Magnetism with Nuclear Resonance Scattering

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With the Extremely Brilliant Source Upgrade Programme, Nuclear Resonance beamline [1] ID18 of the European Synchrotron Radiation Facility (ESRF, Grenoble, France) will allow users to study magnetism with a spatial resolution of ~100 nm.

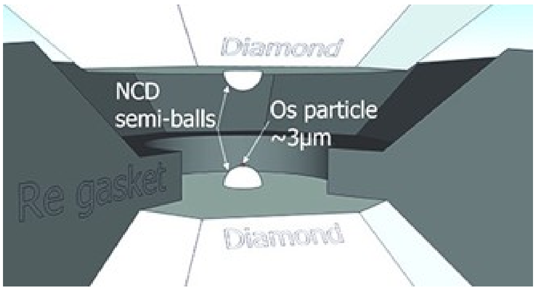

Figure 1. The double-stage diamond anvil cell for ultra-high pressure generation [2]. Image courtesy Elena Bykova, University of Bayreuth.

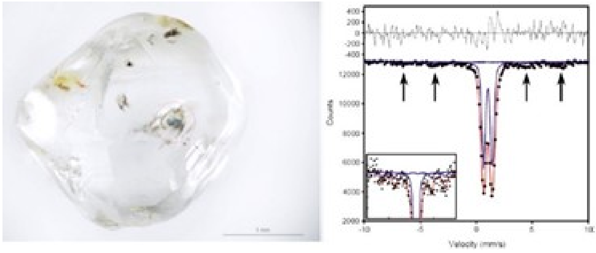

Figure 2. Diamond with a ferropericlase inclusion (left). Mössbauer spectrum (right) suggesting the presence of magnetic splitting (from [3]).

In this talk, we will consider applications of nuclear resonance scattering for studies of magnetism in nano-scale systems. This includes ultra-high, in TPa range, pressures using novel high-pressure instruments as double-stage diamond anvil cell (DAC, Fig.1), studies of magnetism with tiny samples as sub-micron iron-bearing inclusions in diamonds (Fig. 2), the nano-scale landscape of magnetic avalanches in superconducting samples in experiments similar to Ref. 4 (Fig. 3), and some other challenging applications enabled by coming development of the ESRF.

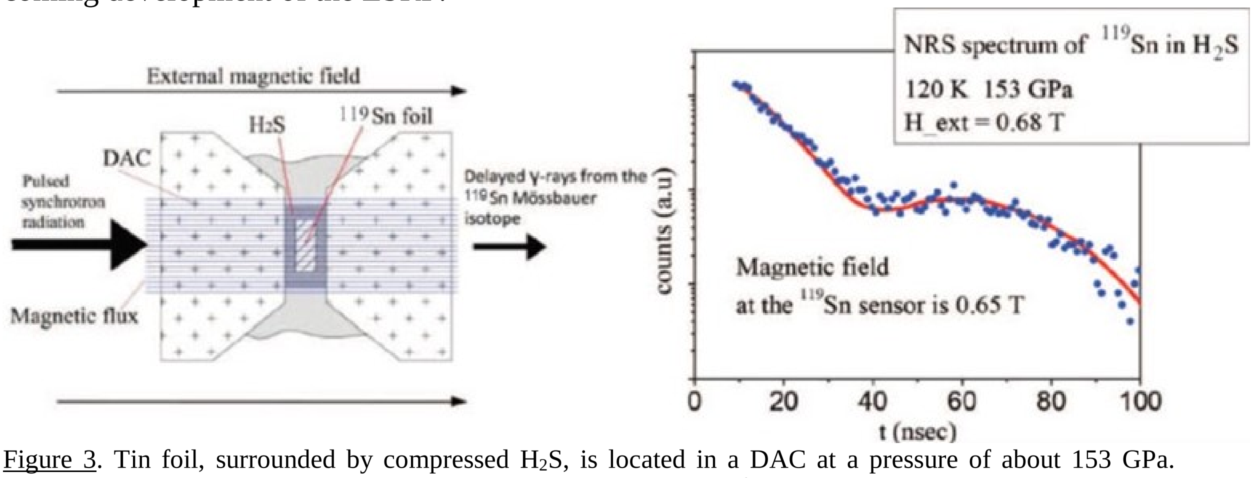

Figure 3. Tin foil, surrounded by compressed H_2S, is located in a DAC at a pressure of about 153 GPa. Synchrotron radiation excites the nuclei of the Mössbauer isotope ^{119}Sn (left). At high temperature, nuclear forward scattering shows quantum beats (right) due to magnetic splitting of the nuclear levels (from [4]).

References

[1] - http://www.esrf.fr/UsersAndScience/Experiments/MEx/ID18#
[2] - L. Dubrovinsky *et al.*, Nature **525**, 226 (2015).
[3] - F. Nestola *et al.*, Lithos **265**, 328 (2016).
[4] - I. Troyan *et al.*, Science **351**, 1260 (2016).