μSR / ^{27}Al-NMR Studies on Quasi-crystal and Approximant Au-Al-Yb

K. Ishida[1,#], S. Kitagawa[1], T. Yamanaka[1], T. Hattori[1,2], W. Higemoto[2], A. Koda[3], R. Kadono[3], K. Deguchi[4], and N. K. Sato[4]

[1]Department of Physics, Kyoto University, Kyoto 606-8502, Japan
[2]ASRC, Japan Atomic Energy Agency, Tokai-mura, Ibaraki 319-1195, Japan
[3]Muon Science Laboratory, High Energy Accelerator Research Organization (KEK-IMSS)
[4]Department of Physics, Nagoya University, Nagoya 464-8602, Japan

[#]Corresponding author: kishida@scphys.kyoto-u.ac.jp

Novel quantum critical state, which is robust against the static pressure but is immediately suppressed by magnetic field, was found in the quasi-crystal Au-Al-Yb that lacks the translational symmetry and has a five-fold diffraction-pattern [1]. The 4*f*-electronic spin dynamics and ground state in the quasi-crystal Au-Al-Yb were studies by means of muon-spin-relaxation and ^{27}Al-NMR measurements. Zero-field muon-spin relaxation prove absence of magnetic ordering down to 100 mK. The dynamic muon spin relaxation is dominated by homogeneous spin fluctuations, and the muon relaxation rate λ_d measured in $\mu_0 B_{LF}$ = 20 mT exhibits a power-law temperature dependence $T^{-\alpha}$ with α = 0.51, in the wide temperature range 100 mK - 50 K, indicating that the quasi-crystal Au-Al-Yb possesses the homogeneous quantum critical spin dynamics from the microscopic point of view. A time-field scaling relation suggests that the spin-spin autocorrelation function is short-range and expressed with the power-law formula.

^{27}Al-NMR measurements were carried out on the quasi-crystal and approximant Au-Al-Yb under various field. Nuclear spin-lattice relaxation rate divided by temperature $1/T_1T$ in the quasi crystal shows large increase with decreasing temperature, but the enhanced $1/T_1T$ at low temperature is suppressed with increasing H. The $1/T_1T$ at low temperature in the quasi-crystal is larger than that in the approximant. These behaviors are quite consistent with the bulk susceptibility results.

[1] K. Deguchi, S. Matsukawa, N. K. Sato, T. Hattori, K. Ishida, H. Takakura, and T. Ishimasa, Nature Materials **11** (2012) 1013.