Neutron diffraction in 40 GPa - pressure range : a tool to study magnetic and crystal structures

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Neutron scattering is the powerful tool to study microscopic properties of condensed matters. It is the only direct way to determine spin arrangements and to study positions of light elements in structure. Recent progress in neutron diffraction experiments under pressures as high as 40 GPa at the Laboratoire Léon Brillouin is described. Original pressure cells use diamond, sapphire, moissanite and c-BN anvils. They are compatible with low-temperature equipments. Special focusing systems allow us to increase intensity by order of magnitude and therefore to study much smaller samples (0.01 mm^3) than conventional samples for neutron scattering experiments (0.1 cm^3). The techniques had been successfully used to study magnetic and structural phenomena in various compounds [1]. We focus on recent results obtained in high-pressure oxygen. At P=0, oxygen is the only elementary molecular magnet. At high pressure it becomes a metal and a superconductor [2,3]. Even though it was obvious that the magnetic interactions should play an important role in high-pressure oxygen, until now there was no any direct information on magnetic structure in solid O_2 under pressure. At the first time we studied magnetic ordering in the alpha- delta- and epsilon-O_2. New magnetic structure had been found in delta-O_2 at P=6 GPa [4]. The structure had unusual ferromagnetic coupling of the O_2 planes. A gradual weakening of magnetic interactions followed by a magnetic collapse was observed at higher pressures [5]. We discuss prospects for high-pressure neutron studies, including rotational ordering in solid oxygen and hydrogen and new pressure-induced magnetic phases.

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