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Investigating cosmic rays and gamma ray bursts

The present century has witnessed many revolutions in astronomical techniques. Gone are the days when all the information about the Universe used to be collected through a narrow band of the electromagnetic radiation spectrum, for which we are endowed with a natural detector—the human eye. First to appear outside this restricted channel was cosmic rays, discovered by Hesse in 1912, followed by radio and infrared, and then higher energy radiations with the opening up of the space window. In this issue we have two excellent articles reviewing two of such new techniques, giving first hand knowledge from their own scientific efforts.

'Cosmic rays', named by Millikan shortly after the discovery, is not a happy choice, as the pair of words conceal two misconceptions about the phenomena: These are not rays, but streams of very high energy particles, and we are still at a loss to understand their origin. To confound the issue further 'primary cosmic ray' particles are not directly detectable from ground being extensively modified by our atmospheric envelope. So, efforts were made over decades to hoist instruments up by balloons, rockets, satellites and space probes beyond our near space environment. In this direction the Indian collaborative effort 'Anuradha' has been a remarkable success; the story of its conception, design, fabrication and flight in a space shuttle has been described (**page 721**) by the leader of the project team, unfolding some glimpses of new findings of the nature of these particles.

The second topic covers the very high energy radiations from some cosmic sources; the article has been written by a team of scientists from ISRO who themselves have made considerable contributions. Gamma ray bursts were serendipitously discovered from some satellite experiments in late sixties; the observations had posed a puzzle, and ever since efforts towards unfolding their secrets are being pursued. The Indian scientific team has designed, fabricated new instruments and have them installed in two of their multi-purpose satellites. The article (**page 732**) describes the mystery surrounding the phenomena and suggests new efforts needed for understanding them.

J. C. Bhattacharyya

Going beyond the Born–Oppenheimer description

One of the greatest challenges to chemical theory is the derivation of molecular level understanding of macroscopic properties. Two types of computational methods are currently employed for this purpose. First, single molecules or small clusters of them are studied using quantum chemical methods. Although the systems consist of interacting nuclei and electrons, a common approach is to treat the problem in stages. For a given frozen nuclear configuration, the electronic energy is computed. The process is repeated for different geometries to obtain a multi-dimensional potential energy surface. The problem of what the nuclei do in such a surface is solved subsequently. When a large collection of molecules is involved, Monte Carlo and Molecular Dynamics represent the best methods to use. The range of geometric configurations the system can adopt is generated by a Boltzmann sampling or by solving Newton's equation of motion. Of course, these calculations often use empirical potential functions and do not necessarily rely on PE surfaces derived from quantum chemical calculations.

An alternative computational strategy is becoming increasingly popular. It is to treat nuclear and electronic motions at the same time. The energetics of a system as it dynamically responds to changes in nuclear and electronic coordinates is evaluated using Quantum Monte Carlo methods. Technical details as well as computational nuances of these procedures are reviewed by C. Chakravarty (**page 739**). Some representative applications of the methods to interesting chemical problems are also discussed.

J. Chandrasekhar

Fighting oxidative damage with vitamin C

Linus Pauling's enthusiastic espousal of the use of mega doses of vitamin C for staving off the common cold and cancer may not have found much favour in the scientific establishment. The Pauling campaign however promoted the widespread use of vitamin C and millions around the world probably have their own tales to tell of the benefits of regular consumption. The vitamin itself was first discovered accidentally, with the discoverer, Albert Szent-Györgi having no pretensions to belonging to the heroic tribe of vitamin hunters of the early decades of this century. Indeed, Szent-Györgi irreverently christened the white crystals, 'ignose' ('ig' for ignorance and 'ose' for sugar). Hexuronic acid and ascorbic acid were names that came later. While vitamin C was originally identified as the anti-scurvy factor its biochemical functions are diverse, stemming almost exclusively from its anti-oxidant properties. Oxidative processes are associated with many degenerative conditions and aging; unsurprisingly antioxidants are frequently touted as the universal panacea against a wide spectrum of physiological disorders.

In India, research on the biosynthesis of ascorbic acid was pioneered in the 1950s by B. C. Guha in Calcutta. This tradition has been well maintained in many of the researches on vitamin C that are described by I. B. Chatterjee and coworkers on **page 747**.

P. Balaram