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8:24AM R47.00003 Dispersive elastic properties of Dzyaloshinskii domain walls

, JAMES PELLEGREN, DEREK LAU, VINCENT SOKALSKI, Carnegie Mellon University — Recent studies on the asymmetric field-driven growth of magnetic bubble domains in perpendicular thin films exhibiting an interfacial Dzyaloshinskii-Moriya interaction (DMI) have provided a wealth of experimental evidence to validate models of creep phenomena, as key properties of the domain wall (DW) can be altered with the application of an external in-plane magnetic field. While asymmetric growth behavior has been attributed to the highly anisotropic DW energy, $\sigma(\theta)$, which results from the combination of DMI and the in-plane field, many experimental results remain anomalous. In this work, we demonstrate that the anisotropy of DW energy alters the elastic response of the DW as characterized by the surface stiffness, $\tilde{\sigma}(\theta) = \sigma(\theta) + \sigma(\theta)$, and evaluate the impact of this stiffness on the creep law. We find that at in-plane fields larger than and antiparallel to the effective field due to DMI, the DW stiffness decreases rapidly, suggesting that higher energy walls can actually become more mobile than their low energy counterparts. This result is consistent with experiments on CoNi multilayer films where velocity curves for domain walls with DMI fields parallel and antiparallel to the applied field cross over at high in-plane fields.

8:36AM R47.00004 Current-induced spin torques in inversion broken materials

, HIDEKAZU KUREBAYASHI, University College London — The spin-orbit interaction has been providing richness and greatness of magnetism and spintronics. In solid states, it couples electron's momentum and spins, which make it possible to electrically excite or detect spin accumulation/currents. Looking at localized spins, it helps magnetic anisotropies emerge (together with the magnetic-dipole interaction) where the sample's real space symmetry, such as surface-induced two-fold and crystalline-induced four-fold, is reflected on the magnetic energy landscape. Along this line, we can also think of what will happen when we lower the sample symmetry to "inversion broken". In this case, an electron propagating along one direction is, on the symmetry argument, no longer required to be on the same state as ones moving to the opposite direction. The spin-orbit interaction picks up this and causes a preferential spin direction for each electronic state, as a whole, forming spin textures in momentum space. These spin textures are a fascinating playground for developing spin-charge conversion effects. Although the electric excitation of spin textured materials has been known as the Edelstein effect [1] for more than two decades, its real spintronic use, e.g. magnetisation control [2], has been a much more recent interest. By employing microwave techniques to electrically exert magnetic torques through spin textures, we have successfully excite ferromagnetic resonance using this mechanism and characterise spin-orbit properties in our samples [3]. In this talk, I will summarise our recent results on spin torque effects using spin textures in inversion-broken materials. I will show microscopic origins of current-induced magnetisation control by the Edelstein effects in single ferromagnetic layers [3,4], as well as similar experiments by using non-magnetic inversion-broken layers [5] where we observed two spin torques, one arising from the spin-texture effect that co-exist with the other one from the spin-Hall effect. As the final part, I will present our latest results from our research. [1] Edelstein, Solid State. Comm. 73 233 (1990). [2] Chernyshov, et al., Nature Phys., 5 656 (2009). [3] Fang et al., Nature Nanotech. 9 211 (2011). [4] Kurebayashi, et al., Nature Nanotech, 9 211 (2014). [5] Skinner et al., Nature Comm. 6 6730 (2015).

9:12AM R47.00005 Current-driven domain wall ratchet in a nanomagnet with functionally graded Dzyaloshinskii-Moriya interaction

, KOSTIANTYN V. YERSHOV, Bogolyubov Institute for Theoretical Physics, Ukraine, DENIS D. SHEKA, Taras Shevchenko National University of Kyiv, Ukraine, VOLODYMYR P. KRAVCHUK, YURI GAIDIDEI, Bogolyubov Institute for Theoretical Physics, Ukraine, AVADH SAXENA, Los Alamos National Lab — We develop a concept of functionally graded Dzyaloshinskii-Moriya interaction, which provides novel ways of efficient control of the magnetization dynamics. Using this approach we realize the ratchet motion of the domain wall in a magnetic nanowire driven by spin polarized current with potential applications in magnetic devices such as race-track memory and magnetic logical devices. By engineering the spatial profile of Dzyaloshinskii-Moriya parameters we provide a unidirectional motion of the domain wall along the wire. We base our study on phenomenological Landau-Lifshitz-Gilbert equations using a collective variable approach [1]. In effective equations of motion the functionally graded Dzyaloshinskii-Moriya interaction appears as a driving force, which can either suppress the action of the pumping by the current or can reinforce it. All analytical predictions are well confirmed by numerical simulations.

K. V. Yershov et al., Phys. Rev. B **93**, 094418 (2016).

9:24AM R47.00006 Universal absence of Walker breakdown for spin–orbit and spin Hall torque driven domain walls

, VETLE RISINGGARD, JACOB LINDER, Department of Physics, Norwegian University of Science and Technology — We consider ferromagnetic domain wall motion driven by spin–orbit and spin Hall torques, hereafter referred to as SOTs. Regardless of the relative importance of the reactive and dissipative components of the SOT, we find that for experimentally relevant spin–orbit coupling strengths it is possible to achieve universal absence of Walker breakdown. Specializing to the well-known Rashba and spin Hall SOTs we find dramatically different behavior for large current densities. The contribution from the Rashba SOT cancels exactly against the contribution from the spin-transfer torque, and the net velocity levels off to a constant as a function of current density. The different symmetry of the spin Hall SOT prevents such a cancellation, making the velocity an ever increasing linear function of the current. This effect is robust against the presence of interfacial Dzyaloshinskii–Moriya interaction, and is found both in perpendicular anisotropy ferromagnets and in shape anisotropy-dominated stripes. In the light of recent theoretical [Phys.Rev.B **90**, 094411 (2014); arXiv:1610.00894] and experimental [Nat.Nano. **10**, 221 (2015)] interest in antiferromagnetically coupled racetracks we consider the impact of these results in bilayer stripes coupled by interlayer exchange.

9:48AM R47.00008 Rashba conducting strips coupled to ferro- and antiferromagnetic layers

, JOSE RIERA, Instituto de Fisica Rosario- CONICET-UNR — A system composed of a conducting planar strip with Rashba spin-orbit coupling (RSOC), magnetically coupled to a layer of localized magnetic moments, at equilibrium, is studied within a microscopic Hamiltonian with numerical techniques at zero temperature. In particular, transport properties for the cases of ferromagnetic (FM) and antiferromagnetic (AFM) coupled layers are computed in linear response on strips of varying width. In the case of an AFM localized order, results for the optical conductivity, for small strip widths, suggest the proximity to a metal-insulator transition. More interesting, in the proximity of this transition, and in general at intermediate values of the RSOC, it is observed a large spin-Hall conductivity that is two orders of magnitude larger than the one for the FM order for the same values of the RSOC and strip widhts. There are clearly two different regimes for small and for large RSOC, which is also present in the behavior of Rashba helical currents. Different contributions to the optical and the spin-Hall conductivities, of inter- or intraband origin, or coming from the hopping or spin-orbit terms of the Hamiltonian, are examined. Finally, the stability of the AFM order when magnetic moments are allowed to rotate is studied.

10:00AM R47.00009 Origins of open circuit voltage hysteresis driven by transverse charge current in ferromagnet/normal metal structures

, CHRISTOS TENGERIS, PENGKE LI, IAN APPELBAUM, Univ of Maryland-College Park, APPELBAUM LAB TEAM — We quantify the current-induced ensemble spin polarization due to non-equilibrium occupation of the 'spin-momentum locked' surface states in a 3D topological insulator, using the Boltzmann transport formalism in the relaxation-time approximation. Despite these states' high in-plane spin projection, practically achievable spin density polarization is minuscule in linear response. Using an open circuit voltage scheme identical to those used by others to claim observation of unphysically large polarizations in topological insulators, we experimentally demonstrate potential switching and hysteresis on ferromagnetic contacts driven by the charge current in a topologically-trivial metal thin film beneath it. Our comprehensive study includes the effects of varying parameters (such as the current density, thin film thickness, types of metal materials, and temperature) and aims to resolve the different origins that contribute to this phenomenon.