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# Paramagnonlike excitations and spin diffusion in magnetic resonance studies of copper oxide superconductors

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## Abstract

The relaxation function theory for a doped two-dimensional Heisenberg antiferromagnetic system in the paramagnetic state for all wave vectors through the Brillouin zone is presented in view of the low frequency response of high-  $T_c$  copper oxide superconductors. We deduced the regions of long lifetime [ $T < 400 (1-4x) K$ ] and "overdamped" [ $T > 700 (1-4x) K$ ] paramagnonlike excitations in the temperature ( $T$ ) -doping index ( $x$ ) phase diagram from plane oxygen nuclear spin-lattice relaxation rate ( $1/T_1$ ) data right up to optimally doped  $La_{2-x}Sr_xCuO_4$ , thus providing the regimes for the spin-wave concept and the overdamped mode. © 2007 The American Physical Society.

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