"… I consider natural science to be very much on the same line as the other trends of learning – or Wissenschaft, to use the German expression – cultivated at our universities and other centres for the advancement of knowledge … You may ask – you are bound to ask me now: What, then, is in your opinion the value of natural science? I answer: Its scope, aim and value is the same as that of any other branch of human knowledge … it is to obey the command of the Delphic deity … 'get to know yourself' ".

Let me hope this little issue of *Resonance* gives you a glimpse of this extraordinary personality.

Erwin Schrödinger – A Sketch

In 1926, Erwin Schrödinger (1887–1961) discovered wave mechanics and presented his celebrated Schrödinger equation. During that year, he published a set of four papers entitled 'Quantisation as an Eigenvalue Problem' in *Annalen der Physik*. The Schrödinger equation was contained in the first of these papers. It was also shown there that it leads to the correct energy spectrum for the hydrogen atom. In the next part, the energy eigenvalues were calculated for a simple harmonic oscillator and for a rotator. Another 'derivation' was also given by considering the mechanics-optics analogy. The perturbation theory for eigenvalues, with an application to the Stark Effect, was worked out in the third part, while the last part dealt with time dependent problems such as scattering, emission and absorption of radiation, etc. In these papers, wave mechanics was thus formulated in essentially the form we know it now. As Max Born said in 1961 "What is more magnificent in theoretical physics than his first six papers on wave mechanics?" And it was about the Schrödinger equation that Dirac had said in 1929 that it provides "the underlying physical laws necessary for the mathematical theory of a large part of physics and the whole of chemistry… ."

Schrödinger at the time of writing these papers had been a full Professor at Zürich since 1920. He was the third occupant of a chair in theoretical physics of which the previous occupants had been Einstein and von Laue. This might give the impression that he was already recognised as a great physicist at that time. It was not exactly so. He had published some thirty or so research papers spread out over the general theory of relativity, X-ray diffraction and statistical mechanics. Surprisingly, there are even four papers on colour theory and vision. The Zürich faculty was impressed rather by his versatility.

Schrödinger says in the preface to his *My View of the World* in 1960 " In 1918, when I was thirty-one, I had good reason to expect a chair of theoretical physics at Czernowitz.... I was prepared to do a good job lecturing on theoretical physics, with, as my supreme model, the magnificent lectures given by my beloved teacher, Fritz Hasenöhrl, who had been killed in the war; but for the rest, to devote myself to philosophy, being deeply imbued at the time with the writing of Spinoza, Schopenhauer, Mach, Richard Semon and Richard Avenarius. My guardian angel intervened: Czernowitz soon no longer belonged to Austria. So nothing came of it. I had to stick to theoretical physics, and, to my astonishment, something occasionally emerged from it". That "something" includes wave mechanics.

Louis de Broglie in his thesis, published in November 1924, had proposed that all particles have a wave nature associated with them and had given a formula relating particle momentum to the associated wavelength. In June 1924, S N Bose had proposed a new statistics, now called Bose or Bose–Einstein statistics, for light quanta to give an entirely novel derivation of Planck's law of black body radiation. Einstein generalised these statistical considerations to material particles soon after in a set of three papers. In the second of these papers, published in 1925, Einstein, while considering number fluctuations, noted that these have two components, one of which is particle like and other is wave like, just as he had found earlier for black body radiation. In this connection, Einstein referred to de Broglie's work, calling it important. Schrödinger was interested in statistical mechanics of ideal gases at this time. Einstein's comments brought de Broglie's work to his attention. As Schrödinger said "wave mechanics was born in statistics".

At Zürich, Debye asked Schrödinger to give a Colloquium report on de Broglie's work and this was given, most likely, on December 7, 1925. Felix Bloch recalls another seminar given by Schrödinger a few weeks later which began with the words "My colleague Debye suggested that one should have a wave equation; well, I have found one!"

It is amazing that quantum mechanics was discovered, almost contemporaneously, in two versions. Heisenberg discovered the 'matrix mechanics' version of quantum mechanics a little earlier than Schrödinger's wave mechanics, in July 1925. The two versions appeared entirely different and it was a mystery as to why they led to the same results. Luckily, their mathematical equivalence was soon established in an important paper by Schrödinger, and simultaneously by Eckart, in March 1926. The announcement of the 1932 and 1933 Physics Nobel Prizes was made together and honoured the founders of quantum mechanics; the prize for 1932 was awarded to Heisenberg, while Schrödinger and Dirac shared that for 1933.

While the mathematical formulation of quantum mechanics soon achieved a final form, the same was not true of the interpretational aspects of it. The 'Copenhagen Interpretation' with its emphasis on acausality, advocated by Niels Bohr and his circle, gradually became the dominant one.

Schrödinger was not very happy with it and once said to Bohr “If all this damned quantum jumping was really here to stay, then I should be sorry I ever got involved with quantum theory”, to which Bohr replied “But the rest of us are extremely grateful that you did. Your wave mechanics has contributed so much to mathematical clarity and simplicity that it represents a gigantic advance over all previous forms of quantum mechanics”.

At Planck’s persuasion, Schrödinger moved to Berlin in August 1927. The Nazis came to power in Germany soon after his Nobel Prize in 1933. Because of his well-known anti-Nazi views, though he was himself not a Jew, he had to leave Germany. He moved to Oxford and from there went to Graz in Austria. In a paper in 1935, after the Einstein–Podolsky–Rosen paper, he brought out rather forcefully the nonlocal aspects of quantum mechanics asserting “I would not call that one but rather the characteristic of quantum mechanics”. In another paper, published in the same year, he introduced the famous ‘’Schrödinger cat paradox” which brings out vividly the nonintuitive nature of the measurement process in quantum mechanics.

In 1938, the Nazis annexed Austria and Schrödinger had to escape from Graz to Rome. At the invitation of de Valera, Prime Minister of Eire and a mathematician, he accepted a professorship at the newly created Institute for Advanced Studies at Dublin. His research at Dublin was mainly in the general theory of relativity.

In Dublin, he also wrote his book *What is Life*? (1944). It “was peculiarly influential” and “attracted people who might otherwise not have entered biology at all” according to Crick. His other books on *Space-time Structure* (1950), *Statistical Thermodynamics* (1946) and *Expanding Universes* (1956) are gems of exposition, always emphasising the basis concepts and doing so with brevity. He also returned to his philosophical concerns in his books *Science and Humanism* (1951), *Nature and the Greeks* (1954), and the epilogue of ‘*What is Life?*’. He is a master of graceful and lucid prose style.

In 1956, he returned to Vienna, place of his birth and youth, on a professorship created for him personally. Vienna had a lot of formative influences on him. He was an intellectual in the Viennese mould who did his most influential work in physics but who was equally at ease with theater, classics and philosophy. His books *Mind and Matter* (1958), *My View of the World* (1961) containing ‘What is Real?’ and his earlier Zurich lectures ‘Seek for the Road’, are from this period. He was exposed to the Vedanta in his young days. This influence is clear in all his philosophical writings where he integrates Vedantic formulas such as “tat tvam asi, that thou art” with his own thought.

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