^{13}C-NMR study on the Dirac-nodal-line materials [M(dmdt)$_2$] (M = Ni, Pt)

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Dirac fermion (DF) systems with Dirac points, excitations around which are characterized by pseudorelativistic quasiparticles, show anomalous electron correlation effects such as a logarithmic velocity enhancement [1] and an excitonic instability [2] as revealed in α-(BEDT-TTF)$_2$I$_3$. Single-component molecular conductors [M(dmdt)$_2$] (M = Ni, Pt), where dmdt = dimethyltetrathiafulvalenedithiolate (Fig.1 (left)), also host DFs with conducting and magnetic behaviors characteristic of DF [3]. Remarkably, these materials are theoretically suggested to host the Dirac nodal lines (DNLs), which are formed by a series of the Dirac points in the three-dimensional Brillouin zone. In the present study, we used the ^{13}C nuclear magnetic resonance to microscopically probe the magnetism exhibited by the DNLs in [M(dmdt)$_2$]. In [Pt(dmdt)$_2$], the nuclear spin-lattice relaxation rate divided by temperature $(T_1T)^{-1}$ approximately follows a power-law of T^2 above 160 K similarly to α-(BEDT-TTF)$_2$I$_3$ (Fig. 1 (right)). At lower temperatures, $(T_1T)^{-1}$ gradually increases on cooling and levels off below 5 K as expected in a Femi liquid. The Fermi liquid-like behavior is ascribed to the electron and hole pockets around the energetically dispersive DNLs. In [Ni(dmdt)$_2$], where the dispersion of the DNL is narrower than half in [Pt(dmdt)$_2$], $(T_1T)^{-1}$ shows a broad peak at 20—30 K and becomes constant below 5 K. Notably, the peak of $(T_1T)^{-1}$ is more enhanced under the lower magnetic field, suggesting a novel electron correlation effect that is strongly dependent on the magnetic field and on the dispersion of the DNL.

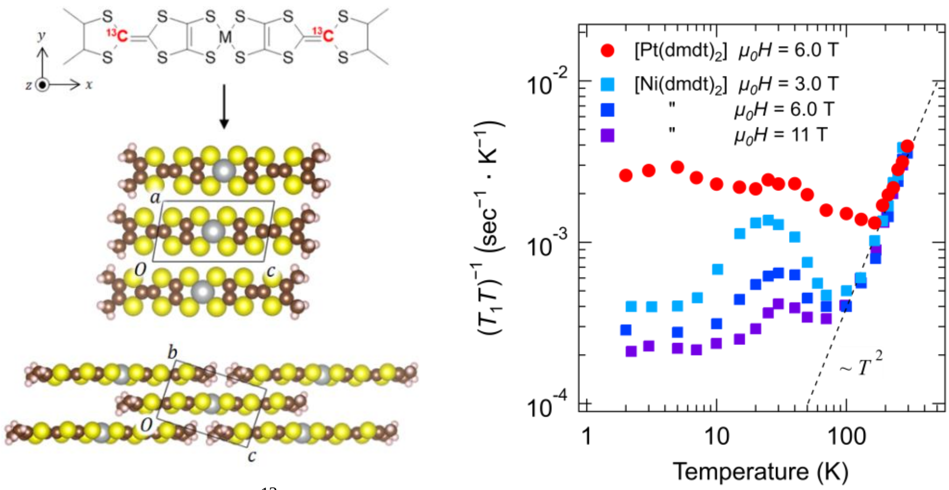

Fig. 1 (Left) Molecular structure of ^{13}C-isotope M(dmdt)$_2$ and the crystal structure of [M(dmdt)$_2$]. (Right) $(T_1T)^{-1}$ of [Pt(dmdt)$_2$] under 6 T (red) and that of [Ni(dmdt)$_2$] under 3 T (light blue) , 6 T (blue), and 11 T (purple)

References

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