In this issue

Chandrasekhar—scientist extraordinary

A few articles about S. Chandrasekhar—the astrophysicist of Chicago, the Nobel prize-winner, a founder Fellow of the Indian Academy of Sciences—appear in this issue. Originally it was not planned this way. We decided to publish (**page 10**) the introduction to Volume VI of his *Selected Works* by his collaborator Basilis Xanthopoulos who was recently killed in Crete. There was a delay and during this period we received the *book review* of Kameshwar Wali's biography of Chandrasekhar by G. Srinivasan (**page 50**) which we had commissioned. We therefore decided to publish both these in the same issue and later on we added other bits and pieces.

Chandrasekhar is one of the greatest theoretical physicists who ever lived, says Freeman Dyson who has himself contributed greatly to theoretical physics in recent times. This is praise indeed. Chandrasekhar has contributed immensely to many fields in physics, astrophysics and applied mathematics: the theory of stellar structures, radiative transfer, stochastic processes, dynamical friction, hydrodynamical stability, general relativity, black holes, etc. He usually begins by solving a major scientific problem and works in that area for a few years and by publishing a large number of scientific papers he literally cleans up the field, and finally presents the entire subject in the form of a tome which then becomes a *classic*.

Very few scientists have had the previlege of being a subject of a biography during their lifetime, but to be a subject of one, of the quality Wali has produced is truly a great honour. Wali's book reads like a novel. To make it dramatic he uses the Eddington episode as the pivot for his thesis that anything that Chandrasekhar has done since then is due to the effect of that incident; straight and simple—black and white. Further to make it read like a novel he almost avoids talking much about serious science. One wishes he tells us more of the remarkable problems of radiative transfer which seems to have given Chandrasekhar himself infinite joy; what the central problem in the ellipsoidal equilibrium is; or for that matter the excrutiatingly beautiful result he obtained when two gravitional waves collide.

Of the many scientific biographies this is the one to which the cliche 'One is compelled to read it from cover to cover at one sitting' can be applied. Yet one feels a little sorry for Wali. For when his masterpiece is reviewed, the reviewer usually cursorily dismisses his book with a few words and writes a long essay on Chandrasekhar. This, of course, is a tribute to the gripping manner in which the biographer has presented his subject. The gentle Wali, friendly and self-effacing might not really mind all this. Many say his subject is so marvellous that he cannot but write a great biography. We disagree. We have read innumerable biographies of great scientists which are often quite indifferent or even boring. We feel that Wali has earned a place amongst the great biographers like Emil Ludwig or André Maurois. He has written a biography full of imaginative interpretations and psychological insights.

Yet when one goes through this enchanting work a doubt does arise whether all this is fact or fiction. Is it a rhapsodic praise of a votary towards his *Ishtadevata*? Wali too wonders, 'Is it more like a memorial to a living person than a biography?'. When Weisskopf was asked to list the weaknesses and flaws of Chandrasekhar, he says 'none, none... nothing of vanity, nothing of pushing, nothing of publicity-seeking... his deep education, his humanistic kind approach... his knowledge of world literature.... You would never find another physicist or astronomer so deeply civilized'. It is remarkable that in the competitive American scientific community which has no respect for personalities, Chandrasekhar is described as almost without the flaws of lesser men. He himself quotes, 'beauty is associated with strangeness of proportion', so it may be with greatness. The only hint that Wali gives us that there must be other sides to Chandrasekhar's personality is from what Donna Elbert, who assisted him for 30 years says, 'I could never understand how someone who is so rational in his work can be so upset and irrational about nonscientific matters'.

All this is not of much importance, Kameshwar Wali has written a magnificent biography. We are grateful to him for giving us an incredible view of this scientist *non pareil* and a glimpse into the workings of his unique mind.

Geometrical theory of diffraction

Isaac Newton in spite of his having discovered the celebrated Newton's rings would not ascribe wave nature to light. The wave theory was firmly established when Thomas Young sent light from one source through two slits and demonstrated the existence of bright and dark fringes, bright where the crests of the two waves add up and dark where the crest of one wave gets cancelled by the trough of the other. Light can therefore bend round obstacles and get diffracted producing beautiful patterns. The textbook theory of diffraction associated with the names of Huygens, Fresnel and Kirchhoff takes a direct approach of summing up the contributions from the whole aperture. This can become cumbersome even for simple shapes like a triangle (see cover picture) if one wants analytical solutions and physical insights. Obviously a physical approach is necessary and Thomas Young himself gave us such an approach—that the diffraction pattern arose due to the *interference* between the transmitted wave and the wave scattered by the edge. This became simplified later on in that the edge wave could be replaced by radiations from a few poles or corners. So the diffraction pattern arises due to the interference of the waves from these poles. Using simple interference conditions, rulers and compasses the diffraction patterns of complex figures like a one-anna coin, now extinct, (see cover) can be deduced. Many great opticians have been involved in establishing the theoretical basis of this simple and elegant approach. Sunil Kumar and G. S. Ranganath (**page 22**) tell us of this exciting story of discovery and rediscovery, some authors not knowing what the others have done. The paper also contains hints of new paths that can be followed.

An address label

All eukaryotic cells contain organelles, which have distinct functions. These organelles, e.g. endoplasmic reticulum, lysosomes, peroxisomes, mitochondria, chloroplasts and the nucleus, import many proteins from the cytoplasm, where the proteins are synthesized on free polysomes. An average cell synthesizes 10,000 or more different proteins, each of which is predetermined to reach a specific location in the cell. The signals for the transport of proteins to the organelles are often encoded in the amino-acid sequence of the proteins.

The signals for the sorting of proteins to mitochondria, chloroplasts, secretory vesicles, etc. are generally a stretch of amino acids located at or near the NH_2-terminus of the proteins. Until recently, there was virtually no information on the transport of proteins into peroxisomes. Suresh Subramani and his colleagues have made a breakthrough into the topogenesis of peroxisomal proteins by combining the techniques of cell biology and molecular biology (**page 28**). With the demonstration that firefly luciferase was localized within peroxisomes in the cells of the firefly lantern, Subramani and his colleagues began to use cloned firefly luciferase gene as a reporter to elucidate the process of protein import into peroxisomes. Transfection of monkey kidney cells with the cloned luciferase gene, followed by immunofluorescence tracking of the gene product demonstrated that the protein, foreign to the monkey kidney cells, was targeted to peroxisomes. Extension of these studies to other eukaryotic cells revealed that luciferase was transported to peroxisomes in yeasts, plants, insects and mammals, implying that peroxisomal sorting of proteins was highly conserved throughout evolution. Deletion of a stretch of 12 amino acids from the carboxy terminus of luciferase rendered the mutant protein incapable of targeting itself to the peroxisomes. Conversely, attachment of the C-terminal sequences to non-peroxisomal proteins by recombinant-DNA techniques yielded fusion polypeptides that were transported to peroxisomes. Further dissection of the targeting signal indicated a motif composed of three amino acids, serine–lysine–leucine, which was found in the C-terminus of a number of peroxisomal proteins. These studies have assumed significance in view of the presence of peroxisomal membrane ghosts with aberrant organelle assembly in Zellweger syndrome, a human genetic disorder that results in neurological impairment. With the novel experimental approaches developed by Subramani and his colleagues a number of questions relating to the mechanism of recognition of the topogenetic signal and the transport of proteins through the lipid bilayer of the peroxisomal membrane can now be answered.

Spin–statistics connection

The quantum mechanical spin of a particle is a form of intrinsic angular momentum and coming in integral (e.g. photon) or half integral (e.g. electron) multiples of the Planck's constant divided by 2π. The statistics also comes in two varieties—that proposed by Boss (for photons) which encourages multiple occupancy of a state and that by Fermi and Dirac which forbids any more than one electron (say) in one state. One of the landmarks of relativistic quantum theory is that these two apparently unrelated notions become correlated uniquely. According to the spin statistics theorem (proposed by Pauli amongst others), his integer spin implies Fermi statistics and integer spin, Bose statistics. The work reviewed in the article by R. Ramachandran (**page 18**) is another way of looking at this theorem. Relativity is implicit in the deceptively intuitive form of world lines which can be bent and cut off in a manner made famous by the late Richard Feynman. Notions of topology and group theory come to the fore. And spin–statistics theorem emerges not at the drop of a hat but at the twist of a belt as those who heard the lecture (at Bhubaneswar), on which this article is based, can testify.

Antimalarial drug

It is the dream of X-ray crystallographers that from the information they get from three-dimensional structures of drug molecules they will not only get to know how these act and also to design new molecules with the desired pharmacological activity. The mechanism of action of antimalarial drugs like chloroquine and amodiaquine is still quite unclear. Of the several potential mechanisms DNA intercalation is one. The crystal structure of amodiaquine has been determined (**page 39**) which reveals many interesting intermolecular features. From modelling studies, it is conjectured that the molecule could in fact bind to DNA by intercalation of the chloroquine chromophore between the base pairs.

Buckminsterfullerene

Buckminsterfullerene (Bf, C_{60}) the new allotrope of carbon shaped like a geodesic dome has been one of the great surprises to both physics and chemistry. The latest is that doping films of Bf with potassium renders it conducting. Cooling the doped material to 18 K makes it superconducting. When the dopant is changed to rubidium, the transition temperature rises to 28 K. Only $Ba_{0.6}$, $K_{0.4}$, BiO_3 or cuprate superconductors have higher transition temperatures! G. Baskaran and E. Tosatty (**page 33**) present a theory of the normal and superconducting states of doped solid Bf. They make use of the resonant valence bond theory of superconductivity which is usually applicable to two-dimensional systems. However, Bf has a two-dimensional $p\pi$-electron system. The exchange of intermolecular excitons results in a narrow-band model, which according to the authors could explain the observed superconductivity. There is also a note (**page 8**) which reviews the latest data on the crystal structure of the doped Bf crystals.