The research programmes of the laboratory can be broadly grouped under six major disciplines. These are,

i. Theoretical Physics;

ii. Nonlinear Dynamics and Computational Physics;

iii. Laser Physics and Quantum Optics;

iv. Astronomy and Astrophysics;

v. Planetary Atmospheres and Aeronomy;

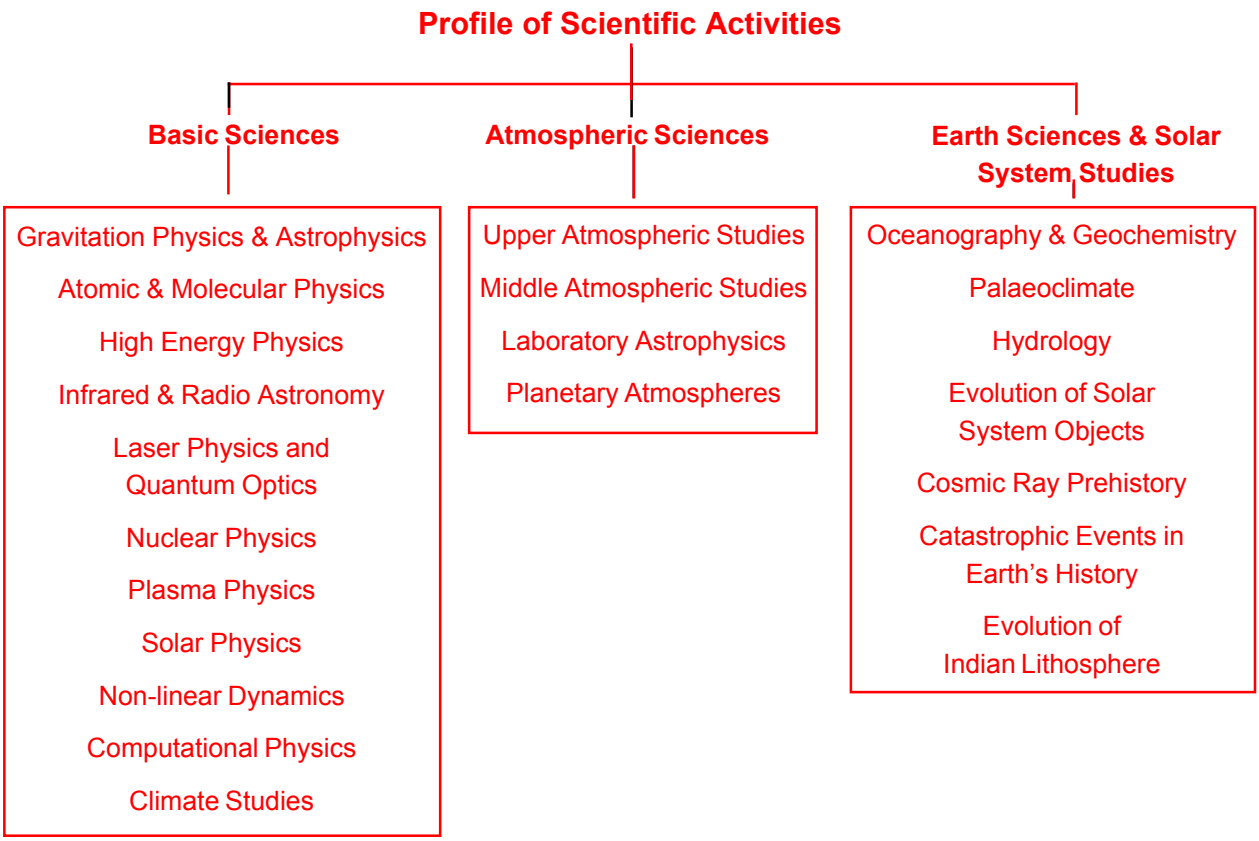
vi. Earth Sciences and Solar System Studies.

The chart below profiles the scientific activities.

Some of the important research contributions are summarised.

Astronomy and Astrophysics

The group has been innovatively using the medium-sized 1.2 m IR telescope at Gurushikhar. Transient events, bright sources that vary with time, large scale mapping and techniques that do not primarily depend upon the size of the telescope are some of the ideas we are using to obtain maximum output out of the modest facility. However, some specific observations demand the use of larger/better facilities available elsewhere. The group is thus continuing its efforts to propose and obtain precious observing time on outside telescopes – Isaac Newton 2.2 m telescope at La Palma had been used earlier; UKIRT, KPNO are also being used by us for optical/IR observations. Radio astronomy is being pursued at outside facilities such as Ooty Radio Telescope and GMRT. Apart from these regular programmes, we do take advantage of opportunities offered by cosmic events such as the apparition of comets and the total solar eclipse. We did have two such occasions during the past one year. Udaipur Solar Observatory (USO), equipped with modern instruments is a premier facility in the country to conduct research in Solar Physics. A solar X-ray spectrometer (SOXS) payload for inclusion on a satellite in near future is under development in PRL.



In addition, a state-of-the-art laboratory facility to develop required technologies in the submillimeter wave region has also been initiated.

Total solar eclipse (TSE) provides an opportunity to unravel the mysteries of the corona of the sun. Although a tremendous amount of information is being obtained from the spacecrafts such as SOHO, YOHKOH, Ulysses and so on, the ground-based observations are still important to study the inner coronal regions at a faster sampling rate. One such chance came our way on 21 June but the totality could be seen in Southern Africa.The PRL Astronomy & Astrophysics group in collaboration with the Udaipur Solar Observatory group made an expedition to Lusaka, Zambia to make the observations. The teams conducted two major experiments : the first to measure the coronal temperature and kinematic features from the line profiles in [FeXIV] line using the technique of Fabry-Perot Interferometry and the second to measure the polarization in the coronal continuum and across the [FeXIV] line. These two experiments were intended for obtaining clues for the coronal heating mechanism. These experiments were successfully carried out. The analysis is in progress.

Comets provide opportunity to study the pristine matter in the solar system. Observations related to the cometary plasma and dust throw light on the comet – solar wind interaction mechanisms as well as on the growth and destruction of dust particles. The apparition of Comet Linear triggered off a series of important observations at Mt. Abu using an optical polarimeter and NICMOS 3 for imaging in the infrared bands. Critical observations were made on the phase angles where the turn over takes place from positive to negative polarization which is sensitive to the nature of dust grains.

In continuing our on-going programmes on the spatio-kinematic studies on Planetary Nebulae, we found a highly complex structure in the nebula NGC 1514. Our spatially resolved line profile study using the imaging Fabry-Perot Spectrometer provided evidence for a morphology of a double-lobed structure embedded in an elliptical shell. This structure suggests a common envelope ejection from a binary central star with a progenitor mass of 3.5 $M_{\odot}$ and a binary period of 14-20 days.

Be phenomenon is believed to be caused by mass ejection from rapidly rotating B type stars evolving in the main sequence phase. Non-radial pulsations could also contribute to the mass loss. A third and often ignored mechanism is that of mass loss due to tidal interaction in a binary system at the periastron encounter of the components. One such rare example was caught in its act at Mt. Abu using both visible (FLAGS) and infrared (NICMOS 3) spectroscopy which revealed rich Hydrogen emission spectrum, a feature that indicates Be phenomenon.

Observations of interplanetary scintillations (IPS) at Ooty radio telescope at 327 MHz (on a collaborative basis with TIFR) revealed probably the first evidence for extremely low densities of plasma over a very wide spread region around the Sun. This was accompanied by unusually low solar wind velocities too. This event, occurred around 11 May 1999, resulted in the widening of the earth's magnetosphere and receding of the bow shock away from the earth. One possible cause could be the magnetic field reversals leading to regions of reconnection in which the depletion of plasma can in principle occur.

On the development of new facilities/techniques, the group has successfully commissioned the country's first e-mail-triggered robotic telescope for observations of transient phenomena such as γ- ray bursts. A software developed in-house checks incoming e-mail alerts at one-minute intervals and triggers an 8-inch telescope equipped with a CCD camera. It can also alert observers through telephonic message. The facility awaits occurrence of a suitable event.

PRL has initiated building a state-of-the-art laboratory facility to develop required technologies in the submillimeter wave region. The development of state-of-the-art high-resolution receiver systems is underway. A step tunable optically pumped laser local oscillator (LO) has been installed successfully. Typical output of the pump laser in the mid-IR (λ = 9-11μm) is between 10-50 watts. We have achieved more than 30milliwatts of power at 96.5μm, 118.8 μm, and 163.0 μm wavelengths. Currently, laser is being optimized for longer μ

wavelengths. This LO is used to optimize mixer performance in the laboratory. A room temperature Schottky diode has been optimized for the heterodyne operation. Traditionally, two kinds of spectrometers have been used for IF signal analysis in receiver system, Acousto-Optic Spectrometer and Filter bank Spectrometer. However, for eventual space payload we have chosen a state-of-the-art Chirp Transform Spectrometer (CTS) capable of giving 45 KHz resolution and 180 MHz processing bandwidth with 4096 channels. Preliminary design review is underway.

The Solar X-ray Spectrometer (SOXS) payload, scheduled to fly onboard GSAT-2 Indian Mission, will achieve sub-keV energy resolution and 100ms temporal resolution for uninterrupted ten hours period everyday. This will enable us to study the break-energy point among thermal, superhot and non-thermal components of the solar flare. The high-resolution observations of SOXS payload will also enable to study, for the first time, short and long term solar coronal variability, and its effects on the Earth's environment. The SOXS Low Energy Detector (SLD) payload employs state-of-the-art semiconductor devices viz. Si-PIN and CZT detectors. The laboratory model of the SLD payload has been designed, developed and tested successfully at the Physical Research Laboratory. The energy resolution of about 500 eV at 5.9 keV and 800 eV at 22.2 keV has been achieved to meet the scientific goals. Recently, the Qualification Model (QM) of SLD payload has also been tested successfully for all critical environmental tests, while the Flight Model (FM) is currently under fabrication.

The effect of flares on solar oscillation characteristics is rather elusive, but recent work was able to detect several flare events leading to distinctive changes in solar oscillation characteristics. Magnetic flux imbalance in solar active regions was shown to vary in step with the solar cycle, implying large scale connectivities that changed with the solar cycle. A study of approximately 54 large geomagnetic storms (Dst <-100 nT) in the present solar cycle during 1996-2001, showed that near solar minimum, the geoeffective CMEs were more associated with eruptive prominences, while near the maximum of the solar cycle they had association with strong flares.

Theoretical Physics

Theoretical Physics division is mainly concerned with the fundamental interactions of nature, electro-magnetic, weak, strong and gravitational, and as a part of this in addressing some basic questions in Astrophysics, High Energy Physics, Atomic Physics, Nuclear Physics and Plasma Physics. In Astrophysics, the focus is on some aspects of relativistic astrophysics, cosmology and astro-particle physics; in high energy physics, on neutrino physics, weak interactions, hadronic physics and quark-gluon plasma; in nuclear physics, on drip line nuclei, symmetries and chaos in nuclei; in atomic physics, on atoms in fields and Rydberg atoms and in plasma physics, on the phenomena in dusty plasmas and space plasmas.

Considering the effects of curvature coupling to fermions in the realm of general relativity two important effects have been realised, through the CPT violating terms, arising from a vector and a pseudo-vector potential. While on one hand numerical estimates are made that could be measured through satellite based torsion balance experiments, on the other, it has been shown that the left-right asymmetry could lead to lepton asymmetry, which when used along with primordial tensor perturbations would result in a baryon asymmetry of the correct magnitude as required in the early universe scenario for baryogenesis. Few other significant results obtained concern the effects of introducing Coriolis force in the context of accretion flows around rotating compact objects and the effect of centrifugal force reversal, which is realised to exist only for particles on circular geodesics, implying a condition that the angular velocity has to be larger than the radial velocity. This result has implications of the well known Mach's principle concerning inertial forces in general relativity.

Some aspects of neutrino physics, strong interactions, cosmology and collider physics have been studied. An important experimental result was obtained in neutrino physics this year by the solar neutrino detector at Sudbury Neutrino Observatory (SNO). This experiment provided for the first time a complete determination of all flavours of neutrino fluxes coming from the

Sun. These results were exploited by the group to derive important constraints on the neutrino magnetic moment and lifetime of neutrino. The solar neutrino results also constrained neutrino masses and mixing very strongly. Radiative mechanisms for neutrino masses were proposed which could explain the observed neutrino parameters correctly. In collider physics, following the observation of CP violation in K and recently in B mesons, it has become important to look for signatures of such violations in other systems. A systematic study was made to see CP violation in the production of tau meson using polarized beams at future collider TESLA. Also studied were quantum corrections to CP violating angular asymmetry in $e^+e^- \to t\bar{t}$. In cosmology, understanding the dynamics of inflation which is supposed to have taken place during very early evolution of our universe is a challenging task. A systematic study was made of the inflationary phase transition including a specific cases which considered effects of couplings between two scalar fields. In hadron physics, it is known that the properties of the known hadrons can change considerably at very high temperature and/or at very high nuclear density. A study of how quantum corrections change the vector meson masses in the presence of hot and dense hadronic matter was made. It was shown within a specific non-perturbative framework that the quantum corrections tend to increase the masses of vector mesons.

In order to understand the structure of N=Z odd-odd nuclei above ^{56}Ni, which is a topic of high current interest in nuclear physics, binding energy data were analyzed and predicted that remnants of Wigner's spin-isospin SU(4) symmetry should be present in these nuclei. Secondly, for spectroscopic studies of these nuclei, isospin projected deformed shell model is being developed and first successful analysis of the isospin T=0 and T=1 levels in ^{62}Ga and ^{66}As are carried out.

For the study of transitions between neighboring states of Rydberg atoms, a *new* approximate expression of the Jacobi polynomial $P^{(\alpha,\beta)}_k(\cos\phi)$ valid for small ϕ and arbitrary α, β and k is obtained which for large k, reduces to a known *asymptotic* expression of the mathematical literature.

Collective phenomena in dusty plasmas have been investigated in weakly as well as strongly interacting regimes. In addition, in partially ionized plasmas, it is found that the neutral dynamics in partially ionized plasma is responsible for suppression of macro-instabilities. It is the collision between ions and neutrals that is important for the suppression and it is not necessary to invoke viscosity as was done by some workers on this topic.

Nonlinear Dynamics & Computational Physics

We have studied the emergence of complex behaviour from often deterministic and simple physical laws with the aid of both theoretical and computational physics. Control and synchronization of chaos, networks, cryptography, quantum chaos and large scale computations of the properties of large atoms are some of the topics on which work is being carried out. We focus attention this year on implementing chaos based secure communication, dynamical networks, and universal bounds on quantum entanglement.

We have developed methods for estimation of initial conditions of both periodic and chaotic dynamical systems. This has enabled us to propose a method of secure communication that is practically very difficult to crack. We are also exploring ways to implement these algorithms. Study of networks such as the small world network and growing networks are very important in understanding the emergence of complexity. We have studied the effects of dyanmical chaos at the nodes of networks and the resultant complex behaviour, especially synchronization and cluster formation.

We had recently found that quantum chaos can substantially increase entanglement. Subsequently, employing random matrix theory modelling we have derived an universal statistical upper bound on entanglement that we may expect generic interactions to lead to.

Laser Physics and Quantum Optics

Major activities of our recent work have been in the areas of coherent control of the propagation of light pulses, cavity QED, entanglement of quantum systems and optical vortices.

We show that a suitably applied control field can facilitate the stoppage of light pulses in a coherently driven atomic medium via electro-magnetically induced transparency. We demonstrate that a control field can also be used to separate temporally the two polarization components of a linearly polarized pulse propagating through a coherent medium.

The decoherence of coherently prepared superposition of states is a major issue in several fields such as quantum information processing. We show how the interaction of a system with a sequence of 2π pulses can slow down its decay into continuum and help realize an analog of quantum anti-Zeno effect.

In cavity QED, we have studied the feasibility of enhancing the fundamental radiative interactions between distant atoms. In particular, we showed how giant dipole-dipole interaction can be produced by placing dipoles close to micron sized silica spheres and resonantly coupling them via the whispering gallery modes. We have also examined how one- and two-photon processes compete when an ultra cold three-level atom undergoes cascade transitions in a bimodal cavity.

We show the existence of dramatic non-classical spatial correlations in the resonance fluorescence produced by identical coherently driven two level atoms, and point out that the non-classical features are produced by state reduction as a consequence of detection. The detection of the first photon produces entanglement between two atoms and the detection of the second photon becomes a probe for such entanglement. Such ideas have also been applied to Bose condensates to entangle three different many-particle states by Bragg spectroscopy with nonclassical light. We demonstrate that high-gain parametric amplifiers can be used as intense sources of entangled photons for potential applications in quantum information and quantum imaging.

We have studied the one-dimensional projection of a vortex field and calculated the extent of spatial coherence and entropy of such projections. Finally, we have produced a symmetrical optical vortex using a computer generated hologram. This is made into a non-canonical vortex after passing it through a cylindrical lens. We have studied the propagation of such a vortex in free space experimentally and the results were explained theoretically.

Planetary Atmospheres and Aeronomy

Planetary Atmospheres and Aeronomy Division aims to understand various scientific phenomena taking place in the upper part of the earth's atmosphere, which is accessible by balloons, rockets and satellites and the near earth environment. These studies are conducted by developing suitable experiments and taking them up on balloons, rockets and satellites and analyzing the scientific data by modelling and numerical simulation techniques. In addition to space-borne measurements, the division also undertakes laboratory studies of some of the most intriguing reactions occurring in the upper atmosphere.

A Nd-YAG laser based lidar is operational at Gurushikhar in Mt. Abu since November 1997 to study the temperature structure and dynamics in the middle atmosphere at tropical latitudes. Climatology of the temperature in the region 30-75 km is obtained using the Rayleigh scattered signals and compared with existing models. While the measurements compare well with model values below 50 km, there exists considerable difference above 50 km. Day to day and year variability is also evaluated. For the past 2 years lidar is also used to obtain temperature in the region 5-30 km from Raman scattered signals. Density perturbations are also being used to study features of atmospheric gravity waves at tropical latitudes.

A unique set of rocket measurements was carried out from Sriharikota during Leonid meteor storm which occurs once in 33 years with enhanced meteoric activity. Experimental evidences are obtained for the first time, for the presence of sub-meter (50 cm) scale sizes plasma irregularities having peak amplitude at 105 km. The properties of these sub-meter irregularities are different from the conventional irregularities observed in the equatorial E-region during non-meteor storm days. Preliminary theoretical analysis suggests that the streaming of plasma cloud associated with meteoric trails

are likely to be responsible for the generation of such irregularities.

In the area of planetary atmosphere, theoretical studies on the ionosphere/magnetosphere of Mars and comets are carried out to understand solar wind interaction processes on them. This study suggests that protons can precipitate down in the dayside and nightside ionosphere of Mars and comets. The energy of solar wind electron is not found to be sufficient to penetrate deep in to the dayside Martian atmosphere. It contributes significantly in the nightside ionosphere. The photon impact ionization is the dominant process in the dayside ionosphere of Mars and comets.

Earth Sciences and Solar System Studies

The programmes on Earth Sciences and Solar System Studies focus on the spatial and temporal evolution of the Earth and other planetary bodies through studies of the isotopic and chemical signatures contained in samples derived from them. Such studies are carried out using sohisticated instrumentation and a subtle combination of analytical methods and theoretical models.

Chemical composition of aerosols near sea surface is expected to have Na:Cl ratio very similar to that in sea water. Contrary to this, aerosols over the Bay of Bengal show unusually large chloride deficit, 55%-98%, highest values observed in aerosols. This results from volatilization of chloride by interaction with sulphuric acid produced from SO_2 in the atmosphere. The strong positive correlation between chloride deficit and non-sea-salt SO_4 in these aerosols supports this hypothesis. The impact of this process is to sequester sulphuric acid as SO_4.

One of the unique characteristics of rivers draining the southern slopes of the Himalaya, such as the headwaters of the Ganga and the Yamuna is their high dissolved uranium concentration. Identifying sources for such high uranium has been a topic of study of the Earth Sciences group. It is shown that black shales on an average have ~37μg U per gram, Weathering of ~50 mg of the black shales can contribute ~1.7μg U, its average concentration per liter of the Ganga and Yamuna headwaters. This further, brings to light the importance of minor lithologies in influencing budget of trace elements in the Himalayan rivers.

The group added a new dimension to Luminescence Geochronology of young sediments by the addition of a single grain OSL reader with capabilities of laser stimulation of single 200 micron size grains. This system is equipped with three optical excitation sources including a precision Nd:YV04 laser, an IR laser and Blue laser diodes giving a flexibility of excitation wavelength. A precision XY stage allows laser beam of ~ 100 micron diameter to focus onto a single grain of ~ 200 micron size with a position precision of ~ 2 micron. This system has been installed and has been used to date young sediments from the Anantpur district, Thar and Kalahari Desert sequences.

Ion microprobe studies of Al-Mg, Ca-K and Be-B isotopic systematic in a set of first generation solar system solids isolated from the primitive meteorite Murchison allowed to place a limit on the energetic particle irradiation of the solar nebula. An effective fluence of solar energetic protons of $10^{18}cm^{-2}$ with E > 10 MeV and characterized by a hard spectra than the contemporary solar flare particles, is consistent with the observed data.

Refractory Ca-Al-Inclusions (CAIs) from the CR carbonaceous chondrites, with different mineralogical characteristics show uniform abundance of ^{26}Al at the time of their formation suggesting a very short time interval within which these early solar system objects formed in the solar nebula. However, there are sharp contrasts in isotopic records between CAIs from CR chondrites and that from CH chondrites indicating possible temporal or spatial differences in their formation epochs or locations.

New data on Al-Mg systematics in differentiated meteorites strengthened earlier observations and confirms the role of ^{26}Al as an important heat source leading to early melting and differentiation of planetesimals.

Petrologic, minerological, isotopic and spectroscopic (Mössbaur) studies of the ferruginous Permian-

Triassic boundary sections revealed presence of quartz vein with strained quartz, nanometer-sized particles of iron minerals that are absent in samples above and below the boundary layers. These observations resemble findings in the K/T boundary sections and suggest the possibility of a large impactor as the cause of P/T extinction during the phanerozoic.

A detailed geochronological study of well-constrained chemical- and magneto-stratigraphic lava flow sequence in the Narmada region of the Deccan Volcanic Province clearly demonstrate that the onset of Deccan volcanism predate the Cretacious-Tertiary boundary event. The study also resolved a long standing inconsistency between the radiometric and palaeomagnetic age constraints.

Unambiguous identification of carrier phases of anomalous isotopic components is a pre-requisite for understanding the early solar system processes. An isotopically heavy nitrogen component has been identified in the solar wind bearing dark lithology of the L3-5, brecciated Itawa Bhopji chondrite, which fell on May 30, 2000, in Rajasthan. Its low temperature release and association with radiogenic ^{129}Xe are highly suggestive that a halogen rich labile phase is the host of this heavy nitrogen.

A new programme on Planetary Sciences and Exploration has been initiated at PRL this year. It has four components related to : (1) Planetary Astronomy; (2) Modelling of Planetary interiors, atmospheres and ionospheres; (3) Laboratory studies of Planetary materials, e.g. meteorites, lunar samples and (4) Planning and preparation for planetary missions. The programme also plans to develop and train manpower for its activities and would support institutional proposals in the country. Two workshops, one at Ahmedabad and the other at Mt. Abu were conducted for orienting young students and scientists for working in problems related to Planetary Sciences. Facilities for preparation and study of thin sections has been set up. Studies related to an orbiter mission to Moon and sensor development have been taken up. This programme is supported by the Department of Space.

Technical Developments

Vacuum Crusher

Noble gases in a given sample (both terrestrial or extraterrestrial) are a mixture of trapped and *in situ* produced (radiogenic, cosmogenic and nucleogenic) components. It is a challenge to decouple these various components by clever experiments. The normal step heating pyrolysis technique is not very fruitful at times. Crushing the sample in ultra high vacuum wherein trapped gases are selectively released has been shown to be very effective in achieving this component separation. We have fabricated a vacuum crushing device, wherein about one gram samples can be processed. A magnetic hammer (inside vacuum) is operated by an external electro-magnet, and weighing about 500 g pounds the sample at a rate of 30 strokes per minute and liberates the gases trapped in the sample, which can be processed and measured. Presently we are studying gases trapped in carbonatites, which cannot be analysed by any other method and are planning to analyse some martian meteorites in near future.

Development of Mesospheric Scanning Photometer

In view of obtaining intrinsic parameters of gravity waves and their influences in mesospheric region using simultaneous measurements of mesospheric region with MST radar, lidar and airglow photometric techniques, a mesospheric scanning photometer (MSP) is developed. This instrument which has 4^0 field of view can monitor the OH emission intensities from OH (8,3) band and O_2 (0,1) band emissions from mesospheric region. By monitoring two rotational lines from a same vibrational band, it is possible to derive rotational temperature of the mesospheric region. This MSP is fitted with mirror arrangement to provide multidirectional scanning by moving the mirror assembly with computer controlled stepper motors. Faster scanning or the mirror assembly attached to the photometer provides sampling of airglow emission from different azimuthal regions which enables to derive wave parameters. Field trials are being planned.

New Computational Facility

Modern scientific research requires modern computational facilities and during the past year PRL acquired new computational facilities as well as a new high-speed local area network (LAN). The new LAN has a gigabit backbone and has star topology with structured cabling standard (SCS). The LAN was designed by PRL engineers keeping in mind the requirements of various divisions. The best of the passive and active components were procured from various manufacturers and integrated into a system. This design provides for sufficient redundancy, high-speed connectivity and future expandability. Thus, it was the most cost effective method of building a state of the art network. In addition, other PRL centres at Udaipur and Mt. Abu were connected to the PRL LAN on a 64 Kbps BSNL leased line.

The new computer facility consists of a IBM-SP RS/6000 system which has sixteen Power3-II processors with 32Gbytes of physical memory. Each processor is capable of 1.5 GFLOPS at peak performance and the sixteen processors can give a combined peak performance of 24 GFLOPS. In addition, for visualization and image processing a four processor graphics IBM RS270 workstation was acquired. The enormous computing power of IBM-SP offers the possibility of taking up numerically intensive problems which were impossible with the earlier system. It also opens avenues to new problems which are computationally challenging. The large amount of data generated using IBM-SP can be visualized for interpretation and analysis using the graphics workstation. Thus the IBM-SP and IBM RS270 together provide a complete solution to the laboratory's requirement for high performance computing. The new computers are complemented with high quality scientific software and libraries like Mathematica and the IMSL while visualization is provided by IDL and the DataExplorer package.

Infrastructural Facilities Available

Computer Centre, Electronics Laboratory,

Scanning Electron Microscope,

Liquid Nitrogen Plant, Glass Blowing Facility,

Radio Carbon Dating Laboratory,

Aluminising Facility at Mt. Abu

Research Opportunities

One of the important aims of the laboratory is to serve as a post-graduate and post-doctoral study centre for physics and earth sciences and to train research students in experimental and theoretical physics. With this in view, PRL offers graduate programme leading to Ph. D. degree. It also provides opportunities for carrying out post-doctoral research (**Fig.1**). The laboratory's visitor's programme includes an Associateship Programme for university teachers to interact with its scientists.

Training Opportunities

PRL provides summer training programme to students doing their Master's degree in Physics to acquaint them with the research programmes and opportunities available at PRL. PRL provides project training in computer science and application to post-graduate students. It also offers training in electronics and computer engineering to engineering students (**Fig.2**)

PRL also offers training and apprentice programmes in computers, library science, engineering and administrative services (**Fig.3**).

Research and other Scientific Details

The research work carried out by PRL scientists are published in reputed national and international journals. Few of our scientists are also invited to write review articles in the field of their specialisation.

Many of our scientists attend conferences and symposia at home and abroad where they present the results of their research investigations. Some of them are invited to present review papers. Few of them serve as chairmen and members of scientific committees for organising national conferences and symposia. Sometimes they are also invited to convene and chair sessions during symposia and meetings. The scientific output during the reporting year is shown in **Fig.4**.

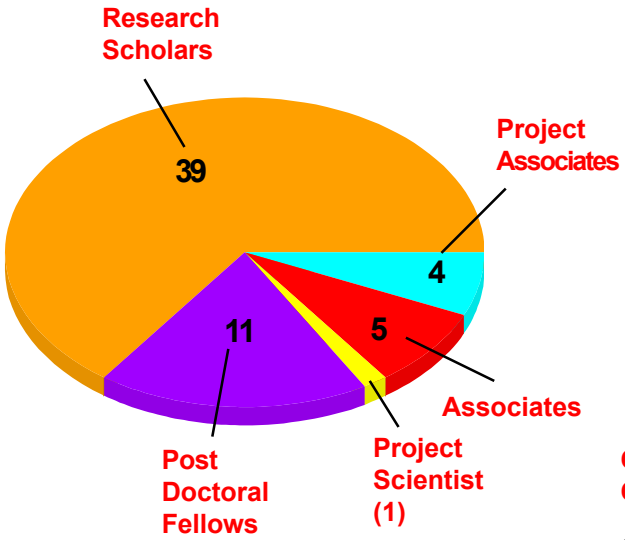


Fig.1 Doctoral, Post Doctoral and other Programmes

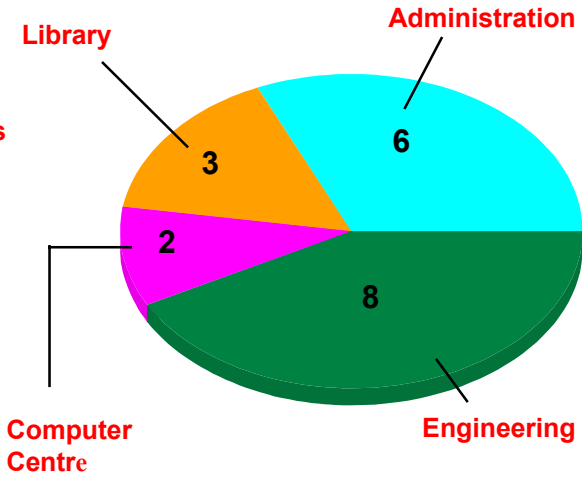


Fig.3 Apprentice Programme

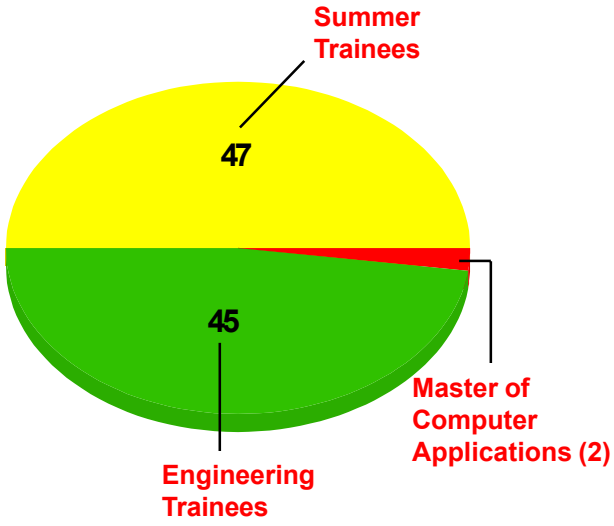


Fig.2 Graduate & Post Graduate Programme

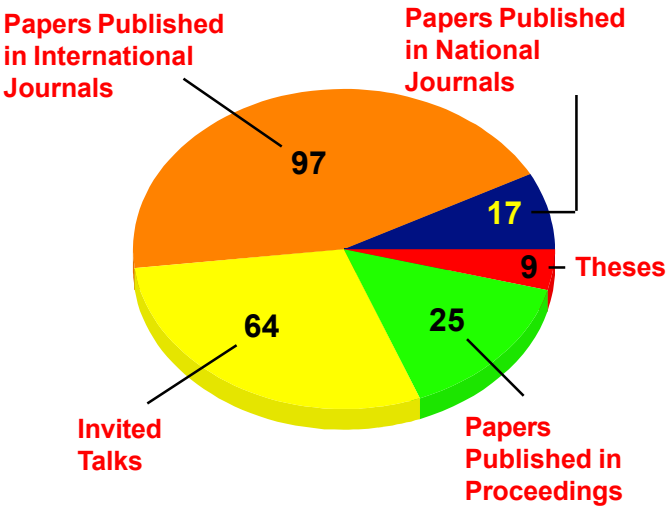


Fig.4 Scientific Output

Books/Journals Edited/Published

D.S.G.Thomas and **A.K.Singhvi** (eds.), Special issue of *Quaternary Science Reviews on Interaction between Arid and Humid Records of Climatic change in Drylands (IGCP-413).*

Conferences / Symposia Convened

The laboratory from time to time convenes symposia, conferences and workshops in different disciplines. Scientists and research students from other institutions and universities are invited to participate. During the reporting year PRL convened the following :

1. Workshop-cum-Training Course on Meteorite, Asteroids and Planets, December 15 -20, 2002, **Drs.J. R. Trivedi and N. M. Ashok - Conveners**

2. Meeting on Probing the Sun with High Resolution was held in Udaipur from 16-19 October, 2001, **Dr. P. Venkatakrishnan**

Distinguished Visitors at PRL

The Second Sub-committee of the Commitee of Parliament on Official Language comprising of nine MPs from both Rajya Sabha and Lok Sabha and three officers visited PRL on October 4 -5, 2001 to inspect the implementation of the Official Language in six central government offices, PRL, BSNL, Railways (Western Zone), BIS, FCI and Air India. The activities of the laboratory for proper implementation and progressive use of Hindi in day-to-day official activities were briefed to the committee through audio-visual presentations.

The Committee under the Chairmanship of Prof. B. V. Sreekantan, Former Director, TIFR and Fellow of NIAS, Bangalore visited PRL during October 28-29, 2001 to conduct a peer review of the laboratory. The activities of the laboratory was presented and the committee members had extensive interaction with the scientists. The committee was highly appreciative of the activities and the ongoing programs of the laboratory.

Prof. A. Dalgarno, FRS, Harvard Smithsonian Centre for Astrophysics, Cambridge, USA visited PRL as twenty second **Vikram Sarabhai Professor**. During his visit he gave a number of lectures, a colloquium and a popular lecture on *Molecular Synthesis in the Universe*.

Prof. N. Mukunda, Honorary Professor at the Indian Institute of Sciences and the Jawaharlal Nehru Centre, Bangalore delivered the seventeenth **Prof. K.R. Ramanathan Memorial Lecture** entitled *Phases in Physics*.

Prof. B. L. K. Somayajulu, CSIR Emeritus Scientist, Physical Research Laboratory, Ahmedabad delivered the eighteenth **Prof. K.R. Ramanathan Memorial Lecture** entitled *Past holds Clues to Future.*

During the Silver Jubilee celebrations of the Udaipur Solar Observatory few distinguished visitors participated in the meeting on Probing the Sun with high resolution. **Dr. Robert Rutten**, Utrecht University, the Netherlands gave a talk on *High-resolution Solar Physics* using image restoration through speckle and phase-diverse reconstruction technique, and image improvement through adaptive optics. **Prof. SM Chitre** delivered a talk on recent results of helioseismology and solar neutrinos. **Dr. Luc Dame**, Service d'Aeronomie du CNRS, France presented details of the *French Solarnet Experiment* - a novel technique for high resolution observations using multi-telescope solar interferometer. **Dr. Satoshi Masuda**, Nagoya University, Japan gave a detailed review of high energy processes in solar flares based on the results obtained from Yohkoh observations. **Dr. John Leibacher,** Project Director, GONG program, National Solar Observatory, USA and the USO scientists completed the *upgradation of the GONG instrument* being operated at USO as part of a six-site international network of ground-based observatories.

Seminars and Colloquia

The laboratory has an extensive seminar and colloquium programme. Reputed scientists, both from national and international institutions were invited to give seminars and colloquia. Prof. Paul Hickson of University of British Columbia, Canada and Prof. R. U. Haq of Laurentian University, Canada gave interesting colloqua. In addition, the laboratory organised popular lectures by internationally renowned scientists. The following gives an idea of the seminars and colloquia including popular lectures held at PRL :

Seminars held	112
Colloquia including public lectures held	33

Administrative Support

Behind the scientific achievements of PRL is the able and efficient support given by the administrative and the technical staff. The administrative section of our laboratory continues to play a pivotal role in providing an excellent management support to carry out our scientific activities. In addition, it also provides management support to the Solar Observatory at Udaipur and the Infrared Observatory at Mt. Abu. The budget and staff structure of PRL are shown in **Figs. 5 and 6**.

Miscellaneous

The laboratory honoured **Prof. C. N. R. Rao**, Linus Pauling Research Professor at the Jawaharlal Nehru

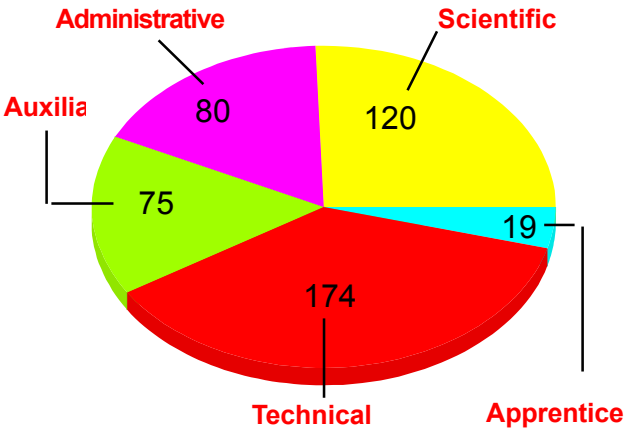


Fig.5 Staff Structure of PRL

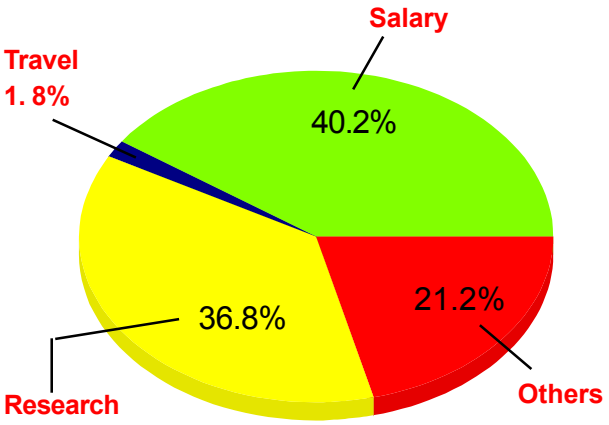


Fig.6 Budget of PRL

Centre for Advanced Scientific Research, Bangalore and former Director of the Indian Institute of Science, Bangalore with the award of the **Hari Om Ashram Prerit Senior Scientist Award** for the year 2000 for his outstanding contributions in science and technology. The award was presented by Dr. K. Kasturirangan, Chairman, ISRO and Secretary, DOS. The function was presided over by Prof. U. R. Rao, Chairman, PRL Council of Management. The Senior Scientist Award has been instituted in 1998 by the Physical Research Laboratory, with the funds donated by the Hari Om Ashram Trust, Nadiad, to commemorate the birth centenary of Pujya Shri Mota, Founder of the Hari Om Ashram. The award, being given biennially, carried an amount of Rs. 1 lakh and a citation.

As a part of implementation and progressive use of Hindi in PRL, the **Hindi Week** was celebrated at PRL from September 10 - 14, 2001. The highlights of the celebrations included word quiz, essay, elocution, Hamara Karya, self written poetry competitions and Antakshari. The special attraction of this year's celebration was a lecture by eminent educationist - *Dr. Chandrakant Metha*, Ex-Vice Chancellor of Gujarat University, Ahmedabad who delivered the inaugural lecture.

PRL also participated in *DOS Inter Centre Technical Seminar on Towards Self Reliance* organised by the Department of Space at ISRO Satellite Centre, Bangalore on 13 September, 2001 in which five of our staff members participated and presented their papers on various topics. In addition, DOS also organised another Inter Centre Technical Seminar on Rashtriya Vikas ke liye Antarix Prodyogiki at the Space Applications Centre, Ahmedabad on 22 February, 2002, in which four PRL participants presented papers.

Shri Som Sharma participated in the DOS Inter Centre Technical Seminar on Rashtriya Vikas ke liye Antarix Prodyogiki, held at SAC, Ahmedabad on 22 February, 2002 and presented his paper *Green House Gaison ka aayanmandal par prabhav*. He also received the IInd prize for best presentation.To encourage the participants the organisers presented all the participants Rs.2000/-.

The Hindi Officer also participated in the 12th International Hindi Sangosthi organised by Gujarat Vidyapith, Ahmedabad during 8-9 December, 2001 and delivered a talk on *Prodyogiki ki Sahayata se Hindi ka Prasar*.

The Hindi section attended the *Rajbhasha Sammelan* at Mumbai, on 29 March, 2002, organised by Deptt. of Official Languages and Hindi workshops held by various Deptts. like United Insurance, SAC, SISI, NTC, Door Darshan and Aakashvani and delivered lectures on different topics.

PRL celebrated the **National Science Day**, in association with the Indian Physics Association (IPA), Ahmedabad Chapter. The Science Day was dedicated to teachers and students from high schools. Science

Quiz, both written and oral, formed the main part of the programme. The science quiz was open to students of Stds. IX and X from schools all over Gujarat. Two hundred and thirty three students participated in the written science quiz. PRL presented science kits to top eighteen students from the written science quiz and popular science books to the three best teams in oral quiz.

Wealth from Waste was the theme for the National Science Day for this year. Accordingly, **Dr. Jagdish Baro**t from World Health Organisation, Gandhinagar was invited to deliver a talk on the above subject. The talk was highly informative and evoked a lot of interest in students and teachers. Keeping in view of the new directions in the research conducted in PRL, two interesting talks on Excitements in Planetary Sciences and New Facts on Mars were presented by our scientists.

PRL Scholarships from the Aruna Lal Endowment Fund, established by Prof. D.Lal, Honorary Fellow and former Director, were awarded to five students on the basis of their performance in Science Quiz, both written and oral, and personal interview. All the five students are to receive Rs.5000/- per year for three consecutive years provided the students continue to study in science stream with high academic record.

Awards and Honours

1. **Prof. U. R. Rao** has been awarded the

   i. *Life Time Contribution Award in Engineering* for the year 2001 from *Indian National Academy of Engineering,* New Delhi.

2. **Dr. K. Kasturirangan** has been awarded the

   i. *International Collaboration Accomplishment Award 2001* by the International Society for Air Breathing Engines (ISOABE), Bangalore.

   ii. *Rathindra Puraskar for the year 1999* by Visvabharati, Santiniketan.

   iii. *4th Sri Chandrasekarendra Saraswati National Eminence Award* by the South Indian Education Society, Mumbai

   iv. *The Degree of Doctor of Sciences* (Honoris Causa) by Calcutta University, Kolkata.

   v. *The Degree of Doctor of Sciences* (Honoris Causa) by Gurunanak Dev University, Amritsar.

3. **Prof. G. S. Agarwal** has been :

   i. awarded the *INSA Albert Einstein Centenary Research Professorship*.

   ii. awarded the *M.N. Saha Birth Centenary Award* by Indian Science Congress.

   iii. invited to be a *Member of Editorial Board* for Journal of Optics B: Quantum and Semiclassical Optics, 2003.

   iv. invited to be a *Fellow of the Institute of Physics, London* for a year.

4. **Prof. N. Bhandari** has been elected *Fellow of the Indian National Science Academy*, New Delhi.

5. **Dr. S.V.S. Murty** has been elected *Fellow of the Indian Academy of Sciences*, Bangalore.

6. **Prof. A.K. Singhvi** has been elected *Fellow of the National Academy of Sciences*, Allahabad.

7. **Dr. S. K. Gupta** has been elected a *Fellow of the National Academy of Sciences*, Allahabad.

8. **Prof. S. Krishnaswami** has been invited to be :

   i. a *Member of the Editorial Board* of Proc. Ind. Acad. Sci. (Earth and Planetary Sciences).

   ii. a *Member of the Editorial Board* of Indian Jour. Marine Sciences.

   iii. an officer (Treasurer) of the International Geosphere and Biosphere Programme.

9. **Prof. J.N. Goswami** has been invited to be a *Member of the Advisory Editorial Board* of *Earth and Planetary Science Letters* (Elsevier)

10. *Three* of the eight *optics postcards of the Institute of Physics, Bristol, U. K. for the year 2002* were designed from coloured images off a paper by **J. Banerji** co-authored with R. M. Jenkins and A. R. Davies.

11. **Dr. Vinai K. Rai** has been invited to chair the scientific session *Let there be Ureilites* at the 64th Meteoritical Society Meeting in Rome, September 10 -14, 2001

12. The paper ^{187}*Re* - ^{187}*Os systematics of Black Shales from the Vindhyans: Implications to their Chronology* by **Sunil K. Singh, Santosh K. Rai and J.R. Trivedi,** presented at the 10th ISMS workshop on Mass Spectrometry, held at Puri during February 25 to March 1, 2002, received the *First Prize in the Research Scholar section*.

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Theses Submitted during 2001-02

1. **E.A. Kherani**

   "Investigations of Equatorial F-region plasma in stabilities under different background conditions" (2001).

2. **Rajesh Agnihotri**

   Chemical and isotopic studies of sediments from the Arabian sea and the Bay of Bengal (2001).

3. **Rajneesh Bhutani**

   ^{40}Ar-^{39}Ar thermochronological study of the trans-Himalaya in Ladakh sector, India (2001)

4. **Koushik Dutta**

   Study of marine processes in the northern Indian Ocean using radiocarbon (2001).

5. **Kuljeet K. Marhas**

   Isotopic studies of refractory phases in primitive meteorites by an ion-microprobe (2001)

6. **V.K. Rai**

   Nitrogen isotopic systematics in ureilites (2001)

7. **Tarun K. Dalai**

   Major ions, stable isotopes, $^{87}Sr/^{86}Sr$ and Re in the headwaters of the Yamuna: Implications to chemical weathering in the Himalaya (2002)

8. **M.G. Yadava**

   Stable isotope systematics in cave calcites: Implications to past climatic changes in tropical India (2002).

9. **R. Sankaranarayana**

   Studies on time dependent and stationary classically chaotic quantum systems (2002).

Scientific/Technical Reports Submitted

1. **Vishal N. Shah, Vinod Namboodiri, K. P. Subramanian and A. P. Gohil**

   "Remote Controlling of Tektronix DSO by IBM-PC using GPIB Interface", PRL-TN-79-2001.

2. **R. E. Amritkar and D. R. Kulkarni**

   "Application of Chaotic Dynamics to Communications through Synchronization", PRL TN-80-2001.

3. **A. Bhatnagar**

   "Study of Solar Oscillations Phase I, II, III from 1990 to 2001", Report on the INDO-US Collaborative Project.

4. **P. Venkatakrishnan, D. P. Choudhary, A. Ambastha, S. C. Tripathy and N. Srivastava**

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5. **S. K. Bhattacharya, R. J. Francey, D. V. Borole, C. E. Allison, P. Steele and Ken Masarie**

   "Isotope aided studies of atmospheric carbon dioxide and other greenhouse gases, Phase II", *Technical Document of International Atomic Energy Agency*, IAEA-TECDOC-1269, 81-89 (2001).

Invited Papers Presented in Symposia/Schools in 2001-02

Astronomy and Astrophysics

1. "Near - Infrared Investigations of Star Forming Regions", *21st Meeting of Astronomical Society of India*, IUCAA,**Pune**, February 5-8, 2002,by **B.G. Anandarao**.

2. "Understanding the Sun-Earth Connection", *XII National Space Science Symposium, Barkatulla University*, **Bhopal**, 25-28 February 2002, by **P. Janardhan**

3. "The Active and Explosive Sun", *UGC Refresher Course in Physics*, ML Sukhadia University, **Udaipur**, October 25, 2001, by **Ashok Ambastha**.

4. "Can Geoeffectiveness of CMEs be Predicted?", at the *21st Annual ASI* meeting held in **Pune** during Feb 5-8, 2002 by **Nandita Srivastava.**

5. "New Insights into Solar Magnetic Activity", at *National Space Science Symposium*, **Bhopal**, February 25-28, 2002 by **P. Venkatakrishnan**.

Theoretical Physics

Astrophysics

6. "Advection Dominated Flows around Rotating Compact Objects", at the *International Conference on General Relativity and Gravitation* (GR16), **Durban**, South Africa, July 2001, by **A.R. Prasanna**.

7. "Electromagnetic Fields on Curved Spacetimes", at the *International Workshop in General Relativity*, **Durban**, South Africa, July 2001, by **A.R. Prasanna**.

8. "Inertial Forces in General Relativity", at the *International Workshop on Mach's Principle and Origin of Inertia*, Indian Institute of Technology, **Kharagpur**, February 6-8, 2002, by **A.R. Prasanna**.

Atomic and Molecular Physics

9. "Analytical Evaluation of Quantum Mechanical Matrix Elements for High Rydberg States", at the *Two-day Symposium on Recent Advances in Mathematical Physics*, Calcutta University, **Kolkata**, March 12-13, 2002, by **D.P. Dewangan**.

10. "Jacobi Polynomial Method for Transition between Rydberg States", at the *International Conference on Current Developments in Atomic, Molecular and Chemical Physics With Applications (CDAMCP)*, Department of Physics and Astrophysics, University of Delhi, **Delhi**, March 20-22, 2002, by **D.P. Dewangan**.

High Energy Physics

11. "CP Violation in Open tt Production at a Linear Collider", at the *4th ACFA Workshop on Physics/ Detector at the Linear Collider*, **Beijing**, October 31-November 2, 2001, **S.D. Rindani**.

12. "U(1) Symmetry and R Violation", at the *7th Workshop on High Energy Particle Phenomenology (WHEPP-VII)*, Harish-Chandra Research Institute, **Allahabad**, January 4-15, 2002, by **Rishikesh Vaidya**.

Nonlinear Dynamics & Computational Physics

13. "Neural Networks and Their Applications", **four** talks at the *Instructional Workshop On Soft Computing with MATLAB* at M. S. University, **Baroda**, January 7-12, 2001, by **D. R. Kulkarni**.

14. "Synchronization of coupled map networks", at the *Conference on Dynamics of Networks and Spatially Extended systems*, held at Saha Institute of Nuclear Physics, **Kolkata**, January 21-23, 2002 by **R. E. Amritkar**.

15. "Chaos and Quantum Entanglement", at *Second Winter School on Quantum Computation and Information*, held at S. N. Bose National Centre for Basic Sciences, **Kolkata**, January 2-11, 2002 by **A. Lakshminarayan.**

Laser Physics and Quantum Optics

16. "Multiparticle Entanglement using Cavities" at the *School on Quantum Physics and Information Pro-*

cessing (QPIP-02), TIFR, **Mumbai,** February 18, 2002, by **G. S. Agarwal.**

17. "Controlling Light by Light - Stoppage, Storage and Superluminal Propagation of Light" at *Golden Jubilee Year* of the Indian Institute of Technology, **Kharagpur,** January 9, 2002**,** by **G. S. Agarwal.**

18. "Entanglement Non-locality and Non-classical Interference Effects in Radiation from Trapped Atoms" at *2nd International Conference on Foundation of Quantum Theory and Quantum Optics*, S. N. Bose National Centre for Basic Sciences, **Calcutta,** January 3-11, 2002**,** by **G. S. Agarwal.**

19. **Inaugural address** on "Quantum Entanglement" at *National Laser Symposium*, **Indore** , December 19, 2001, by **G. S. Agarwal.**

20. "Controlling Light by Light - Stoppage, Storage and Superluminal Propagation of Light", at the *67th Annual Meeting of the Indian Academy of Sciences*, **Tirupati,** November 9-11, 2001, by **G. S. Agarwal.**

21. "Heisenberg's Uncertainty Relations and Quantum Optics" at conference *on 100 years of Werner Heisenberg - Works and Impacts,* Bamberg, **Germany,** September 26-30, 2001, by **G. S. Agarwal.**

22. "Traversal of Ultra-Cold Atoms through Vacuum Induced Potentials" at the *7th International Conference on Squeezed States and Uncertainty Relations* (ICSSUR-2001), **Boston, USA,** June 4-8, 2001, by **G. S. Agarwal.**

23. "Freezing and Unfreezing Dynamical Evolution by Co-herent Fields" at the *International Workshop and Seminar on Coherent Evolution in Noisy Environments*, Dresden, **Germany**, , May 21-25, 2001, by **G. S. Agarwal**.

Planetary Atmospheres and Aeronomy

24. "In-situ Measurements of Electron Density and Electric Field Fluctuations over Low Latitudes", at the *National Space Science Symposium,* 25-28 February, 2002, **Bhopal** by **H. S. S. Sinha**

25. "Space Science", at the *International Course on Application of Space Science and Technology for Social Scientists* organized by CSSTEAP and Dept. of Space at Space Applications Centre, December 6, 2001, **Ahmedabad**, by **H. S. S. Sinha**.

26. "Overview of Space Science and Applications", at *6th RS & GIS Course of CSSTEAP*, October 5, 2001, **Dehradun** by **H. S. S. Sinha**

27. "CRABEX", *National Workshop on Recent Developments in Atmospheric and Space Sciences*, University of Roorkee, **Roorkee**, March 19-21, 2001, by **Harish Chandra**.

28. "Space Weather Studies at PRL", *Space Weather Workshop*, Boston College, **Boston**, June 7-8, 2001, by **Harish Chandra**.

29. "Long Term Changes in Ionosphere at Low Latitudes", *10th Quadrenial STP meeting* at Longmont, **Colorado, USA**, June 17-22, 2001, by **Harish Chandra**.

30. "Spread-F at Tropical Latitudes in the Indian and American Longitudes", *SIRI Workshop*, San Jose Dos Campos, SP, **Brazil**, June 25-29, 2001-07-17, by **Harish Chandra**.

31. "Aerosol Radiative Forcing and Climate Feedback" at the *Workshop on Aerosols, Cloud and Climate*, 9-13 July 2001, IISc., **Bangalore by A. Jayaraman**.

32. "Knowledge Gaps in Aerosols and Radiation", *Brainstorming Workshop on INDOEX*, 17-21 September 2001, IIP, **Dehradun**, by **A. Jayaraman**.

33. "Cruise Observations of Aerosol Properties over Indian Ocean" at the *International Symposium on Global Aerosol Climatology Database,* 13-14 October 2001, **Portland, USA**, by **A. Jayaraman**.

34. "What Have We Learnt during INDOEX and the Gap Areas" at *the INDOEX Brainstorming Session*, 12-13 December 2001, Calcutta Univ**.,** **Kolkatta** by **A. Jayaraman**.

35. "Aerosol Radiative Forcing over the INDOEX Region" at the XII *National Space Science symposium*, 25-28 February 2002, Barkatullah Univ., **Bhopal**, by **A. Jayaraman**.

36. "Aerosols and Radiation" (**three** lectures) at the SERC School on *Mathematical Modeling of Air Pollution*, 28-29 May 2001, Bangalore Univ., **Bangalore** by **A. Jayaraman**.

37. "Aerosol Cloud Interaction and Climate Feedback of Aerosols", (**three** lectures) at the *2nd SERC School on Cloud Physics and Atmospheric Electricity*, 7 June - 5 July, 2001, IITM, **Pune** by A. Jayaraman.

38. "Vertical Distributions of Trace Gases in the Upper Troposphere and Lower Stratosphere and their Applications", *8th Scientific Assembly of IAMAS*, Innsbruck, **Austria**, July 2001 by **S. Lal**.

39. "Atmospheric Chemistry- Knowledge Gaps", *INDOEX Workshop*, **Dehradun**, 18-21 September. 2001 by **S. Lal**.

40. "Composition, Structure and Dynamics of the Atmosphere" (**3 lectures**), *First SERC School on Mathematical Modelling of Atmospheric Pollution*, held at Bangalore university, **Bangalore**, May 15-16, 2001 by **S. Lal**.

41. "Trace Gases and Gas to Particles Conversion Processes" (**2 lectures**), *Second SERC School on Cloude Physics and Atmospheric Electricity-Frontiers*, Indian, Institute of Tropical Meteorology, **Pune**, 11-12 June, 2001 by **S. Lal**.

42. "General Structure and Properties of the Atmosphere and Stratospheric Ozone" (**2 lectures**), *Refresher Course in Environmental Science and Engineering* at Guru Jambheshwar University, **Hisar**, 2-3 November, 2001 by **S. Lal**.

43. "Structure of the Earth's Atmosphere and Trace Gases" (**2 lectures**), *Refresher Course in Physics at Mohan Lal Sukhadia University*, **Udaipur**, 1-2 Nov., 2001 by **S. Lal**.

44. "Trace Gases, Ozone Depletion and Global Warming" (**3 lectures**), *Centre for Space Science and Technology Education in Asia and the Pacific region (CSSTE-AP)* affiliated to the United Nations, IIRS, **Dehradun**, April 2-3, 2002 by **S. Lal**.

45. "Solar Wind Absorption into Martian Atmosphere", in *XII National Space Science Symposium*, **Bhopal**, February 25-28, 2002 by S**.A. Haider**.

46. "Upper Atmosphere Electrodynamics", in *Third winter school on MST radar* at **Tirupati** 2001 by **R.Sekar**.

47. "Plasma Instability Models in the Equatorial F Region of the Ionosphere" in *16th National Symposium on Plasma Science & Technology* at **Guwahati** , December 2001 by **R.Sekar**.

Earth Sciences and Solar System Studies

48. "Mystery of the Origin of the Moon" at Astronomical Society of India meeting, **Pune**, February 5, 2002, by **N. Bhandari**.

49. "Heavy Nitrogen and Nucleogenic Kr and Xe in Itawa Bhopji Chondrite" at 64th Meteoritical Society Meeting, Rome, Italy, Sept . 10-14, 2001, by **S.V.S. Murty**.

50. "Noble Gases in Individual Chondrules of Dhajala: A Laser Microprobe Study" at 64th Meteoritical Society Meeting, **Rome**, Italy, Sept. 10-14, 2001, by **S.V.S. Murty**.

51. "Solar System Research at PRL" at Refresher Course to College Teachers of Gujarat, S.P. University, **Vallabh Vidyanagar**, Jan. 1-15, 2002, by **S.V.S. Murty**.

52. "Current Trends in Solar System Research" at National Space Science Symposium-2002, Bhopal, Feb.25-28, 2002, by **S.V.S. Murty**.

53. "Past Monsoon Variations over Peninsular India Deciphered using Margin Sediments from the Eastern Arabian Sea: Role of AMS ^{14}C dating",

10th ISMAS Workshop, Thoshali Sands, **Puri**, Feb 25-Mar 1, 2002, by **B. L. K. Somayajulu.**

54. "Quantitative Reconstruction of Paleomonsoon from Cave Calcites", "12*th Mid-year Meeting of the Indian Academy of Sciences*, **Bangalore**, July 7, 2001 by **R.Ramesh**.

55. "Application of stable carbon and nitrogen isotopes in climate studies" at the Agricultural University, **Bangalore**, March 9, 2002 by **R.Ramesh**.

56. "Stable isotopes as tools in paleoclimatic research," *PAGES Workshop*, IITM, **Pune**, May 2001 by **R. Ramesh**

57. "Nuclear and Chemical Dating Techniques: Interpreting the Environmental Records", *PAGES Training Workshop on Paleoclimatic Methods*, IITM, **Pune**, May 14 - 19, 2001, by **M.M. Sarin**.

58. "Sediment Trap and ^{234}Th methods for Carbon Export Flux Determination" *SCOR Working Group (No. 116) Meeting*, July 8 - 10, 2001, **Amsterdam, The Netherlands**, by **M.M. Sarin**.

59. "Chemical & Isotopic Characterization of Aerosols", *Aerosol, Clouds & Climate Workshop*, July 10 - 13, 2001, IISc., **Bangalore**, by **M.M. Sarin**.

60. "Carbon and Nutrient Fluxes in Marginal Seas and Tropical Coastal Zones", *Continental Margin Task Team (CMTT) Workshop*, September 27 - 29, 2001, **Taipei, Taiwan**, by **M.M. Sarin**.

61. "Past 150000 years of Thar Desert", **Review talk** at the 150th year celebration of GSI during the *Symposium on the Role of Earth Sciences in Integrated Development and Related Societal Issues*, November 1-3, 2001, **Lucknow**, by **A.K. Singhvi**.

62. **Invited** training course lecture on "Luminescence Dating: Principles, Applications and Prognostics", *International Conference on Global Correlation of Late Cenozoic Fluvial Sequences*, December 2001, IIT, **Kanpur**, by **A.K. Singhvi**.

63. "Terrestrial and Marine Records of Climatic change in India", *International Seminar on Austral-Asian Pole-Equator-Pole transect,*. November 2001, **Singapore**, by **A.K. Singhvi**.

64. "Ca-K and Al-Mg studies of CAIs from CH and CR chondrite" at 64th Meteoritical Society Meeting, **Rome**, Italy, September 10-14, 2001, by **G. Srinivasan**.

Lectures given at Workshop on

Meteorites, Asteroids and Planets

Dec. 15-21, 2001, at Mt. Abu, PRL,

organised by Indian Space Research Organisation.

Name	No. of Lectures	Topics
J.N. Goswami	4	Extinct nuclides records in solar system objects, Planets of other/extra solar system, Nucleo synthesis processes, Laboratory studies of Planetary material.
N. Bhandari	3	Origin of the Solar System, Remote sensing of planets, Planetary Science Exploration - Indian perspective
S.V.S. Murty	3	Cosmic Ray effects on solar system objects, Study of Inner Planets, Atmospheres of terrestrial planets
G. Srinivasan	3	Kuipers belt objects, Heat sources for planets and Asteroids, Meteorites and Early Solar System
P.N. Shukla	2	Evolution of Moon, Trace elemental studies
J.R. Trivedi	2	Evolution of life in the universe, Radiogenic Isotopes used to understand Planetary Processes
A. Ambastha	2	Structure of the Sun and Structure and Dynamics of the solar corona
T. Chandrasekar	2	Observational Aspects of Asteroids, Observations of Outer Planets and their Satellites
N.M. Ashok	2	Minor Objects in the Solar System, Origin and Evolution of Comets
Kanchan Pande	1	Dynamic planets
H. Dave	1	High Resolution Spectroscopy for Planetary wind & Composition Measurements
H. Chandra	1	Lidar Probing of Upper Atmosphere
S. A. Haider	1	Role of Solar Wind on Mars.