6.4 "Weak Measurements" and the "Quantum Time-Translation Machine" in a Classical System

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Five years ago, a group of theoretical physicists (Y. Aharonov, J. Anandan, S. Popescu and L. Vaidman, Phys. Rev. Lett. 64, 2965 (1990)) suggested a scheme, that modified the time-evolution of a quantum mechanical system in a way that the resulting effect was analogous to a time-translation machine: under the modified evolution, the system evolves into a state that it would, under the normal conditions, reach only at a much later time. We have implemented this scheme in a nuclear magnetic resonance experiment as well as in a simple optical setup. The physical system consists of two coupled spins 1/2 and the amplification scheme is applied to the heteronuclear coupling between the two spins. This implementation to a physical system that obeys well-known and analytically solvable equations of motion, made it possible to understand the phenomenon. Using a density matrix formulation, we could show, that this seemingly counterintuitive effect can be explained in a straightforward manner. Our alternative explanation shows, that the spreading of a quantum mechanical wave packet, together with a biased measurement is the true cause of the 'time-translation' effect.