Proceedings of the

XVII INTERNATIONAL YOUNG SCIENTISTS' CONFERENCE ON APPLIED PHYSICS

May, 23-27, 2017, Kyiv, Ukraine

Taras Shevchenko National University of Kyiv
Faculty of Radio Physics, Electronics and Computer Systems

Збірник наукових праць

СІМНАДЦЯТОЇ МІЖНАРОДНОЇ КОНФЕРЕНЦІЇ МОЛОДИХ УЧЕНИХ З ПРИКЛАДНОЇ ФІЗИКИ

23-27 травня 2017 року, Київ, Україна

Київський національний університет імені Тараса Шевченка
Факультет

General information

Date	May, 23-27, 2017
Location	Taras Shevchenko National University of Kyiv, Faculty of Radio Physics, Electronics and Computer Systems, building No 4 g, Acad. Glushkov Avenue
Organizers	Taras Shevchenko National University of Kyiv, Faculty of Radio Physics, Electronics and Computer Systems, Young Scientists Council of Taras Shevchenko National University of Kyiv, Student Parliament of the Faculty of Radio Physics, Electronics and Computer Systems, Ukrainian Physical Society

Scope

The XVII International Young Scientists' Conference on Applied Physics is the annual meeting of students, postgraduate students, young scientists and researchers in field of applied physics (radio physics and electronics). The leading Ukrainian and foreign scientists will speak on the plenary meeting of the Conference. The reports of the participants will be given hearing during sections and published afterwards in the book of proceedings.

Scientific program

The Conference contributions are accepted from the following areas:

- Laser Physics and Optoelectronics
- Magnetism and Superconductivity
- Surface Physics and Nanoelectronics
- Physics of Semiconductors and Dielectrics, Semiconductor Devices
- Medical Physics
- Plasma Physics
- Computer Engineering
- Radio Engineering and Communications

Conference venue

All events associated with the XVII International Young Scientists' Conference on Applied Physics will take place in the lecture halls of Faculty of Radio Physics, Electronics and Computer Systems (building No 4 g, Acad. Glushkov Avenue)

Climate

The weather in Kyiv in May is usually warm and sunny. The average temperature in May is + 18^0C. The climate in Ukraine is mild, moderate continental.

Time

Local time is one hour ahead of Middle European time.

Conference language

The language of the Conference Proceedings is English.

Meals

There are many snack bars, cafes and open-area cafes close the Conference Site (at the territory of Faculty of Radio Physics, Electronics and Computer Systems, in the University Campus and at the National Exhibition Center of Ukraine)

Presentation

The Conference program includes invited lectures and contributed paper. All reports will be lectured in oral presentation and poster session.

Invited talks: 60 minutes (including discussion)

Other talks: 20 minutes (including discussion)

Multimedia projectors are available.

Social program

General information

The main organizer of the Conference is the Faculty of Radio Physics, Electronics and Computer Systems of Taras Shevchenko National University of Kyiv. During over fifty years it is the prominent center of education and scientific research in fields of applied physics, radiophysics, electronics, computer engineering, radio engineering. Taras Shevchenko National University of Kyiv is founded in 1834. It possesses the unique position among the high schools of Ukraine, which is accepted by the special edicts of the President of Ukraine.

Kyiv

Kyiv is the capital of Ukraine, one of the most ancient cities in the world. It is known in history as the "Mother of Russian cities", the capital of the first Eastern-Slavonic state, the Kyiv Russ. Kyiv plays an important role in the development of the world culture. It is founded in the VI century and from the Christianity, adopted by Prince Vladimir in 988, started spreading in Russ.

Kyiv is a major scientific center. It is the seat of numerous universities and institutions of higher education, research and design organizations.

Kyiv is one of largest cultural centers. There are many remarkable monuments of history, architecture and arts such as St. Sophia Cathedral (XI-XVIII centuries), The Golden Gates (XI-XX), the Kyiv-Pechery Lavra (XI-XX), St. Cyril Church (XII-XIX), St. Andrew Church (XVIII, architect B.Rastrelli), Marian Palace (XVIII, architect B.Rastrelli) etc.

Kyiv is known as city-park. Woods, gardens, parks and tree-lined boulevard take more than 2/3 of its area. Kyiv is situated on the banks of the Dnipro River, making it inimitable in its charm.

Walking-tour (excursion) in the center of Kyiv will take place at May 25, 2017 from 16:00 to 20:00.

Another Conference's events will be announced at the Conference registration desk during the Conference.

Edited by Dr. Olexiy Y. Nechyporuk,
Dr. Andriy V.Netreba,
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MAGNONIC CRYSTALS IN NANOWIRES WITH PERIODICALLY MODULATED CURVATURE

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A magnetic wave-shaped nanowire is one of the simplest one-dimensional magnetic systems with clearly pronounced influence of curvature to magnetic system. The curved geometry induces an effective Dzyaloshinskii-Moriya interaction and an effective anisotropy. They result in a deviation of the magnetization from the strictly tangential distribution, in spite of the easy-tangential anisotropy. We found the ground state of the wire which has a periodical structure and plays a role of periodic potential for magnons. The spin-wave spectrum has a band structure: the dependence of bandgaps on curvature is found. We propose a new type of the magnonic crystals produced by the curvature. The statics and dynamics of magnetization are calculated analytically in the approximation of small curvatures.

The material patterning is the one of the mechanisms used for controlled propagation of waves. The concept of periodic nanopatterned metamaterials is encapsulated in photonic crystals and allows to model the flow of electromagnetic waves in the optical regime. Nowadays this idea is intensively implemented for other types of excitations, such as phonons and plasmons. In magnetism, the counterpart of photon is a magnon and the magnonic crystal is the magnetic analogue of photonic crystal. Magnonic crystals are the artificial magnetic structures with periodic distribution of the constituent materials or periodic modulation of magnetic parameters [1]. Magnonic crystals have modified spectra of spin-waves which contain bandgaps where spin-wave propagation is prohibited. Magnonic crystals are perspective elements for data transfer and processing [2] and are used for the realization of logic operations [3].

Magnonic crystals are usually produced by periodic modulation of the magnetic parameters, such as saturation magnetization, exchange constant or geometrical parameters [4]. In this study we propose a new type of magnonic crystals, namely curvature induced magnonic crystals. In particular, we consider a planar ferromagnet nanowire with strong easy-tangential anisotropy. The spatio-inhomogeneous curvature of the wave-shaped wire is a periodic square wave function:

$$\kappa(s) = -\kappa_0 \sum_{n=-\infty}^{\infty} (-1)^n [\mathrm{H}(s - 2\pi R n) - \mathrm{H}(s - \pi R - 2\pi R n)], \quad (1)$$

where $\mathrm{H}(\bullet)$ is the Heaviside step function, $\kappa_0 = \frac{1}{R}$, see Fig. 1.

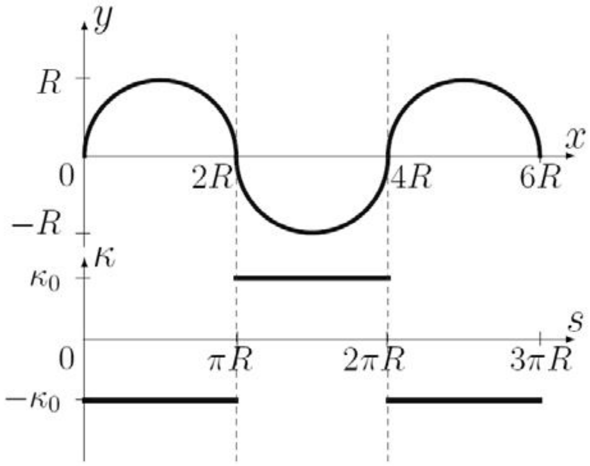

Fig. 1 The planar wave-shaped wire along x direction and the curvature κ; s is a is the arc length, R is a radius of the each half-circle.

We study the statics and dynamics of magnetization in the magnetic nanowire, using the recently developed approach [5] for arbitrary shaped wires. In a curvilinear reference frame, the dimensionless energy reads:

$$\mathcal{E} = \int d\xi \{[(\theta')^2 + \sin^2\theta\,(\varphi')^2] + 2\,\kappa\ell\,(\varphi')\sin^2\theta + [(\kappa\ell)^2\sin^2\theta - \sin^2\theta\cos^2\varphi\,]\}\,, \qquad (2)$$

where ξ is a dimensionless coordinate along the wire, φ, θ are an azimuthal and polar magnetization angles through which we write the unit magnetization vector $\boldsymbol{m} = \sin\theta\,\cos\varphi\,\boldsymbol{e}_T + \sin\theta\,\sin\varphi\,\boldsymbol{e}_N + \cos\theta\,\boldsymbol{e}_B$, prime means the derivative with respect to s and ℓ is the magnetic length. The first term corresponds to an isotropic exchange interaction similarly to the straight systems, the second term is an effective Dzyaloshinskii-Moriya interaction and the last term is the sum of natural and effective in-plane *(TB)* anisotropies. Additional effective interactions lead to the emergence of shape induced patterning. Effects of curved geometry are explained in terms of curvature induced exchange driven anisotropy and Dzyaloshinskii-Moriya interaction [5, 6]. The deviation is inhomogeneous along the wire. The strongest deviations are achieved at the inflection points of the wire. By minimizing the energy (2) and using the approximation of small curvatures we found the ground state of the magnetization which plays a role of periodic potential for magnon excitations. Using the Floquet technique and the empty lattice approximation we obtain the spin-wave spectrum of this magnonic crystal.

The first bandgap is determined by curvature, $\Omega_{gap} = \kappa^3\ell^3$(see Fig. 2). The minimal spectrum frequency decreases with increasing of curvature κ and the numerical analysis shows that the gap at zero wave vector disappears for the critical curvature $\kappa_c\ell \approx 0{,}6$.

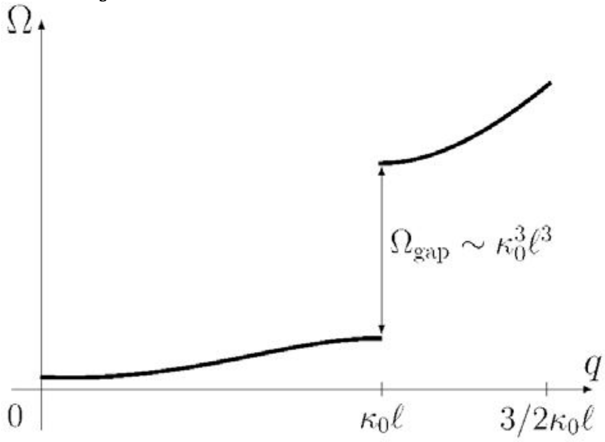

Fig. 2 Schematics of spin-wave spectrum of the magnonic crystal: Ω *is the frequency, q is the wave vector of spin waves.*

In conclusion, we propose a new type of magnonic crystal, produced by a curvature of a wire. Static magnetization distribution and magnon dynamics is described. The proposed system can be effectively used in spintronics in a role of functional elements of data processing devices and functional waveguides.

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HIGH-FREQUENCY ELECTRODYNAMICS OF NANOSTRUCTURED HIGH-Tc SUPERCONDUCTOR FILMS 44
P.A. Borisenko*, A.L.Kasatkin**
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THICKNESS DEPENDENCE OF MAGNETIC PARAMETERS OF PERMALLOY IN Cu/Py NANOSTRUCTURES 46
T.I. Polek*, V.Y. Borynskyi, D.M. Polishchuk*, A.I. Tovstolytkin***
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PROPERTIES OF SPIN-CRROSOVER MAGNETIC MATERIALS ON NANOSCALE LEVEL 48
V. V. Ivashko, Iu. V. Gudyma
Yuriy Fedkovych Chernivtsi National University Kotsubinsky Str. 2, 58012, Chernovtsi, Ukraine, victor.ivashko@gmail.com

CURVATURE EFFECTS IN ANTIFERROMAGNETIC NANOWIRES 50
D.Y. Kononenko*, O.V. Pylypovskyi*, Yu. Gaididei, D.D. Sheka***
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MAGNONIC CRYSTALS IN NANOWIRES WITH PERIODICALLY MODULATED CURVATURE 52
A. I. Korniienko[1], O. V. Pylypovskyi[1], V. P. Kravchuk[2], D. D. Sheka[1], Yu. Gaididei[2]
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TEMPERATURE EVOLUTION OF THE BAND STRUCTURE OF FeSe 54
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MAGNETOOPTICAL REGISTRATION OF MAGNETIZATION VECTOR REORIENTATION IN EPITAXIAL YTTRIUM IRON GARNET FILM WITH INDUCED ANISOTROPY 55
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