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Negative muon spin rotation and relaxation on superconducting MgB_2

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Although μ^+SR is widely used as a tool for studying a microscopic internal magnetic field in condensed matters over 40 years, the counterpart technique, i.e., μ^-SR is less common for such purpose mainly due to a low counting rate for reaching reliable statistics. However, the recent progress in the beam power and counting system overcame such problem. We therefore started a new μ^-SR project to measure a nuclear magnetic field in hydrogen storage materials and battery materials since 2018 [1].
In order to expand the μ^-SR work, we have attempted to measure the μ^-SR spectra on superconducting MgB_2 in ISIS to join the time reversal symmetry breaking business. This is because the past μ^+SR work on MgB_2 [2] reported the dynamic change in a nuclear magnetic field even below $T_c = 39$ K due to muon diffusion, resulting in difficulty to know the variation of the nuclear magnetic field below T_c. From a μ^-SR viewpoint, Mg almost lacks nuclear magnetic moments (since the natural abundance of ^{25}Mg with $I = 5/2$ is 10%), and as a result, the μ^-s captured by Mg feel a nuclear magnetic field formed by surrounding B and could detect the change in it accompanied with the superconducting transition. Note that the natural abundance of ^{10}B with $I = 3$ is 19.9% and that of ^{11}B with $I = 3/2$ is 80.1%. Thus, the μ^- captured by B should exhibits a fast decay due to its own nuclear magnetic moment, and the corresponding asymmetry will disappear.

[1] J. Sugiyama et al., Phys. Rev. Lett. **121**, 087202 (2018).
[2] Ch. Niedermayer et al., Phys. Rev. B **65**, 094512 (2002).

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