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Size effects in microstructured superconductors and quantum materials

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CURRICULUM VITAE

I was born in February 1993 in Rotterdam. In the same city, I completed my pre-university education at the Rotterdams Montessori Lyceum in 2012. Afterwards, I studied physics at Leiden University, obtaining a BSc and MSc degree cum laude. Throughout my BSc education, I have also successfully finished an honors course in philosophy. During my masters, I performed two research projects, which gained me experience in transport experiments in microstructures. During the first, carried out under the supervision of prof. Jan Aarts, I developed a method of exfoliating and contacting Sr_2RuO_4 flakes, a skill that has enabled Chapter six and seven of this thesis. The second project I carried out at the Max Planck Institute for Chemical Physics of Solids in Dresden, Germany, under the supervision of Dr. Philip Moll. During this project, I studied the resistivity anisotropy in the normal state of an iron pnictide superconductor. Since these crystals can only be grown in micrometer-sized crystallites, we employed focused ion beam milling to fabricate microstructures with different geometries to extract the components of the resistivity tensor. Learning how to apply focused ion beam milling properly has greatly influenced the research presented in this thesis. After my time at the Max Planck institute, I returned to Leiden University to start my PhD research under supervision of prof. Jan Aarts in 2018.

LIST OF PUBLICATIONS

- A. Bellunato, S. D. Voltan, C. Sabater, E. W. de Vos, **R. Fermin**, K.N. Kanneworff, F. Galli, J. M. van Ruitenbeek and G. Schneider. Dynamic tunneling junctions at the atomic intersection of two twisted graphene edges, *Nano Letters* **18**, 2505-2510 (2018).

- Y. Yasui, K. Lahabi, V. F. Becerra, **R. Fermin**, M. S. Anwar, S. Yonezawa, T. Terashima, M. V. Milošević, J. Aarts and Y. Maeno. Spontaneous emergence of Josephson junctions in homogeneous rings of single-crystal Sr_2RuO_4, *npj Quantum Materials* **5**, 21 (2020).

- T. J. Blom, T. W. Mechielsen, **R. Fermin**, M. B. S. Hesselberth, J. Aarts and K. Lahabi. Direct-write printing of Josephson junctions in a scanning electron microscope, *ACS Nano* **15**, 322-329 (2020).

- **R. Fermin***, G. Avallone*, K. Lahabi, V. Granata, R. Fittipaldi, C. Cirillo, C. Attanasio, A. Vecchione and J. Aarts. Universal size-dependent nonlinear charge transport in single crystals of the Mott insulator Ca_2RuO_4, *npj Quantum Materials* **6**, 91 (2021).

- **R. Fermin**, D. van Dinter, M. Hubert, B. Woltjes, M. Silaev, J. Aarts and K. Lahabi. Superconducting triplet rim currents in a spin-textured ferromagnetic disk, *Nano Letters* **22**, 2209-2216 (2022).

- **R. Fermin**, N. Scheinowitz, J. Aarts and K. Lahabi. Mesoscopic superconducting memory based on bistable magnetic textures, *Physical Review Research* **4**, 033136 (2022).

- **R. Fermin**, B. de Wit and J. Aarts. Beyond the effective length: How to analyze magnetic interference patterns of thin film planar Josephson junctions with finite lateral dimensions, under review at *Physical Review B*, arXiv:2210.05388.

- **R. Fermin** et al. Controlling chiral domain walls in mesoscopic Sr_2RuO_4 using geometry and in-plane magnetic fields, *To be submitted.*

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Usually, PhD students are supervised by a promotor and a co-promotor. Although I did not have a co-promotor, I worked closely with Kaveh Lahabi on most of the projects presented in this thesis. I could always count on his knowledge and support, making him closest akin to a co-promoter.

As evidenced by the long author lists at the beginning of each chapter of this thesis, experimental physics is always a team effort. I want to express my gratitude for the collaborations with scientists from other universities that helped this thesis come about. First, Mikhail Silaev, for his theoretical work on the generation of long-range triplets in the Co-disk junctions. Next, Guerino Avallone, Victoria Granata, Rosalba Fittipaldi, Carla Cirillo, Carmine Attanasio, and Antonio Vecchione for working together on the size-dependent nonlinear charge transport in the Ca_2RuO_4 crystals. Especially, *'Wajio'* Guerino, for doing the experiments on Ca_2RuO_4 with me and the discussions on the sample quality, during his stay here in Leiden. Finally, I thank Alexander Brinkman for allowing me to measure the Sr_2RuO_4 samples at Twente University and Joost Ridderbos for supporting me with those measurements. The measurements were not only helpful for completing this thesis, but I also learned a lot about low-noise measurement set-ups during those two weeks.

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