Jubilee Function of Department of Physics St. Thomas College, Thrissur

Key Note Address
by

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- His Excellency Mar Raphael Thattil; Manager
- Former Principal Rev. Dr. Devassy Panthalookaran,
- Principal Dr. P O Jenson,
- Prof. K M Paul, Head of the Department of Physics
- Prof. P L Anto, Convenor of the Ceremony
- Prof. P C Thomas
- Prof C K Xavier
- Mr. M O Daison
- Mr. John Clint
- Erudite Faculty Members;
- Distinguished Invitees;
- My dear Students;
- Friends from the Media;
- Ladies & Gentlemen …

1. I sincerely appreciate the affection and honour bestowed by this Centurion institution in inviting me to be a part of the momentous occasion of Jubilee Celebration of the Department of Physics. I must congratulate one and all stakeholders of the Institution in this moment of glory and wish it scales greater heights in the years to come. This is yet another occasion to reverentially remember and pay tributes to the visionary *Rt. Rev. Adolphus Edwin Medlycott*,

the first Vicar Apostolic of Thrissur, who founded this College way back in 1889.

2. I sense a hint of great excitement and joy to step into St Thomas College, an icon of learning in this region that has unearthed and nurtured an array of illustrious alumni who played pivotal role in the making of modern India through their contributions in diverse fields. Friends, I am proud to mention my father learned Physics here during the 1930's in these very class rooms. Certainly one is touched by this moment of recognition.

3. In the early days, the pioneering work of the great men of physics has enabled us to better understand the world around us, the world inside us, and the world beyond us. Physics challenges our imaginations with concepts as simple and fundamental as gravity, yet is intriguing and mysterious to say that gravity bends light or imprisons light in a black hole. Like mathematics, physics is also the very fundamental building block on which modern science is built upon. Man's insatiable quest for knowledge and understanding of the world has led to several scientific theories and from these theories, new technologies are invented. We can see the

deep relationship between discovery in physics and new technology for the common man. It is indeed heartening to note that this institute has been delivering great men of science to the society for nearly a century.

4. Friends, I feel nostalgic. A young graduate from Government Engineering College, Thrissur, I joined Vikram Sarabhai Space Centre of ISRO 39 years back when the Indian Space programme was then in its nascent phase.

5. Space is the last frontier for the human race. The study of space involved the study of our expanding universe starting from about 100 km above the earth surface, called the Karman line, to inter-planetary, inter-stellar, and inter-galactic space and beyond.

5.1. Here, we strive to find answers to the basic questions such as: Where do we come from? Where are we going to? And finally, are we alone in the universe? Space platforms provided excellent opportunities to study the expanse around us, and through the several windows of the electromagnetic spectrum, helped us overcome the limitations imposed by the atmosphere.

5.2. In this process, we are confronted by the technological complexities required by the humankind to explore the space, to reach to space defying the gravitational force of the Earth and the vagaries offered by the atmosphere, to be there withstanding the harsh and unforgiving space environment and to return from there safely conciliating the thermal stresses during the re-entry into the atmosphere. A satellite needs to attain a velocity of about 7.5 km per second to reach a polar sun-synchronous orbit of about 700 km to view the earth periodically and discerning small objects, for example your car on the road.

5.3. In the 20th century, exploration and discovery have been pioneered mainly by the Russians and the Americans - the Sputnik and Apollo being the early milestone achievements, powered by the passion of the cold war and space race. The Russian theoretician Tsiolkovski and the American physicist Godard were the pioneers of rocketry and astronautics in that era.

5.4. A very humble beginning of the Indian Space endeavor was made in the small building of Mary Magdaline Church situated in a fishermen hamlet near Thiruvananthapuram. Our founder Dr. Vikram Sarabhai started the voyage with a strong vision and a few hundred bright, sharp and motivated young souls; oven-fresh from their colleges and universities. He took the mandate of shaping the then Prime Minister Pandit Jawaharlal Nehru's national vision of utilizing science & technology to find the solution to the real problems of common man. Evidently, he was successful in sermonizing and enshrining the vision to his team. We were blessed with the most inspirational experience of seeing Indian Space Programme evolving into a huge family providing price-less and self-less service to the nation.

5.5. Today, India can be proud of an application driven space programme for the society at large that is fully operational and regarded as the most innovative one in the world. We have successfully developed a sound indigenous base in terms of multitude of technologies and infrastructure required for producing

reliable space transportation systems and best-in-the-class satellites, which is sought after even by the European Satellite operators. When Chandrayaan-1 was put precisely in an orbit of 100 km around the moon about two years back, it was the beginning of a new era for the country, demonstrating our technological prowess in several disciplines.

6. Let us understand that at this juncture of the 21st century, we stand at a unique time in our exploration of the heavens. Chandrayaan mission has enabled the detection of water on the Moon. Elsewhere, robotic probes have found traces of water on the planet Mars. A mission to Jupiter has revealed that oceans are likely to be underlying the icy surfaces of that planet's moons. Astronomers have discovered over 100 planets circling other stars. Together, these findings indicate that our universe may be more habitable than previously known. Worldwide, the exploratory voyages of the next few decades have the potential to answer many age-old questions within our lifetimes.

7. This is where Space Astronomy comes in place. Observing platforms in space opened new spectral windows for

astronomical observations, overcoming the limitations imposed by the atmosphere. Space based astronomy not only collects photons in all regions of the electromagnetic spectrum to image deep space phenomenon, but also uses spectroscopic methods to characterise the incoming radiation.

7.1. Special instruments capable of detecting X-rays and cosmic rays have revealed exotic objects like the neutron stars, black holes and gave insight into stellar evolution. X-ray telescopes give us insight into high-energy objects like pulsars and quasars.

7.2. Hubble telescope has been emphatically successful in probing into extreme deep space in the visible spectrum, revealing unseen pictures of stellar cycles and galactic motions.

7.3. We retrieve high energy gamma ray information and try to understand the interaction between cosmic radiation and inter-stellar gas in galaxies, explosive events like gamma ray bursts and the phenomenon near remnants of supernova and black holes.

7.4. The ultra-violet spectral range, which is strongly absorbed by the atmosphere, can be collected by orbiting spacecraft to detect very hot objects such as young stars, white dwarfs, neutron stars and supernova.

7.5. Observation of full IR spectrum is possible only from space which provides deep penetration into cosmic dust clouds and reveals star formation. Also, cooler processes, such as planetary formation, can be detected in the IR spectrum from space.

8. In most cases astronomical observation satellites do not impose heavy demands on the orbit except in certain specific cases where we may need to, for example, observe the sun from the sun-earth Lagrangian points for large durations.

9. The first dedicated Indian Astronomy Satellite Mission ASTROSAT, planned to be launched in 2011 in an orbit around Earth at an altitude of 650 km and 8 degree inclination, will enable multi-wavelength observations of the celestial bodies and cosmic sources in X-ray, spectral bands simultaneously.

10. Wherever required, space objects such as planets and asteroids can be closely observed using remote sensing robotic missions or human presence based on the given mission scenario. Planetary samples are required to be returned to earth for detailed investigations, but this calls for extensive technology developments. Also, to study the local planetary geo-magnetic fluxes, it may be required to send spacecrafts to specific locations.

11. The Chandrayaan-2 mission, planned for 2013, is expected to improve further our understanding of the origin and evolution of moon using (a) instruments onboard an orbiter and (b) in-situ analysis of the samples collected by a rover put on the lunar surface.

12. The space environment has to be carefully characterised before sending a spacecraft and it must be thoroughly designed and tested on ground for the expected environments.

    12.1. The very first striking difference in space is hard vacuum and issues such as out-gassing, static discharge, free molecular aerodynamic drag etc. These are important and require to be characterised.

12.2. Above the atmospheric range, in the magnetosphere, the local properties are governed by the earth magnetic field. Beyond the magnetopause, interplanetary space is dominated by the solar wind.

12.3. On earth, the atmosphere protects us from dangerous radiation; in fact it enables the very existence of life. But this radiation absorption is also an impediment to space research.

12.4. The solar wind from the sun comprise of 99% protons, helium nuclei and electrons. Solar storms or solar disturbances cause much higher energy in the range of 1MeV. Charged atomic particles may enter the magnetosphere and get trapped in the Van Allen belts with energies up to 10keV. This has a diabolic potential to the orbiting spacecraft and must be carefully tread.

13. YOUTHSAT, a microsatellite built by students from Universities of India and Moscow to study space weather is scheduled to be launched by the forthcoming flight of PSLV.

14. Space is an ideal laboratory enabling fundamental experiments, orders of magnitude more accurate than on earth eliminating the influence of gravity and seismic noise and other interactions.

    14.1. High precision experiments and astronomical observations of increasing sensitivity offer a chance to learn about the microscopic and macroscopic structure of the universe.

    14.2. Some of the advantages of undertaking space based experiments are: (a) longer interaction times required for atomic studies; (b) long distance measurements for studying gravitational waves, large changes in velocity; (c) low noise and low vibration environment; (d) higher potential differences and so on. These have enormous applications in relativistic physics, atomic physics, quantum physics, cosmology and high energy physics.

15. The International Space Station (ISS) is a standing example of an orbiting laboratory, serving as a platform for dedicated experiments. Since the early days of Skylab and the Apollo-

Soyuz mission, research on metallic materials and crystal growth has been an integral part of micro-gravity research.

15.1. We know that all fluids exert hydro-static pressure on earth and this has a substantial influence in metallurgy research on earth. Gravity plays an important role in crystallisation or solidification of flowing metals, since convection induced in the liquid will change the heat and mass transportation. The challenge of material research and the advantage offered by space environments lies precisely here.

15.2. In the upcoming re-entry mission scheduled for 2011, we are instituting micro-gravity metallurgy experiment during the earth orbit phase.

16. The earth system comprising of the land, its core, oceans and atmosphere can be observed from space either directly via electromagnetic spectrum emitted or reflected by the object of interest or indirectly by the measurement of gravity and magnetic fields. Progress in the understanding of the earth's climate and environments has been accelerated by the Earth Observing satellites that have made revolutionary

changes in the way we manage our natural resources and monitor our environment or combat natural disasters today.

17. One of advantages of space platforms is the possibility for global, long term observation in both horizontal and vertical profiles. This unravels the delta level interferences by the human on the atmosphere on a global scale, for example the effect of fertilisers applied by farmers in producing green house gases, ozone depletion and so on.

    17.1. Changes in the Essential Climate Variables pertaining to Atmosphere, Land and Ocean can be observed from space platforms. Typically upper air temperature, water vapour, Wind Vector, Cloud Cover, Glacier and Snow, vegetation and land cover, ocean colour, sea level sea state are just to name a few.

    17.2. Considering the scope and impact of space systems in climate monitoring, India has evolved a satellite-based observation system and networking with appropriate institutional networking.

18. Considering the requirements of high quality manpower for the growth of space science activities as well as for attracting faculty and students in national space science research programmes, ISRO has established a space science promotion scheme for supporting these activities in selected universities having national representation and regional distribution.

19. Friends, utilising the plethora of precious data beamed by these space missions and improving our understanding of the solar system is a long and arduous. And the national challenges are to be negotiated by the bright and sharp minds of inspired young friends like you.

20. While engaging in this exciting field of space exploration that I elucidated now, the bedrock of our future space endeavour would still be space applications for the benefit of common man and society and in realisation of space systems for this purpose.

21. The younger generation must play the crucial role in realising India's aspiration for global leadership and I am sure you will rise to the occasion. Mahatma Gandhi said, and I quote: *"The difference between what we do and what we are*

capable of doing would suffice to solve most of the world's problems". I strongly believe, we need to heed this message to realise our fullest potential.

22. I would like to conclude re-iterating my heartfelt best wishes to this bright audience. It was a pleasure talking to you and I thank the organisers for rendering me the opportunity to share my views with all of you.

Thank you all.