
**ISRO-UoP
Space Technology Cell
University of Pune**



Annual Report
2010-11

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Contents

1.	Introduction	1
2.	Management of Joint Research Programme	2
3.	Supported areas of research	4
4.	Completed research projects	5
5.	Research Projects in progress	10
6.	New research projects for the year 2010-11	17
7.	Major events in the STC calendar	19
8.	ISRO Proposal format	22
9.	Annexure – Suggested topics for the research proposals	27

1. Introduction

Space activities in the country started during early 1960s with the scientific investigation of upper atmosphere and ionosphere over the magnetic equator that passes over Thumba near Thiruvananthapuram using small sounding rockets. Realising the immense potential of space technology, Dr Vikram Sarabhai, the visionary leader, envisaged this playing a meaningful role in national development and solving the problems of common man. Thus space activities in the country, focused on achieving self reliance and developing capability to build and launch communication and remote sensing satellites for television broadcast, telecommunications, meteorological applications and for management of natural resources. While pursuing its defined goals, Indian Space Research Organization (ISRO) evolved a programme through which financial support could be provided for conducting research and development activities related to Space Science, Space Technology and Space Application in academia in India. This programme of Research Sponsored by ISRO is called RESPOND. Main objective of the RESPOND programme is to establish strong links with academic institutions to carryout quality research and developmental projects which are of relevance to Space and derive useful outputs of such R&D to support ISRO programmes. RESPOND programme is thus expected to enhance academic base, generate quality human resources and infrastructure at the academic institutions to support the space programme. Currently research proposals are supported in space science, space technology and space application. RESPOND also supports basic research, which will have futuristic linkages with the Indian Space programme. Considering the academic achievements and expertise existing at the University of Pune (UoP), ISRO showed interest in generating basic knowledge through advanced academic research to be carried out at UoP with financial help from ISRO. As a result of this, Joint Research Programme (JRP) was conceived and a Memorandum of Understanding (MOU) was signed between Chairman ISRO and Vice Chancellor, University of Pune on 21st January 1998. Initially five broad disciplines were identified for carrying out this JRP. The co-operation between the two organizations had been found beneficial and as a result, while renewing the MoU on 24 February 2006, these areas were further enlarged by identifying six new disciplines.

2. Management of Joint Research Programme

The Joint Research Programme continues to focus advanced research in the areas of relevance to the technological needs of Indian Space Research Organization and more particularly in those areas which have been specifically identified in MoU. Overall management of interaction programme is carried out by Joint Policy Committee (JPC) chaired by Hon'ble Vice Chancellor and Members drawn from University faculty and ISRO centres. The responsibilities of JPC as defined in the Office Order, constituting the JPC, are as follows:

- The overall management of the interaction programme
- Recommending the funds requirement for the approved and the planned programmes from time to time to ISRO HQ for consideration
- Suggesting new areas of activities as and when felt necessary

To assist the JPC in its execution of Joint Research Programme, Programme Management Committee (PMC) has been constituted as the main coordinating body and its responsibilities as defined in the Office Order, constituting the Committee, are as follows:

- To receive research proposals from UoP/ISRO and process for approval/sanction after due scrutiny
- To review/monitor the progress of the projects and report to Joint Policy Committee (JPC)
- To suggest/recommend mid term corrections (if required) to the programmes
- To lay guidelines for publication of the outcome with due consideration to the classified nature

JPC and PMC Committees include members from the University as well as ISRO Centres. With a view to have increased interaction with the Investigators, Chairman, JPC/Vice Chancellor, UoP has constituted a Preliminary Evaluation Committee (PEC) consisting of members only from the University. This committee is to carry out preliminary evaluation of new research proposals received under ISRO-UoP Joint Research Programme in University of Pune. This Committee will scrutinize and make suggestions to Principal Investigators to modify the proposals wherever required. The proposals cleared by the Committee are then examined by the Programme Management Committee (PMC) and Joint Policy Committee (JPC) as explained above. PEC is a local committee that also undertakes periodical review of progress of the ongoing projects.

ISRO-UoP Space Technology Cell at University of Pune, is responsible for carrying out activities required for the satisfactory execution of the ISRO-UoP Joint Research Programme. Presently these include:

- Creating awareness/interest among the University faculty and research scholars in goal oriented and time bound ISRO programmes

- Organizing Joint Policy Committee (JPC), Programme Management Committee (PMC) and Preliminary Evaluation Committee (PEC) meetings to review the progress of ongoing projects and selection of new projects
- Organizing meetings/discussions with University faculty members and ISRO scientists to improve interaction
- Acting as catalyst between project investigators from University and ISRO scientists for successful completion of the interaction programme
- Bringing to the notice of University faculty the new needs/developments of programmes and facilities available in various ISRO Centres
- Bringing to the notice of the ISRO scientists, the excellent facilities and expertise that is available in University
- Arranging periodical review of ongoing projects and inviting new research proposals from University
- Dissemination of technical output to ISRO Centres from the research work carried out under JRP
- Liaising with ISRO in regard to ISRO Chair in University of Pune
- Coordinating with ISRO HQ in regard to ISRO grants and providing funds utilization details

3. Supported areas of research

Research proposals in the areas of space science, space technology and space application are generally encouraged. However Research proposals from the University should preferably be submitted in the disciplines identified in the MoU between ISRO and UoP. Currently recognized areas for this purpose are given below:

- Origin of life
- Space Radiation
- Wind measurements and modeling
- Optical coatings and sensors
- Rural development and developmental communication
- Geo-informatics
- Remote sensing applications
- Material Sciences
- Biodiversity
- Instrumentation
- Image processing

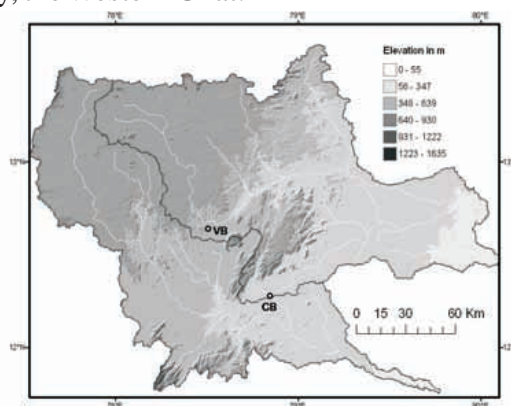
Some of the specific topics in which ISRO would like academic institutes like University of Pune, to take up the research work have been listed in the Annexure (Chapter 8). Prospective Investigators may consider them for their guidance for submission of new research proposals.

4. Completed research projects

ISRO-UoP Joint Research Programme started in 1998 with the signing of MoU between ISRO and University of Pune and with the release of funds for the financial year 1998-99. Under this programme, as on now, a total of 114 research projects have been undertaken. At the end of the project, Principal Investigator submits the final technical report highlighting the findings of the study. In order to bring the research work carried out under ISRO-UoP Joint Research Programme, to the knowledge of ISRO Scientists/Engineers, brief details along with summary findings of the completed research projects are published from time to time. Research Project Compendium published in 2006-07 gives the details of the projects completed till 2006-07. Subsequent to this publication, details of other completed projects have been included in the respective Annual Reports. After the publication of Annual Report 2009-10, three more projects have been completed and final technical reports received from the Investigators. Brief details along with summary findings of these three projects are given below:

PROJECT NO	83
TITLE	Reconstruction of Late quaternary fluvio-sedimentary response of Kaveri and Palar rivers: Based on chronostratigraphy, digital geomorphometry and remote sensing analysis
INVESTIGATORS	Prof Vishwas S Kale (PI), Dept of Geography, UoP Dr Hema Achyuthan (CO-PI), Centre for Geoscience and Engineering, Anna University, Chennai
DURATION	3 years (Started on: June 2007)
BUDGET (Rs)	7,65,000
SUMMARY OF FINDINGS	Study on fluvial stratigraphy of South Indian region was intended to get a better understanding of the response of stream systems of South India to monsoon variations, and the relationship of these fluvial systems to regional and global climatic patterns. The entire landscape drained by Kaveri River and its tributaries is ancient as it is underlain by Archean rocks. Kaveri, Palar and Ponnaiyar show prominent anomalies in their drainage network characteristics. While Kaveri displays many youthful geomorphic characteristics, Palar exhibits truncated drainage and oversized channel. The course of Kaveri appears to disregard the structure in some segments, while fault control is well revealed in sharp-angle bends in other reaches. The river

takes a difficult course across Biligirirangan-Mahadeswaramalai (BR-MM) Hill Ranges and has carved a ca 95-km long, deep gorge in the middle reaches. In this study, DEM-based digital geomorphometry, remote sensing data, and chronostratigraphy have been used to understand the geomorphic, tectonic and quaternary history of Kaveri River. Geomorphometric analysis and estimation of different tectonic indices using SRTM-DEM data show striking deviations from other parts of the basins. Narrow valleys, extremely low concavities and high values of SL index and hypsometric integral imply strong disequilibrium conditions and possibility of uplift. High concentration of lineaments in the same region also provides support to this inference. Examination of 5.8 m resolution LISS-4 image and analysis of DEM generated from Cartosat-1 data of Hogenakkal area, indicate that Kaveri River bend at Hogenakkal is not due to the lateral movement of the horst blocks along faults. Also there is no evidence of Kaveri River flowing into Palar River. For most world rivers, the channel width increases with basin area at the exponent rate ranging from 0.2 to 0.4. This value for Palar River was found to be 1.2, an order of magnitude higher, implying that the width of Palar River is increasing at an abnormally high rate. Outsized channel of Palar River is very likely due to an extraordinary flood that occurred in November 1903. The fluvial sedimentary records at Siddapur have provided evidence of at least six short-term, high discharge events on the upper Kaveri River during the period of deterioration of monsoon climate. Increased monsoon variability implies increased frequency of extreme rainfall (excess and deficient) years. We believe that the flash flood record preserved at Siddapur reflects this increased variability in the wettest part of the Deccan Peninsula, namely, the Western Ghat.

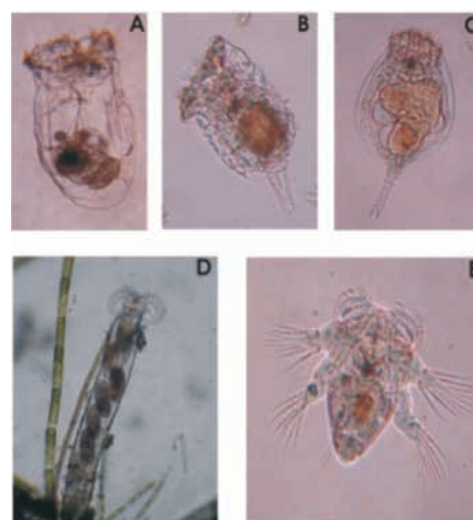


DEM of the Palar and Ponnaiyar river basins showing the major bends. VB: Vaniyambadi Bend; CB: Changam Bend

PROJECT NO	92
TITLE	Biodiversity and gravitational studies of rotifer fauna from few freshwater bodies around Pune, Maharashtra
INVESTIGATORS	Dr Kalpana Pai, Dept of Zoology, UoP
DURATION	2 years (Started on: July 2007)
BUDGET (Rs)	3,50,000
SUMMARY OF FINDINGS	<p>Rotifers or wheel animalcules are freshwater microscopic invertebrates with size ranging from 0.2 to 1.2 mm and regarded as primitive organisms. Present study aimed at sampling of rotifers from two perennial water bodies for about 20 months. Using a plankton net (50μ mesh size), sampling at four stations in both sites was carried out. Observations were made under Phase Contrast Microscope before and after preservation in 4% formalin. Population density measurement (individuals/liter) was carried out using Sedgwick-Rafter counting cell supported by statistical analysis. Factors responsible for diversity and abundance of rotifers are discussed on the basis of physico-chemical parameters and presence of hydrophytes. It was envisaged to assess the effect of hyper gravity and zero gravity on the rotifers, but this could not be done due to problems encountered in culturing of rotifers in laboratory. However results of hatching of rotifers from dried mud samples have been studied and analysed. Five sessile rotifers were documented and three sessile species <i>Collotheca ornata</i>, <i>Collotheca tenuilobata</i> and <i>Sinantherina socialis</i> have been described for the first time from Pune District. All the documented species are new records from both the collection sites. Species found are cosmopolitan and cosmopolitan. Alkaline nature of both the water bodies is indicated by the presence of bio-indicators as <i>Brachionus</i>, <i>Keratella</i> and other species. Most of the species found chose habitats in close affinity with the submerged hydrophytes. This may indicate the importance of hydrophytes in defining rotifer diversity and distribution. This study provides groundwork data for rotifers present in the dried sediments of the water body. Results though limited in nature are significant because experimentation under controlled laboratory conditions yield total list of rotifers from water bodies.</p>

Where sampling from innermost parts of a water body is difficult, sediment mud samples during dry seasons can be obtained. The resting eggs of rotifers can be induced to break their dormancy under laboratory incubation. Development of methods to break dormancy of rotifer eggs present in the sediment provides an avenue into rotifer research. Further studies on rotifera will reveal the actual status of biodiversity present in the water body. As biodiversity of these organisms in this area is totally unknown, conserving these aquatic habitats is needed. Strategy for conservation of these neglected freshwater invertebrates needs to be developed considering the pivotal role they play in the aquatic food web (Edmondson,1959).

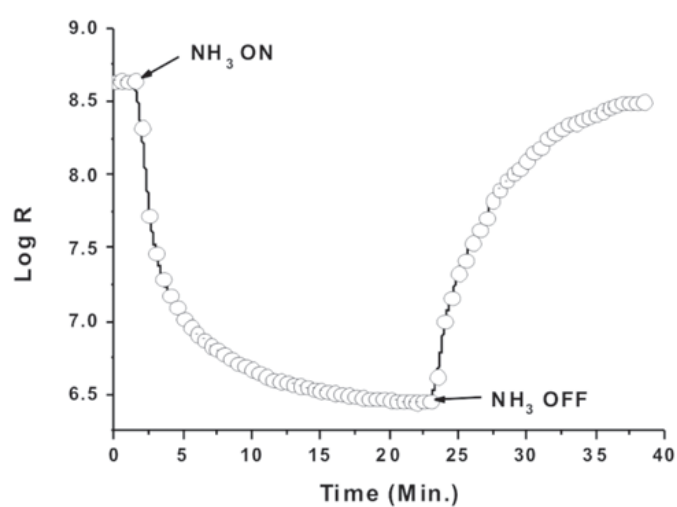
- A:** *Asplanchna brightwellii*
- B:** *Epiphanesbrachionus spinosa*
- C:** *Euchlanis* sp.
- D:** *Limnias melicerta*
- E:** *Hexarthra mira*



Rotifers hatched from sediments samples

PROJECT NO	96
TITLE	Gas sensing applications of metallophthalocyanines
INVESTIGATORS	Ashok M. Datir, Sr. lecturer, DRS College, Akole, Pune
DURATION	2 years (Started on: June 2008)
BUDGET (Rs)	3,00,000
SUMMARY OF FINDINGS	Sensing (detection and measurement) of gases by virtue of electrical resistance changes in semiconducting materials has been widely investigated. Organo-metallic materials like metal phthalocyanines (MPcs) are important candidates for sensing of hazardous gases. High thermal stability of these materials makes them suitable as gas sensors. Metal phthalocyanines like

copper phthalocyanine (CuPc), cobalt phthalocyanine (CoPc), nickel phthalocyanine (NiPc), aluminium phthalocyanine (AlPc) and magnesium phthalocyanine (MgPc) were synthesized using Phthalic Anhydride - Urea Route. Synthesized materials were characterized using X-Ray Diffraction (XRD), Ultra violet-Visible (UV-VIS) and Fourier Transform Infra Red (FTIR) techniques. Samples for sensing measurements were prepared in the form of pellets and metal electrodes were connected with the help of silver paste. The experimental setup for measurement of sensing response has been developed in the laboratory. The sensing characteristics were studied for humidity, Ammonia (NH_3) and Nitrogen dioxide (NO_2). CoPc shows the best performance for humidity sensing. Metal phthalocyanines samples were also evaluated for repeatability in their sensing behavior. All samples were observed to closely recover to their initial resistivity value indicating that they can be used for multiple uses. Low cost of these materials also make them suitable for single-use (use and throw) applications. CuPc and CoPc give almost same performance as nitrogen dioxide gas sensors. Response time was observed to decrease with increase in concentration of gas. This suggests that the rate of change of resistance can determine gas concentration. Copper phthalocyanines samples were studied for their response to ammonia (concentration of 5 %). Response parameters indicated 91.57 % sensitivity, response time 2 minute and recovery time 6 minutes. Prototype sensor device has been made using copper phthalocyanine and tested. CuPc response to ammonia at room temperature is shown below.



CuPc response to Ammonia

5. Research Projects in Progress

Out of 114 research projects undertaken in University of Pune and funded by ISRO, 93 projects have been successfully completed and progress of the ongoing projects (21 numbers) is being monitored regularly. In order to assess status of the projects, progress reports are obtained at regular intervals and Investigators are encouraged to take corrective action wherever necessary. Programme Management Committee (PMC) reviewed the progress of the ongoing projects in its meeting held on 6-7 December 2010. Members had observed long delay in Project No.58, titled **Doppler shift flow meters for liquid & gases**. Dr (Ms) S A Gangal, Principal Investigator (PI) of the project explained the reasons for this delay and assured to complete it by October 2011. Joint Policy Committee (JPC) also reviewed the progress of the ongoing projects during its deliberation in its meeting held on 17 March 2011. It was suggested that PEC, committee consisting of Members from the University, should hold regular review meetings to assess the progress of the ongoing projects and take corrective measures. Present status in respect of the ongoing projects is given below:

Project title, name of Investigator, Project cost & Duration.	Status
1 Doppler shift flow meters for liquid & gases (Project no.58) Dr (Ms) SA Gangal Project cost : Rs 4.90 lakhs Duration : 2 years	Extended completion date is August 2011. Different blocks of the system for ultrasonic level meter have been designed, fabricated and tested for their performance. Software is written in Assembly language and assembled using 8051 cross-assembler. Code is written, to directly display the value of level on Liquid Crystal Display. Remaining work is to make it in the instrument form. In regard to Laser Doppler Velocimeter, components are under procurement. Experimental work is planned to be completed by October 2011.
2 Development and analysis of MOS device with embedded nanocrystals of silicon dioxide layer for enhancement in charge transfer rate (Project no.87) Prof SV Ghaisas	Extended completion date is May 2011. Objective was to establish the deposition parameter and characterization of device quality thin SiO ₂ films. Fabrication and characterization of SiO _x thin films have been completed. Si-nanocrystals in SiO ₂ matrix successfully obtained and confirmed by Atomic Force Microscopy (size 8~10 nm). A

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| <p>Project cost : Rs 7.712 lakhs
Duration : 3 years</p> | <p>paper titled <i>Properties of silicon dioxide films prepared using silane and oxygen feeds by PE-CVD at low power plasma</i> has been accepted for publication.</p> |
| <p>3 Synthesis of ZnS thin film by modified Spray Pyrolysis method and study of its physical properties for optical sensor and solar cell applications (Project no.90)
Prof R V Zavare and Mr S A Arote</p> <p>Project cost : Rs 7 lakhs
Duration : 3 years</p> | <p>Experimental work in regard to ZnS films/nano materials is not complete. Study in regard to effect of doped impurities on optical, electrical and dielectrical properties is to be carried out.</p> <p>Investigators have requested for a further extension, till December 2011.</p> |
| <p>4 Autonomous navigation system for Low Earth Orbit (LEO) Satellite Using Global Navigation Satellite System (GNSS) (Project no.93)
Prof S A Gangal, and Dr Suwarna Datar</p> <p>Project cost : Rs 8.822 lakhs
Duration : 2 years</p> | <p>Extended completion date is January 2011.</p> <p>There was a delay in getting technical data from ISRO to verify their model. Now this is available and PI is taking action to complete the studies and submit the final report.</p> |
| <p>5 Study of temporal and spacial distribution of seaweeds for their sustainable utilization using ground based and satellite borne systems (Project no.94)
Dr BB Chaugule, and Dr DB Jadhav</p> <p>Project cost : Rs 7 lakhs
Duration : 3 years</p> | <p>Extended completion date is March 2011.</p> <p>Study is nearing completion. Based upon biomass field and satellite measurements, Malvan and Velaneshwar along the coast of Maharashtra and Kalubhar Island, Gulf of Kutchh, Gujarat, India have been identified as geographical areas for sustainable utilization of seaweeds. final report is to be submitted.</p> |
| <p>6 Synthesis of undoped and Cd, Al, In,</p> | <p>Project completion date is June 2011.</p> |

- B doped nanostructures of ZnO by intermittent chemical spray pyrolysis for optoelectronic and gas sensing applications (Project no.97)
Prof CMMahajan
- Project cost : Rs 11.85 lakhs
Duration : 3 years
- To synthesize undoped ZnO and Al, Cd, process parameters have been optimized. In and B doped ZnO thin films to be used as transparent conducting electrode for photovoltaic applications. Under optimized conditions undoped and doped ZnO films are preferably oriented. Formation of nanocrystalline and nanostructured ZnO, Al:ZnO and Cd:ZnO film is confirmed from X-ray diffraction, SEM and AFM measurements.
- 7 Studies on preparation and photocatalytic applications of nanocrystalline TiO₂ and its nanocomposites (Project no.99)
Dr(Mrs) SS Joshi
- Project cost : Rs 10.55 lakhs
Duration : 3 years
- Project completion date is June 2011.
- Nanocrystalline ZnFe₂O₄, TiO₂ and TiO₂-ZnFe₂O₄ have been successfully synthesized by desired routes. Optical, thermal, structural and morphological properties have been studied as function of particle size by UV-DRS, TG-DTA, FTIR, XRD, SEM and TEM. Exploring possible photocatalytic applications using nanocrystalline TiO₂ and TiO₂-ZnFe₂O₄ nanocomposites is in progress.
- 8 Development and characterization of thin film solid electrolyte cells as voltage source, temperature, pressure and gas sensor (Project no.100)
Dr SB Iyyer
- Project cost : Rs 10.1 lakhs
Duration : 3 years
- Project completion date is August 2011.
- Vacuum coating system with measuring instruments has been set up. This was used to prepare thin films of (i) Al/CdS/Al sandwiched and planner structures (ii) Ag/CdS/Al sandwiched structure. Study is planned to reduce cell resistance, increase cell voltage and also improve shelf life.
- 9 Photographic observations of meteor showers (Project no.101)
Dr (Mrs) RV Dabhade
- Project cost : Rs 5 lakhs
Duration : 2 years
- Extended completion date is June 2011.
- Study is nearing completion.

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| <p>10 Developing an environmental magnetic model for assessment of the anthropogenic particulate loading in the urban environments : A case study from the Pune Metropolitan region, Maharashtra (Project no.103)
Dr SJ Sangode</p> <p>Project cost : Rs 17.39 lakhs
Duration : 3 years</p> | <p>Project completion date is July 2011.</p> <p>Detailed analysis of environmental magnetic parameters of over 780 samples of soil, bedrock, water and dust collected from 3 seasons, during 2007 to 2011 has been completed. Analysis of cores obtained from the seasonal dump area to find historical component of residence and depth of residence of the anthropogenic loading is in progress. Two papers have been published, one in Current Science and other one in Environmental Earth Science.</p> |
| <p>11 Application of remotely sensed data for the evaluation of impervious surface growth and its effect on surface runoff in two rapidly urbanizing watersheds of Western Maharashtra, India (Project no.104)
Dr (Ms) Anargha Dhorde</p> <p>Project cost : Rs 9.66 lakhs
Duration : 3 years</p> | <p>Project completion date is April 2013.</p> <p>Work component carried out is related to preparation of the base layers needed for further work. This includes making sub-divisions of the entire study area into smaller sub-basins, preparation of landuse/landcover (LULC) maps, incorporating available census data at village level, attaching soil data and extracting impervious surfaces for the selected sub-basin using a simple NDVI approach.</p> |
| <p>12 Modelling spatial patterns in fresh water reservoirs with special reference to plankton, mollusks and fishes using physicochemical characteristics of water and remote sensing techniques (Project no.105)
Dr Pandit Sangeeta V</p> <p>Project cost : Rs 13.68 lakhs
Duration : 3 years</p> | <p>Completion date of project is April 2013.</p> <p>Identification of biological samples collected from Panshet and Varasgaon reservoirs has been carried out. Water was collected from each site for analyzing the physiochemical parameters. Estimation of carbonate, bicarbonate, alkalinity, Ca²⁺, Mg²⁺, total hardness, phosphate and sulphate was done in the laboratory. A paper based on the current work, was presented in a National Conference held at Gyanvihar University, Jaipur in February 2011.</p> |
| <p>13 Chemical deposition of layered transition metal chalcogenides to</p> | <p>Completion date of project is April 2012.</p> |

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| <p>study their tribological properties.
(Project no.106)
Dr SD Sartale</p> <p>Project cost : Rs 7 lakhs
Duration : 2 years</p> | <p>Advantages of SILAR method and its applicability for deposition of different materials has been studied. Ag thin films deposited by SILAR and chemical bath deposition of MoS₂ thin films have been established and evaluated.</p> |
| <p>14 Synthesis and applications of composites of TiO₂ with Carbon nanotubes and metal chalcogenides (Project no.107)
Dr Pragati R. Thakur</p> <p>Project cost : Rs 14.52 lakhs
Duration : 3 years</p> | <p>Completion date of project is April 2013.</p> <p>TiO₂ nanoparticles of high surface area (150 m²/g) have been synthesized by sol gel method. Synthesized TiO₂ nanoparticles were characterized by XRD, SEM, TEM, BET analysis. XRD analysis showed presence of pure anatase phase. SEM images revealed the presence of spherical morphology of the particles. Average particle size of TiO₂ was found to be 7nm. Photocatalytic activity was checked for the degradation of methyl orange dye.</p> |
| <p>15 Chemical deposition of CuInSe₂, CdS and ZnO thin films for solar cell applications (Project no.108)
Dr. Habib M. Pathan</p> <p>Project cost : Rs 9 lakhs
Duration : 2 years</p> | <p>Completion date of project is April 2012.</p> <p>Experimental set up has been completed and deposition of CuInSe₂ films using chemical deposition successfully done. Band gap energy of CISE was found to be 1.45 eV. Surface morphology of CuInSe₂ has been studied. Chemical deposition techniques for CdS and ZnO films are established. Increase in deposition time results in increase in film porosity. Optical properties and surface morphology of chemically grown films have been studied. A research article on the present work has been submitted and is under review.</p> |
| <p>16 Use of a geographical information system to study tuberculosis epidemiology and the factors affecting case detection in a rural population in Pune district, Maharashtra (Project no.109)</p> | <p>Completion date for the project is April 2012.</p> <p>To describe the epidemiology of tuberculosis in the population, work on GIS based system for mapping demographic, socio-economic, geographic and social facility data has been completed. Identification of health care</p> |

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| <p>Dr Anita Kar</p> <p>Project cost : Rs 9.61 lakhs</p> <p>Duration : 2 years</p> | <p>providers in the population is completed. Reporting system for tuberculosis from private and public sector is established. Study in regard to determining the number of incident and prevalent cases in population is progressing. Chakan, a peri-urban area with a large migrant population, has been selected as study area.</p> |
| <p>17 A comparative study of telecommunication technology: Its impact and relevance on Urban, Rural and Tribal community of Maharashtra. (Project no.110)</p> <p>Dr Prakash B. Gambhir</p> <p>Project cost : Rs 4.40 lakhs</p> <p>Duration : 2 and half years</p> | <p>Completion date of the project is October 2012.</p> <p>Pilot survey was done in Nagpur, Nasik and Nandurbar areas and the questionnaire finalized on the basis of survey. Validity and reliability have been confirmed with the help of experts in the field of statistics and social science. Questionnaire related to demographic profile, different aspects of telephone/mobile/internet etc has been prepared. Action is on in respect of methodology for data collection and determining sample size.</p> |
| <p>18 Study of invertebrate biodiversity of Swanga Lake region, Dist Amravati, Maharashtra (Project no.111)</p> <p>Dr Varsha Wankhade</p> <p>Project cost : Rs 13.18 lakhs</p> <p>Duration : 3 years</p> | <p>Completion date of the project is April 2013.</p> <p>Required equipments have been procured and site visits have been made.</p> |
| <p>19 Impact of radiations on the food quality and shelf life of food for space mission (Project no.112)</p> <p>Prof. Madhurima Dikshit</p> <p>Project cost : Rs 14.91 lakhs</p> <p>Duration : 3 years</p> | <p>Completion date of the project is April 2013.</p> <p>Among various food categories; cereals, pulses, fruits, vegetables and juices, pulses (Mung beans and Soybeans) have been selected for initial study. Investigations involve space relevant radiation effect on the raw as well as processed food. Mung beans were first sprouted and then irradiated while Soybeans were first irradiated and then sprouted. Some proximate constituents and antioxidants and non-nutrient antioxidants have been analyzed in raw sprouts.</p> |

- 20 Study of the direct radiative forcing of atmospheric aerosols over different environments (Project no.113)
 Dr G. R. Aher
 Project cost : Rs 13.64 lakhs
 Duration : 3 years
- Completion date of project is April 2013.
 Data is being analyzed to study spectral and temporal variability of AOD, aerosol size spectrum and other parameters like columnar content of atmospheric aerosols, weighted mean and effective aerosol particle radius and columnar aerosol mass loading. Two research papers have been submitted for presentation at the Asian Aerosol Conference (AAC-2011) and at the European Aerosol Conference (EAC-2011).
- 21 Study of Si quantum dots for solar cell applications (Project no.114)
 Dr Shailaja Mahamuni
 Project cost : Rs 3.392 lakhs
 Duration : 1 year
- Completion date of project is June 2011.
 Si quantum dots passivated by oxygen, coated on Si solar cell yield higher efficiency. To understand the mechanism, experiments were carried out on Si quantum dots passivated by heptane, octane and hydrogen. Oxygen passivated Si quantum dots are found to give far better performance. Morphology was studied in case of thin films formed by solvent evaporation from the dispersion. Water molecules get associated with Si quantum dots and reveal droplet like structures at room temperature. At higher temperature or in vacuum, water evaporates and fractal like structure was observed. Such morphology remains unique in case of oxygen passivated Si quantum dots. Si quantum dots passivated with heptane, octane or hydrogen show significantly different morphology.

6. New research projects for the year 2010-11

Faculty members belonging to University of Pune or its affiliated colleges are invited once in a year to submit research proposals under ISRO-UoP Joint Research Programme. Requirement is that Principal Investigator(s) should be full-time employee(s) of the concerned institution and proposal is to be forwarded through Head of the academic institution. Research proposals from individuals not affiliated to any recognized institution of the University are not considered. Institutions proposing a project for support are expected to commit the use of the existing infrastructure available with them. ISRO provides financial grants to support fellowship, materials, consumables, internal travel, testing charges, data etc. Funds for purchase of essential minor equipments which are not available in the institution and would be useful for future projects are also provided. There is no provision for any kind of payment to the Principal Investigator (or other staff) belonging to the Institution.

In response to our invitation for the new research projects, 47 proposals from various Departments of the University and its affiliated colleges were received and evaluated by Preliminary Evaluation Committee, (PEC) chaired by Prof S Ananthakrishnan and 15 were shortlisted based on the following criteria.

- Relevance of proposed research work in the identified areas and ISRO activities/programme
- Novelty/innovation in the proposed research work
- Past performance of the Investigators in regard to their completed/on-going projects under this scheme

Modifications in objectives, methodology, schedule etc wherever needed, were suggested and Investigators were advised to incorporate the same and resubmit the proposals. Three proposals were referred to ISRO scientists to get comments in regard to the relevance of these works with reference to ISRO programme. 14 proposals were recommended by PEC for further processing. Programme Management Committee (PMC) reviewed the recommendation of PEC and invited PIs for a detailed presentation. Committee also considered the comments received from ISRO experts and made appropriate suggestions for the approval of JPC. In principle, JPC agreed with the PMC recommendation of the new proposals. Projects where comments from ISRO experts have been received, necessary modifications in the proposals need be made. As far as possible, an ISRO expert need be identified as co-investigator for each of the research project. List of the proposals planned to be taken up in the year 2010-11 is given below.

1. Studies on structural, optical and electrical properties of transparent conducting thin film(TCO)
2. Novel electrochemical approach to prepare CuInGaSe₂ based solar cells using non-aqueous bath
3. Design and development of an odor tracking system
4. Study of interferometric data and its applications for subsidence monitoring
5. Identification of critical areas of conservation concern using RS-GIS technique from northern Western Ghats of India

6. Development of high performance polycarbonate/Graphite nanocomposites with low percolation for EMI shielding application
7. Synthesis and characterization of Copper Chromite for propellant
8. Preparation of ternary oxides like lead zirconium titanate (PZT) with and without dopants and barium titanate - polymer composites for microwave dielectric application (12-15 GHz).
9. Biogradation of Ammonium Perchlorate by phytoremediation approaches
10. Bioleaching of electronics wastes (E-wastes)
11. Effective rural developmental communication for rural development: A study of western India
12. Measurement of plasma temperature and identification of species during re-entry of Space Shuttle, using plasma emission spectroscopy
13. Robust control of launch vehicle with slosh suppression

7. Major events in the STC calendar

- **Reconstitution of Preliminary Evaluation Committee (PEC) for ISRO-UoP Joint Research Programme**

Chairman JPC/Vice Chancellor, UoP reconstituted the Preliminary Evaluation Committee (PEC) vide Office Order No. VC/159 dated 16 June 2010. Composition of the new Committee is given below.

Dr. S Ananthkrishnan (Adjunct Professor & Raja Ramanna Fellow)	Chairman
Dr P B Vidyasagar	Member
Dr (Mrs) Deepti Deobagkar	Member
Prof Madhurima Dikshit	Member
Director, BCUD	Member
Finance & Accounts Officer, UoP	Member
M C Uttam	Member Secretary

- **Preliminary Evaluation Committee (PEC) Meetings**

6th Meeting of PEC under the Chairmanship of Dr S Ananthkrishnan was held on 15 September 2010 to carry out the initial evaluation of the new research proposals. The Committee had its next meeting on 12th October 2010 where the prospective Investigators were invited to make detailed presentation on their proposals to the Committee and provide necessary clarifications. Committee also sought views on some of the proposals from ISRO scientists where a need was felt to ascertain its relevance with respect to ISRO programme.



7th PEC Meeting in Progress

- **Programme Management Committee (PMC) Meetings**

To review the progress of the ongoing research projects PMC held its 19th meeting on 17th May 2010 under the Chairmanship of Shri VR Katti. Investigators of 12 ongoing projects were invited to make technical presentation in respect of the progress of their projects. Committee opined



19th PMC Meeting in progress

that Findings of the completed research projects should find a place in applications. If need be, interaction with ISRO scientists should be strengthened. The Committee held its next meeting under the Chairmanship of Shri P P Kale on 6th & 7th December 2010 to process new research proposals for approval/sanction after due scrutiny. Committee also reviewed the status of ongoing projects and made specific suggestions where undue delay in completion of the project was noticed.

- **ISRO-UoP Joint Policy Committee (JPC) Meeting**

XIII JPC Meeting under the chairmanship of Dr Raghunath Shevgaonkar, Vice-Chancellor of the University was held on 17 March 2011. Committee noted the long delay in construction of the building for Space Technology Cell at University of Pune. Concerned University Officials have been requested to expedite the work. In regard to delay in submission of expenditure status and Fund Utilization certificate to ISRO, detailed discussion took place and suggestions were made to overcome the hurdles



XIII JPC Meeting in progress

causing this delay. Committee reviewed the status of ongoing projects and noted that a total of 114 research projects have been undertaken and 93 projects have been completed satisfactorily. PEC, committee consisting of Members from the University, was requested to hold regular review meetings to assess the progress of the ongoing projects. In regard to new proposals, Committee considered the recommendation of PMC and approved new research proposals for the year 2010-11. Considering the funds requirement of ongoing projects as well as for the new proposals, Committee approved a budget proposal of Rs 110 lakhs.

- **ISRO Chair in University of Pune**

Indian Space Research Organisation has created "Vikram Sarabhai Space Chair" at the University of Pune. Dr RR Kelkar joined as Chair Professor in May 2004 and completed his tenure in December 2008. In order to continue the position of the Chair in University of Pune, actions such as obtaining approval from ISRO for renewal of the Chair, preparing the requirements for advertising the post etc were taken during this period. After the completion of requisite formalities, Prof SS Gangal joined as Chair Professor on 3rd August 2010.

- **Visit by ISRO scientists**

Dr Vilas Palsule, Director DECU visited ISRO-UoP Space Technology Cell on 4th February 2011. During this visit, a meeting was arranged with Professor Sanjeev Sonawane, who had submitted a research proposal on "*Enhancing rural development through improved communication case study Western India*". Suggestions in regard to proposed study were made and proposal was suitably modified. During his visit to Pune,

Shri M V Dekhane, Deputy Director, Vikram Sarabhai Space Centre (VSSC) had a detailed discussion with Prof Shailaja Kurode in regard to her research proposal on "*Robust control of launch vehicle with slosh suppression*". Suggestions were made by Shri Dekhane to make the study relevant to ISRO programme. Investigator agreed to modify the proposal and resubmit the same.

Shri Rajaram Nagappa, former Associate Director, VSSC, Thiruvananthapuram visited STC Office. Shri V P Balgangadharan, Senior Scientist from VSSC visited ISRO-UoP STC and Biohydrocarbon Project on 3rd December 2010.



Dr. Vilas Palsule, Director DECU having a discussion with PI



Shri Rajaram Nagappa, former Associate Director, VSSC visits ISRO-UoP STC



Shri V P Balgangadharan keenly observing the products of biohydrocarbon lab.

8. ISRO Proposal Format

Faculty members of University of Pune and its affiliated colleges are required to follow the ISRO proposed format as given in <http://www.isro.org/respond/html/m-proposalformat.htm> and reproduced below for making research proposals and seeking financial grant from ISRO. Generally invitation for making research proposals is sent in the month of September-October and processing of the proposals is completed in 4-5 months time. For any information/clarification, faculty members may contact the Space Technology Cell at any time of the year and get necessary information.

Application for grant of funds

1. Application Institution
2. Title of the Research Proposal
3. Name of the Principal Investigator
4. Name(s) of other investigator(s) with the name(s) of their Institution
5. Proposed duration of Research Project
6. Amount of grant requested (in Rs.)

	1st Year	2nd Year	3rd Year	Total
Staff				
Equipment and Supplies				
Others				
Total				

7.
 - a) Bio-data of all the Investigators (Format-A).
 - b) Brief description of the Research Proposal with details of budget (Format-B).
 - c) Declaration (Format-C).
8. I/We have carefully read the terms and conditions for ISRO Research Grants and agree to abide by them. It is certified that if the research proposal is approved for financial support by ISRO, all basic facilities including administrative support available at our Institution and needed to execute the project will be extended to the Principal Investigator and other Investigators.

	Name	Institution	Designation
Principal Investigator			
Co-Investigator(s)			
Head of the Department/Area			
Head of the Institution			

Format A**Bio-data of the Investigator(s)***

1. Name
2. Date of Birth (dd/mm/yyyy)
3. Designation
4. Degrees conferred (begin with Bachelor's degree)

Degree	Institution conferring the degree	Field(s)	Year
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5. Research/training experience (in chronological order)

Duration	Institution	Name of work done
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6. Major scientific fields of Interest
7. List of publications
8. Email id and Telephone number of PI
9. Email id of the Head of the academic institution

* Bio-data for all the investigators should be given, each on a separate sheet

Format B

Proposal Preparation Format

1. *Title of the research proposal*
2. *Summary of the proposed research*
A simple concise statement about investigation, its conduct and anticipated results in no more than 200 words
3. *Objectives*
A brief definition of the objectives and their scientific, technical and techno-economic importance
4. *Major scientific fields of interest*
A brief history and basis for the proposal and a demonstration of the need for such an investigation preferably with reference to the possible application of the results to ISRO's activities. A reference should also be made to the latest work being carried out in the field and the present state-of-art of the subject.
5. *Approach*
A clear description of the concepts to be used in the investigation should be given. Details of the method and procedures for carrying out the investigation with necessary instrumentation and expected time schedules should be included. All supporting studies necessary for the investigation should be identified. Necessary information of any collaborative arrangement, if existing with other investigators for such studies, should be furnished. The Principal Investigator is expected to have worked out his collaborative arrangement himself. For the development of balloon, rocket and satellite-borne payloads it will be necessary to provide relevant details of their design. ISRO should also be informed whether the Institution has adequate facilities for such payload development or will be dependent on ISRO or some other Institution for this purpose.
6. *Data reduction and analysis*
A brief description of the data reduction and analysis plan should be included. If any assistance is required from ISRO for data reduction purposes, it should be indicated clearly.
7. *Available Institutional facilities*
Facilities such as equipments, test instruments etc available at the parent Institution for the proposed investigation should be listed.
8. *Fund Requirement*

Detailed year wise break-up for the Project budget should be given as follows.

		1st Year	2nd Year	3rd Year	Total
8.1	Salaries:				
8.1.1	Research Fellows/ Research Assistant				
8.1.2	Supporting Technical Staff				
8.1.3	Other staff, if any				

Total:

(Note: please specify designation and rate of salary per month for each category)

		1st Year	2nd Year	3rd Year	Total
8.2	Equipment				

Total:

(Note: Please specify various individual items of equipment and indicate foreign exchange requirement, if any)

		1st Year	2nd Year	3rd Year	Total
8.3	Consumables and Supplies				

Total:

(Note: Please specify the items and indicate foreign exchange requirement, if any.)

		1st Year	2nd Year	3rd Year	Total
8.4	Travel				

Total:

		1st Year	2nd Year	3rd Year	Total
8.5	Other project costs, if any (give details)				

a. Grand Total:

9. Whether the same or similar proposal has been submitted to other funding agencies of Government of India. If yes, please provide details of the Institution & status of the proposal.

Format C

Declaration

I/We hereby agree to abide by the rules and regulations of ISRO research grants and accept to be governed by all the terms and conditions laid down for this purpose.

I/We certify that I/We have not received any grant-in-aid for the some purpose from any other department of the central government/state government/public sector enterprise during the period to which the grant relates.

Name	Designation	Signature
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Principal Investigator

Head of the Department/Area

Head of the Institution

Seal of the Head of the Institution

9. Suggested topics for the research proposals

Sr. No.	Research Topics	Brief details of suggested research work
1	Development of Hydrogen Peroxide based propellant systems	Hydrogen Peroxide based propellant systems have advantages over conventional liquid propellants. Their application requires development of process to get H ₂ O ₂ of 98% purity, stabilizers for safe storage and catalyst for decomposition of H ₂ O ₂ .
2	Development of thermoplastic elastomers for liquid cooling & ventilation garment (LCVG) of space suit	This requires development of a “wicking material” which allows one-way water transport. Material usually used is a block copolymer based on polyethylene oxide (PEO) soft segment and polyether-ester block amide (PEBA) hard segment. Polymer should have high tear strength, toughness and water vapor transmission.
3	Development of hydroxylammonium nitrate (HAN) solution of more than 60% concentration	Aqueous solutions of HAN are promising “green monopropellants” for replacing the currently used highly toxic hydrazine. Suitable method to prepare aqueous solution of HAN at a minimum concentration of 60% needs to be developed.
4	Development and characterization of catalysts for decomposition of hydroxylammonium nitrate (HAN) based monopropellant	Temperature of the gases released during decomposition of HAN is found to be much higher (greater than 1400°C) than the gases from hydrazine propellant. A suitable catalyst needs to be developed which can trigger the decomposition of HAN at temperatures much lower than the thermal decomposition temperature.
5	Indigenization of FLUOR-06 and FLUOR-60 lubrication oils for liquid rocket engine	FLUOR-06 and FLUOR-60 are fluoro polymers of high thermal stability, possess excellent resistance to acids and alkalis and have high compatibility with metals, plastics and elastomers. These are used as lubricating oils for equilibrium regulator and main engine valves of liquid rocket engines. There is a need to indigenize these lubricants.

- 6 Development of addition curing silicone binder resin systems

These polymers are used for preparing thermal paints for satellite components. Development involves preparation of silicone polymers with pendant hydrosilyl (-SiH) and vinyl groups and suitable platinum catalyst soluble in silicone polymers.
- 7 Development of software for modeling/simulation of mechanical/ballistic properties of solid rocket propellants

Objective is to develop a code/software to accurately predict the mechanical properties and burn rate of HTPB-Al-AP based composite solid propellant. This may be carried out in two phases. In the first phase, concept and general framework of a modeling/simulation code need be established and in the second phase, a working code containing full graphical user interface (GUI) and capable of running on a multi-processor platform should be provided. The code should predict the mechanical properties of the propellant and burn rate at a given pressure with a minimum of empirical correlations.
- 8 Simulation & analysis of different humidification methods for hydrogen and oxygen gases

Study involves simulation & analysis of different humidification methods for hydrogen and oxygen gases with reference to flow rates, dew point, size, weight and power requirement in microgravity environment. Methods for using product heat and water for humidification are to be evaluated. Study is needed with regard to space application of fuel cells.
- 9 Analysis of different gas-water separation techniques for oxygen and hydrogen gases

Different techniques for separation of liquid water from exhaust hydrogen and oxygen gases at variable flow rate in microgravity environment with regard to space applications of fuel cells are to be studied.
- 10 Study of water permeation characteristics of fuel cell proton exchange membrane (PEM) under different operating conditions

Optimum water balance across PEM is important in getting required performance from PEM type fuel cells. Balancing of electro-osmotic drag and back-diffusion of water provides the required optimum water balance. Influence of various parameters such as membrane type, membrane

- thickness, temperature, stack clamp force, saturation level, etc on the water balance of PEM fuel cells need to be studied.
- 11 Development of a model for bipolar plate to optimize the gas flow field with regard to water management and current distribution
Fuel cell performance is controlled mainly by bipolar plate flow field geometry. A reliable model enables faster design fine tuning and scale-up. The study should aim at development of a reliable model.
 - 12 Ceramic supported lithium hydroxide (LiOH) for Human Space Flight Programme
Lithium hydroxide is useful for the removal of carbon dioxide produced by human metabolism in the crew cabin of a manned spacecraft. For efficient absorption of carbon dioxide, surface area of LiOH particles should be maximum. This can be achieved by supporting LiOH particles on a highly porous ceramic material. A detailed study needs to be carried out to develop the system.
 - 13 Development of cubane and substituted cubanes for high energy high density propellant fuel
Positive heat of formation of cubane and substituted cubanes and their high density render them potential candidates for fuels for semi-cryo engines. Considerable improvement in specific impulse has been predicted for these fuels in comparison with RP-1 type hydrocarbon fuels. Study should focus on synthesizing these chemicals in required quantities.
 - 14 Development of catalysts for splitting of carbon dioxide
Atmosphere of Mars comprises mainly of carbon dioxide (95%). Oxygen required for return flight to Earth, can be produced in Mars by catalytic splitting of carbon dioxide into carbon monoxide and oxygen. Alternatively carbon dioxide can be reduced using hydrogen (transported from Earth) to produce oxygen and methane. Study should focus in developing suitable catalysts for these reactions and optimization of reaction conditions.
 - 15 Monitoring and assessment of EB weld of Titanium, spot welding of Aluminium inter-stages through acoustic emission
Real time monitoring of Electron Beam Welding process by AE technique enables online detection of weld defects like porosity, lack of fusion in the weld etc. Corrective actions can be taken and weld quality can be improved. Proposed study is to develop this technology.

- | | | |
|----|---|---|
| 16 | Development of fiber optic sensor based measuring system for in-flight measurement | Object is to realize a flight worthy compact interrogator system with multiplexing capability of approximate 100 channels, for simultaneous measurement of strain, temperature, pressure, and displacement. System should have data acquisition, storage, reduction and alarm capability. |
| 17 | Development of automated/semi-automated method for strain measurement using bi-refrangent coatings | Aim is to develop portable and compact equipment based on computerized digital optics capable of whole field strain measurement from photoelastic coating fringe data. |
| 18 | 3D strain mapping using stereovision and digital image correlation | Development of an algorithm and integrated computer based optical system capable of non-contact whole field strain mapping with minimum resolution of 50 micro strains using the principles of stereovision and Digital Image Correlation (DIC). |
| 19 | Strain measurement at high temperature (800°C and above) | Realization of a suitable methodology including sensor system and data acquisition/analysis for measurement of strain on space structural components at temperatures higher than 800°C. |
| 20 | Development of digital holographic microscope for MEMS characterization, deflection and shape measurement | To characterize the performance and reliability of micro and nano electro mechanical systems like sensors, actuators and controls under static and dynamic conditions a robust non-destructive quantitative measurement tool needs to be developed. Digital holographic interferometry technique presently used for testing of macro structures is to be adapted in micro and nano structures. Digital holographic microscope, loading fixtures for micro sensors and phase map generator for deformation mapping, 3D profile measurement, micro material property measurement etc. are to be developed and validated by testing of MEMS and NEMS intended for ISRO's future space program. |

- 21 Piezoelectric actuators for position control applications
- Because of their reversible property, piezoelectric material can act both as sensor as well as actuator. Piezoelectric actuation can be used in precision (small strain, fast response time) applications. One application envisaged is the precision position control of mirrors used in optical structures of satellites. Research proposal should be to procure and characterize piezoelectric actuation capability of piezo stack actuators and Macro Fibre Composite (MFC). MFC is a specific configuration of piezo electric patch where patch is flexible and can be bonded over curved structures.
- 22 In-flight health monitoring of launch vehicle structures using Acoustic Emission
- Aim is to assess the capability of acoustic emission technique in detecting the generation and growth of an active defect during flight of launch vehicles. Development plan should include selection and mounting of suitable AE sensors and preamplifiers in the flight modules, acquiring online data during the flight and transmitting it to ground station, performing online analysis and giving feed back in real time.
- 23 Automated Acoustic Emission data analysis through ANN
- AE monitoring is done for the integrity evaluation of flight hardware during proof pressure test of Titanium gas bottles, Inconel pressure vessels, aluminium and 15 CDV6 chambers. Automated AE monitoring with Neural Network for the real time integrity evaluation needs to be developed. AE parameters like amplitude, duration, counts, energy etc. from the test results of similar hardware form the input for the automated integrity evaluation.
- 24 Filtering out noise from genuine AE signature based on spectral content analysis
- During pressure and structural tests of flight hardware, differentiating genuine AE signals from external noises is a problem faced in the real time AE monitoring. Due to the noise, initiation of defects like crack, yield etc. is not identified in the loading phase. Some of the noise signals are similar to genuine AE signals, identifying these noise signals in real time is a complex job. Method for filtering these noise signals based on the combination of different AE parametric values needs to be developed.

- 25 Development of miniature specimen test techniques
Miniature specimen test techniques enable the evaluation of mechanical properties using very small quantity of the material. These techniques need be developed for characterization of C/C composites and CNT based composites. Reliability and accuracy by different miniature specimen test methods are to be established by modeling.
- 26 Ultra low power RF transreceiver
Transreceiver system architecture suitable for ultra low power implementation is UWB based system and frequency hopping spread spectrum. Low power circuit design techniques include current reuse topology, direct modulation & demodulation and MEMs based transreceiver. Low power system architecture and circuit design techniques for RF transreceivers need be investigated.
- 27 Non-linear stability analysis of multi-transistor MMIC
Though non-linear stability is an established field, microwave CAD system which can predict the stability of a non-linear circuit, as done in linear case, is presently not available. For multi transistor MMIC, methods like convergence of harmonic balance simulator, S11 at all the active device points etc, are used. This is time consuming and empirical in nature. Non-linear stability analysis for MMIC design needs to be developed.
- 28 Development of temperature dependent models and their validity at cryogenic temperatures
Circuits are designed at ambient conditions and their response is studied at these temperatures. Models of basic devices need be developed over temperature and frequency of operation, to enable optimized circuit design of LNAs for DSN in S, X and Ku band.
- 29 Application of exact synthesis methods in design of microwave and millimeter wave non-linear circuits
Currently this method is applied to linear active microwave circuit designs where input and output of the active device is approximated by simple equivalent circuit. There is a need to extend this powerful exact synthesis method to non-linear

microwave circuit designs like mixer, modulator, frequency multiplier etc to get the best optimized results.

- 30 Design of active input filter for switching power supply
- An input filter should be designed to achieve the required EMI compliance. This makes it bulky and requires large space and size in the power converter package. An input filter with low mass and volume needs be designed by inductor and capacitor values enhancement techniques using active devices. Aim of the study should be to define the filter requirements, synthesis of the filter circuit and developing design methods for realizing input filter of the given attenuation and impedance characteristics.
- 31 EM simulation of dielectric resonator (DR) filters using space mapping technique
- To design the filter, the coupling between the resonators and the resonant frequency of each resonator need be calculated accurately. The equivalent circuit design is very fast but has poor accuracy. The EM method is accurate but very slow. A hybrid of Equivalent and EM technique, called space mapping, combining accuracy of EM solver and the speed of Equivalent, needs to be developed.
- 32 Geometric processing of remote sensing imagery with radial basis functions
- Three broad categories of geocorrection models are identified for post-preprocessing of remotely sensed data, namely (i) based on ephemeris platform and sensor information (ii) relating corresponding ground control points or features and (iii) hybrid models. Bivariate mapping polynomial is commonly used method for registration and rectification of digital imagery. In Radial basis function method, both Hardy's multiquadric (MQ) and the thin plate spline (TPS) have been the subject of considerable theoretical and applied research. Detailed investigation in the above areas by the academic institutions is needed.
- 33 RPC based data processing
- A generic model based on Rational Polynomial Coefficient (RPC) is a common approach in satellite data processing in encapsulating the interior and exterior orientation of image

- acquisition, geometric correction and derivation of digital elevation models (DEM). Investigation related to various orders of polynomials, other functional representations, bundle adjustment of block of images using such representations, DEM generation for a block of imagery and extension of this methodology to planetary data processing, need to be carried out.
- 34 Super resolution and MTF improvements
Currently satellite images have resolution ranging from 25 m to 0.8 m and this is likely to be improved to 0.25 m. Research work is to be done for generating images with better than 0.25 m resolution using available multi-resolution images. This involves concepts like super resolution, image registration, sub-pixel processing and multi-resolution.
- 35 Stereo image matching techniques for satellite imagery
With the availability of high resolution stereo imagery, there is a need to explore new techniques for a dense set of match point pairs from such data to derive the DEM. In view of large volume of data involved due to high resolution, practical optimization aspect is to be investigated. New algorithms should improve the drawbacks of cross-correlation techniques using FFTs.
- 36 Derivation of city DEMs
Urban DEM poses a different challenge due to the singular nature of the underlying DEM surface which needs to be detected/derived. It should cater to identification of buildings and steep landscapes and determination of their heights through space intersection by other means. Special techniques based on morphological features and AI paradigms to be developed for solving this problem. Generation of relative DEM also needs to be investigated.
- 37 Intelligence technique for interpolation of DEM from satellite imagery
Current techniques address cases where the underlying irregular DEM is derived from contour maps and spot heights from topographic maps. For irregular set of match-point-pair based DEMs obtained from stereo pairs of remote sensing

- imagery, such techniques are not suitable. Robust techniques using the image cues need be developed for interpolating from such DEMs. Constraints such as break points, break lines and exclusion masks provided through external masks need be taken into consideration.
- 38 Sensor calibration on ground based test sites
- Evaluation of sensor performance requires parameter specific design and deployment of artificial targets on test site. Study requires selection of test sites, targets and ground measuring instruments for measurement of target radiance, reflectance and atmospheric parameters like aerosol, water and other gaseous content. These measurements are input to radiative transfer code for atmospheric correction. Calibration activity is experimental in nature, which requires accuracy and consistent repeatability of measurements.
- 39 Terrestrial stereo data processing
- There is a need to develop algorithms and techniques for processing the terrestrial imagery acquired in stereo/mono. This includes the understanding the coordinate systems, modeling the camera geometry, digital elevation model generation from the stereo imagery including the image matching and the stereo data analysis.
- 40 Planetary geodesy
- Objective is to understand different types of geometry (polygon, polyline, point and multipoint measures) called geodesic tools and Geoid (gravity model) for different planets. There is a need for optimization in calculating surface measurements (coordinates, distances, areas) on a variety of spheres or spheroids depending on the particular planet. Computing Geoidal undulations and its effect over digital elevation model generated through stereoscopic method is one of the key research areas for different planets. The study will provide important input for future planetary missions.

- 41 DEM fusion
Digital elevation model (DEM) fusion is an approach to merge two or more DEMs for improving the overall accuracy of DEM. A comprehensive methodology needs to be developed for combining all the DEMs from various sources into a single DEM considering slope, aspect and other terrain properties for better DEMs.
- 42 Signal and image processing algorithms
Signal processing and Tracker algorithms for altimeter sensor, complex correlation algorithm for synthetic aperture radiometer and performance analysis, feature extraction algorithm for microwave data etc. are the areas for detailed study.
- 43 Assimilation of satellite data in numerical weather and ocean prediction models
This involves development of various assimilation techniques for improving the initial condition in models. Special emphasis is on direct assimilation of satellite measured radiance into the input. Radiative transfer modeling and optimization techniques need be investigated.
- 44 Numerical weather prediction with general circulation models
Real time weather forecast is required during satellite launching. Short range weather prediction is made using numerical weather prediction model and assimilation of satellite data. Study should focus on dynamic modeling, physical parameterization and assimilation of satellite data.
- 45 Ocean state forecast with global and regional numerical dynamic models
Ocean state forecast is done using ocean general circulation model and wave modes. As there are only a few observations available over the ocean, there is large uncertainty in the initial condition. Study should focus on development of advance assimilation technique to generate the initial condition and the forcing field.
- 46 Air sea interaction studies
To understand the atmospheric and oceanic processes near ocean surface, air sea interaction study is important. Because of inadequacy of the observed data over the ocean, diagnostic study need be carried out using satellite data.

- 47 Cyclone track and intensity prediction using satellite data and numerical models
- Satellite data is used to determine location of a cyclone when it is over the ocean and away from the coast. Exact determination of the current and past location of the cyclone is needed for prediction of its future movement and intensity. Study should focus on developing both empirical and dynamic modeling and assimilation techniques.
- 48 Himalayan cryosphere
- Aim is to develop techniques for analyzing multisensor satellite data in conjunction with field data collected using spectro-radiometer, DGPS, GPR and available hydrological and metrological data for understanding Himalayan cryosphere. Study should focus on developing algorithms /models for generating 5-daily and 10-daily snow cover products, modeling snow melt run-off, features of glaciers etc.
- 49 Marine lithosphere
- Aim is to develop technique to retrieve gravity/geoid using satellite altimetry over marine regions and its application to model marine lithosphere. Study involves modeling sea level changes, understand subsurface tectonics, natural oil seepage detection and modeling of its dispersion and identify areas for hydrocarbon exploration in offshore regions.
- 50 Coastal processes
- Requirement is to develop techniques to model sediment transport in coastal and marine environment using satellite retrieved parameters. Study involves identifying source to sink path ways, impact on habitats, mapping shoreline changes, coastal erosion, predicting shoreline changes and quantifying coastal vulnerability to predicted sea level rise.
- 51 Geo-hazards
- Aim is to develop methods to understand earthquake precursors using satellite retrieved data such as land surface temperature and gravity anomalies. Study involves mapping surface deformation using DGPS, SAR interferometry / differential interferometry techniques, rainfall threshold and slope instability based models for early warning of landslides etc.

- 52 Mineral exploration
- Aim is to develop methods to analyse multisensor satellite data for detecting guides such as hydrothermal alteration zones, gossans, structural features, geobotanical anomalies etc. Study involves developing GIS based models to identify mineral prognostic zones by integrating geological, geophysical and geochemical data followed by test drilling.
- 53 High resolution satellite data for development of 3D city models and its applications in urban planning using GIS techniques
- Urban models are computer based simulations used for testing theories about spatial location and interaction between land uses and related activities. As computers, software and data have become richer, urban models have moved from theories and structures that articulate land use and movement in aggregate static terms, to more dynamic models of individual behavior from which spatial structure emerges. Three dimensional models of urban areas are useful for many kinds of applications. Aim is to develop such models using GIS techniques.
- 54 Urban hydrological modeling
- Urban hydrological modeling using RS and GIS techniques is gaining momentum to estimate run-off in the urban areas based on hydrological and hydrographic parameters. Event based rainfall-runoff models are already developed and hence there is a need to develop continuous simulation models to represent the entire hydrological system on computer so as to simulate the natural system. Application of these models for municipal has been limited primarily due to large amount of data requirement. This gap in retrieving data for continuous simulation models can be bridged using high resolution satellite data embedded with GIS technique. Detailed investigation in the above areas is needed.
- 55 Impact of geo-hazards on human settlements
- Development of a model to evaluate the impact of geo-hazards is an important research area. Geo-hazards can occur in form of landslides, floods, volcanic eruptions, earthquakes, tsunamis, dam failure etc. They can be natural or human induced. There is a need to develop multi facet models for

- assessing the impact of a geo-hazard on human settlement. It is also necessary to simulate and model the damage scenarios of human habitats with respect to different intensities.
- 56 Partitioning land surface temperature into components using angular thermal remote sensing
- Studies in the past have used land surface temperature only for evapotranspiration (ET) modeling of land as a whole. Partitioning lumped ET into soil evaporation and canopy transpiration requires component temperatures such as soil and canopy temperatures respectively. There is a need to understand the effect of sun-sensor view and azimuth angles surface emissivity and temperatures. Ground based experiments are needed with multi-channel thermal radiometer and spectroradiometer with goniometer to understand, characterize and validate the theoretical concepts before applying to satellite observations.
- 57 Modeling of green-house gases
- There is a need to develop scheme to quantify the variability of GHG using space borne sensors. There are functional sensor systems from NASA, ESA and JAXA for monitoring different types of GHG. India is planning to launch indigenous GHG sensor system for climate change research. Requirement is to develop the instrumentation and radiative transfer modeling.
- 58 Remote sensing of aerosols
- Aerosols play important role in climate modeling, dust storm monitoring and atmospheric correction of remotely sensed data for ocean and terrestrial applications. There is a need to refine the approach method in estimating aerosols over land and ocean and develop innovative techniques using multiangular and polarization measurements. Scope of the research work is instrumentation, radiative transfer modeling and analysis of satellite data related to aerosol applications.
- 59 Agro-ecosystem studies
- Characterizing agro-ecosystems, using remote sensing data, involve assessing their function and wealth. Agro-ecosystem models need be developed to study the long term sustainability of the system. Remote based indicators can be

- developed for assessment of agro-ecosystems. Study need be carried out both for irrigated and rainfed ecosystems of the country.
- 60 Hydrological models
There is a need to develop land data assimilation systems to optimally merge remote sensing observations with hydrological models. Land data include surface soil moisture, brightness temperature data, vegetation indices, snow cover fraction, snow water equivalent, land surface temperature etc.
- 61 Marine ecosystem model
Ecosystem models are used to assess the condition of marine ecosystems like coral reef, sea grass bed etc. Quantitative productivity modeling of seagrass ecosystems, biogeochemical cycle of mangrove systems etc need be carried out.
- 62 Land use/cover change
Modeling the dynamics of change of land use cover for future projection is needed. Also modeling the nutrient cycle of agriculture systems, nutrient and chemical cycle of wetland rice systems etc need be investigated.
- 63 Wetland
Physical and biophysical dynamics of high altitude wetlands and sensitive parameters are indicators of change. Modeling hydrological cycle of natural wetlands in relation to change in land use/cover needs be developed.
- 64 Development of epitaxial GaN/AlN thin films on sapphire and development of DLC coatings for high frequency thin films Surface Acoustic Wave (SAW)
High frequency SAW devices are used in communication systems. The device frequency operation is limited by the velocity of acoustic wave and available lithographic resolution for IDT electrode fabrication. The high acoustic velocity of suitable substrate material, such as diamond/Z-cut Al_2O_3 , combined with thin film piezoelectric films such as AlN, ZnO makes it attractive for high frequency SAW devices. Growth of oriented piezoelectric films on Z-cut Al_2O_3 , NCD substrates are needed to be developed for

- producing low propagation loss and high performance, high frequency SAW device.
- 65 Growth of Langasite single crystal (LGS) for development of SAW devices
- Generally LiNbO_3 ST cut quartz single crystal wafers are used for fabrication of SAW devices. LiNbO_3 has good electro mechanical coupling coefficient (K₂) but with poor temperature stability. Quartz has zero temperature sensitivity but poor K₂. LGS is an attractive piezoelectric substrate because of its large K₂ and good temperature stability. Development of LGS is needed to realize high performance, low loss narrow band SAW filters.
- 66 Development of spinnable and water soluble conducting polymer for SAW devices
- Lift off technology is needed to realize SAW devices with features better than 0.5μ with high reproducibility, good definition and zero defects. In this process conventional wet etching process is avoided. The unwanted features/patterns are lifted in suitable solvent. For development of EBMP based lift off technology, e-beam writing on bare wafers induces sever charging which causes pattern deformation. Water soluble conducting polymer if spun on wafer prior to e-beam writing can solve this problem.
- 67 Development of oriented BST films on alumina for tunable microwave components
- Microwave filters are used in satellite communication systems. Electronically tunable filters are required for many applications in frequency agile wireless communication systems. Ferroelectric thin films based tunable filters offer distinct advantages in terms of high performance, low loss, low power consumption with high degree of miniaturization. BST based ferroelectric thin films are required to be developed for the above application.
- 68 Development of nanostructured magnetostrictive thin films for Surface Acoustic Wave device applications
- Conventional SAW device consist of metallic IDT on top of a piezoelectric film or substrates. Research involves development of high quality thin films of giant magnetostrictive materials which exhibit high magnet-ostriction coefficient suitable for low insertion loss SAW devices.

- 69 Optics & detectors
- Hyper spectral systems are replacing multi-spectral type instruments. Finer resolution implies larger and bulkier optics. There is a great scope in this area for compaction, innovative focusing, alignment techniques and swath improvement. Multipurpose large area array detectors are replacing the present day linear detectors. Mathematical modeling and optical domain processing are to be developed and implemented. Following are some of the areas where academic institutes can contribute either in terms of study, algorithm development or prototype development:
- Compact optical systems, study for gravity effect on large diameter light weight optics, development of thin and deformable mirrors, interferometric sensing system, on-board focusing, development of room temperature operated MWIR and LWIR detector arrays etc.
- 70 Gas sensors
- Miniature gas sensors for CO, CO₂, N₂, O₂, N₂O, SO₂, and other Greenhouse gases.
- 71 Study of life/failure mechanisms
- Most photo detectors are operated at low temperatures for reduced thermal noise and higher sensitivity. Focus of study should be on identifying failure mechanisms in various photo detectors using InGaAs, InSb and Si-PIN technologies. Factors that accelerate performance degradation need be identified and models/methods to estimate life of such detectors need be developed.
- 72 Estimation of gaseous radiation for interplanetary missions
- Gaseous radiation is significant in re-entry from interplanetary mission when entry velocity is greater than 15 km/s. Both equilibrium and non-equilibrium air radiation have to be modeled for estimation of radiative heating. Number densities of various chemical species, translational, rotational and vibrational temperatures of heavy particles and electrons are to be evaluated for modeling emission and absorption characteristics of air under these conditions. Study is to focus on evaluating radiation heating under these conditions.

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| 73 | Socio-economic research/evaluation of satellite-based societal applications | <p>Areas which need detailed investigation :</p> <ul style="list-style-type: none"> ● Studying societal needs and projecting future needs that will serve as inputs to the planning of space applications system ● Organizing demonstration projects for new applications of space and related technologies for a variety of end-users of socio-technical systems ● Studying social, economic and cultural impact of new technologies ● Producing suitable “software” as models/examples |
| 74 | Tele-Education/Tele-Medicine programme | <p>Areas which need detailed investigation:</p> <ul style="list-style-type: none"> ● Edusat utilization needs content generation in terms of multi-media programs ● Evaluation studies at national and regional levels |
| 75 | Gramsat programme to provide state based connectivity for the rural specific needs | <p>Areas which need detailed investigation:</p> <ul style="list-style-type: none"> ● Interactive programs for applications like Training, Education, e-Governance, Disaster Management, Tele-conferencing, Urban/Rural Development, etc. ● Training and development communication channel |
| 76 | Village Resource Centres | <p>Areas which need detailed investigation:</p> <ul style="list-style-type: none"> ● Make multi-service low cost ● Integrate ISRO’s VRCs with existing VRCs |