

Dynamics and distribution of doped holes in the CuO₂ plane of slightly doped Y_{1-y}Ca_yBa₂Cu₃O₆ studied by Cu(1) NQR

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Abstract

Cu(1) nuclear quadrupole resonance (NQR) in slightly doped YBCO₆: Ca compounds allows us to study the incidence of doped holes on the antiferromagnetic state. Distributions of transverse ($1/T_2$) and longitudinal ($1/T_1$) relaxation rates of the NQR are found at low temperature, which allows us to determine a fraction of doped holes which are localized. We conclude that the holes doped in the CuO₂ plane by Ca²⁺ → Y³⁺ substitution are distributed homogeneously in the CuO₂ plane above 70 K and move freely in the plane. We establish that the reduction in hole mobility from metallic to variable-range hopping induces the differentiation of Cu(1) nuclei. At lower T the holes' motion slows down and we estimate that the holes localize finally in restricted regions (4-6 lattice constants) in the Coulomb potential of the Ca²⁺ ions. © 2009 The American Physical Society.

<http://dx.doi.org/10.1103/PhysRevB.79.014513>
