

Research Project Title:

**Theoretical Understanding of static and  
dynamic properties of SKYrmions:  
towards a skyrmion-based technology**

**Principal Investigator:**  
Riccardo Tomasello



**Popular Title:**  
Swirling magnetic particles in nanomagnets

**Scientific Field:**  
Natural Sciences

**Host Institution:**  
Foundation for Research and Technology  
(FORTH)



In our information-everywhere society with ubiquitous ICT devices, technologies that can match the increasing demand for power efficient, high density, high speed information processing and storage are needed. In this project, magnetic skyrmions, the smallest possible topological perturbation to a uniform magnetic configuration, have been identified as the building blocks for such a technology. Skyrmions are very attractive candidates for transporting information, because they can have nanometer size, and can be easily manipulated with spin-polarized currents. However, the recent experimental evidences have highlighted discrepancies and “missing pieces” of the theory and predictions developed up to date. ThunderSKY aims at obtaining an understanding of the latest open questions arisen from those experimental room-temperature measurements in ultrathin heterostructures through the establishment of a theoretical framework for the description of the statics and dynamics of skyrmions, to provide guidelines for the design of skyrmion-based applications. In order to accomplish this scientific breakthrough, ThunderSKY will use an integrated approach by combining analytical theories and numerical simulations, benchmarked against experimental data. ThunderSKY breakthrough will be attained by achieving the two devised objectives: one scientific objective, divided into three sub-objectives, for the theoretical advances, and one technological objective, which will involve both analytical and micromagnetic models, for conceiving novel concepts of logic gates based on skyrmions. Only an interdisciplinary approach including methods and concepts from mathematics, physics, computer science and electrical engineering allows for the realization of such a challenging project. Therefore, the research team of ThunderSKY includes people with different expertise. It is expected that the knowledge generated within the project will be a strong support and reference for the implementation of viable skyrmion-based spintronic applications. Those applications could potentially sustain the internet of things and big data revolutions for going over the standard microelectronic devices, which are crucial enablers of today’s IT technology.

ThunderSKY will provide several fundamental understandings needed to establish a radically new skyrmion-based technology and to push it towards broad industrial development. This technology will beneficially impact the entire ICT, by simplifying the architecture and design of the devices in order to lead to major advantages, such as a novel computational paradigm where memories and logic work at the same level.

The broad new knowledge will become a strategic asset to harness Greek strengths in fundamental research and innovation, and to empower a new class of scientists, which will thus obtain a competitive advantage in the labor market and will be able to transfer the know-how acquired thanks to the project to their future workplaces in Greece, Europe or even worldwide.

The research results can drive new investments in Europe from investors interested in the potential benefits and challenges that the introduction of novel materials and skyrmion-based devices may hold.

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The funding from H.F.R.I. is for me a source of great pride, honor and responsibility. It represents an important step for my professional and personal development. It will be my first scientific project as coordinator and leader of a research group, thus giving me the opportunity to carry out the lines of investigation on my own, which I firmly believe in and I have intensively been working on over the past years. For these reasons, I considered that H.F.R.I. is giving me a unique and crucial opportunity to acquire a solid foundation to become a more qualified professional in my area of expertise. Finally, I feel extremely grateful to H.F.R.I. for believing in the objectives of my project, which I hope will bring scientific and technological luster to the Greek community.

*The Principal Investigator,  
Riccardo Tomasello*

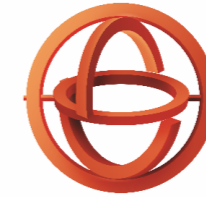
## Funding

Amount: **186,178 €**

Duration: **36 months**

Foundation: **H.F.R.I.**





**H.F.R.I.**  
Hellenic Foundation for  
Research & Innovation

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