Annual Academic Conference of Dept. Physics, Fudan University, 2019

Muon Spin Relaxation Study on Quantum Spin Liquid Candidate $H_3LiIr_2O_6$

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Motivations

- $H_3LiIr_2O_6$ has been proposed as a quantum spin liquid (QSL) candidate according to NMR and specific heat.
- The honeycomb lattice is an excellent system to study the kitaev model which can be exactly solved.
- We carried out zero/longitudinal field muon spin relaxation (ZF/LF-μSR) to investigate the ground state of $H_3LiIr_2O_6$.

Muon spin relaxation spectra and fitting parameters

ZF-μSR

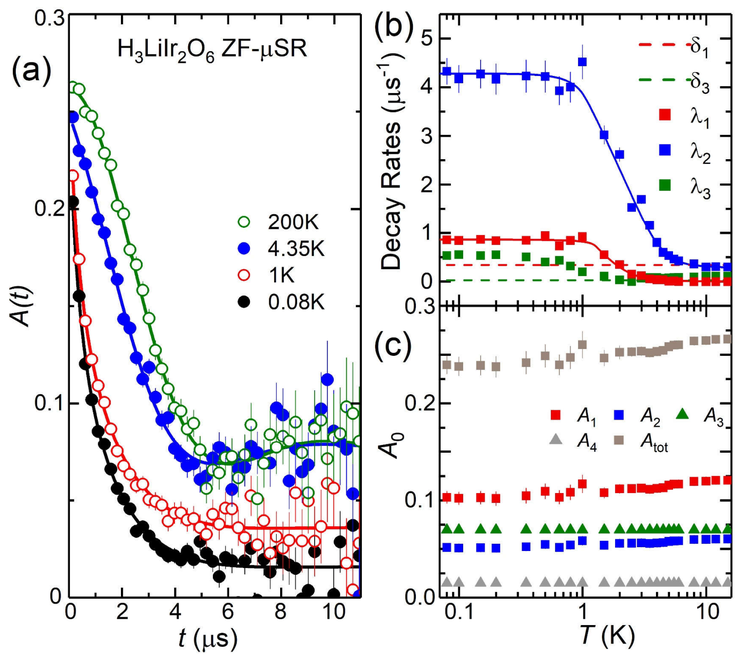

FIG. 1 (a) ZF-μSR spectra at selected temperatures. (b) Temperature dependence of muon spin relaxation rates. (c) Temperature dependence of initial asymmetries

LF-μSR: Temperature scan

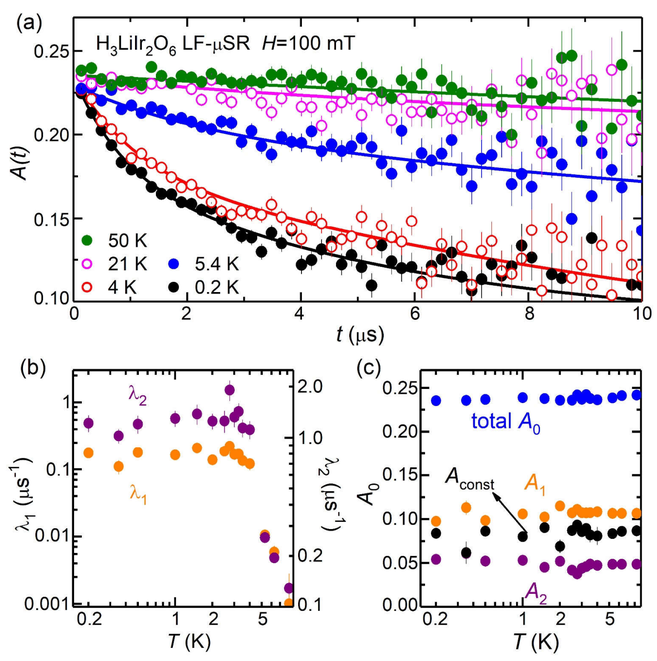

FIG. 2 (a) LF-μSR spectra at selected temperatures with a longitudinal field of 100 mT. (b) Two muon spin relaxation rates indicate two unequivalent muon sites in $H_3LiIr_2O_6$. (c) Initial asymmetries versus *T*.

LF-μSR: Field scan

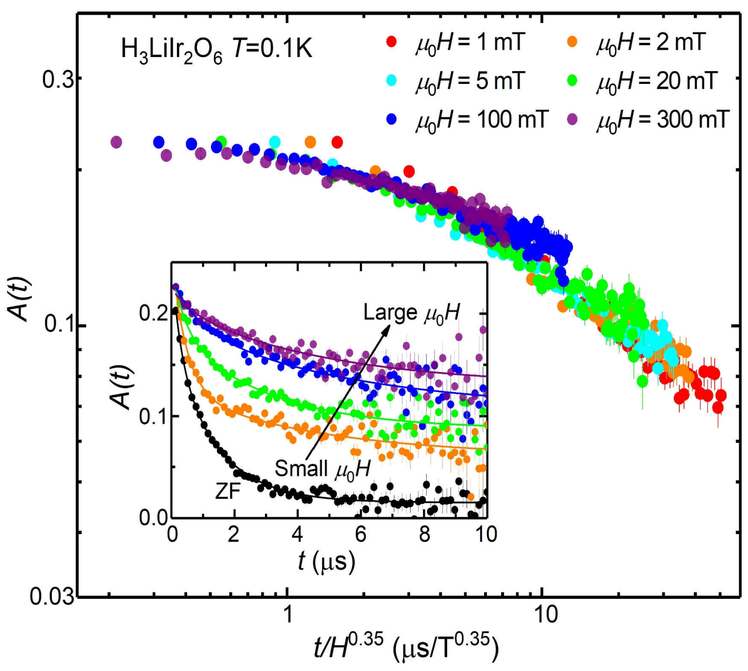

FIG. 3 Time-field scaling of LF-μSR $A(t) \sim t/H^{0.35}$ at 0.1 K. Inset: ZF- and LF-μSR spectra at 0.1 K.

ZF-μSR

- No evidence of magnetic order was found since neither oscillations nor a drastic drop of initial asymmetry appears.
- Muon relaxation is dominated by dynamic fluctuations at low *T*.
- Existence of static random fields (nuclear dipole moments).
- Fitting function (FIG. 1a):

$$A(t) = A_1 \exp(-\lambda_1 t)\, G_Z^{KT}(\delta_1, t) + A_2 \exp(-\lambda_2 t) + A_3 \exp(-\lambda_3 t)\, G_Z^{KT}(\delta_3, t) + A_4$$

- As shown in FIG. 1 (b), drastic increases of λ_α below T_α (2 ~ 4 K) are observed, with $\alpha = 1, 2, 3$.
- The low temperature plateaus of λ_α exclude the spin glass state and indicate the persistent spin dynamics (PSD).

LF-μSR: Temperature scan

- The dynamic properties become clear under external field.
- Fitting function (FIG. 2a):

$$A(t) = A_1 \exp(-\lambda_1 t) + A_2 \exp(-\lambda_2 t) + A_{\text{const}}$$

- $A_1 : A_2 \approx 2 : 1$ ($N_{\text{Li-Ir}} : N_{\text{Ir-Ir}} = 2 : 1$).
- The low temperature plateaus of both λ_1 and λ_2 indicate that PSD take place even under $\mu_0 H$ =100 mT magnetic field applied.

LF-μSR: Field scan

- Strong spin fluctuations.
- Time-field scaling in μSR spectra : a signature of slow spin dynamics.

Supplements

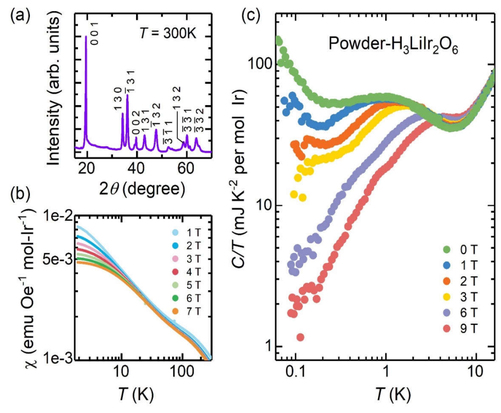

FIG. 4 Basic physical properties of $H_3LiIr_2O_6$.

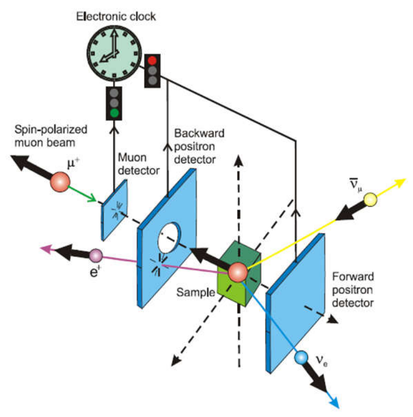

FIG. 5 Sketch of ZF/LF-μSR apparatus.

Conclusions

- Absence of magnetic order.
- PSD at low temperatures.
- Slow spin dynamics are observed from time-field scaling μSR.
- ZF/LF-μSR results suggest the QSL state of $H_3LiIr_2O_6$.

Acknowledgements:

Supported by the National Key Research and Development Program of China (No. 2017YFA0303104 and No. 2016YFA0300503), and the National Natural Science Foundation of China under Grant No. 11774061.

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