Strength and temperature range enhancement of electromagnon in CuO under pressure

M. Verseils[1], P. Hemme[2], D. Bounoua[3], R. Cervasio[1], J-B Brubach[1], T Lijima[4], M. Mochizuki[4], P. Roy[1] and M. Cazayous[2].
[1]*Ligne AILES-synchrotron SOLEIL, Gif-sur-Yvette, France*
[2]*Laboratoire Matériaux et Phénomènes Quantiques, Université de Paris Cité, France*
[3]*Laboratoire Léon Brillouin, Cea-Saclay, Gif sur-Yvette, France*
[4]*Departement of Applied Physics, Waseda University, Shinjuku-ku Tokyo, Japan*

New exciting high-speed transmission technologies in which spin waves (SW) are vectors for processing information at the nanometer scale are now focused on finding more manageable magnetic quantum objects. Indeed, the traditional method in which SW are excited by dynamic magnetic fields generated by microwave currents significantly loses efficiency at the nanoscale due to parasitic couplings as the dimensions of the system decrease. Identifying alternative magnetic quantum objects that could be shaped and guided by electric field with minimal or no energy consumption is a highly promising pathway for SW applications. Such electroactive spin waves do exist in multiferroic materials and are called “electromagnons”, but they are usually weak quantum objects which are only present at cryogenic temperature making them unpractical to manipulate.

We demonstrated that in CuO, a relatively modest hydrostatic pressure (3GPa) allows an increase of the electromagnon strength by a factor 7 and an extension of its temperature range of existence by more than 40 K. Moreover, the extension of our data suggests that this excitation is present at room temperature around 10 GPa.

To obtain these results, we have pushed in its tracks the THz spectroscopy at the AILES beamline of synchrotron SOLEIL by probing such excitations of low absorption intensity (ten times smaller than phonons) on thin sample (less than 100 µm) suitable for high pressure measurements. This achievement is doubled by Monte-Carlo simulations based on a new effective Hamiltonian model and spin-waves dynamics which account for the first time for the complex magnetic phase diagram and allow to simulate the THz response of the CuO electromagnons in excellent agreement with our experimental results.

Our work highlights the possibility to place the CuO compound on the horizon of the spin waves-based technology roadmap.