

## Intrinsic paramagnetic centers in 1-2-3 superconductors

Teplov M., Bakharev O., Brom H., Dooglav A., Egorov A., Krjukov E., Marvin O., Mukhamedshin I., Naletov V., Volodin A., Wagener D., Witteveen J.

*Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia*

---

### Abstract

The  $^{169}\text{Tm}$  "enhanced" NMR in  $\text{TmBa}_2\text{Cu}_3\text{O}_{6+x}$  ( $x=0.5, 0.6$ ) at temperatures below 4.2K and the  $^{63}\text{Cu}(1)$  NQR in  $\text{YBa}_2\text{Cu}_3\text{O}_{6.5}$  at temperatures above 4.2K are used to study properties of intrinsic paramagnetic centers incorporated into superconducting materials. The spin-lattice relaxation of thulium and copper nuclei reveals three types of paramagnetic centers to be present in oxygen-deficient 1-2-3 superconductors, those are (1) two-level ones with a spin  $S=1/2$ , localized outside  $\text{CuO}_2$  bilayers, (2) singlet-ground-state paramagnetic centers with an integer spin  $S \geq 1$  in  $\text{CuO}_2$  bilayers, and (3) exchange copper-oxygen clusters with a half-integer spin  $S \geq 5/2$ , localized in a nearest neighborhood of  $\text{CuO}_x$  basal plane at boundaries of superconducting Ortholl microdomains. © 1995 Plenum Publishing Corporation.

<http://dx.doi.org/10.1007/BF00722818>

---

### Keywords

1-2-3 superconductors, NMR, NQR, paramagnetic centers, spin-lattice relaxation