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**Can the statistical interpretation of quantum mechanics be inferred from the Schrödinger equation?—Bell and Gottfried. (English summary)**

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This is a critical analysis—cast as a continuation of earlier remarks by J. S. Bell [in *Speakable and unspeakable in quantum mechanics*, second edition, 213–231, Cambridge Univ. Press, Cambridge, 2004]—of the arguments advanced by K. Gottfried [*Quantum mechanics*, Benjamin, New York, 1966; Nature **405** (2000), no. 6786, 533–536; K. Gottfried and T.-M. Yan, *Quantum mechanics: fundamentals*, Second edition, Springer, New York, 2004; MR2174511 (2007f:81001)] that, very broadly, the statistical interpretation of quantum mechanics can be deduced from Schrödinger's equation and the density matrix, without the need of any additional postulates concerning eigenvalue selection or wave function collapse at the time of measurement.

In [op. cit., 1966], Gottfried claimed that: (i) coupling to macroscopic variables during the measurement process is sufficient to eliminate off-diagonal terms in the density matrix; and (ii) the remaining diagonal terms demand a statistical interpretation, i.e. wherein each term represents the probability of a particular outcome in a single experiment.

The author appears not to take sides on the first item concerning decoherence, although Bell was skeptical even of this. However, the author disputes Gottfried's additional claim that macroscopic variables do not necessitate an external environment.

Gottfried's argument for the second item seems to rest on the ingoing assumption that a classical limit of the Schrödinger equation exists, and that, as a consequence, the only viable interpretation of the remaining diagonal terms is the statistical one. The author of this paper argues convincingly that Gottfried assumes what he is attempting to prove and so fails to make his case. (The default classical interpretation of the trace of the density matrix must surely be that it is a sum over coexisting terms—arithmetic 'and'—*not* over mutually exclusive alternatives—logical 'or').

A major focus of the paper is Gottfried's test case that if Maxwell were given Schrödinger's equation for several particles with a Coulomb interaction, along with the meaning of all symbols except that of the wavefunction, and without further inputs concerning measurement, he would deduce what we would now call the statistical interpretation of quantum mechanics. The author disagrees. But this disagreement seems to depend crucially on exactly what Maxwell is told, in particular about 'particles' in this context—if anything. Certainly, if particles are not mentioned at all, the classical default interpretation of the continuity equation for the Schrödinger density (modulus squared of the wavefunction) must be that it represents a fluid. But if Maxwell is told that the equation somehow has to do with a finite number of particles, understood in the classical sense, it does not seem impossible that he would deduce the statistical interpretation. After all, historically, that is approximately how the statistical interpretation has come about.

Reviewed by *Michael Ibison*