Possible Low-energy Excitations of Multipoles in Filled Skutterudite Compound SmRu$_4$P$_{12}$

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The filled skutterudite compound SmRu$_4$P$_{12}$ exhibits a metal-insulator (MI) transition at $T_{\text{MI}} \sim 16.5$ K. An entropy release $\sim R \ln 4$ below $T_{\text{MI}}$ suggests that the crystalline-electric-field ground state is a $\Gamma_{67}$ quartet with various multipole degrees of freedom. A spontaneous local field was detected below $T_{\text{MI}}$ by zero field $\mu$SR [1,2], indicating that a magnetic multipole ordering occurs at $T_{\text{MI}}$. A possibility of magnetic octupole ordering has been intensively discussed to explain anomalous elastic properties, field-temperature phase diagram, and suppressed dipole moment [3,4].

We performed $\mu$SR measurements on single crystalline samples of SmRu$_4$P$_{12}$ to investigate the nature of the multipoles in the ordered state. We observed remarkable longitudinal relaxation in the ordered state, the magnitude of which was reduced below $T' \sim 3$ K [2]. We will discuss possible low-energy excitations of magnetic multipoles in the ordered state, as well as the symmetry of the order parameter from $\mu$SR results in high transverse fields applied along the [111] direction.

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