Ferromagnetic Resonance Study on Two-dimensional van der Waals Crystals

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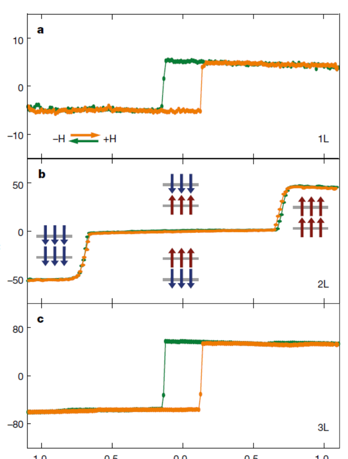
Introduction

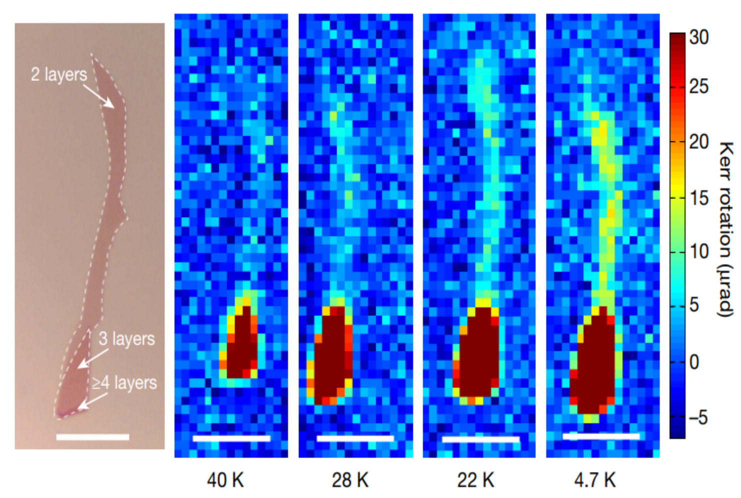
Recent interests in two-dimensional ferromagnetic van der Waals Crystals are driven by their rich electronic and optical properties, further magnetic dynamic studies would provide deeper understanding on the magnetic properties of those materials. In this contribution, we report the results of ferromagnetic resonance of chromium trihalides in the temperature range of 10K-300K.

MOKE signal on atomically-thin CrI_3



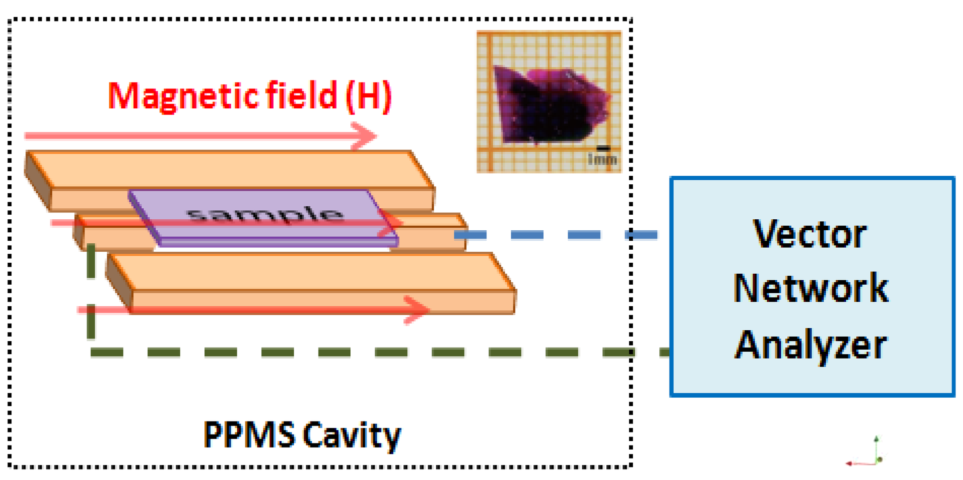
*Bevin Huang, et al. Nature **546**, 270(2017).*

Kerr rotation signal for bilayer $Cr_2Ge_2Te_6$

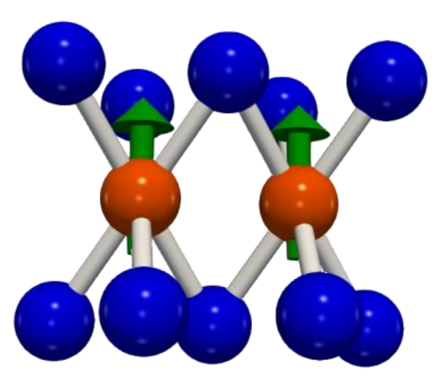


*Cheng Gong, et al. Nature **546**, 265(2017).*

Schematic of FMR measurement

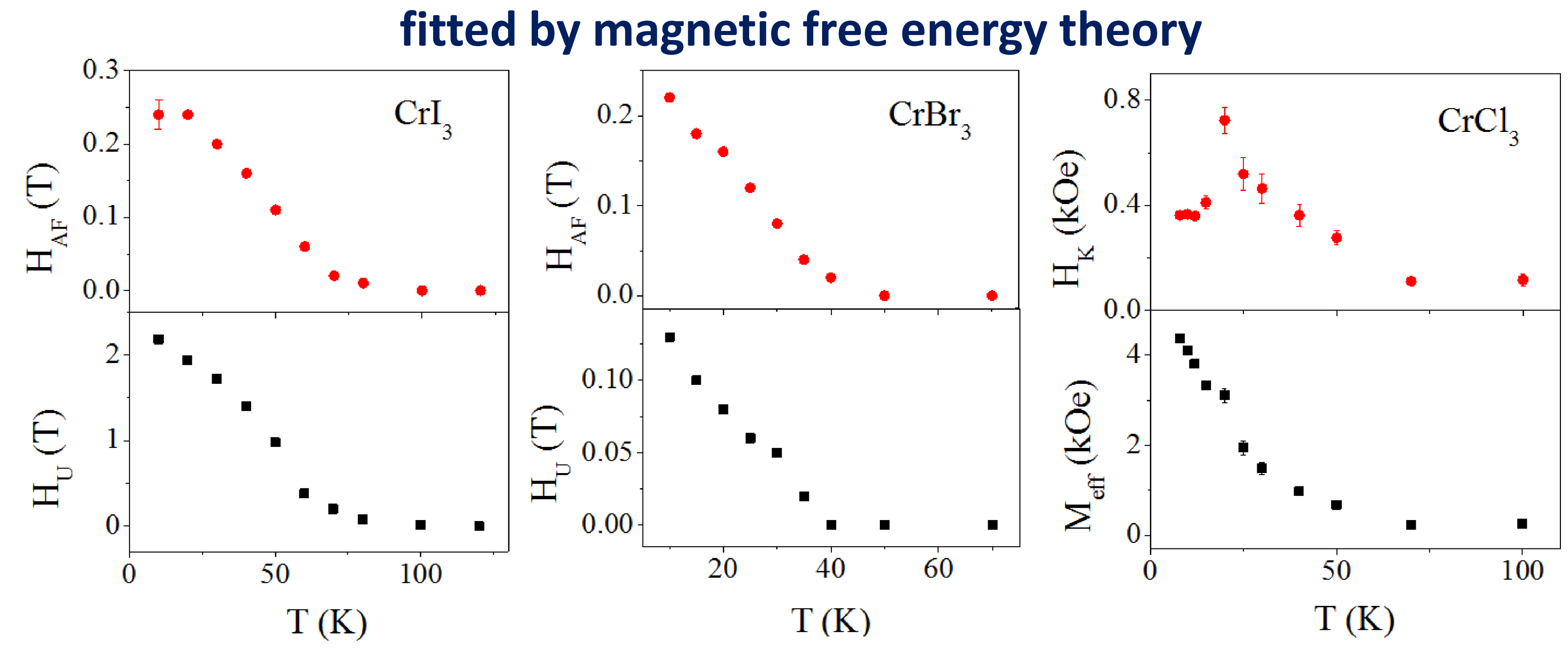


Crystal structure of chromium trihalides

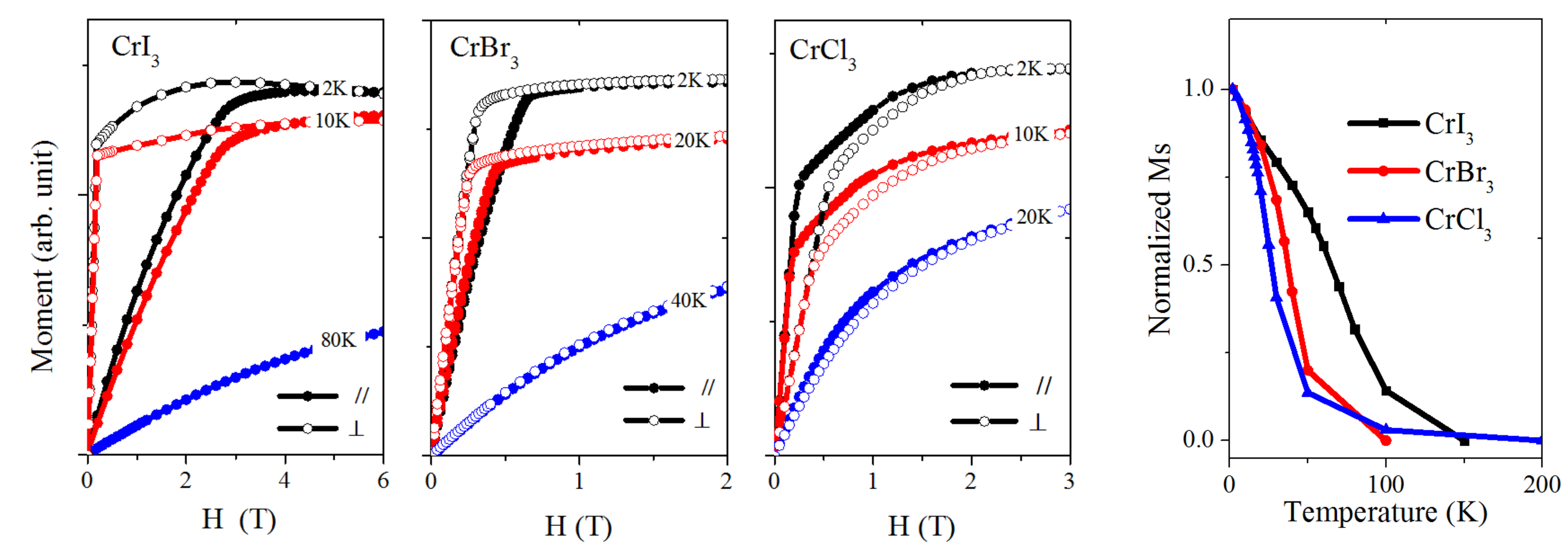


Magnetic anisotropy

Temperature-dependent magnetic properties fitted by magnetic free energy theory



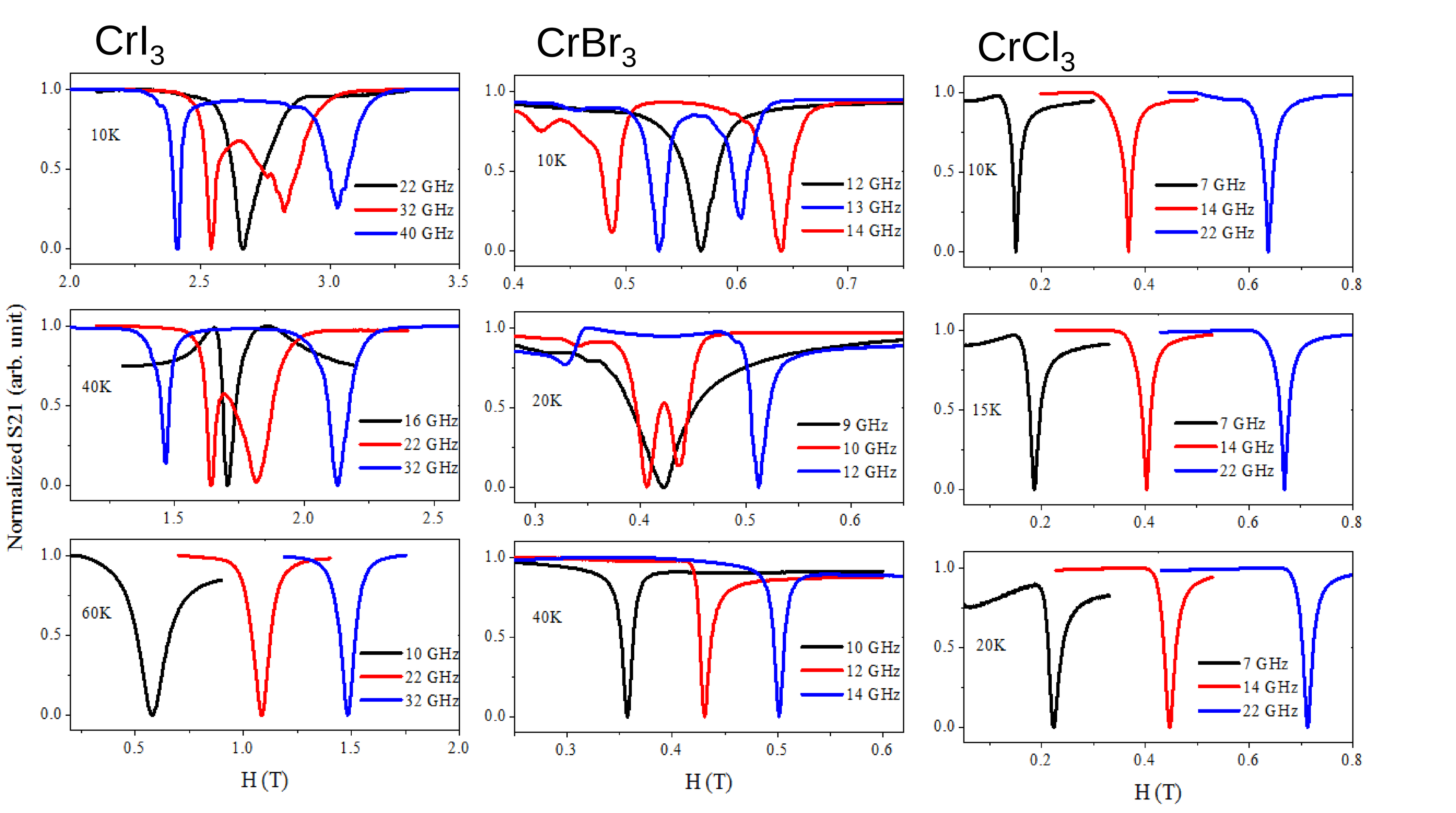
SQUID measurements



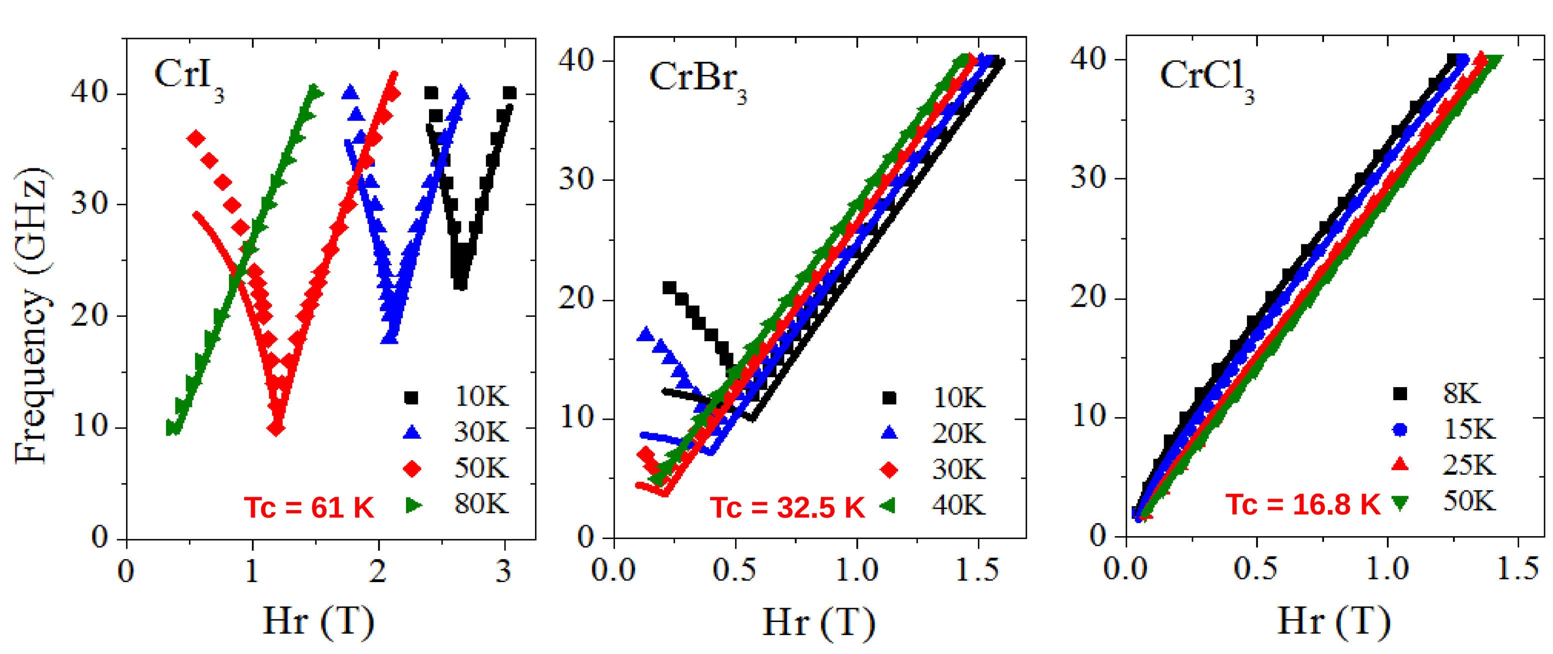
The magnetic anisotropy field obtained from SQUID measurements consistents with our FMR studies.

Experiment

Typical curves of ferromagnetic resonance

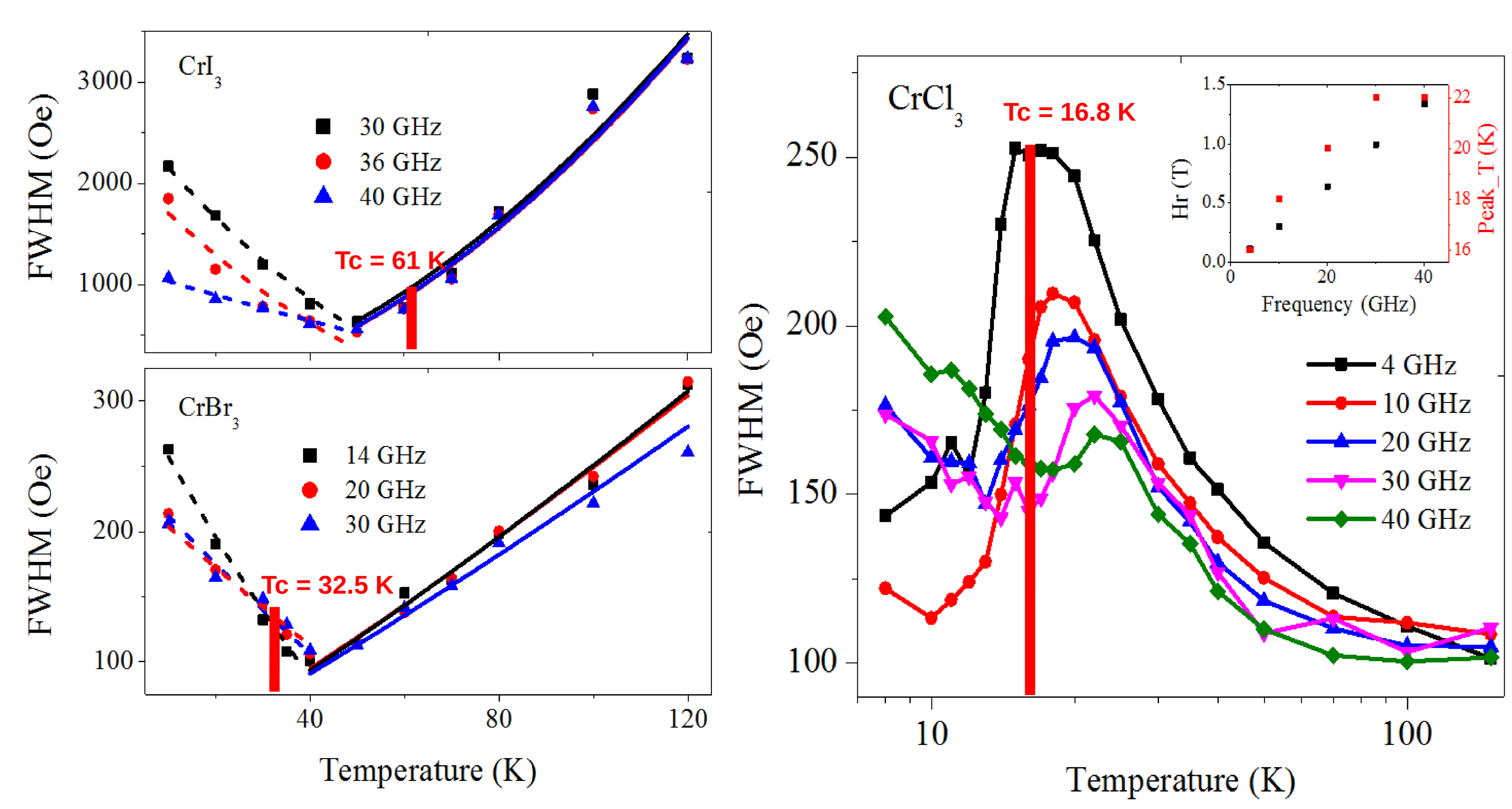


ω-H dispersion at various temperature



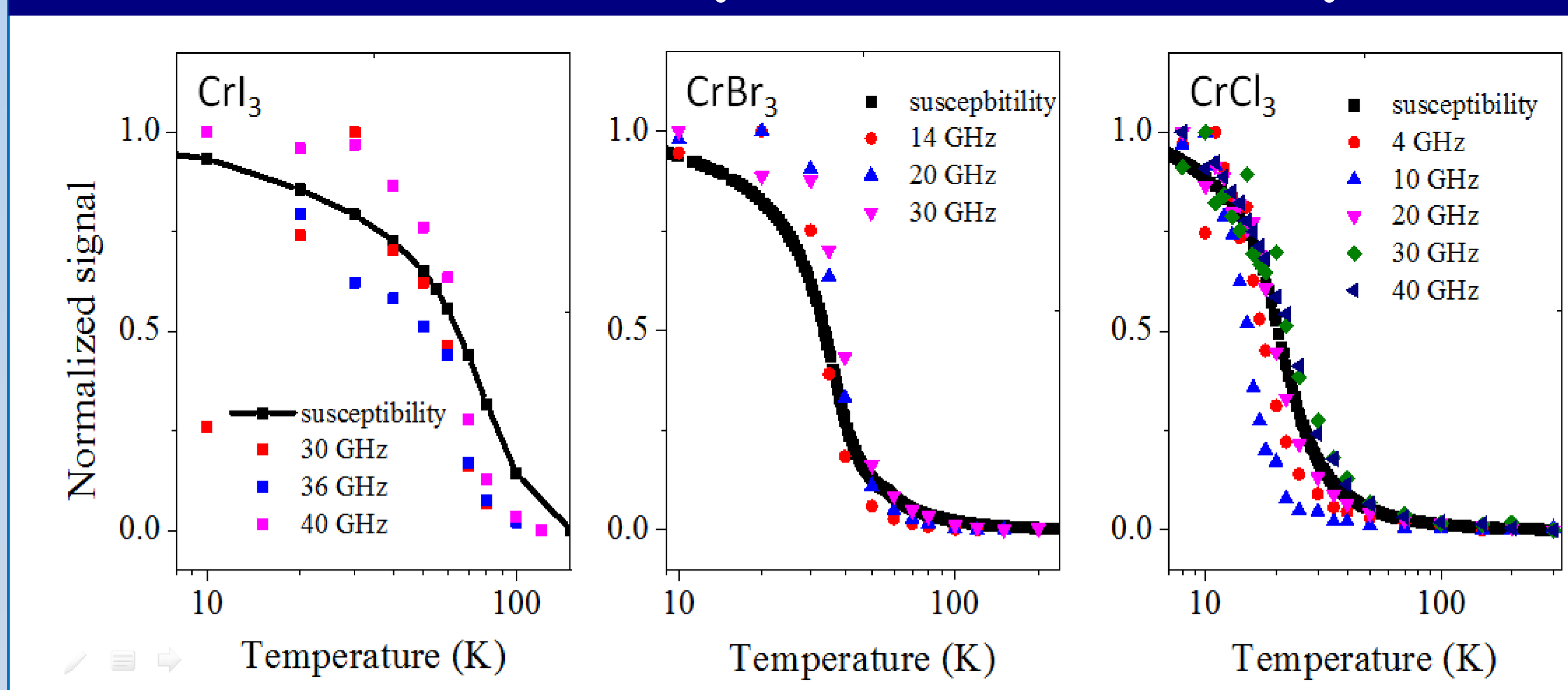
The magnetic anisotropy field can be fitted from ω-H dispersion.

FMR linewidth



CrI_3 and $CrBr_3$ have minimum linewidth value near Tc.
$CrCl_3$ has maximum linewidth value near Tc.

Microwave absorption Vs Susceptibility



$$P_{abs} \propto Signal\_amplitude \times FMR\_linewidth \qquad P_{abs} = \frac{1}{2}\chi_{\perp}''\omega h_{rf}^2$$

Summary

- Strong FMR signal is measured for all these chromium trihalides, the resonance field varies with the temperature.
- Blow Tc, CrI_3 and $CrBr_3$ have AFM interlayer coupling and strong perpendicular magnetic anisotropy field, while $CrCl_3$ has weak in-plane magnetic anisotropy field.
- The magnetic susceptibility is proportional to the power absorbed in magnetic resonance.