Project 6.1 Magnon-plasmon-polaritons: new solid state quasiparticle

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Background:

Recent developments in the research on two-dimensional antiferromagnetic (2DAFM) materials offer unprecedented possibilities. One of them is the coupling of magnons in 2DAFMs with other resonances in the terahertz (THz) range, resulting in new hybrid quasiparticles characterized by new functionalities. We set to obtain the strong coupling between plasmons in two-dimensional electron gases (2DEGs) and magnons in 2DAFMs. This can be achieved by building 2DEG hosting plasmons and flakes of 2DAFMs in one electromagnetic cavity resonator. Such a resonator can be a split-ring resonator (SRR) or Fabry-Perot cavites. We want to observe magnon-plasmon-polaritons using THz optical methods and/or Raman scattering. Alternatively, it is predicted theoretically that magnon-plasmon coupling can be achieved when 2DEG and an antiferromagnet are in proximity, which can be achieved by growing certain semiconductor quantum wells with a layer of an antiferromagnet at a gap in the range of tens of nm. Either way, the observation of magnon-photon coupling using THz techniques would allow the detection of resonance in few-layered 2DAFMs or magnetic thin films. In general, the optical observation of THz magnon-polaritons is scientifically attractive because the research on strong light-matter coupling in the THz range is much less developed than in other parts of the electromagnetic spectrum. Moreover, magnetic excitations have the advantage of narrow line widths that are crucial for light-matter coupling research and applications. The realization of this project will open new avenues for THz research, similar to other polariton systems, such as a platform for studies of quantum effects in 2DAFMs.

Aim:

We want to observe magnon-plasmon-polaritons using THz optical methods and Raman scattering. Intermediated tasks include observation of characterization of magnon-polaritons and plasmon-polaritons and tailoring them to achieve tripartite states of magnon-plasmon-polaritons.

Requirements:

- MSc degree in physics, nanotechnology, or similar,
- good knowledge of basics of solid state physics and electromagnetism,
- basics of programming and data analysis,
- excellent command of spoken and written English,
- nice to have experience in any of the following: spectroscopic techniques, optics, two-dimensional materials, LabVIEW, Matlab.