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Eugene M. Chudnovsky and Javier Tejada
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This is the first book to present a coherent theoretical and experimental treatment of the rapidly developing field of macroscopic quantum tunneling of the magnetic moment.

The theory is based on the concept of the magnetic instanton and its renormalization by the dissipative environment, and the book includes discussions of the tunneling of magnetic moments in small ferromagnetic grains, tunneling of the Néel vector in antiferromagnetic grains, quantum nucleation of magnetic domains, and quantum depinning of domain walls. The experimental part collects the majority of recent data that are, or may be, relevant to spin tunneling. Among the topics described are low-temperature magnetic relaxation and its interpretation in various systems, experiments on single particles and mesoscopic wires, and resonant spin tunneling in molecular magnets.

This study of an important new field in condensed matter physics by two leading contributors to the subject will be of interest to theorists and experimentalists working in magnetism, and will provide a sufficient background to allow either to begin independent research.

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Macroscopic Quantum Tunneling of the Magnetic Moment

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To our parents,
Michael and Sofia Chudnovsky,
Raúl Tejada and Conchita Palacios

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Preface

The book consists of two parts. The first part (Chapters 2–4) is purely theoretical; the second part (Chapters 5–7) is mostly experimental. Chapter 2 contains the general theory of instantons and tunneling with dissipation, which is necessary for understanding the rest of the book. Chapters 3 and 4 deal with magnetic tunneling in single-domain particles and bulk materials, respectively. In Chapter 5, the consequences of tunneling for magnetic relaxation are derived and applied to experiments. Non-relaxation experiments are discussed in Chapter 6. Data on resonant spin tunneling in $Mn_{12}Ac$, and their interpretation, are presented in Chapter 7. In selecting material for this book we were guided by the principle that the theory must be relevant to experiment while experiments must be relevant to magnetic tunneling. Time may prove that some are not. Lengthy theoretical formulas which are difficult to compare with experiments and experimental data the analysis of which is too complicated have been left out. No doubt, there are important results that did not enter the book because we failed to appreciate their significance. Our list of references serves the single purpose of refering the reader to the original papers that we know and understand; in no way does it constitute a complete list of important works on magnetic tunneling.

The work on this book would have been difficult or impossible without support from the National Science Foundation of the USA, the Spanish and Catalan governments, and the Banco Bilbao Vizcaya. We are also infinitely grateful to Joan Manel Hernandez for linking together a vast number of computer files during the final stage of the work on the book.

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