

An outlook of atomic and molecular physics and its applications in space science and technology at IIST

Indian Institute of Space Science and Technology (IIST) is Asia's first space university under the aegis of the Dept. of Space, Govt. of India. IIST is a relatively young institute of just 15 years of age, having 100 faculty members across seven academic departments and approximately 1000 students, including undergraduate, postgraduate and Ph.D. students. Nearly 1,500 IIST alumni students are serving as scientists and engineers in the Indian Space Agency, ISRO. In addition, being part of the Dept. of Space, Govt. of India, IIST has strong research overlap with ISRO. Therefore, IIST has been giving support to ISRO in the fields of propulsion, plasma propulsion, structures and materials, communication and control, remote sensing and atmospheric sciences.

Research in the domain of atomic and molecular physics (AMP) has a much focussed but very strong presence at IIST. There are three laboratories led by Prof. Umesh Kadhane, Dept. of Physics, IIST, which covers a swath of science and engineering activities derived from AMP and applied to space science and technology.

1) Atomic and molecular physics (AMP) laboratory:

The main focus here is to understand how the molecules of life are produced and processed in Space. This is achieved with the help of various instruments and facilities which re-create the solar high-energy radiation environment in the lab. The experiments are mainly based on the multi-coincidence mass spectrometric measurements. Three such facilities are developed at IIST for laser, electron impact and ion trap experiments. Extreme UV experiments are not possible at the moment in IIST; hence, the GASPHASE beamline at Elettra is used for EUV experiments.

2) Electric propulsion diagnostics lab. (EPDL)

Plasma propulsion, more commonly known as electric propulsion in Space, is perhaps the most efficient propulsion technology known to humans today. The Indian space agency is also developing such engines for communication satellites and interplanetary missions. EPDL is responsible for the plasma and beam diagnostics of the engines in ground testing as well as onboard the satellite. EPDL has developed several technologies and test facilities for this purpose. These instruments are then installed and operated at the ISRO facilities while testing their plasma engines.

In order to understand the interaction of the thruster plasma with the satellite components and body, EPDL also performs several simulations and tests with plasma sources in the lab.

3) Sensors and Payloads Development lab. (SPDL)

With the in-house capability of plasma and beam diagnostics research, SPDL focuses on developing and launching various types of plasma probes to the earth's ionosphere. SPDL has already completed two space missions successfully, and two more are in the process of production. One of the payloads under development is slated to be integrated with India's first Venus mission in the coming years.

The AMP lab in IIST has taken a strong nationwide initiative to combine laboratory molecular physics, the origin of life in a solar system and Space technological capabilities of India to envisage and propose future research in the domain of "Genesis and evolution of molecular life in space". A meeting of nearly 300 national and international researchers was held at IIST in February 2023 to discuss the policies and plans for this domain. The next meeting is planned to be conducted in January 2024.