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Schrödinger 1950: The Cat's Situation on the Background of the New Statistics and Second Quantization

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Abstract

Schrödinger's opposition to the so-called Copenhagen philosophy of Quantum Mechanics, his original position in physics and philosophy, his agreement with Bose and De Broglie, his dissent with Einstein, deserve more historical and philosophical studies. They represent in fact the core of European science.

Keywords

Schrödinger, Einstein, Bose, De Broglie, Heisenberg

1. Introduction

According to Schrödinger, the Cat's situation of being half-dead and half-alive was a "burlesque" case in the Heisenberg Copenhagen interpretation, whereas its paradoxical features were to be understood by following Schrödinger's (1950) explanations. These explanations were not suddenly presented in 1950, but originated in 1926, in Schrödinger's (henceforth S.) interpretation of the Bose's statistics for the rarefied gas system (D'Agostino, 2015). They concerned also S.'s 1935 correspondence with Einstein (Fine, 1986: pp. 64-85), and especially S.'s letters to Einstein dated July 13, August 19, October 4, and the November 24 letter.

S. agreed initially with Einstein's EPR, but in the August 19 letter, he harshly criticized Einstein's Statistical interpretation of Quantum Mechanics (hereafter QM; Fine, 1986: p. 79). As regards S.'s August 19 ideas, I maintain that they originated in S.'s 1926 celebrated contributions to a wave conception of QM (Schrödinger, 1926a) and in his contemporary approach to Einstein's theory of the rarefied gas Einstein (1907, 1911, 1912abc, 1913, 1916, 1917). His 1935 remark that the core of the passage from Boltzmann "natural" to Bose statistics, was a conceptual interchange between the multiplicity of the energy particles and the multiplicity of their energy states (Schrödinger, 1935) touches an interesting point. But this passage, he conceded, was equivalent to applying the De-Broglie-Einstein wave-like theory, according to which a particle in motion is no-less than a "crest of foam" on top of a radiation, i.e., to an interchange between a particle and a wave. In my view, the above S.'s interchange can be considered as a forerunner of S.'s 1950 generalization of an interchange between particles and waves as the core of a new physics (Schrödinger, 1953). This interchange received unexpected support from the De Broglie theory according to which the motion of a particle is guided by a wave, or better the particle itself in motion is just a wave. The interchange between particles and waves was generalized on occasion of the commemoration of De Broglie sixtieth birthday at the Poincaré Institute in Paris. S. initiated his discourse by remarking that he himself and De Broglie were shocked and disappointed by the Copenhagen interpretation of QM, as opposed to his and De Broglie own interpretation via the wave function (*Ibidem*). Responding to the accuse that his former wave-like interpretation seemed deceptive and after all too naïve, S. accepted to reconsider it in the light of two new points which have since arisen: 1) the non distinguishable particles a result of the new statistics, 2) the second quantization procedures. As regards 2), he stated (*Ibidem*) that:

> "[...] if a particle is not a permanent entity, quantization of the De Broglie waves around a nucleus yields into one comprehensive scheme all the 3n dimensional representation that I proposed for the n-body problem."

In order to better understand S.'s position let us consider that the solution for the wave-function in the equation for the case of *n* identical particles is not *factorizable*, (i.e. the *n* identical particles do not correspond to the product of probability for a single particle), but it corresponds to the representation of the fuzzy behaviour of S.'s wave function in a firstly quantized theory. As the metaphor of the cat illustrates, the superposition of two electronic compatible microstates cannot be transformed into two biologically incompatible cat's macrostates. Quite differently, the same solution is *factorizable* in the second quantization approach (D'Agostino, 2015). In short, S. considered second quantization as the proper mathematical formulation of his wave-theoretical approach to problems related to many-particles system. Quite differently, Einstein justified the cat's ambiguous situation in the first quantization, as because the firstly quantized function does not refer to a cat but to an ensemble of cats, half-dead and half-alive. Its uncertainty is therefore a statistical uncertainty. Differently for S., the psi solution in the first quantization is "fuzzy", (blurred, indistinct) "[…] but it does not necessarily imply an ensemble of cats [...] a fuzzy snapshot is not like a cloud" (Schrödinger, 1950). Notice that the cat "burlesque" situation is proposed by S. after the Micro situation of the charged electron. The Macroscopic observed cat is strictly related to the electron's Micro situation. Let us call it as the "Schrödinger Micro-Macro paradigm".

2. S. 1950: "What Is an Elementary Particle?"

For S. *it is illegitimate to transpose a relation among sensations from the world of sensations to external objects* (*Ibidem*). S. criticizes Heisenberg's pretention of relieving even one point in the electron trajectory:

> "[…] it is mistaken to persist in describing properties of the real object 'electron' if one cannot reveal its trajectory" (*Ibidem*).

According to S. opening the Cat's gage could not transform an indistinguishable situation in a distinguishable one. The transformation is "burlesque" in the common view, and also is logically contradictory. It is in fact equivalent to transform the initial electron microstate in the Cat's macrostate. *This transformation responds to the naive view of the equivalence of a Microscpic state as a dimensional reduction of Macro objects, and, conversely, to a Macro state as composed of enlarged micro objects* (*Ibidem*). The impossibility of the naive transformation is expressed by S. as: $pl >> h$, where p is the particle's momentum, l is the particle's average distance and h the Planck constant. The above inequality is fulfilled either for large particle's momentum and (even) small particle's average distances—a situation which corresponds to a Macro situation—or for large particle's average distances and (even) small particle's momentum. The rarefied gas situation corresponds to the second case above. Let us notice how S. proposed an original interpretation of the difference between a Macro and a Micro system of particles.

Max Born's statistical interpretation—widely accepted by physicists—Heisenberg's 1927 indeterminacy relations (IR), and Bohr's Complementarity (Bohr, 1920) convinced S. to somewhat modify his former views. He was highly impressed by IR, and by his discovery that the Heisenberg-Born-Jordan matrix theory was mathematically equivalent theories (Schrödinger, 1926b). His decision to abandon the electrodynamic interpretation was published in 1928, justified by the impossibility of a space-time description of micro objects. Another turning point was S.'s 1931 interpretation of the indistinguibility of micro-objects in the Bose-Einstein new statistics (Schrödinger, 1932), since he now thought that the lack of individuality in the atomic world was just an aspect of a more general crisis in the ontology of classical atomism. I argue that the pre-war S.'s considerations are to be considered as the background of his 1950 new outlook on physics and philosophy (Rüger, 1988). What he proposed in the 1950's was a renewed view of QM, founded on a new conception of a physical system. For this view, he found a decisive support in the Second Quantization approach to QM. (The latter was developed in 1927 by Dirac, for particles in the Bose's statistics, and extended in 1928 by Fermi, for Fermi's particles by Wigner and Jordan).

3. A Mode of Conclusion

The view of Heisenberg and Bohr (Bohr, 1920) that a presumed discontinuity, as a conception, was irremediably cast upon us by the recent Black Body experiments, was challenged by S. on historical a philosophical grounds. S. admits that his beloved Wien teachers Hasenorl and Exner conditioned his perspective on physics and science, and his approach to statistics. But no Wien cultural atmosphere could prevent his and his wife's tragic escape from Austria in 1935. They made a short passage in Rome, before S.'s fortunate emigration to the UK and Ireland. The mature years of his intellectual activity were thus spent in the welcome Dublin Institute for Advanced Studies. Although he over there found congenial friends and colleagues, the possibility of recovering his influence on the European scientific and cultural level was irremediably lost. In a last attempt to again acquire cultural influence, he returned in his last years to his beloved Gratz, and to Wien. For what concerns the sociological aspects of S.'s view, he was aware of the enormous efforts and devotion required for producing significant innovations within the predominant paradigm of current physics—an effort which can only rarely be the task of one man. In the 1950s his intellectual isolation from the world center of scientific enterprise was a consequence of the events he experienced in the pre-war and war years and of his opposition to the Nazy power? In short, was his isolation the result of those unquestionable answers which Nature supposedly dispenses to his scientific adepts, or was it "[…] largely a sociological accident" (Dorling, 1987)?

Historians of science should find answers to such questions. However, to my present knowledge, none followed the path mapped out by Schroedinger interpretation of QM.

Although science and physics had yet progressed in the frames of an Anglo-Saxon paradigm, strange as it may seem, the technical approach from recent physicists to QM problems still follows S.'s path.

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References

Bohr, N. (1920). Über die Serienspektra der Elemente. *Zeitschrift fur Physik, 2,* 423-469. https://doi.org/10.1007/BF01329978

D'Agostino, S. (2015). A Good Chance for the Cat's Life: Erwin Schroedinger's New Statistics and a Second Quantization Theory. *Advances in Historical Studies, 4,* 1-7. https://doi.org/10.4236/ahs.2015.41001

Dorling, J. (1987) Schrödinger's Original Interpretation of the S.'s Equations, In: C. W. Kilmister, (Ed.), *Schrödinger Centenary Celebration of a Polymath* (pp. 1-40). Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511564253.004

Einstein, A. (1907). Ober das Relativitatsprinzip und die aus dem self ben gezogenen Folgerungen. *Jahrbuchder Radioaktivitat und Elektronik A, 4,* 411-462.

Einstein, A. (1911). Über den Einfluβ der Schwerkraft auf die Ausbreitung des Lichtes. *Annalen der Physik, 340,* 898-908. https://doi.org/10.1002/andp.19113401005

Einstein, A. (1912a). Lichtgeschwindigkeit und Statile des Gravitationsfeldes. *Annalen der Physik, 343,* 355-369. https://doi.org/10.1002/andp.19123430704

Einstein, A. (1912b) Zur Theorie des statischen Gravitationsfeldes. *Annalen der Physik, 343,* 433-458. https://doi.org/10.1002/andp.19123430709

Einstein, A. (1912c). Relativität und Gravitation. Erwiderung auf eine Bemerkung von M. Abraham. *Annalen der Physik, 343,* 1059-1064. https://doi.org/10.1002/andp.19123431014

Einstein, A. (1913). Zum gegenwärtigen Slande des Gravitationsproblems. *Physikalische Zeitschrift, 14,* 1249-1266.

Einstein, A. (1916). Die Grundlagendes all gemeinen RelaLivitaistheorie. *Annalen der Physik, 354,* 769-822. (Trad. It. 1988. *Come io vedo il mondo. La teorìa della relatività* (pp. 113-185). Roma: Newton Compton). https://doi.org/10.1002/andp.19163540702

Einstein, A. (1917), *Über diespezie Ue und all gemeine Relativitaetstheorie (gemeinverstandlich).* Vieweg. (Trad. It. 1967. *Relatività: Esposizione divulgativa*, Torino: Boringhieri).

Fine, A. (1986). *The Shaky Game, Einstein's Realism and the Quantum Theory* (Chapter 5, pp. 64-85). University of Chicago Press.

Rüger, A. (1988). Atomism from Cosmology: Erwin Schrödinger's Work on Wave Mechanics and Space-Time Structure. *Historical Studies in the Physical and Biological Sciences, 18,* 377-401. https://doi.org/10.2307/27757607

Schrödinger, E. (1926a). Quantisierung als Eigenwerproblem. *Annalen der Physik, 385, 13, Band 80,* 437-490. https://doi.org/10.1002/andp.19263851302

Schrödinger, E. (1926b). Über das Verhältnis der Heisenberg-Born-Jordanschen Quantenmechanik zu der meinem. *Annalen der Physisk, 348,* 734-756. https://doi.org/10.1002/andp.19263840804

Schrödinger, E. (1932). *Über Indeterminismus in der Phyisik: Ist Die Naturwissenschaft milieubeingt? Zei Vorträge zur Kritik der Naturwissenschaftlichen Erkenntnis*. J.A. Barth.

Schrödinger, E. (1935). Die Gegenwärtige Situation in der Quantenmechanik. *Die Naturwissenschaften, 23,* 844-849. (See: Trimmer, D., J. (1980). The Present Situation in Quantum Mechanics. *Proceedings of the American Philosophical Society, 124, 5*, 323-338). https://doi.org/10.1007/BF01491987

Schrödinger, E. (1950). What Is an Elementary Particle? *Endeavor, 9,* 109-116.

Schrödinger, E. (1953). La Signification de la Mecanique Ondulatoire. *Louis De Broglie, Physicien at Penseur* (pp. 2-32). Collection Dirigée par André George Albin Michael.