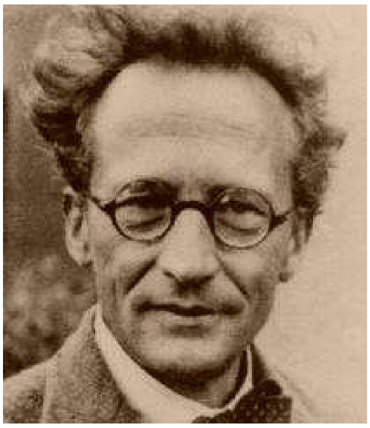


BIOGRAPHY OF E. SCHROEDINGER (1887 - 1961)

born August 12, 1887, Wien, Austria.
died January 4, 1961, Wien, Austria.

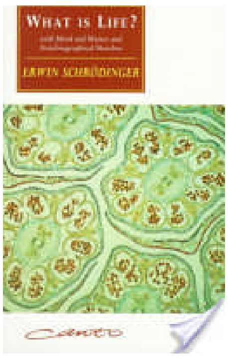
Erwin Schrodinger was one of the main architects of quantum mechanics. Schrodinger developed the wave mechanics. It became the second formulation of quantum mechanics. The first formulation, called matrix mechanics, was developed by Werner Heisenberg. Schrodinger wave equation (or Schrodinger equation) is one of the most basic equations of quantum mechanics.

Schrödinger's Equation

$$i\hbar \frac{\partial}{\partial t} \psi(\mathrm{r}, t) = -\frac{\hbar^2}{2m} \nabla^2 \psi(\mathrm{r}, t) + V(\mathrm{r}, t)\psi(\mathrm{r}, t)$$

i is the imaginary number, $\sqrt{-1}$.
$\hbar$ is Planck's constant divided by 2π: 1.05459×10^{-34} joule-second.
ψ (r,t) is the wave function, defined over space and time.
m is the mass of the particle.
∇^2 is the Laplacian operator, $\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$
V(r,t) is the potential energy influencing the particle.

It bears the same relation to the mechanics of the atom as Newton equations of motions bear to planetary astronomy. However, unlike Newton equations, which result definite and readily visualized sequence of events of the planetary orbits, the solutions to Schrodinger wave equation are wave functions that can only be related to probable occurrence of physical events. Schrodinger wave equation is a mathematically sound atomic theory. It is regarded by many as the single most important contribution to theoretical physics in the twentieth century. Schrodinger book, *What is Life*? led to a great progress in biology.



It is interesting that R. Feynman called the Schrodinger wave equation

$$i\hbar \frac{\partial}{\partial t} |\Psi\rangle = \mathcal{H} |\Psi\rangle.$$

by "THE EQUATION OF LIFE"!

Schrodinger was an unconventional man. Throughout his life he traveled with walking-boots and rucksack and for this he had to face some difficulty in gaining entrance to the Solvay Conference for Nobel laureates. Describing the incident Paul Dirac wrote: When he went to the Solvay Conferences in Brussels, he would walk from the station to the hotel, carrying all his luggage in a rucksack and looking so like a tramp that it needed a great deal of argument at the reception desk before he could claim a room.

Schrodinger was born on August 12, 1887 in Vienna. His father Rudolf Schrodinger, who came from a Bavarian family, which had come to Vienna generations ago, was a highly gifted man. After studying chemistry at the Technical College in Vienna, Rudolf Schrodinger devoted himself for years to Italian painting and then he decided to study botany. He published a series of research papers on plant phylogeny.

Rudolf Schrodinger had inherited a small but profitable business manufacturing linoleum and oilcloth. Schrodinger mother, Georgine Schrodinger (nee Bauer) was the daughter of Alexander Bauer, an able analytical chemist and who became a professor of chemistry at the Technical College, Vienna. Schrodinger was always grateful to his father for giving him a comfortable upbringing and a good education. He described his father as a man of broad culture, a friend, teacher and inexhaustible partner in conversation.

Schrodinger was taught by a private tutor at home until he entered the Akademisches Gymnasium in 1898. He passed his matriculation examination in 1906. At the Gymnasium, Schrodinger was not only attracted to scientific disciplines but also enjoyed studying grammar and German poetry. Talking about his impression at the Gymnasium Schrodinger later said: I was a good student in all subjects, loved mathematics and physics, but also the strict logic of the ancient grammars, hated only memorizing incidental dates and facts. Of the German poets, I loved especially the dramatists, but hated the pedantic dissection of their works. He was an outstanding student of his school. He always stood first in his class. His intelligence was proverbial. One of his classmates commenting on Schrodinger ability to grasp teachings in physics and mathematics said: Especially in physics and mathematics, Schrodinger had a gift for understanding that allowed him, without any homework, immediately and directly to comprehend all the material during the class hours and to apply it. After the lecture…it was possible for (our professor) to call Schrodinger immediately to the blackboard and to set him problems, which he solved with playful facility.

In 1906, Schrodinger joined the Vienna University. Here he mainly focused in the course of theoretical physics given by Friedrich Hasenohrl, who was Boltzmann student and successor. Hasenhorl gave an extended cycle of lectures on various fields of theoretical physics transmitting views of his teacher, Boltzmann.

Schrodinger received his PhD in 1910. His dissertation was an experimental one. It was on humidity as a source of error in electroscopes. The actual title of the dissertation was *On the conduction of electricity on the surface of insulators in moist air*. The work was not very significant. The committee appointed for examining the work was not unanimous in recommending him for the degree. After receiving his PhD, he undertook his voluntary military service. After returning from military service in autumn 1911, he took up an appointment as an assistantship in experimental physics at the University of Vienna. He was put in charge of the large practical class for freshmen. Schrodinger had no love for experimental work but at the same time he valued the experience. He felt that it taught him through direct observation what measuring means. He started working in theoretical physics by applying Boltzmann-like statistical-mechanical concepts to magnetic and other properties of bodies. The results were not very significant. However, based on his work he could earn his advanced doctorate (Habilitation).

At the beginning of the First World War, Schrodinger was called up for active service. He was sent to the Italian border. It was at the warfront that Schrodinger learned about Einstein general theory of relativity and he immediately recognized its great importance. While in war field it was not possible for Schrodinger to keep him fully abreast of the developments in theoretical physics. However, he continued his theoretical work. He submitted a paper for his publication from his position on the Italian front. In the spring of 1917, Schrodinger was transferred to Vienna, where he again could start scientific work.

The First World War resulted in total collapse of the economy of Austria. It also ruined Schrodinger family. Schrodinger had no option other than to seek a career in the wider German-language world of Central Europe. Between spring 1920 and autumn 1921, Schrodinger took up successively academic positions at the Jena University (as an assistant to Max Wien, Wilhelm Wein brother, at the Stuttgart Technical University(extraordinary professor), the Breslau University (ordinary professor), and finally at the University of Zurich, where he replaced von Laue. Soon after arriving at Zurich, Schrodinger was diagnosed with suspected tuberculosis and he was sent to an alpine sanatorium in Arosa to recover. While recuperating at Arosa, Schrodinger wrote one of his most important papers, *On a Remarkable Property of the Quantized Orbits of an Electron*. At Zurich he stayed for six years. This was his most productive and beautiful period of his professional life.

It was at Zurich that Schrodinger made his most important contributions. He first studied atomic structure and then in 1924 he took up quantum statistics. However, the most important moment of his professional career was when he came across Louis de Broglie work. On November 03, 1925, Schrodinger wrote to Einstein: A few days ago I read with great interest the ingenious thesis of Louis de Broglie, which I finally got hold of ... And then on 16th November he wrote: I have been intensely concerned these days with Louis de Broglie ingenious theory. It is extraordinarily exciting, but still has some very grave difficulties. After reading de Broglie work Schrodinger began to think about explaining the movement of an electron in an atom as a wave and eventually came out with a solution. He was not at all satisfied with the quantum theory of the atom developed by Niels Bohr, who was not happy with the apparently arbitrary nature of a good many of the quantum rules. Schrodinger did not like the generally accepted dual description of atomic physics in terms of waves and particles. He eliminated the particle altogether and replaced it with wave alone. His first step was to develop an equation for describing the movement of electrons in an atom. The de Broglie equation giving the wavelength \Lambda=h/mv (where h is the Planck constant and mv the momentum) represented too simple a picture to match the reality particularly with the inner atomic orbits where the attractive force of the nucleus would result in a very complex and variable configuration. Schrodinger eventually succeeded in developing his famous *wave equation*. His equation was very similar to classical equations developed earlier for describing many wave phenomena—sound waves, the vibrations of a string or electromagnetic waves. In Schrodinger wave equation there is an abstract entity, called *the wave function* and which is symbolized by the Greek letter \psi(psi). When applied to the hydrogen atom, Schrodinger wave equation yielded all the results of Bohr and de Broglie. However, despite the considerable predictive success of Schrodinger wave mechanics, Schrodinger had to overcome certain problems. First how he as going to attach some physical meaning to the ideas of an electron if it was nothing but wave and also he had to show what exactly represented by the wave function.

Schrodinger unsuccess- fully tried to account these. He tried to visualize electron as *wave packets* made up of many small waves so that these wave packets would behave in the same way as a particle in classical mechanics. However, these packets were later shown to be unstable. He interpreted the wave function as a measure of the spread of an electron. But this was also not acceptable. The interpretation was provided by Max Born. He stated that the wave function for a hydrogen atom represents each of its physical states and it can be used to calculate the probability of finding the electron at a certain point in space. What does it mean? It means that if the wave function is nearly zero at a certain point then the probability of finding the electron there is extremely small. But where the wave function is large the probability of finding the electron is very large. The wave mechanics cannot be used to determine the motion of a particle or in other words its position and velocity at any given moment. The wave equation simply tells us how the wave function evolves in space and time and the value of the wave function would determine the probability of finding the electron in a particular point of space.

He published his revolutionary work in a series of papers in 1926. Schrodinger wave equation was the second theoretical explanation for the movement of electrons in an atom, the first being Werner Heisenberg matrix mechanics. Schrodinger approach was preferred by many physicists as it could be visualized. On the other hand Heisenberg approach was strictly mathematical and it involved such a complex mathematics that it was difficult to understand. Physicists appeared

to be divided into two groups. However, soon Schrodinger showed that the two theories were identical but expressed differently.
Schrodinger students at Zurich found his lectures extremely stimulating and impressive. One of his students, who attended his lectures, later recalled: At the beginning he stated the subject and then gave a review of how one had to approach it, and then he started exposing the basis in mathematical terms and developed it in front of our eyes. Sometimes he would stop and with a shy smile confess that he had missed a bifurcation in his mathematical development, turn back to the critical point and start all over again. This was fascinating to watch and we all learned a great deal by following his calculations, which he developed without ever looking at his notes, except at the end, when he compared his work on the blackboard with his notes and said this is correct. In summertime when it was warm enough we went to the bathing beach on the Lake of Zurich, sat with our own notes on the grass and watched this lean man in bathing trunks writing his calculations before us on an improvised blackboard which we had brought along. At the time few people came to the bathing beach in the morning and those that did watched us from a discreet distance and wondered what that man was writing on the blackboard.
After the retirement of Max Plank from Berlin University as Professor of Theoretical Physics, three persons were short-listed for the post: Sommerfeld, Schrodinger and Max Born. Schrodinger testimonial drawn up for the purpose beautifully summarised his academic achievements till that time. It said: For some years already he has been favourably known through his versatile, vigorously powerful, and at the same time very profound style in seeking new physical problems that interested him and illuminating them through deep and original ideas, with the entire set of techniques w hich mathematical and physical methods at present provide. He has proved this method of working to be effective in the treatment of problems in statistical mechanics, the analysis of optical interference, and the physical theory of colour vision. Recently he has succeeded in an especially daring design through his ingenious idea for the solution of the former particle mechanics by means of wave mechanics in the differential equation he has set up for the wave function. Schrodinger himself has already been able to deduce many consequences from this fortunate discovery, and the new ideas that he has inspired with it in many fields are even more numerous ...it may be added that in lecturing as in discussions Schrodinger has a superb style, marked by simplicity and precision, the impressiveness of which is further emphasized by the temperament of a South German. Sommerfeld was the first choice and when he declined to leave Munich the offer went to Schrodinger. Even for Schrodinger it was not easy for taking a decision to leave Zurich. Ioan James has written: Every effort was made to persuade him to stay in Zurich. The physics students organized a torchlight parade around the university to the courtyard of his house, where they presented him with a petition. Schrodinger was deeply moved, but in the end it was a personal appeal from Planck that persuaded him to accept the Berlin offer; as the result of doing so he automatically became a German national. Before taking up the appointment at Berlin, Schrodinger traveled to Brussels to attend the Solvay physics conferences. This time the topic was electrons and photons. Schrodinger was invited to deliver one of the prestigious lectures. He took this opportunity to elaborate on his wave mechanics. His views caused considerable debate. Born and Heisenberg attacked it quite vehemently.
Schrodinger joined the Berlin University on October 01, 1927, where he became a colleague of Albert Einstein. The course given by him at the Berlin University was considered the best among the science courses at the University. His style of lecturing was informal. He lectured without notes while many professors at the University practically read their lectures. His dress was also quite informal compared to other professors. He was elected to the Berlin Academy of Science at the age of forty-two. He happened to be youngest member of this august body.
Like many other scientists Schrodinger had to leave Germany after the Nazis seized power. The Nazis had no problems with Schrodinger but it was Schrodinger who did not like policies pursued by the Nazis. In fact Schrodinger disgust for the Nazis was so strong that he was prepared to leave Germany. Initially Scgrodinger thought the Nazi madness will pass over within a couple of years but soon he realized that the Nazis are going to stay in power for a long time. Finally Schrodinger left Germany for Oxford. It was possible for intervention of Frederick Alexander Lindemann (1886-1957), the head of the physics department at Oxford

University and a close friend of Winston Churchill who could persuade Magdalen College, Oxford, to offer Schrodinger a Fellowship. Lindemann had visited Germany in the spring of 1933 to try to arrange positions in England for some young Jewish scientists from Germany. Schrodinger appointment at Magdalen was to be supplemented by a research appointment in industry so that his income became comparable to that of an Oxford professor. The confirmation of his appointment was accompanied by the news that he had just been awarded Nobel Prize in physics, jointly with Paul Dirac. Schrodinger reached Oxford on November 04, 1933. Lindemann and other tried their best to make Schrodinger stay at Oxford comfortable. However, Schrodinger was not satisfied with his status at Oxford. He had received an offer of a permanent position at the Institute of Advanced Studies at Princeton during his visit there in the spring of 1934 for giving an invited lecture. However, finally Schrodinger did not accept the offer.

In 1935 Schrodinger's published a three-part essay on The present situation in quantum mechanics. It was in this essay the much talked about Schrodinger cat paradox appears. This paradox was a thought experiment, where a cat in a closed box either lived or died according to whether a quantum event occurred or not. Schrodinger appointment at Oxford was extended for another two years. But he did not stay there. He left for his own country Austria to take up an appointment at the University of Graz. While waiting for the official confirmation of his appointment at Graz he received an offer of a professorship at Edinburgh. However, the necessary permission for permanent British residence did not come before the official confirmation came from Graz. He finally moved to Graz where he was given a full professorship and also an honorary professorship at Vienna.

While working at Graz, Schrodinger was hoping that eventually he would get an appointment at Vienna. But this did not happen. In 1938, the Nazis extended their anti-Semitic policies pursued in Germany to Austria. The newly appointed Nazi Rector of the University of Graz persuaded Schrodinger to make a repentant confession. The confession began as follows: In the midst of the exultant joy which is pervading our country, there also stand today those who indeed partake fully of this joy but not without deep shame because until the end they had not understood the right course. And it continued in more or less in the same vein. The confession duly appeared in the press. Many of his friends thought that Schrodinger could write such a confession only under pressure. But there was no pressure.

Afterwards Schrodinger, of course, always regretted his decision to write such a confession. Explaining the reason for writing such a confession to Einstein, Schrodinger wrote: I wanted to remain free — and could not do so without great duplicity. Schrodinger attended the celebration of the eightieth birthday of Max Plank, where he was warmly welcomed. But he was no longer acceptable to the Nazi authorities because they did not forget the insult he caused to them by fleeing from Berlin in 1933. His so-called repentant confession was of no use. First he was dismissed from his honorary position at Vienna and then on August 26, 1938 he was also dismissed from his regular post at Graz. The reason cited for his dismissal was his political unreliability. The official in Vienna, whom Schrodinger consulted, advised him to get a job in industry. They also told him that he will not be allowed to leave the country. Schrodinger immediately realized the danger of staying in Austria. So he hurriedly left for Italy. They had no time even to take their belongings with them. They boarded the train to Rome with a few suitcases. Schrodingers were received at the station in Italy by Enrico Fermi, who also lent them some money. From Rome Schrodinger wrote to the Irish statesman Eamon De Valera (1882-1975), then President of the League of Nations (predecessor of the United Nations). Schrodinger met De Valera at Geneva. Devalera offered Schrodinger a position at the Institute of Advanced Studies that he was trying to set up at Dublin. De Valera also advised Schrodinger to leave Italy at the earliest and go for Ireland or England, as according to him the war was imminent. Schrodinger accepted de Valera's offer of appointment at the proposed Institute at Dublin. However, he did not directly proceed to Dublin. Instead he went back to Oxford, where he received an offer of one year visiting professorship at the University of Ghent in Belgium. At Ghent he wrote a significant paper on the expanding universe. From Ghent Schrodinger alongwith his family went to Oxford. Lindemann and others who had earlier welcomed Schrodingers at Oxford was no longer ready to welcome them again. Now Schrodingers were

classed as enemy aliens. But Lindemann made it possible for Schrodingers to reach Dublin in October 1939. Schrodinger adjusted well in the new environs and under his leadership the Institute of Advanced Studies of Dublin became an important centre of theoretical physics. He remained in Dublin until he retired in 1956.
At the beginning of his stay at Dublin, Schrodinger studied electromagnetic theory and relativity and began to publish on unified field theory. As we know Einstein was also working on the same problem at the similarly named Princeton University. In 1947 Schrodinger believed that he had a real breakthrough in his efforts toward creating unified field theory. Schrodinger was so excited about his new theory that he decided to present it to the Irish Academy without examining it critically. Schrodinger announcement was widely publicized in the media as an epoch-making discovery. However, after seeing Einstein comments Schrodinger realized his folly. He was really devastated by the episode. It was certainly a great embarrassment. After this debacle Schrodinger turned to philosophy. His study of Greek science and philosophy is summarised in Nature and the Greeks, which was published in 1954.
Schrodinger most important contribution at the Dublin Institute was his book called *What is Life*?. This was the result of a series of lectures given at the Institute in 1943. The book was published in 1944. It is regarded as one of the most important scientific writings of the twentieth century. Francois Ducheseneau wrote: As a contribution to the Dublin Institute series of public lectures, Schrodinger, who was an engaging speaker, delivered several in February 1943 under the title: What is Life? In these popular scientific lectures Schrodinger, who had only a very slight knowledge of the literature on the physical bases of life, dragged his audience into and then out of a series of blind alleys, leaving them at the end just about where he began. Nonetheless these lectures, printed the following year, achieved an immediate and great reputation with both physicists and biologists, and rank still today as one of the most overrated scientific writings of the twentieth century. The book influenced a good many talented young physicists particularly those who were disillusioned by the destruction caused by atom bombs in Japan and wanted no part in atomic physics. Schrodinger showed these physicists a discipline, which was free from military applications and at the same time very significant and largely unexplored. The book represented the transfer of new concepts of physics into biology. Schrodinger presented a determinist vision of the role of genes. He wrote: In calling the structure of the chromosome fibers a code-script we mean that the all-penetrating mind, once conceived by Laplace, to which every causal connection lay immediately open, could tell from their structure whether the egg would develop, under suitable conditions, into a black cock or into a speckled hen, into a fly or a maize plant, a rhododendron, a beetle, a mouse or a woman. It was Schrodinger who first used the word *code* to describe the role of gene. He also observed that with the molecular picture of the gene it is no longer inconceivable that the miniature should precisely correspond with a highly complicated and specified plan of development.” The book with such passages, written with more insight than that contained in most contemporary biochemical works inspired a generation of scientists to look for such a code and which was eventually found. The book helped to shape the discipline that we call today molecular biology. Michel Morange wrote: Schrodinger book was a remarkable success. Many of the founders of molecular biology claimed that it played an important role in their decision to turn to biology. Gunther Stent, a geneticist (and a historian of genetics), has argued that for the new biologists it played a role like that of Uncle Tom Cabin. Schrodinger presented the new results of genetics in a lively, the book has lost none of its seductiveness: its clarity and simply make it a pleasure to read.
In 1955, Schrodinger returned to Vienna. On his arrival he was treated as a celebrity. He was appointed to a special professorship at the University of Vienna. Though he retired from the university in 1958, he continued to be an emeritus professor till his death. In Vienna he wrote his last book describing his metaphysical views.

Schrodinger died on January 04, 1961. Commenting on Schrodinger personal traits his biographer Walter Moore wrote: Schrodinger was a passionate man, a poetic man, and the fire of his genius would be kindled by the intellectual tension arising from the desperate situation of the old quantum theory…It seems also that psychological stress, particularly that associated

with intense love affairs, helped rather than hindred his scientific creativity.

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Erwin Schrodinger was perhaps the most complex figure in twentieth-century discussions of quantum mechanical uncertainty. In his early career, Schrodinger was a great exponent of fundamental chance in the universe. He followed his teacher Franz S. Exner, who was himself a student of the great Ludwig Boltzmann. Boltzmann used randomness in molecular collisions to derive the increasing entropy of the Second Law of Thermodynamics. Most physicists, mathematicians, and philosophers believed that the chance described by the calculus of probabilities was actually completely determined. The "bell curve" or "normal distribution" of random outcomes was itself so consistent that they argued for deterministic laws governing individual events. They thought that we simply lack the knowledge necessary to make exact predictions for these individual events. Pierre-Simon Laplace was first to see in his "calculus of probabilities" a universal law that determined the motions of everything from the largest astronomical objects to the smallest particles. On the other hand, in his inaugural lecture at Zurich in 1922, Schrodinger argued that the evidence did not justify our assumptions that physical laws were deterministic and strictly causal. His inaugural lecture was modeled on that of Franz Serafin Exner in Vienna in 1908. "Exner assertion amounts to this: It is quite possible that Nature laws are of thoroughly statistical character. The demand for an absolute law in the background of the statistical law — a demand which at the present day almost everybody considers imperative - goes beyond the reach of experience. Such a dual foundation for the orderly course of events in Nature is in itself improbable. The burden of proof falls on those who champion absolute causality, and not on those who question it. For a doubtful attitude in this respect is to-day by far the more natural." Several years later Schrodinger wrote "Fifty years ago it was simply a matter of taste or philosophic prejudice whether the preference was given to determinism or indeterminism. The former was favored by ancient custom, or possibly by an a priori belief. In favor of the latter it could be urged that this ancient habit demonstrably rested on the actual laws which we observe functioning in our surroundings. As soon, however, as the great majority or possibly all of these laws are seen to be of a statistical nature, they cease to provide a rational argument for the retention of determinism. "If nature is more complicated than a game of chess, a belief to which one tends to incline, then a physical system cannot be determined by a finite number of observations. But in practice a finite number of observations is all that we can make. All that is left to determinism is to believe that an infinite accumulation of observations would in principle enable it completely to determine the system. Such was the standpoint and view of classical physics, which latter certainly had a right to see what it could make of it. But the opposite standpoint has an equal justification: we are not compelled to assume that an infinite number of observations, which cannot in any case be carried out in practice, would suffice to give us a complete determination. Despite these strong arguments against determinism, just after he completed the wave mechanical formulation of quantum mechanics in June 1926 (the year Exner died), Schrodinger began to side with the determinists, including especially Max Planck and Albert Einstein. Schrodinger's wave equation is a continuous function that evolves smoothly in time, in sharp contrast to the discrete, discontinuous quantum jumps of the Bohr-Heisenberg matrix mechanics. His equation seemed to Schrodinger to restore the continuous nature of classical mechanics and dynamics. It could be visualized as wave packets moving in space time. Bohr and Heisenberg insisted that visualization of quantum events was not possible. Max Born, Werner Heisenberg's mentor and the senior partner in the team that created matrix mechanics, shocked Schrodinger with the interpretation of the wave function as a "probability amplitude." It was true, said Born, that the wave function evolves deterministically, but its significance is that it predicts only the probability of finding an atomic particle somewhere. When and where particles would appear - to an observer or observing system like a photographic plate - was completely and irreducibly random, said Born. Schrodinger could not restore continuous deterministic behavior and return physics to strict causality. Schrodinger did not like this idea and never accepted it despite the great success of quantum mechanics, which uses Schrodinger wave functions to calculate

Heisenberg's matrix elements for atomic transition probabilities. Discouraged, Schrodinger wrote to his friend Willie Wien in August 1926 "[That discontinuous quantum jumps]...offer the greatest conceptual difficulty for the achievement of a classical theory is gradually becoming even more evident to me."...[yet] today I no longer like to assume with Born that an individual process of this kind is "absolutely random." i.e., completely undetermined. I no longer believe today that this conception (which I championed so enthusiastically four years ago) accomplishes much. From an offprint of Born's work in the Zeitsch f. Physik I know more or less how he thinks of things: the waves must be strictly causally determined through field laws, the wavefunctions on the other hand have only the meaning of probabilities for the actual motions of light- or material-particles." Why did Schrodinger not welcome Born's absolute chance? It was strong evidence that Boltzmann assumption of chance in atomic collisions was completely justified. Exner thought chance was absolute, but did not live to see how fundamental it was to physics. And the early Epicurean idea that atoms sometimes "swerve" could be replaced by the insight that atoms are always swerving - when near other atoms. Could it be that senior scientists like Max Planck and Albert Einstein were so delighted with Schrodinger's work that it turned his head? Planck, universally revered as the elder statesman of physics, invited Schrodinger to Berlin to take Planck's chair as the most important lecturer in physics at a German university. And Schrodinger worked closely with Einstein in their failed attempts to develop a unified (and deterministic) field theory. He won the Nobel prize in 1933. But how different our thinking about absolute chance would be if the greatest theoretician of quantum mechanics had accepted it in 1926. In his vigorous debates with Neils Bohr and Werner Heisenberg, Schrodinger attacked the probabilistic Copenhagen interpretation of his wave function with a famous thought experiment called Schrodinger's Cat. On Determinism and Free Will Schrodinger mystical epilogue to What Is Life? (1944), in which he "proves God and immortality at a stroke" but leaves us in the dark about free will.

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