WAVES IN NANOSTRUCTURES

Nanomaterials Physics Division

Faculty of Physics

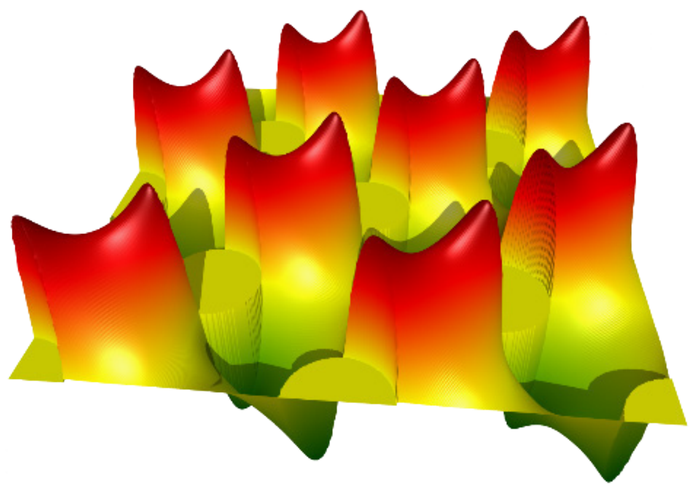
WAVE

WAVE is a disturbance that travels through space with a finite speed, transferring energy. There are many kinds of waves. Some of them, such as sound and light, are well-known and experienced in daily life. Others, such as plasmonic or spin waves, are less known. The main goal of our research is to learn how to manipulate waves in solids (electromagnetic, acoustic, plasmonic or spin waves) on the **NANOSCALE**: to confine them to a small volume, mold their propagation on the nanoscale, and use them in technology.

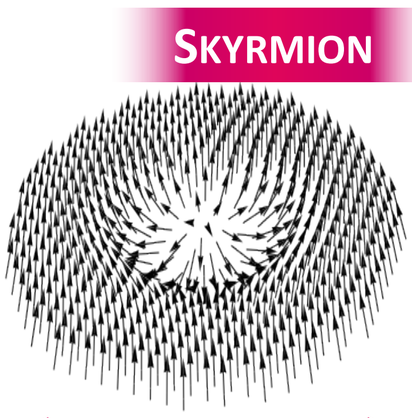
MAGNONICS

Spin waves are the focus of interest of **MAGNONICS**. They are an exciting subject of research and promising information carriers. However, before using spin waves in technology it is necessary to understand the physics behind their dynamics on the **NANOSCALE**. We study the properties of spin waves in complex magnetic structures of various geometries and in various magnetic configurations.

M. Krawczyk et al.., *Review and prospects of magnonic crystals and devices with reprogrammable band structure*, J. Phys. Cond. Matter 26, 123202 (2014).



SPIN WAVE IN A MAGNONIC CRYSTAL

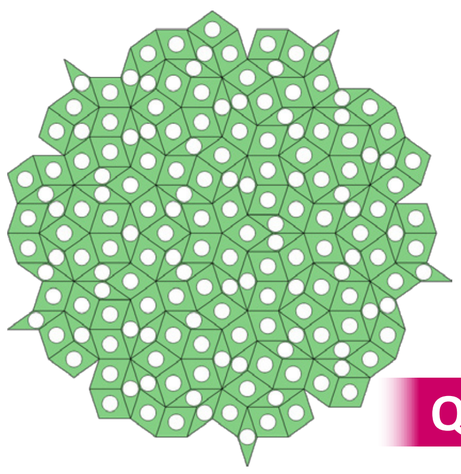


SKYRMION

MAGNONIC CRYSTALS and QUASICRYSTALS

MAGNONIC CRYSTALS and **QUASICRYSTALS** are the structures with magnetic properties varying in space in a regular manner, showing different kids of symmetries. In such structures the wavelength of a spin wave and its velocity of propagation can be controlled on the nanoscale. We use magnonic crystals and quasicrystals for designing miniaturized (micrometer size) filters and signal converters operating for high frequencies (range of gigahertzes).

J. Rychły, et al., *Spin waves in one-dimensional bicomponent quasicrystals*, Phys. Rev. B 92, 054414 (2015).

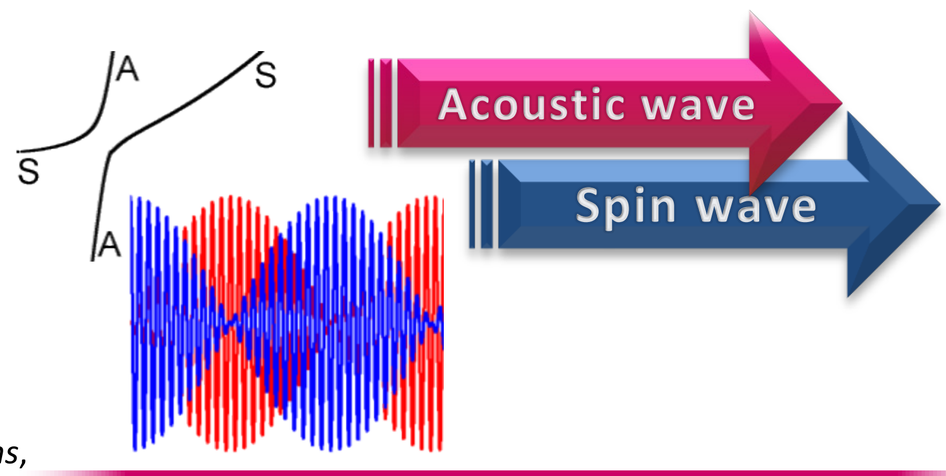


QUASICRYSTAL

SPIN, ELECTROMAGNETIC and ACOUSTIC WAVES: INTERACTIONS

The interactions between **SPIN**, **ACOUSTIC** and **ELECTROMAGNETIC** WAVES make it possible to excite and control traveling spin waves, and consequently integrate them with existing microwave devices. We study spin-wave beams and develop new methods for their generation using microwave antennas and acoustic waves.

P. Gruszecki, et al., *Microwave excitation of spin wave beams in thin ferromagnetic films*, Sci. Rep. 6, 22367 (2016).

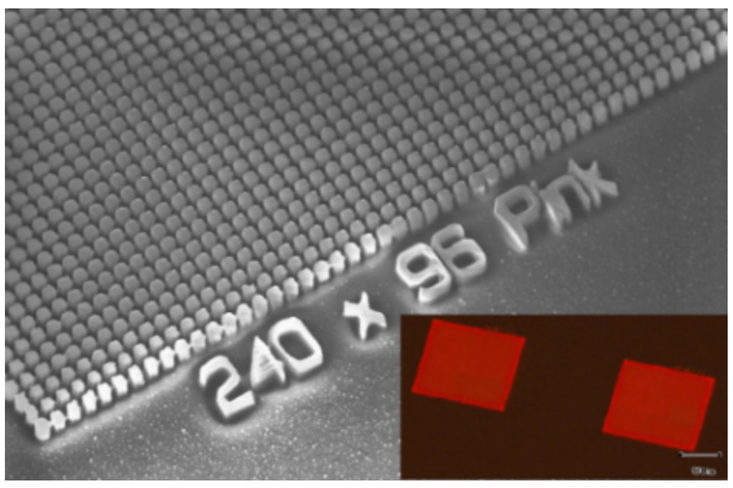


ACOUSTIC WAVE – SPIN WAVE CONVERSION

NANOPHOTONICS

Electromagnetic waves have a frequency spectrum as broad as spectrum of their applications: from radio and microwaves, used in terrestrial communication, to visible light and higher-frequency waves. Electromagnetic waves are the subject of field of science and technology known as **PHOTONICS**. Recent progress in development of artificial structures – **METAMATERIALS** has led to observation of unusual physical effects which don't occur in natural materials. We are working on ultrathin **METASURFACES** for the design of high-efficiency photonic devices.

V. Vashistha, et al., *All-Dielectric Metasurfaces Based on Cross-Shaped Resonators for Color Pixels with Extended Gamut*, ACS Photonics 4, 1076 (2017).



METASURFACE

Research in **Nanomaterials Physics Division**

http://www.staff.amu.edu.pl/~zfn/