SYGT 1: Geometry, topology, and condensed matter

Time: Tuesday 9:30–12:15 Location: H1

Invited Talk SYGT 1.1 Tue 9:30 H1

Thermal Properties of Vortices on Curved Surfaces — Leopoldo R. Gómez[1], Nicolás A. García[2], Daniel A. Vega[1], and •José Lorenzana[3] — [1]Instituto de Física del Sur (IFISUR), Departamento de Física, Universidad Nacional del Sur (UNS), CONICET, Av. L. N. Alem 1253, B8000CPB - Bahía Blanca, Argentina. — [2]Institut Laue-Langevin, 71 Avenue des Martyrs, 3842 Grenoble, France. — [3]Istituto dei Sistemi Complessi-CNR, Dipartimento di Fisica, Università di Roma "La Sapienza", Piazzale Aldo Moro 2, 00185 Roma, Italy.

We use Monte Carlo simulations to study the finite temperature behavior of vortices in the XY-model for tangent vector order on curved backgrounds. Contrary to naive expectations, we show that the underlying geometry does not affect the proliferation of vortices with temperature respect to what is observed on a flat surface. Long-range order in these systems is analyzed by using two-point correlation functions. As expected, in the case of slightly curved substrates these correlations behave similarly to the plane. However, for high curvatures, the presence of geometry-induced unbounded vortices at low temperatures produces the rapid decay of correlations and an apparent lack of long-range order. Our results shed light on the finite-temperature physics of soft-matter systems and anisotropic magnets deposited on curved substrates.

Invited Talk SYGT 1.2 Tue 10:00 H1

Curvature–induced effects in manomagnets — •Denis Sheka — Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

The interplay between geometry and topology is of fundamental importance throughout many disciplines. In this respect, the investigation of physical effects governing the responses of curved magnetic nanoobjects to electric and magnetic fields is of strong fundamental interest but is also technologically appealing. Owing to intense theoretical and experimental efforts, the topic of magnetism in curved geometries has evolved in an independent research field of modern magnetism with many exciting theoretical predictions and strong application potential.

This talk focuses on the peculiarities emerging from geometrically curved magnetic objects, including three-dimensional bent wires and curved shells. The curvilinear geometry manifests itself in emergent anisotropy and chiral interactions. These curvature-induced interactions can be not only local (when they stem from the exchange energy) but also non-local (when they are due to magnetostatics). As a consequence, family of novel curvature-driven effects emerges, which includes magnetochiral effects and topologically induced magnetization patterning, resulting in theoretically predicted unlimited domain wall velocities, chirality symmetry breaking etc.

Invited Talk SYGT 1.3 Tue 10:30 H1

Magnetization configurations and reversal of individual ferromagnetic nanotubes — •Martino Poggio — Department of Physics, University of Basel, Basel, Switzerland

Due to their high surface-to-volume ratio, equilibrium magnetization configurations and reversal processes in magnetic nanostructures are often dominated by the influence of surface and edge domains. As a result, surface imperfections and roughness can determine configurations and impede a controllable, reproducible, and fast reversal process. Nanomagnets in flux-closure magnetization configurations, however, are less sensitive to the shape of boundaries, since these configurations close magnetic flux lines within the magnet. Ferromagnetic nanotubes (FNTs), because of their core-free geometry, favor equilibrium flux-closure configurations with magnetization curling around their hollow core. In addition, reversal of a uniform magnetization in these structures has been predicted to nucleate and propagate through vortex domains. Here, we use three techniques to study the equilibrium configurations and reversal processes in individual FNTs: x-ray magnetic circular dichroism photo-emission electron microscopy, scanning nanometer-scale superconducting quantum interference device microscopy, and dynamic cantilever magnetometry. We find evidence for different types of remnant flux-closure configurations. We also observe the signatures of vortex-nucleated magnetization reversal in individual FNTs, as predicted by theory. These developments may have consequences for the design of nanomagnetic elements required for future high-density magnetic storage devices.

15 min. break

Invited Talk SYGT 1.4 Tue 11:15 H1

An experimental perspective on topology and nanoelectronics in graphene and related 2D materials. — •Ivan J. Vera-Marun — The University of Manchester, UK

Topological phases in 2D systems have attracted intensive attention because of their fundamental physics and potential applications in energy efficient electronics, spintronics and quantum computation. This has been particularly true since the first theoretical prediction of a quantum spin hall state in graphene, shortly after its discovery. In this talk, we review part of the significant experimental progress achieved within the last few years on the realisation of topological phases in graphene and its heterostructures with related 2D materials, with an emphasis on nanoelectronics. Among the plethora of demonstrated approaches and effects are: the magnetic-field induced quantum spin hall state, proximity-induced spin hall effect, topological bands in bottom-up synthesized nanoribbons, up to valleytronics in manually-aligned superlattices. The latter, with the recent observation of superconductivity, pave the way for the future development of this exciting field.

Invited Talk SYGT 1.5 Tue 11:45 H1

Roles of the curvature in two-dimensional nematic films — •Gaetano Napoli[1] and Luigi Vergori[2] — [1]Università del Salento — [2]Università di Perugia

Thin nematic films provide a fascinating instance where the interplay between geometry and physics is at work. We illustrate the vector and the order-tensor theories for deformable fluid films, ideally two dimensional, endowed with an in-plane degenerate nematic order. As an application, we consider a generalization of the classical Plateau problem to an axisymmetric nematic film bounded by two coaxial parallel rings. Within the vector theory, the shape of the film results from a competition between surface tension, which favors the minimization of the film area, the nematic elasticity, that brings up the role of curvature. Furthermore, within tensor Landau-de Gennes theory the curvature competes against the temperature favoring the nematic ordering.