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Dephasing of Atomic Tunneling by Nuclear Quadrupoles

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A few years ago strong magnetic field effects have been observed in low-temperature dielectric susceptibility measurements and in coherent polarization echo experiments on certain glasses and disordered crystals. The low-temperature dielectric properties of such materials are dominated by atomic tunneling systems. It has been suggested that the surprising magnetic field dependence is caused by tunneling particles with nuclear quadrupole moment. For such systems there exists a coupling of the tunneling motion with the nuclear quadrupole moments experiencing the electric field gradients in the localized states. This coupling gives rise to a quadrupole splitting of the energy levels of the tunneling systems. The applied magnetic field then leads to an additional Zeeman splitting of the nuclear levels. We review the results of polarization echo experiments in magnetic fields and discuss the role of the nuclear spins in such experiments.