Project offers / Expressions of Interest from Jülich

Joint Research and Education Programme "Palestinian-German Science Bridge PGSB"
Forschungszentrum Jülich GmbH & Palestine Academy for Science and Technology

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University affiliation*

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Initial contacts at Palestinian university/universities (if available)

Thesis candidate(s) (if available)

Project description*

Advances in materials science are one of the strongest drivers of technological innovations and thereby they shape our daily life. Typical examples are the magnetic properties of solids, which represent a cornerstone of modern information technology. With giant magneto-resistance (GMR), tunneling magneto-resistance (TMR) and current perpendicular-to-plane GMR (CPP-GMR) based read heads in hard disk drives and memory cells in magnetic random access memories (MRAM) as the celebrated starting point of the field of spintronics, a wide range of experimental and theoretical research activities have been aiming to go beyond the limitations of present day devices.

One of the roads followed today focus on ultrafast manipulation of the magnetic states of devices. The question is what if we were able to manipulate magnetic bits on a timescale of femtoseconds? Devices would operate at speeds several orders of magnitude fasten than at present. Since the first experimental demonstration of ultrafast demagnetization with laser pulses, a new field has been triggered, opening the vast and largely unexplored physical landscape of ultrashort time scales. However a key component to successfully transfer such a process to technology is the controllability aspect, i.e. that it can be tuned in order to overcome the practical and physical limitations imposed on the system. For that a large effort has been made on the underlying physical causes of laser-induced demagnetization but still many open questions remain both theoretically and experimentally.

Although this time-dependent aspect is at the heart of many experimental state-of-the-art activities, realistic material-specific simulations are scarce. This is a formidable task and the goal of the proposed PhD thesis is to investigate in the ultra-fast time domain the behaviour of magnetic bits down to the size of single atoms in different type of materials utilizing principles based on quantum-mechanics. The chemical nature of the device components, electronic hybridization, relativistic effects such as the spin-orbit interaction impact certainly on the dynamical properties of the

magnetic entities. We will explore and try to quantify non-equilbrium spin-orbit physics at high (terahertz) frequencies in several materials. A new computational software will thus be developed in the course of the PhD thesis to describe the ultra-fast dynamics of magnetic system from first-principles. The software will run on the supercomputers of the Forschungszentrum Jülich with the crucial aim of a technology-transfer to palestinian universities such that such softwares are not utilized as black boxes, giving thus the opportunity to develop them further locally.

Date*	**Signature***
27.01.2017	

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