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M2Po2A-01: Magneto-structural phase transitions and two-dimensional spin waves in graphite

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We have previously found experimental evidence of several quantum phenomena in oxygen-ion implanted or hydrogenated graphite: ferromagnetism, antiferromagnetism, paramagentism, triplet superconductivity, Andreev states, Little-Parks oscillations, colossal magnetoresistance, and topologically-protected flat-energy bands. In particular, triplet superconductivity results in the formation of Josephson junctions, thus with potential to being used for spintronics applications, in particular in the critical area of quantum computing. Another outstanding feature that we have observed from the temperature-dependent remnant magnetization Mrem(T) measurements is the formation of spin waves.

In this work we are presenting more evidence for the formation of two-dimensional (2D) spin waves in oxygen-ion implanted and in hydrogenated highly oriented pyrolytic graphite. Magnetization measurements were carried out for the temperature range from 1.9 K to 300 K using the Quantum Design Physical Properties Measurement System. Mrem(T) data confirms the formation of spin waves that follow the 2D Heisenberg model with a weak uniaxial anisotropy. In addition, we found that beyond the region showing the 2D spin waves, Mrem(T) goes through a first-order magneto-structural transition from the antiferromagnetic to the ferromagnetic order. This could be the result of reorientation of surface spins around the dislocations and/or domain pinning. We also note that the observed step-like feature of the transition might be due to the coupling between the superconducting the ferromagnetic domains.

Author: Dr GHEORGHIU, Nadina

Co-authors: EBBING, Charles (Univ. of Dayton Research Institute, AFRL/RQQM); HAUGAN, Timothy

Presenter: HAUGAN, Timothy

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