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**Spin echo studies: ZnO: Mn²⁺ under conditions
of high electron spin polarization**

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Nonlinear effects were observed in some paramagnetic systems. The suitable system for maser applications might be Mn²⁺ in ZnO co-doped with the faster relaxer like Co²⁺. In the present study we describe the measurements on Mn²⁺ system in hydrothermally grown ZnO. The applicability of ZnO: Mn²⁺ system for solid state optically pumped maser amplifiers is under consideration.

The optically pumped EPR spectrum of ZnO: Mn²⁺ system demonstrates the selectivity in the population of the manganese electron-nuclear spin levels. The cross-relaxation give rise to the process of dynamic nuclear polarization of ⁵⁵Mn in this system. The time dependent inversion of the populations for Mn²⁺ electron-nuclear states has been observed when applying the optical pumping below 3 K.

The thermal mixing DNP process taken in the high temperature approximation involves a spin system broken up into several heat reservoirs with different spin temperatures: the electron Zeeman, the nuclear Zeeman, and the spin-spin interactions reservoirs. The electron spectral diffusion is studied under dynamic nuclear polarization by using electron spin-echo-detected EPR spectra and Electron-Electron Double Resonance (ELDOR) technique in heavily cobalt doped ZnO: Mn²⁺ at the Co²⁺ exchange narrowing temperature range. It is established that the thermal mixing mechanism of DNP leads to the cooling of the common reservoir of electron dipole-dipole interactions of Mn²⁺ and Co²⁺ spins to the single spin temperature in the rotating frame. We show the variation of the polarization amplification of the common nuclear subsystem as a function of microwave irradiation frequency.