

# Nuclear Spin-lattice Relaxation in Cuprate Superconductors

## – Some New Approaches

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This paper reviews theoretical studies of nuclear spin-lattice relaxation we have made for the normal state of the cuprate high-temperature superconductors  $\text{YBa}_2\text{Cu}_3\text{O}_7$ ,  $\text{YBa}_2\text{Cu}_4\text{O}_8$ , and  $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ . In the case of *planar* sites, we calculated the dynamic spin susceptibility within a constraint-free theory based on the presentation of the  $t - J$  model in terms of Hubbard operators. The results for  $^{63}\text{Cu}$ ,  $^{17}\text{O}$ , and  $^{89}\text{Y}$  are in good agreement with experimental data. The relaxation (and the Knight shift) of *chain* Cu in  $\text{YBa}_2\text{Cu}_3\text{O}_7$  and  $\text{YBa}_2\text{Cu}_4\text{O}_8$  requires a different treatment; our approach uses the Luttinger-liquid model. Again, good agreement with experiment is achieved.

*Key words:* NMR Relaxation;  $t - J$  Model; Cuprate Superconductors.