Astronomische Gesellschaft

The AG was founded in 1863 in Leipzig as an international society dedicated to the 'advancement of science by means of supporting projects which require systematic cooperations of many people'.

The primary activities of the AG are the organization of scientific meetings and conferences, the promotion of young astronomers, awarding of medals and prizes in recognition of outstanding scientific works, awarding of honorary membership, the publication of scientific literature, the fostering of public relations, and the promotion of astronomical education at schools and of the general public.

At present the AG has more than 800 members.

For further information see http://www.astro.uni-jena.de/Astron_Ges/.

Astronomische Nederlands Satelliet (ANS)

First Dutch satellite, launched in August 1974. Operated until 1977. Carried x-ray and ultraviolet instruments. Discovered x-rays from cool dwarf (UV Ceti) stars and the first x-ray burster.

Astronomisches Institut der Universität Würzburg

Part of the ancient university of Würzburg in Bavaria, southern Germany. It specialized in stellar dynamics, star formation studies and solar physics. It is in the process of reorganization.

For further information see http://www.astro.uni-wuerzburg.de/homepage.html.

Astronomy

The science of the universe, its constituent bodies and phenomena. Arguably the oldest of the sciences, its beginnings go back to the dawn of recorded history, to the time when mankind first began seriously to study the apparent motions of the Sun, Moon and planets and to identify patterns and cycles in their behavior. Astronomy found practical application in providing the basis for calendars, timekeeping and navigation, but is now essentially a pure science.

Astronomy is primarily an observational science rather than an experimental one. Whereas in physics or chemistry, for example, it is possible to set up experiments under controlled conditions, to change those conditions and measure the outcomes, in astronomy, apart from using satellites and spacecraft to explore our immediate locality, it is not possible to carry out experiments on stars and galaxies. Instead, astronomers mainly rely on collecting and interpreting information that arrives from astronomical sources in the form of electromagnetic radiation and particles in order to formulate and test hypotheses and theories. Ground-based astronomy is hampered by the atmosphere, which—even under ideal conditions—transmits to ground level only a small fraction of the complete range of electromagnetic radiations (the electromagnetic spectrum). Until the middle of the twentieth century, astronomy was carried out almost exclusively at visible (optical) wavelengths. Since then, ground-based astronomers have extended their observations into the radio and infrared regions of the spectrum (only limited quantities of infrared radiation reach ground level) and to the detection of particle radiations (neutrinos and cosmic rays). During the past four decades or so, with advances in space technology, astronomers have been able to explore planets and the interplanetary medium directly with the aid of spacecraft and, most significantly, to place instruments in orbit above the atmosphere, thereby gaining access to virtually the entire electromagnetic spectrum from gamma rays to radio waves.

In a few cases, astronomers can handle samples of cosmic material—neutrinos, meteorites, interstellar particles, Moon material, soon (possibly) dark matter astroparticles. Gravitational waves are also in the future of astronomy.

The fundamental types of observation that astronomers can carry out include astrometry (the measurement of positions and motions), photometry (the measurement of brightness and brightness changes), imaging and spectroscopy (the detailed analysis of the spectrum of radiation arriving from an astronomical source).

See also: astrology, astrometry, astrophysics, electromagnetic radiation, electromagnetic spectrum, gamma-ray astronomy, infrared astronomy, optical astronomy, neutrino astronomy, radioastronomy, ultraviolet astronomy, x-ray astronomy.

Astronomy and Astrophysics in India

The growth in astronomy and astrophysics (A&A) in India has been mostly since the country achieved independence in 1947. The present work is carried out in a few select research institutes and in some university departments. The Astronomical Society of India has around 300 working A&A scientists as members, with another 50–60 graduate students.

Facilities

In the institutional sector, the major facilities include the Vainu Bappu Optical Telescope of 2.3 m diameter and a 1 m telescope at Kavalur in South India, under the management of the Indian Institute of Astrophysics (IIA) at Bangalore, a 1 m telescope at the Uttar Pradesh State

Observatory (UPSO) at Naini Tal in the foothills of the Himalayas and a 1 m infrared telescope at Gurushikhar in southern Rajasthan under the management of the Physical Research Laboratory (PRL), Ahmedabad. Solar telescopes exist in Kodaikanal in southern India, at the UPSO in Naini Tal and in Udaipur, the first being managed by the IIA and the third by PRL.

In the 1960s radio astronomy entered in a big way with a 550 m parabolic cylindrical antenna being set up on a north–south hill slope near the southern hill resort at Ooty, the axis of the cylinder being parallel to that of the Earth. This telescope is operated by the TATA INSTITUTE OF FUNDAMENTAL RESEARCH (TIFR), in Mumbai, which now has just completed an even more ambitious project known as the Giant Metrewave Radio Telescope (GMRT) at Khodad, about 90 km from Pune. Controlled and operated by its NATIONAL CENTRE FOR RADIO ASTROPHYSICS (NCRA) at Pune, this system has 30 antennas, each of 45 m diameter, spread over a Y- shaped array of arms about 14 km long. It works optimally at meter wavelengths. At lower frequencies (34.5 MHz), there is a T-shaped radio array at Gauribidnur near Bangalore operated jointly by the IIA and the Raman Research Institute (RRI), Bangalore. Indian astronomers have erected a similar array in the island of Mauritius. The RRI also has a 10 m dish for millimeter wave astronomy at its headquarters in Bangalore.

Space astronomy in India began with cosmic ray research under H J Bhabha at TIFR and later under V A Sarabhai at PRL. A national balloon facility at Hyderabad caters to the various balloon borne experiments. This activity blossomed into a fully fledged space program which now routinely launches satellites and prepares payloads of a commercial as well as a scientific nature. Its headquarters are at the Indian Space Research Organization at Bangalore.

In the university sector, the only significant working facility is the 1.2 m telescope at the Japal Rangapur Observatory under the control of Osmania University, Hyderabad. A major resource facility for the universities was, however, set up in 1988 by the University Grants Commission (UGC), New Delhi, at Pune. Known as the Inter-University Centre for Astronomy and Astrophysics (IUCAA), this center provides an excellent resource library in A&A, an advanced computer centre with A&A-related software, a data centre and an instrumentation laboratory. These facilities can be used by visiting academics and students from universities with their travel funding met by grants provided by the UGC at IUCAA. The IUCAA also assists university academics in using observing facilities in India and abroad under the various guest observing programs.

There are three new optical telescopes under various stages of construction. The IUCAA will have a 2 m telescope near Giravali, about 70 km from Pune, whereas the IIA is planning to set up a 2 m telescope at Han Le, at a height of 4000 m near Ladakh in the northern Himalayas. The UPSO and TIFR are jointly planning to set up a 3 m telescope in Devasthal, near Naini Tal.

Research areas

INDIAN ASTRONOMY has traditionally been working in stellar astronomy and spectroscopy, solar and planetary astronomy. However, in the last three decades of the 20th century it has expanded its range to include solar physics including solar oscillations, pulsar astronomy and modelling, problems in cosmic ray and high-energy astrophysics, gravitational lensing, extragalactic astronomy and cosmology. The Ooty Telescope was responsible for a major survey of angular sizes of radio sources through the lunar occultation method. Theoretical cosmology has ranged from abstract mathetical models in general relativity (for India has always had a strong school in general relativity) to fitting models to observations of discrete extragalactic source populations. Thanks to a less rigid outlook towards alternatives to mainstream ideas, these have flourished in India more than they have in the West.

Indian astronomy has made its presence felt internationally. The late Vainu BAPPU was President of the International Astronomical Union, while several Indian astronomers have occupied positions of Presidents of various IAU Commissions.

Jayant Narlikar

Astrophysical Bounds on Particle Properties

Ever since NEWTON proposed that the Moon on its orbit follows the same laws of motion as an apple falling from a tree, the heavens have been a favorite laboratory for testing the fundamental laws of physics, notably Newton's and EINSTEIN's theories of gravity. More recently, astrophysics and cosmology have become crucial testing grounds for the microcosm of elementary particles. This area of scientific inquiry is part of a discipline often called astroparticle physics or particle astrophysics. There are a few important cases where unexplained astrophysical phenomena can be attributed to new elementary particles or new properties of known particles; the solar neutrino deficit and the dark matter problem are cases in point. Here, another widespread method will be discussed, where one uses established properties of stars or even the universe at large to constrain possible modifications caused by novel properties of elementary particles.

Neutrino masses

One of the earliest astrophysical particle limits is the cosmological bound on the masses of the three known NEUTRINOS, the electron, muon and tau neutrino ν_e, ν_μ and ν_τ. The main idea is that these particles, in spite of their weak interactions, must have been thermally produced in the hot and dense early universe and thus form a 'cosmic neutrino sea', much like the 3 K cosmic microwave background radiation. A detailed calculation reveals a present-day density of neutrinos plus antineutrinos of