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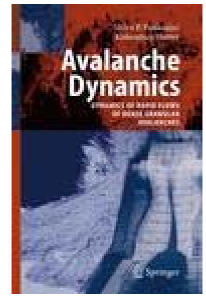


***Avalanche Dynamics—****Dynamics of Rapid Flows of Dense Granular Avalanches*, edited by Shiva P. Pudasaini & Kolumban Hutter, 2007. Springer, Heidelberg. Hardcover, 602 pages. Price EUR 129.95; USD 169.00. ISBN 978-3-540-32686-1.

Natural gravity-driven flows are a major threat to human activities in all mountainous areas throughout the world. In the Alps, which are heavily populated compared to other mountain ranges, and which are crossed by major roads from northern to southern Europe, snow avalanches and torrential floods are a longstanding problem, which imposes severe constraints in terms of land use. Recent catastrophes such as in winter 1999 and fall 2000 remind us that protecting people and infrastructures remains a demanding and delicate task.

In this context, developing models that are able to predict the behavior of extreme events is of paramount importance to land-use planners, decision makers, and local authorities. The first models were developed by engineers for specific purposes. In the 1920s, in his study of impact forces exerted by an avalanche against a ski-lift pylon, a Swiss engineer, Henri Lagotala, used a very simple model, considering the avalanche as a sliding ,rigid block experiencing Coulomb friction. This was the beginning of a long maturation phase, marked by brilliant ideas of a few people, mostly in Switzerland, Russia, and France. Voellmy, Salm, Pochat, Eglit, Kulikovskiy, Grigorian and many others thus gave birth to the science of snow avalanches.

It was not until 1989 that the first complete theory was proposed by Savage and Hutter. They not only gave a new impetus to avalanche modeling by moving the state-of-the-art in a substantial way forward, but they also modified our way of conceptualizing natural flows. Indeed, in their 1989 paper, Savage and Hutter did not compare their model directly to field data, but to granular-flow experiments conducted with laboratory flumes. Although the idea in itself was not new (it was quite common for density currents), its use in the domain of gravity-driven subaerial flows was innovating and gave rise to a growing number of investigations. At that time, both the Savage-Hutter model, together with the use of laboratory data in place of field data, were vividly debated and even today part of the scientific community rejects this approach, which is considered an overly simplified representation of complex events, which gets nowhere.

This opposition may explain why Hutter spent a large part of his scientific career to further investigate granular avalanches. With his assistant, Shiva Pudasaini, he wrote this impressive compendium to summarize twenty years of research in the field of granular flows. The book is of particular relevance to snow avalanches, but it also contains material that is related to debris flows and rockfalls. The readership targeted is clearly scientists with a sufficient background in mathematics and mechanics, graduate students following courses in geophysics, applied mathematics, physics, and mechanics, as well as trained practitioners.

The book is divided into 5 parts:

The first part is an introduction to avalanche research and granular flows. Taking a clever advantage of his substantial experience in the field, connections with many laboratories throughout the world, and many lectures given to master/doctoral classes and summer schools, Hutter presents a nice and well-structured overview of avalanche research and physical properties exhibited by granular flows. Although the title may lead to the assumption that the book aims at describing the physics of snow avalanches, the focus of this book is on granular avalanches. All natural flows that are akin to granular flows are thus potentially concerned.

The second part introduces the reader to the concepts and developments underpinning the Savage-Hutter model and subsequent variants. The governing equations of an avalanching mass down a curvilinear profile are detailed and justified physically. Applications to rotating drums are also outlined. The last chapter of this part summarizes exact and approximate solutions for the governing equations in various settings (curvilinear profile, rotating drum). The mathematical content is nicely introduced and should be useful to newcomers and students.

The third part reviews numerical techniques that can be used for solving the governing equations. These equations being hyperbolic, shocks can arise in finite times and therefore specific techniques must be used to cope with discontinuous solutions. The overview given in this part is quite thorough and covers a wide range of techniques, from the simplest to more sophisticated treatments. Emphasis is given to the finite-volume approach, which turns out to be the most efficient technique to date. Alternative approaches, such as Lagrangian methods, are also described in detail.

The fourth part is devoted to experiments, with emphasis on experimental techniques (image-processing techniques), experimental data obtained by Hutter and coworkers, and comparison with theory. Various geometries of increasing complexity are studied, and theory is systematically and convincingly compared with data. Some applications to real topographies and events are also outlined, but this may frustrate a number of practitioners and field scientists, who would rather like to see how the models compare with real data. There are also some efforts to compare the Savage-Hutter model to other Coulomb-based shallow-flow models developed by different teams at the cutting edge of research. To a lesser extent, alternative approaches (e.g., velocity-dependent friction law) are mentioned. Scientists working on dry granular flows may be surprised to see no account of recent trends in the rheology of granular flows. Given how controversial the issues related to rheological properties of bulk materials are, the authors probably wanted to keep a unified point of view.

The final part presents applications to real problems and gives an outlook on future research. The intent in the chapter on avalanche mitigation seems to review the different strategies used to protect constructions against avalanches. The content contrasts with that of previous chapters. This chapter is not sufficiently documented and structured, providing only partial views of mitigation strategies and tools.

In conclusion, I warmly recommend the book to students, engineers, and scientists who have an interest in granular flows and/or snow avalanches. In a sense, it is part of Hutter's legacy, and it offers a unique way of entering the fascinating world of granular geophysical flows. The theoretical developments presented and defended by the authors are a remarkable example of the necessary balance between scientific rigor, thoroughness, sparse representation of complex natural phenomena, and simplification. The book suffers from a few defects (in particular, poor iconography), but on the whole it is well written and structured. Although the largest part of this book requires a sufficient background in mathematics and mechanics, there are real efforts to explain physical and mathematical developments at a basic level.

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