Editorial

K L Sebastian, Chief Editor

Email: kls@ipc.iisc.ernet.in

This issue of *Resonance* features one of the most influential scientists of all time – Niels Bohr, who proposed the famous model for the hydrogen atom that is now known by his name. This started off a revolution in the way we think about the atom. Bohr was the leading personality in this development. His model for the atom published as three papers in 1913 in the British journal *Philosophical Magazine* successfully married the ideas of classical mechanics with the quantum concepts of Planck and Einstein to get a very successful model of the atom, which could explain the discrete spectrum of hydrogen atom completely. This was a radical departure from the ideas of classical physics and fittingly he was given the Nobel Prize in Physics for the year 1922, just one year after Einstein was given the Prize for his work on photoelectric effect (which was carried out in 1905).

Bohr's life and work is covered in this issue in an article by N Mukunda, who dwells on all aspects of his life – family, his stay in England and the crucial contact with Rutherford, old quantum theory and his role as a mentor of several young quantum physicists. In another article, Mukunda compares two giants of quantum physics, viz., Dirac and Bohr. The details of the Bohr model are reviewed in the article by Avinash Khare. His model had a tremendous impact in the area, particularly in understanding chemistry as is described by Durga Prasad in his article.

Niels Bohr's famous model for the hydrogen atom started off a revolution in the way we think about the atom.

Bohr suggested his quantization condition for circular orbits. This was taken up by Sommerfeld who went on to generalize the technique to include elliptical orbits, much like the orbits of planets around the sun. The quantization conditions can be understood using what is known as the semi-classical approach to quantum mechanics. This type of approach is quite useful and can be successfully applied in a variety of problems as illustrated in the article by Subhash Karbelkar, who uses it to quantize orbits of charged particles in a magnetic field.

Bohr was a revolutionary in every sense of the word. He was prepared to abandon even the most accepted notions of physics, if the situation demanded it.

After working out the model for H-atom, Bohr continued to work on the development of quantum mechanics and has contributed significantly to it. He established and headed an Institute in Copenhagen which was dedicated to research in this area. It is now known as the Niels Bohr Institute. In addition, he was a mentor to several of the key scientists involved in the development of quantum mechanics. For example, Heisenberg was Bohr's assistant in Copenhagen when he developed the ideas of the uncertainty principle in the year 1927. Bohr had no difficulty in absorbing the principle, and showed that the ideas could be understood easily by a successful combination of classical and quantum arguments. In addition to Heisenberg, others like Max Born, Wolfgang Pauli and Paul Dirac were members at this Institute at various points of time.

Einstein who was unhappy about many of the ideas that were emerging at that time, objected to some of them. This led to arguments between him and Bohr, and it was Bohr and the new quantum theory that always won. These discussions had contributed tremendously to a better understanding of the then newly emerging subject.

Bohr was a revolutionary in every sense of the word. He was prepared to abandon even the most accepted notions of physics, if the situation demanded it. As an example, he had suggested that in beta decay, law of conservation of energy was not obeyed. However, this was proved wrong by the suggestion by Pauli of the then hypothetical particle, the neutrino.

The ideas of Bohr and his group on the new and rather mysterious wave function and its relation to experiments are usually referred to as the Copenhagen Interpretation of quantum mechanics (see the Wikipedia article on the topic for details). As these are the most popular, they are usually referred to as the standard interpretation of quantum mechanics. Some aspects of it have been the subject of quite a bit of controversy. According to this interpretation, the moment a measurement is made the wave function for the system would collapse to an eigenfunction of the measured observable. This leads to problems if one thinks of a super-system, consisting of the system that is being measured and the measuring apparatus. The whole super-system had to obey its own Schrödinger equation, which forbids any abrupt change in the total wave function! This problem has lead to a different interpretation, known as the many-worlds interpretation of quantum mechanics by Hugh Everett III (see Bryce DeWitt, R Neill Graham, Eds, *The Many-Worlds Interpretation of Quantum Mechanics*, Princeton Series in Physics, Princeton University Press, 1973). Another aspect of the Copenhagen interpretation is that the measuring apparatus is assumed to be classical. However, recent results suggest that quantum aspects of the measuring device/surroundings cause the phenomenon of decoherence which plays a very crucial role (see the book by Maximilian A Schlosshauer, *Decoherence and the Quantum-to-Classical Transition*, Springer, 2007).

Bohr had an unusual interest in the philosophical implications of the newly discovered subject of quantum mechanics. One of his major ideas was the concept of complementarity.

Bohr had an unusual interest in the philosophical implications of the newly discovered subject of quantum mechanics. One of his major ideas was the concept of complementarity. According to this, the wave and particle nature of a microscopic object are complementary. One would observe the particle (wave) nature in an experiment designed to probe the particle (wave) nature, but it would not be possible to observe both simultaneously. Bohr with his philosophical bent of mind had no problem in this, but others had. The ideas of complementarity, its historical background and its relevance in the modern context are discussed in an article by Dipankar Home who has done interesting work on this topic. Another famous principle suggested and used extensively by Bohr was the correspondence principle, which is simple to understand. It simply says that in the limit of high quantum numbers, quantum mechanics should reduce to the classical mechanics of Newton.

The Classics item in this issue is an annotated version of Bohr's lecture on biology and atomic physics in which he talks about the problems of understanding life from the perspective of the laws of physics. This annotation has been specially prepared for *Resonance* by Biman Nath. On the whole, the issue covers every aspect of the life and work of Niels Bohr. I hope our readers will enjoy going through the issue.