

Preface

The purpose of the book is to discuss nonequilibrium phenomena in fluidized granular materials, with an accent on granular kinetic theory and some of its stochastic extensions. A few other books exist on this subject. The difference in this new one is to provide the reader with a *brief* introduction, which goes through a few salient points in the subject: models for collisions, Boltzmann equation, fundamental boundary conditions, transport equations and hydrodynamics, macroscopic ordered phenomena, the motion of tracer particles, and the breaking of time-reversal symmetry.

This book is *not* a topical review. Therefore reference sections are not meant to be exhaustive. My intent is to offer a selection of starting points, for instance by citing reviews or other books, where the reader will find more detailed bibliographies. This book merges material from two courses given for Ph.D. students at the Physics Department of Sapienza University (2010 and 2012), and a general reorganization of the results of GranularChaos project. GranularChaos is a 5-year-long project (2009–2014) funded by the Italian Ministry for University and Research, after winning the selection at the European Research Council (Starting Grant 2007). The focus of the project is fluctuations in granular media.

I am indebted to Angelo Vulpiani for most of what I learned about nonequilibrium statistical mechanics and granular materials: collaboration with Angelo has always been enjoyable and fruitful. The hint to write this Brief came from him: again an interesting and challenging incitement. Umberto Marini Bettolo Marconi, Alberto Petri and Vittorio Loreto are the other three friends who greatly improved my knowledge and understanding of the subject, since the beginning of my study of granular fluids. Many of the ideas and results contained in this book are due to collaboration and discussions with them, during the last 15 years and more. I wish to say thanks also to Andrea Baldassarri, who shared with me many progresses on granular kinetic models and, in the early years of my doctorate, was an intense stimulus to become a better c-programmer and a more careful researcher. My understanding of granular fluids in the wider context of nonequilibrium steady states has received a great impulse during a stay of 2 years in Orsay (Paris), where I collaborated with Alain Barrat, Emmanuel Trizac, and Frederic van-Wijland,

whom I wish to warmly thank. In the last years I had the exciting possibility, as a coordinator of the GranularChaos project, to interact with brilliant young collaborators, in particular with Giulio Costantini, Giacomo Gradenigo, Alessandro Sarracino, and Dario Villamaina, whom I acknowledge for a constant passion, curiosity, and their many intriguing interrogatives: they shaped my ability to explain and teach. My hope is that, as a consequence, this book will be clear and useful to students and young researchers. The GranularChaos project, thanks to the crucial help of Andrea Gnoli, has allowed me to enter in the fascinating world of real experiments with granular fluids, an experience which has deeply influenced my perspective on this subject. A special acknowledgment goes to Andrea Gnoli, Alessandro Sarracino, Camille Scalliet, and Angelo Vulpiani, who read the manuscript, found plenty of errors, and gave me many useful advices.

Last, but certainly not least, I wish to thank my beloved family, in particular Fabiana (well before that unstoppable and joyful creature which dwells in our house since a couple of years), for their patience, tolerance, and love.

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