Reviews

PUDASAINI, P.S. and K. HUTTER. 2006. *Avalanche dynamics*. Berlin, Heidelberg and New York, Springer-Verlag. 602pp. ISBN 978 3 54032686 1, hardback. £100/US$169.

This book by Shiva Pudasaini and Kolumban Hutter is an excellent summary of their and their collaborators' achievements on the dynamics of granular avalanches. Hutter has worked on granular avalanches for more than 20 years and Pudasaini has made many contributions in recent years.

The book is divided into five parts. First there is an introduction that discusses different types of avalanches and other geophysical flows such as lahars, debris flows, pyroclastic flows and landslides. The physical processes that can occur in all these flows are introduced with extensive references. The combined discussion that stresses the similarities is particularly welcome, as often the differences are overemphasized. There is also a good history of avalanche research up to modern times, ordered by country, that has been written in collaboration with the different national experts.

The second part introduces the theory of the Savage–Hutter model and recent extensions and generalizations, which form the backbone of the book. These are depth-integrated continuum models that describe the flow of shallow layers of dry grains. The authors carefully derive the model equations in arbitrary curved and twisted channels. The authors' mathematical expertise is clear from the rigour of this section. It concludes with a discussion of some analytic solutions in channels, open slopes and rotating drums.

The third part concerns numerical solutions of the Savage–Hutter equations and their historical development. The section starts with a discussion of early work that used naïve Eulerian or Lagrangian approaches and explains why these fail. Next the discussion focuses on modern shock-caption approaches for hyperbolic systems and provides a good introduction to how they can be applied to one- and two-dimensional shallow flow equations. Finally it shows extensive results of two-dimensional simulations for a variety of complicated geometries and for different physical parameters. This section would provide an excellent starting point for anyone wishing to solve similar problems. It references much of the relevant literature. Something that is perhaps missing is a discussion of how these results compare with other modelling approaches.

Part four contains a summary of more then 20 years of experiments on dry granular flows in a variety of geometries. Two- and three-dimensional flows are covered, including irregular geometries that correspond to natural topographies. The initial discussion concerns films of experiments where the boundary and the depth of the flow is compared with the theory. There is then a detailed introduction to particle image velocimetry (PIV), describing how this modern technique can be used to measure the velocities on the surface and boundaries of granular flows and also depth profiles. Finally there is a discussion of velocity-dependent effects which links this work with the large literature on the behaviour of flows for relatively shallow slope angles near the angle of repose.

The final part covers avalanche protection and defence structures. The same approach is followed as in the other sections, where the history is discussed along with subsections for each country. They have interesting photographs of all the main classes of active and passive protective structures such as snow sheds and snow fences. The authors conclude with a brief discussion of some experiments to test a proposed defence structure at the Zugspitze in Germany and the formation of hydraulic shocks by deflecting dams.

Pudasaini and Hutter have done an excellent job in describing the Savage–Hutter model, its theoretical development, its numerical solution and its agreement with a wide range of experiments. The literature on granular flows and avalanches is vast and widely scattered and this book provides a very useful reference and introduction to these subjects.

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