北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Seminar

Strong-coupling phenomena in spintronics

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Abstract

Traditional spintronic devices control the magnetic order digitally. Magnetic and electric fields, charge, spin, and heat currents, sound, microwaves, light, etc. can write a bit by switching the magnetization of a memory element between the “up” to “down” states. However, new computational classical and quantum architectures require analogue control over the magnetic texture. Ideally, the dynamic magnetization is controlled coherently to point into any direction on the Bloch sphere, which requires control parameters that strongly couple to the magnetic order, i.e. an interaction strength that exceeds the lifetime broadening. Since magnetic dipoles interact only weakly with the environment, the strong coupling regime of spintronics can be reached with high-quality materials and devices only.

The material of choice to study the physics and applications of strong coupling is yttrium iron garnet (YIG), an electrically insulating ferrimagnet with a Curie transition far above room temperature. Its record magnetic, acoustic and optical quality led already to the discovery of entirely new phenomena, such as the spin Seebeck effect, which raise the hope for new applications in a sustainable future electronics. Due to a decade of a global research effort, we now quantitatively understand much of YIG’s basic physics, such as the temperature-dependent spin dynamics and the interaction of the magnetic order with photons and phonons.

I will present a selection of our recent progress in the physics of YIG and our search for evidence for strong coupling in YIG devices.

About the speaker

Gerrit Ernst-Wilhelm Bauer (*1956) holds an Engineering Degree (1980) in Chemical Technology from Twente University (The Netherlands) and Doctor Degree in Physics (1984) from the Technical University Berlin (Germany) for research carried out at the Hahn-Meitner-Institute of Nuclear Research. After a postdoc at the Institute for Solid State Physics of the University of Tokyo (1984-86), he became a member of the Scientific Staff of the Philips Research Laboratories (1986-92). He was appointed Professor of Physics at Delft University of Technology in 1992, Professor at the Institute for Materials Research of Tohoku University in 2011, Professor of Physics at University of Groningen in 2018, Principal Investigator (cross appointment) at the National Institute for Material Science of Japan (NIMS) in 2019, and PI at the AIMR-WPI at Tohoku University in 2020. He (co)authored numerous scientific papers in the area of theoretical condensed matter physics, mainly in the field of spintronics and nanomagnetism (Researcher-ID F-8273-2010, H-Index 66). He received the Wilhelm-Conrad-Röntgen Award from Würzburg University (2000), the Outstanding Referee Award by the American Physical Society (2008), the Lars Onsager Medal from the Norwegian University of Science and Technology (2009). He became Fellow of the American Physical Society in 2010 “for exposing the interaction between spin transport, magnetization dynamics, charge and heat transport, and mechanical motion” and 2012 Distinguished Lecturer of the IEEE Magnetics Society on the topic of “Spin Caloritronics”. He occupied the Donders Chair of Utrecht University in 2015, has been Zernike Professor of Groningen University in 2016-17. He was appointed China State High-End Project Foreign Expert in 2018.