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Inducing Quantum Criticality in $CrCl_3$ Under Pressure

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Accelerated by the discovery of graphene, research on two-dimensional (2D) materials have attracted tremendous attention both from fundamental and applied sciences. Among the large number of 2D materials, chromium trihalides CrX3 (X = Cl, Br, I) van der Waals (vdW) magnets have also raised a large interest due to the existence of many magnetic subtleties that cannot be explained by their magnetic and/or structural transitions. Numerous studies were performed on CrI3, but only a few have been reported so far on its analogue CrCl3. The 2D vdW CrCl3 compound is stabilized under a rhombohedral symmetry, consisting of 2D Cr layers arranged in a honeycomb web fashion and surrounded by octahedrally coordinated Cl, with weak vdW inter-layers coupling. The layer structure and inter-layer coupling make CrCl3 an ideal system to study under external stimuli such as pressure or magnetic field, where new intriguing states of matter can be unveiled. With such expectations, studies of CrCl3 under room temperature, high pressure have been reported[1]. However, its spin dynamics at low-temperature and high-pressure regime remain unexplored.
In this study, we present the results of our recent muon spin rotation (MuSR) investigations performed on hydrostatically pressured CrCl3. Our previous MuSR results at ambient pressure revealed successive transitions from paramagnetic to short-ranged-order-ferromagnetic then to antiferromagnetic states with strong spin dynamics as the temperature decreases[2]. When applying pressure, we observed that the magnetic ground state is gradually suppressed. A linear extrapolation points toward the suppression of magnetism at about p_c= 30 kbar indicating the possible existence of a quantum critical point at p_c.[3]

[1] Ahmad, Azkar Saeed, et al. "Pressure-driven switching of magnetism in layered CrCl3." Nanoscale 12.45 (2020): 22935-22944.
[2] Forslund, Ola Kenji, et al. "Spin dynamics in the Van der Waals magnet CrCl3." arXiv preprint arXiv:2111.06246 (2021).
[3] Ge, Yuqing, et al., in preparation.

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