A7 Collective effects and instabilities of a magnon gas

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Project Goals and Structure

Main Goals

The project focuses on

- the creation of novel correlated states in magnon gases,
- study their properties as a function of the correlation strength,
- understanding of the underlying physical mechanisms

through the investigation of dynamic and kinetic interaction processes in magnon gases whose density is controlled by external electromagnetic pumping.

Magnon gases as model systems for the study of non-equilibrium phase transitions in many-body systems of interacting Bose-particles.

Project Structure

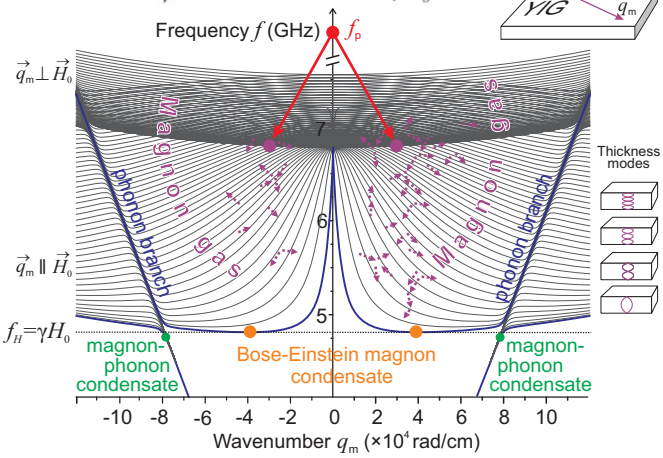
Subproject A: Spatially confined magnon condensates and coherent magnon transport

Subproject B: Coherent interactions and phase transitions in magnon gases and condensates

Parametrically populated magnon gas

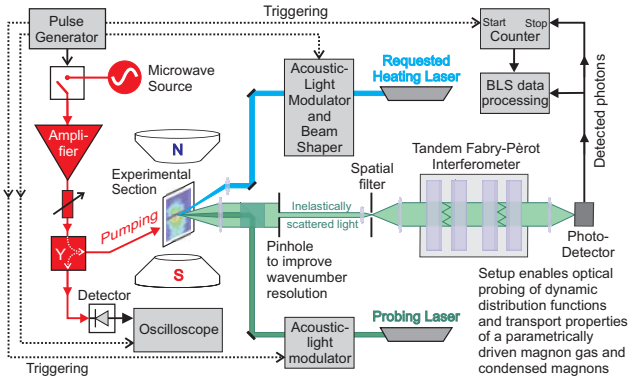
$$\frac{\partial \vec{M}}{\partial t} = -|\gamma|\,\vec{M}\times\vec{H}_{\text{eff}}$$

$$\vec{H}_{\text{eff}}(\vec{r}) = \vec{H}_0 + \int_V \tilde{G}(\vec{r},\vec{r}')\cdot\vec{M}(\vec{r}')\,dr'^3 + \frac{\eta}{\gamma M_S}\nabla^2\vec{M} + \ldots$$



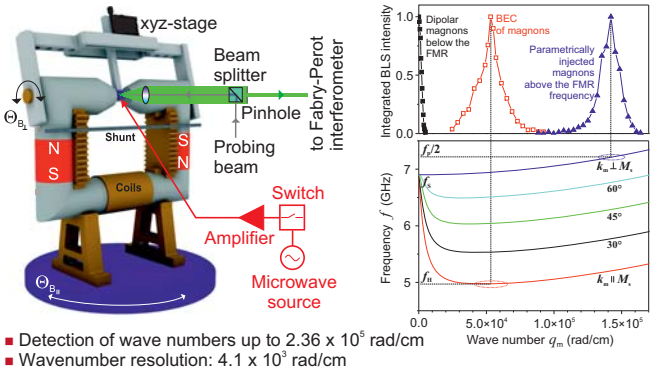
Experimental Setup

Time- and Space-Resolved BLS



Setup enables optical probing of dynamic distribution functions and transport properties of a parametrically driven magnon gas and condensed magnons

2D Wavevector-Resolved BLS Setup



- Detection of wave numbers up to 2.36 x 10^5 rad/cm
- Wavenumber resolution: 4.1 x 10^3 rad/cm
- Time resolution: 250 ps
- Frequency resolution: 50 MHz
- Spatial resolution: 25 µm

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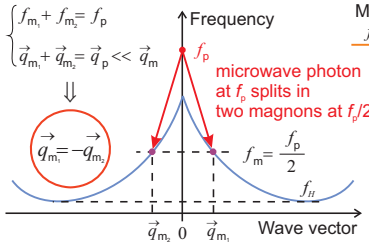
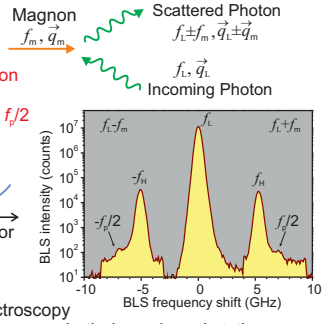
Rev. Sci. Instrum. **80**, 053905 (2009)
Rev. Sci. Instrum. **80**, 043903 (2009)

Methods

Parametric Microwave Pumping



Brillouin Light Scattering (BLS) Spectroscopy



Combination of

- microwave parametric pumping
- time-, space-, phase-resolved BLS spectroscopy

powerful tool which allows to control and measure both dynamic and static spectral characteristics of the magnon gas and condensate

Staff and Requested Funding

Principal Investigators

Burkard Hillebrands
Project head and coordinator

Oleksandr Serha
Supervisor of experiments

Research Staff

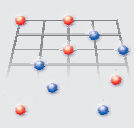
- **Dmytro Bozhko** (Ph.D. student)
  will realise the work programme of subproject A:
  - coherent magnon transport and leakage phenomena in one- and two-dimensional thermal gradients
  - magnon-phonon condensation in ultra-thin films and micro- and nano-structured YIG samples

- **Laura Mihalceanu** (Ph.D. student)
  will concentrate on the low-temperature part of subproject B:
  - time-dependent distribution function of a parametrically-driven magnon gas at low temperatures
  - magnon-magnon and magnon-phonon scattering and condensation scenarios as temperature dependent phenomena

- **Tobias Fischer** (PhD. student)
  will be in charge of the parts of subproject B:
  - interplay of electron carried spin currents and the magnon BEC
  - spin-Seebeck effect induced magnon condensation
  - out-of-plane magnetized films for magnon-photon condensation

Funding

- 3 Ph.D.-positions
- Consumables per year 15'500 €
- Small equipment for upgrade of optical setup 33'590 €



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