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Mathematical theory of the Feynman path integrals for quantum continuous measurement of positions and spin

Quantum spin systems of many particles moving in an electric-magnetic field are considered. Let's make measurements simultaneously of both positions of every spin component of all particles and spin directions of all particles continuously during a finite time. Then, taking account of reaction to measurement, the probability amplitudes of particles with spin after this continuous measurement are given by the restricted Feynman path integrals or the weighted Feynman path integrals, as has been proposed by Feynman and Mensky. Our aim in this talk is to prove under some general assumptions about the electric-magnetic field that the weighted Feynman path integrals corresponding to this measurement are well defined mathematically and satisfy the non-self-adjoint Pauli equations for quantum spin systems of many particles.

In our proof a sharp estimate for the L^2-boundedness of the pseudo-differential operators, stated in Zworski's book (2012), plays a key role. When the error of our measurement is infinite, which means no measurement at all, then our weighted Feynman path integrals become equal to the usual Feynman path integrals for spin systems of many particles.