Title:
Hyperbolic shallow water moment models with complex friction: derivation, analysis and numerical methods

Authors:
Julian Koellermeier, University of Groningen and Ghent University
Qian Huang, University of Stuttgart

Abstract:
Granular free-surface flows pose challenges due to complex velocity profiles and non-trivial friction effects. Traditional shallow water models, such as the Savage-Hutter equations, approximate velocity as depth-averaged, limiting their accuracy. A recent alternative, the Shallow Water Moment Equations (SWME), introduces a polynomial expansion of the velocity profile to improve the physical representation while maintaining computational efficiency.
In this talk, I will outline the inclusion of complex friction terms in the SWME and derive analytical expressions for different examples, including Newtonian slip, Coulomb-type, and granular rheologies. The hierarchical nature of the model allows for systematic refinement by increasing the number of moments, capturing more detailed velocity variations. The stability of equilibrium states will be analyzed, highlighting the role of internal and basal stresses.
Numerical simulations are performed using tailored numerical schemes and I show recent work on well-balanced schemes capable of handling topography and wet-dry interfaces.
Comparisons with existing models demonstrate the improved accuracy and robustness of SWME for granular flows.