In this issue

Musings on The Prize

The reading of the accounts of the remarkable scientific achievements of six Nobel Prizemen of 1993 (Physics, page 5 by D. Bhattacharya; Chemistry, page 6; and Physiology or Medicine, page 8, both by Umesh Varshney) was responsible for some of these random thoughts. Many often ask why there is no Nobel Prize for Mathematics, the queen of the sciences. Alfred Nobel took a very dim view of mathematicians and their activities after his wife eloped with a mathematician! Strangely Astronomy and Astrophysics were also excluded from the Prize for a long time probably because at that time these subjects were not considered to be in the cutting edge of science. In the late forties Raman was keen on nominating S. Chandrasekhar (the Astrophysicist of Chicago) for the Nobel Prize. Chandrasekhar seems to have been not in favour of this move for various reasons, including the fact that Astronomy and Astrophysics were not subjects for which the Prize was given. Raman is known to have muttered: 'He thinks I want to propose his name for the complicated calculations he makes in Astrophysics; No, it is for the new physics his work is and will generate.' Raman seems to have seen the importance of Chandrasekhar's early work which was not recognized by the astronomers of that time but for which he later, in 1976, got the Prize. Raman knew of the suggestion of Zwicky and Baade on the formation of neutron stars: Raman's perception had some connection with his reading the papers of Oppenheimer with Serber (1938) and with Volkoff (1939) in *Physical Review*. This too prompted him to ask Homi Bhabha (who had just come back to India) to take up the study of neutron stars, as he felt Bhabha was amongst the few he knew who understood particle physics.

Till today seven Radio Astronomers have been awarded the Nobel Prize but no optical Astronomer is still in the list. Reliable rumours say that Hubble (who measured the red shift which led to the concept of the expanding universe) was selected by the Nobel Committee for the Prize for *Physics*. He could not be awarded it as he died in late September 1953 and Nobel Prizes are not given posthumously. The Nobel Committee then, we are told, quickly selected Frits Zernicke, the discoverer of the phase contrast microscope principle, for the 1953 Prize.

This year's Nobel Prize for Physics goes to Joe Taylor and his graduate student Russel Hulse 'for the discovery of a new type of pulsar, a discovery that opened up new possibilities for the study of gravitation'. One recalls that Einstein in his classic paper made many predictions and courageously ended the paper stating that if anyone of these was found experimentally untrue his theory should be rejected. It has been a triumph all the way; Arthur Eddington discovered the deflection of star light by the sun's gravitational field; Pound and Rebhka observed the gravitational red shift in the earth's field; Shapiro detected retardation of light using satellites, planets and stellar radio sources; Joseph Weber started his quest to detect gravitational radiation without success.

Finally Taylor and Hulse found a binary pulsar. At last 'Nature suddenly started to flaunt General Relativity'. These pulsar observations indicate the incredible accuracies astronomical measurements are capable of.

For example the frequency of the Taylor-Hulse pulsar (PSR1913+16) was 16.940539184253(1) Hz (cycles per second). The eccentricity of ellipse is 0.6173089(4). The precession of the major axis of the ellipse is 4.22662(1) *degrees per year*, compared with the miniscule value for Mercury which precesses at *43 seconds of arc per century*. These measured precession rates agree well with General Relativity. By combining all these data Taylor and his group got the masses of the two neutron stars to be 1.4410(5) and 1.3874(5) solar masses. After two decades of measurement Taylor showed that the frequency of the pulsar changed by $-2.47583(1) \times 10^{-15}$ Hz per second. This decrease again agrees with Einstein's theory, the slowing down being due to gravitational radiation that the system emits. 'What makes the binary pulsar *sparkle* is its spectacular display of gravitational radiation—This evidence is a *true* first for General Relativity and puts the pulsar in a class by itself.' Taylor patiently studied PSR 1913+16 for almost 20 years, assisted by a few students, post-doctorals and collaborators worked with modest instrumentation at the Arecibo facility; *it was small science at its very best.* In what appears to be the unglamorous search for hundreds of pulsars, Taylor had the remarkable vision to notice one that was truly a gem—a laboratory in space which seems to have been designed to study General Relativity and he exploited it.

Equally exciting are the inventions that changed the very face of Molecular Biology and Molecular Genetics for which this year's Nobel Prize for Chemistry was given. With the polymerase chain reaction (PCR) technique of Kary B. Mullis scientists can detect the tiniest trace of genetic material, and with the site-specific mutagenesis of Michael Smith one can alter the very structure of a genetic material at will.

Mullis calls himself a maverick (dictionary meaning (US)-a strong animal without an owner's brand) who studied anything that interested him. For instance, while working as a biochemist graduate student he published a paper in *Nature* entitled 'The cosmological significance of time reversal'. After his doctorate (in biochemistry) he joined a private company, Cetus Corporation, where he discovered the polymerase chain reaction. For this he was given a bonus of US $ 10,000 and the company sold its right to Hoffmann La Roche for US $ 300 million! Today Mullis has abandoned mainstream science for a life of consultancy, surfing and rollerblading. A colleague stated 'It is exciting to see that a professional community recognizes one who is completely non conformist but who has made a major contribution'. Mullis himself says that 'this time the Prize recognizes the significance of a finding and not the work of individuals during their life time'.

It is interesting to read what Mullis wrote about his discovery, seven years after the ideas flashed across his mind.

> Sometimes a good idea comes to you when you are not looking for it. Through an improbable combination of coincidences, naivete and lucky mistakes, such a revelation came to me one Friday night in April 1983, as I gripped the steering wheel of my car and snaked along a moonlit mountain road into northern California's redwood country. That was how I stumbled across a process that could make unlimited number of copies of genes, a process now known as the polymerase chain reaction.
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> Beginning with a single molecule of the genetic material DNA, the PCR can generate 100 billion similar molecules in an afternoon. The reaction is easy to execute: it requires no more than a test tube, a few simple reagents and a source of heat. The DNA sample that one wishes to copy can be pure, or it can be a minute part of an extremely complex mixture of biological materials. The DNA may come from a hospital tissue specimen, from a single human hair, from a drop of dried blood at the scene of a crime, from the tissues of a mummified brain or from a 40,000-year-old woolly mammoth frozen in a glacier.
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> In the seven years since that night applications for PCR have spread throughout the biological sciences; more that 1,000 reports of its use have been published. Given the impact of PCR on biological research and its conceptual simplicity, the fact that it lay unrecognized for more than 15 years after all the elements of its implementation were available strikes many observers as uncanny.

Michael Smith's contribution has become one of the backbones of molecular biology. The genetic code is programmed into the DNA molecule and this determines the number and sequence of the amino acid in a protein. This in turn determines the functional properties of the protein. His method makes it possible to reprogramme the genetic code and hence to replace specific amino acids in the protein. With this 'site-directed mutagenesis' one can study the structure and function of the protein which has changed fundamentally. Therefore constructing proteins with brand new properties, i.e *designing* new proteins is now possible. The sky seems to be the limit. For example one may improve the stability of proteins so that they can be used at higher temperatures or pressures in technical processes, tailor-made antibodies that can attack cancer cells or alter proteins to create faster growing crop strains. One side-line that is almost funny is that when Smith sent his epoch-making paper to the very reputed journal *Cell*, the editor rejected it saying 'It is a technical development but not of general interest'. Smith was never able to persuade the journal to publish the paper!

In this issue we do not review the work of the Nobel Prize for Economic Sciences. The 1993 Nobel Prize has been awarded jointly to Robert W. Fogal of the University of Chicago and Douglass C. North of the Washington University 'for having renewed research in economic history by applying economic theory and quantitative methods in order to explain economic and institutional change'. They are economic historians and are pioneers in the branch, now called the 'new economic history' or cliometrics. They have contributed greatly to our knowledge and understanding as to how, why and when economic change occurs.

After this one wonders whether a Nobel Prize for History would be instituted. Of course in 1953 it was awarded to one who did write history, Winston Churchill. The award was nominally for literature possibly because he could not be given the prize for peace.

S. R.