NMR Study of the FFLO State and Magnetism in $CeCoIn_5$

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A quasi-2D heavy-fermion compound, $CeCoIn_5$ shows number of fascinating superconducting (SC) and magnetic properties. It is believed to host a Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) state and to exhibit a coexistence of modulated magnetic order at a restricted region at high field and at very low temperature. Here, we have measured NMR of the In(1) and In(2) site of $CeCoIn_5$ in the direction of both $H//a$- and $H//c$-axis down to 50mK. [1] In the case of $H//a$-axis, the NMR spectra change dramatically below $T(H_c^*)$ upon entering the novel SC state. A well-separated peak structure at the In(2b) site shows the spatially-uniform spin density wave (SDW) is induced, and that this magnetic ordering is emerging only in the newly-discovered SC state. We also show that field dependences of the Knight shifts of the spectra at the In(2a) and the In(1) site provide a direct evidence for the emergence of the spatially-distributed normal quasiparticle region. The quantitative analysis for the field evolution of the paramagnetic magnetization and low-lying energy quasiparticle density of state is consistent with the nodal plane formation, which is characterized by an order parameter in the FFLO state. NMR results for $H//c$-axis will be also discussed.

[1] K. Kumagai *et al.*, Phys. Rev. Lett. **106**, 137004 (2011),