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Report:

Probing the Electronic Nature of Two Coexistent Distinct Magnetic States in ErPd2Si2

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Neutron diffraction results show a coexistence of two incommensurate magnetic structure in $ErPd_2Si_2$ for temperatures around 3 and 4 K (regime II) [1]. It has been thought that the two states is a mixture of an AFM state from purely localized 4f moments and a spin density wave (SDW) from weakly-pinned collective spins in the valence bands. Reflections from the two states are related to the two wave vectors Q±=(H±0.557,0,L±0.15) and Qc=(H±0.564,0,L). We have performed a resonant elastic X-ray scattering study at the L3 absorption edge of $ErPd_2Si_2$ the 11-axis Huber diffractometer; XMaS, BM28 at ESRF, to investigate the electronic nature of the two simultaneous magnetic states.

An $ErPd_2Si_2$ single crystal was cut and mounted in the H0L scattering plane with the c-axis face, normal to the polished surface of the sample, so that (0 0 L) type reflections were in a specular scattering geometry. The initial signal was fixed to the absorption edge L3 = 8.3579 keV and λ = 1.48344 Å. After aligning the crystal and cooling it down to observation temperature ~3.5K, the polarization analyzer was set to select σσ and σπ polarized scattered photons, using the (400) reflection of a MgO crystal.

Weak and broad signals were found at all attempted Q-vectors, at all energies around the L3 edge, and at all temperatures, in and around regime II, for both phases. Figure 1 displays an energy scan at Qc=(0.5616,0,4.0114) showing a reflection of the order of 10^{-5} counts/monitor on the L3 edge. The scan through H- and L- space can be seen in Figure 2 as a mesh plot. The targeted areas were around the Qc and

Q± wave vectors. No area showed any signs of a magnetic Bragg peak for neither σσ nor σπ. Mesh scans at 1.5K with σπ were attempted to see the stronger magnetic peak in regime I, but no peak was detected.

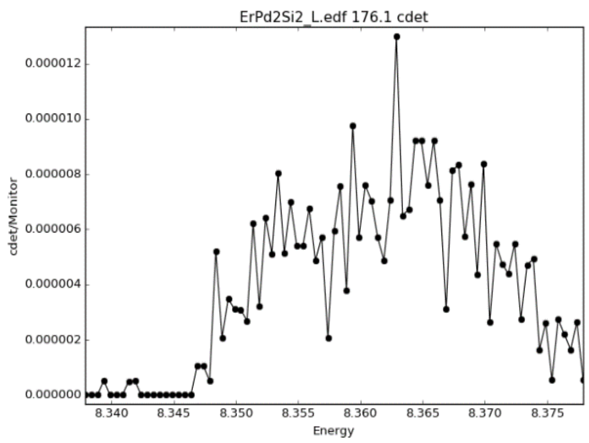

Figure 1 Energy scan at Qc=(0.5616,0,4.0114) showing a diffraction of the order of 10^{-5} counts/monitor for L3.

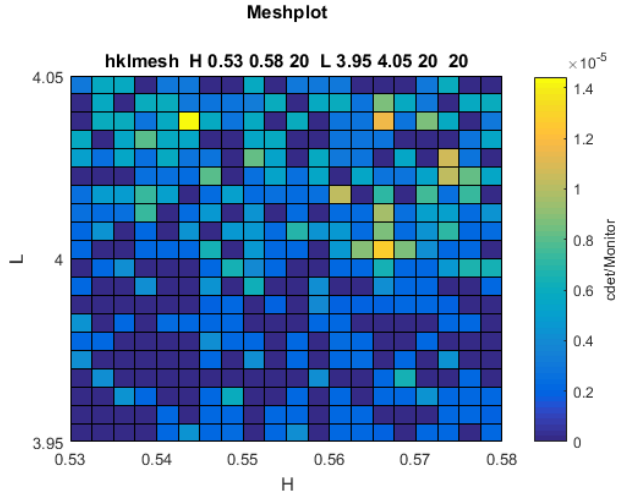

Figure 2 Mesh scan in H and L with H = (0.53-0.58) and L = (3.95-4.05)

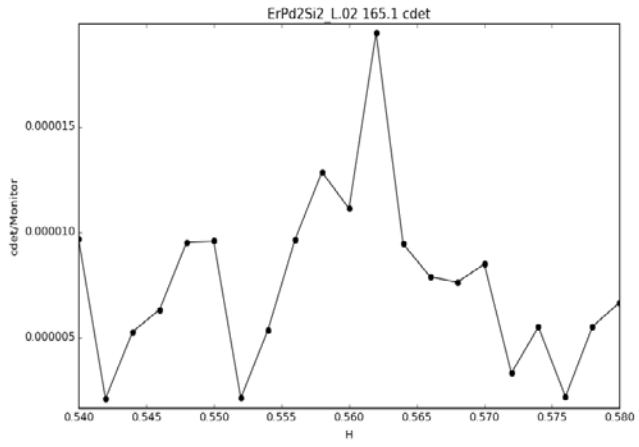

Figure 3 Hklscan along L = 4, targeting the peak at (0.565, 0, 4) in Figure 2.

The lack of peaks give rise to several explanations, some which will be briefly discussed here. First, the possibility of the peaks resonanting at a different edge, e.g. M – edge, could be an explanation. To conduct an experiment at this energy one would need to use soft X-rays, unfortunately cryogenic temperatures of 3K are not accesible with soft X-rays.

Another attempt at explaining the lack of magnetic peaks can be that the measured temperature didn't correspond to the true value, and the critical temperature was never reached. Beam heating is a factor to consider when attempting RXS at such low temperatures. The fact that the true temperature of the sample couldn't be checked through structural peaks makes the heating issue difficult to handle.

[1] Hai-Feng Li, et al., SCIENTIFIC REPORTS, 5, 7968 (2015). DOI: 10.1038/srep07968