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## COLLOQUIA DI DOTTORATO, A.A. 2025/2026

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A101, Dipartimento di Fisica  
**Giovedì 19 febbraio 2026 ore 16:00**

# ***You'd better shape up: topological excitations in physics***

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If you throw a stone into a still pond then the wave set up on the surface of the water dies away, both at a distance far from the initial disturbance and after a relatively short interval of time. However, some waves in Nature are not like this. They are, instead, localised in space and trapped in existence for long periods, their removal costing a great deal of energy. There are many examples of these long-lived, wave-like topological objects in physics such as magnetic domain walls, vortices, and skyrmions [1,2]. Recently, many more have been discovered, including more exotic textures known as hopfions, torons and blochions. Topology, the study of the shapes of objects, provides an organising principle to understand the existence and extraordinary properties of these objects. Topology also allows us to understand and classify large families of unusual quantum-mechanical states of materials.

In this lecture, we will discuss the existence of topological excitations based on ideas from symmetry breaking in phase transitions. We will see how topological objects occur in magnetic materials, where they can be readily measured and visualized. Finally, we will see how these ideas can be applied to a pressing problem: the possible fate of the Universe!

[1] Lancaster, T. (2019). Skyrmions in magnetic materials. *Contemporary Physics*, 60(3), 246–261. <https://doi.org/10.1080/00107514.2019.1699352>

[2] Lancaster, T. and Blundell, S.J. (2015) *Quantum Field Theory for the Gifted Amateur* (OUP, Oxford).