THE MAGNETIC AND ELECTRONIC PROPERTIES OF THE $FeRhGe_2$ COMPOUND (B20)

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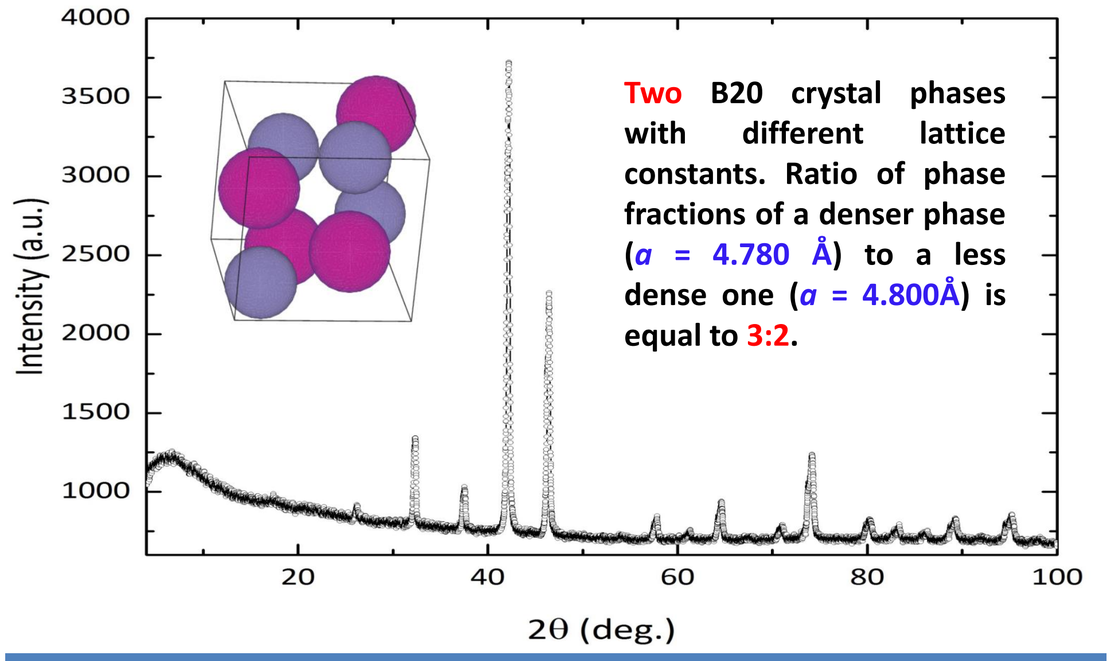
Motivation

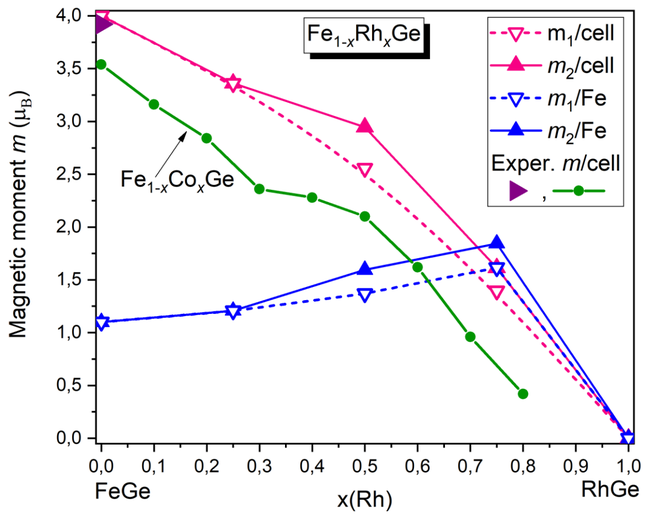
FeGe in its B20 crystal phase (*ϵ*-FeGe) is a well-known chiral magnet with a rather high transition temperature T_N = 279 K. RhGe becomes superconductor below 4 K and weak itinerant magnetism was assumed in the compound. The high pressure–high temperature synthesis allows us to obtain $Fe_{1-x}Rh_xGe$ series in B20 crystal structure for a wide concentration range 0≤x≤1. Here, we focus at the $FeRhGe_2$ (x = 0.5) compound.

X-ray powder diffraction



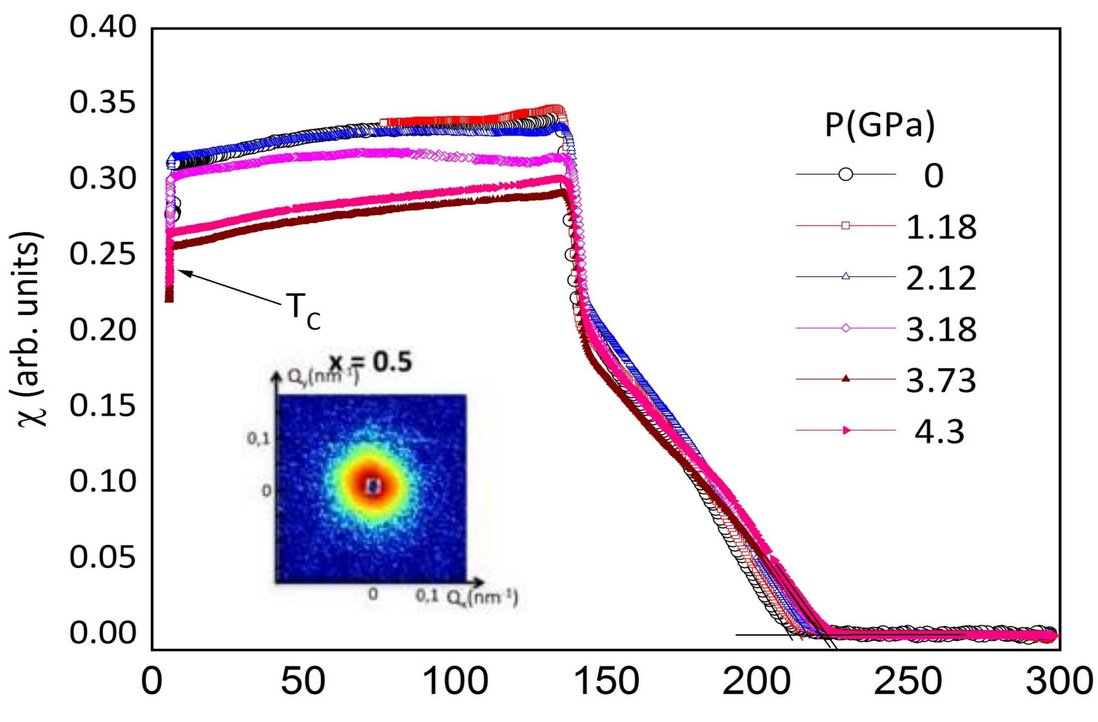
Two B20 crystal phases with different lattice constants. Ratio of phase fractions of a denser phase (a = 4.780 Å) to a less dense one (a = 4.800Å) is equal to 3:2.

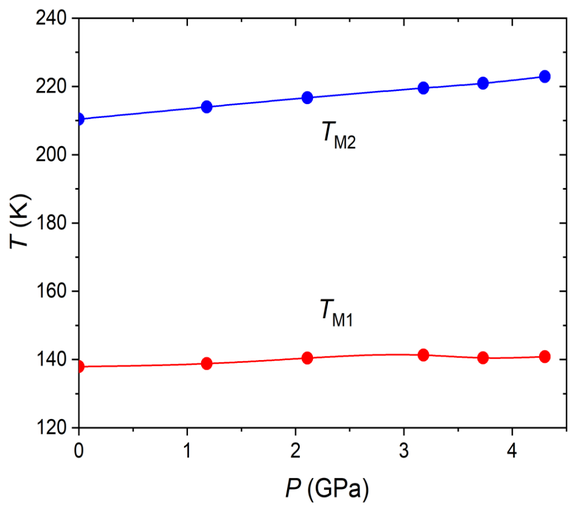
WIEN2k calculation



Both crystal phases were calculated at experimental lattice parameters and turned out stable, with a small energy preference of the first (denser) phase. The evaluated magnetic moments (1.37 and 1.58 μB) and hyperfine magnetic fields *H*hf (107.2 and 109.7 kGs) at the Fe atom are larger for the second phase, which correlates with experiment.

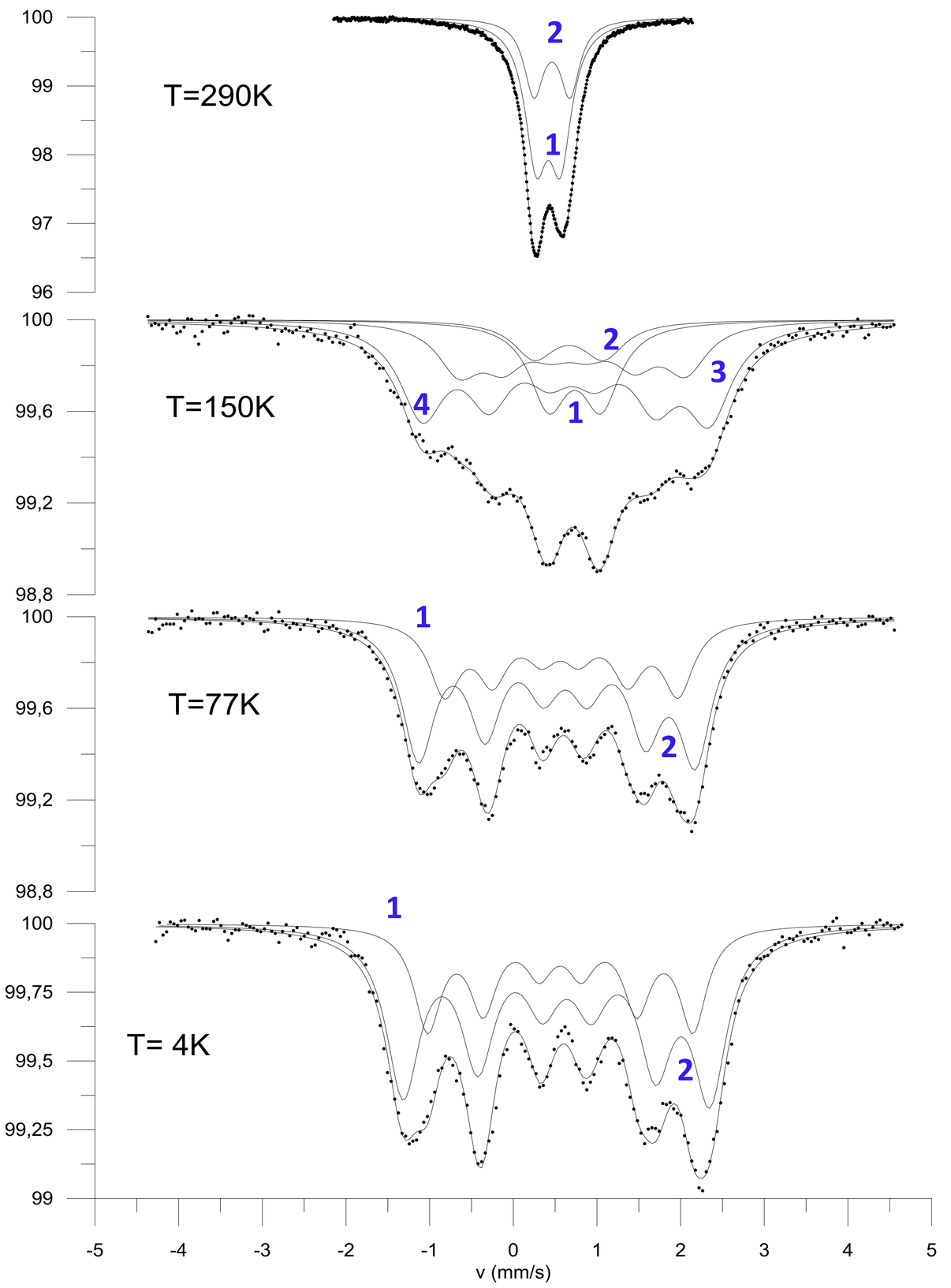
SANS and χ(*T*), χ(*P*)





In the temperature dependence of magnetic susceptibility, we observe two transitions at 150 and 210 K. The temperatures of the transitions weakly increase with pressure up to 5 GPa. The small angle neutron scattering (SANS) pattern at 5 K showed that the magnetic structure of $FeRhGe_2$ is ferromagnetic or spiral with a very large period (wave vector ks < 0.01 nm^{-1}). No phase separation is detected on the SANS pattern.

Mössbauer spectroscopy



	Component	Intensity [%]	IS [mm/s]	QS [mm/s]	MHF [kGs]
290K	1	66.667	0.419	0.146	–
	2	33.333	0.462	0.215	–
150K	1	7.084	0.673	0.371	–
	2	14.168	0.739	0.308	–
	3	26.249	0.826	0.077	86.283
	4	52.499	0.615	-0.043	100.278
77K	1	33.333	0.568	0.007	86.491
	2	66.667	0.571	-0.051	102.510
4K	1	33.333	0.561	0.001	98.308
	2	66.667	0.578	-0.062	113.600

Summary

We present experimental and *ab initio* study of the high-pressure-synthesized compound FeRhGe2 obtained on the basis of chiral magnet FeGe and most likely nonmagnetic superconductor RhGe. The existence of two B20 phases for FeRhGe2 observed experimentally is confirmed by our Wien2k calculations. Theoretical value of hyperfine magnetic field at the Fe atom is larger for the second (denser) phase inqualitative agreement with our measurements. Calculated dependence of magnetic moment on concentration is similar to that previously measured for the Fe-Co-Ge system.

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