Indian Institute of Astrophysics.



One of Two elements of the Interferometer (left). A typical fringe pattern obtained at IERC (right).



Large dish antennas are being installed in this campus. Stanford University made AWESOME VLF antenna & receiver, and University of Otago, New Zeland made SoftPAL antenna and receiver system have been installed here. Already half a dozen papers have been published and several PhD thesis have been submitted or being submitted with majority of results from IERC.

In order to have self-sufficiency in this remotest village, IERC has its own solar power system to run half a dozen of computers. The boundary fencing has been completed.

Solar panel on the terrace of IERC Sitapur

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, 2013 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 amount was unspent 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 2013 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 Sd./- S.K.Chakrabarti Honorary Secretary, Indian Centre for Space Physics

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

P.K. Chakravorty, Proprietor M.No. 51701 Place: Kolkata Date: 22nd Sept'2013 F/52, Bapuji Nagar, PO: Regent Estate Kolkata 700 092

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

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

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

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

Place: Kolkata Date: 22nd Sept'2013

(P.K. Chakravorty)

Proprietor M.No. 51701

> 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 31.03.2013

		As on 31.03.2013	As on 31.03.2012
SOURCE OF FUNDS	Schedule	Amount (Rs.)	Amount (Rs.)
Capital Funds	1	11240397.80	9351027.00
Loan Funds	2	0.00	0.00
TOTAL		11240398.00	9351027.00
APPLICATION OF FUNDS			
Fixed Assets			
Gross Block	3	7485311.00	6483776.00
Less:			
Depreciation		864793.00	1390021.00
Net Block		6620518.00	5093755.00
Current Assets, Loans & Advar	nces:		
Security Deposit		5100.00	5100.00
Cash & Bank Balances	4	7997620.00	10062167.00
Dues from funding			
agencies	4A	0.00	159666.00
Total		8002720.00	10226933.00
Less: Current Liabilities	5	191210.00	340598.00
Less: Unspent during the			
year	9	3191630.00	5629063.00
Net Current Assets		4619880.00	4257272.00
Miscellaneous			
Expenditure			
to the extent not			
written off	6	0.00	0.00
		11240398.00	9351027.00
Schedules referred to above from As per our Annexed Report of ev	n an integral pa en date	rt of the Balance Sheet	
P.K. Chakravorty &			
Associates		Sd./-	S.K.Chakrabarti
Chartered Accountant	Honorary Sec	retary, Indian Centre for Space	e Physics
	Sd./- P.Bandyopadhyay		
	Honorary Treasurer, Indian Centre for Space Physics		
(P.K.Chakraborty) Proprietor			
Date: 22nd Sept. 2013		Sd./-	B.B.Bhattacharyya
	Honorary President, Indian Centre for Space Physics		e Physics

INDIAN CENTRE FOR SPACE PHYSICS 43 Chalantika, Garia Station Road Kolkata-700084

		As on 31.03.2013	As on 31.03.2012
	Schedule	Amount(Rs.)	Amount(Rs.)
INCOME			
Income	7	6847759.00	9999978.00
		6847759.00	9999978.00
EXPENDITURE			
Administrative & Other Expenses	8	8891801.00	6478727.00
Preliminary Expences written off		0	0.00
Depreciation		75923.21	648061.00
		8967724.21	7126788.00
Excess of Expenditure Over Income		-2119965.21	2873190.00
Surplus(Deficit) brought forward			
from the		8066263.00	5193073.00
earlier year			
Balance transfered to the Balance			
Sneet		5946297.80	8066263.00
	10		
Notes on Account	10		
Significant Accounting Policies	11		
Schedules referred to above from an i	ntegral part of	the Balance Sheet	
As per our Annexed Report of even da	ite		
P.K. Chakravorty & Associates			S.K.Chakrabarti
Chartered Accountant	Honorary Sec	cretary, Indian Centre for Sp	ace Physics
		, , , ,	,
			P.Bandyopadhyay
	Honorary Tre	asurer, Indian Centre for Sr	bace Physics
(P.K.Chakraborty)			-
Proprietor			
Place: Kolkata			
Date: 22nd Sept. 2013			B.B.Bhattacharyya
	Honorary Pre	sident, Indian Centre for Sp	ace Physics

INDIAN CENTRE FOR SPACE PHYSICS			
43 Chai	antika, Garia Station Roa	d	
Kolkata- 700084			
	As on 31.03.2013	As on 31.03.2012	
	Amount (RS.)	Amount (RS.)	
Schedu	ule -1 Capital Fund	1	
Life Membership Fees	16500.00	16500.00	
Prior period adjustment	5277600.00	1268264.00	
Balance Transferred from			
Income & Expenditure Account	5946297.80	8066263.00	
TOTAL	11240397.80	9351027.00	
<u>Schedule -2</u>	Loan Fund		
Loan from Directors	0.00	0.00	
TOTAL	0.00	0.00	
Schedule-4 Cash & Bank Balances			
Cash in hand	73274 00	29270.70	
Fixed Deposit at Axis Bank, Salt Lake	0.00	9974328.00	
Axis Bank Ltd. Salt Lake. Sector-III	7912429.65	48233.00	
Malda Dist. Central Co-op Bank Ltd.	11916.00	10335.00	
TOTAL	7997620.00	10062167.00	
Schedule-	4A Loans & Advan	ces	
Advance to Employees	0.00	138303.00	
CSIR Fellows	0.00	21363.00	
TOTAL	0.00	159666.00	
Schedule	<u>Schedule-5</u> Current Liabilities		
Audit Fees	1300.00	0.00	
Liability for Projects	189910.00	340598.00	
TOTAL	191210.00	340598.00	
<u>Schedule</u>	<u>-6</u> Miscellaneous I	Expenditure	
Preliminary & Pre-operative Expenses	0.00	0.00	
TOTAL	0.00	0.00	
Schedule-7			
	Income		
Grant-In-Aid	5560422.00	12280882.00	
Overhead recovery from project	30000.00	230000.00	
Recovery from project	0.00	2207826.00	
Other Receipts	205440.00	0	
Guest House Rent	94500.00	70539.00	
Interest & other Income	647618.00	485331.00	
Misc. Income	309779.32	3000.00	
TOTAL	6847759.00	15277578.00	

Schedule-8		
Administr	ative & Other Expenses	
Fund draw for Project Expenses	390968.00	3157849.00
Salaries/ Stipend	6427725.00	1873554.00
Office Expenses	672608.46	516288.34
Postage	330.00	776.00
Travelling & Conveyance	461726.00	114542.00
Telephone, Fax & Internet	64661.00	114370.00
Stationary, Consumables & Printing	181291.90	56369.50
Filing Fees	30567.50	15640.00
Bank Charges	393.26	219.27
Rent & Electricity	229884.00	173657.00
ICSP Development	290602.00	53135.00
TDS /P.Tax	136209.00	57823.00
Provision for expenses	0.00	5618198.00
Miscellaneous Expenses	3535.00	1906.00
Audit Fees(For Statutory Audit)	1300.00	2000.00
TOTAL	8891801.00	11756327.00
Schedule-9		
Uns	spent During the Year	
DST Projects	192400.00	123492.00
EMJDP	98161.32	0.00
CSIR PROJECT	47857.00	0.00
MoES	2833212.00	5277600.00
ISRO Projects	20000.00	227971.00
Total unspent (committed) during the		
year	3191630.00	5629063.00
P.K. Chakravorty &		
Associates		S.K.Chakrabarti
Chartered Accountant	Honorony Soorotony India	n Contro for Space Dhysics

Chartered Accountant	Honorary Secretary, Indian Centre for Space Physics
	P.Bandyopadhyay
	Honorary Treasurer, Indian Centre for Space Physics
(P.K.Chakraborty)	
Proprietor	
Place: Kolkata	
Date: 22nd Sept. 2013	B.B.Bhattacharyya
	Honorary President, Indian Centre for Space Physics

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 preoperative 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 lifemember-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

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

M.No. 5170I F/52, Bapuji Nagar, PO: Regent Estate

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

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

Place: Kolkata

(P.K. Chakravorty)

Proprietor

Date: 22nd Sept'2012

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



Group photo of some students of Prof. S.K. Chakrabarti (Center) at the COSPAR Conference (Left). Mr. Sudipta Sasmal replying to the session Chairman at COSPAR (Right).





ICSP participated in ISC 2013 and was jointly awarded to display the most innovative stall, Group Photo of some ICSP scientists at the stall (above, Left), Jubilation of ICSP scientists with the Trophy (above, Middle), ICSP scientists RETCO, Guwahati conference (above, Right).

Indian C



Dr. D. Debnath presenting a talk at MG13 conference in Stockholm.



t MG13

ICSP stall at Indian Science Congress 2013.

entre for Space Physic

-Multidisciplinary approach to Earth science in relation to Space

Participants from Kolkata at MG13 in Stockholm.







Dr. A. Das and Mr. L. Majumdar at Beijing conference (Left), ICSP Scientists at IIT/Roorkee Conference on Origin of life (Middle), M.Sc Project Students with their Instructors (Right).

Burst of the Booster balloon while the Orbiter stays on – A pioneering initiative of ICSP to have long duration flights.

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