Coupled Gas-Granular Media Flows Using Smoothed Particle Hydrodynamics

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ABSTRACT

Coupled flows of fluids and porous media are ubiquitous in engineering and science, from liquefaction and slurry flows to rocket exhaust gas impinging on sandy surfaces. Numerical tools traditionally used to study these problems lack the ability to model large deformation, flow, and fragmentation of the granular material, as well as the range of coupled flow regimes for the gas-porous media mixture. In this work, we present a method to capture all of these physics using Smoothed Particle Hydrodynamics (SPH).

As a mesh-free particle method, SPH offers the opportunity to capture large deformation and fragmentation of solids, particularly when they can be modelled as a yield-stress fluid, as in the case of granular media. Futhermore, SPH has been shown to perform well in simulating dilute “dusty-gas” flows [1]. We implement these capabilities as well as a *u-U* formulation of the equations governing dynamic soil-fluid interaction to develop a code capable of modelling flows of granular media, flows of liquids through granular media, and flows of gas with entrained granular particles. This code covers the range of coupled flow regimes for gas and granular media, from dilute to very dense. Furthermore, this code provides a tool for modelling large-scale flows of granular media.

The motivation for this work is the challenge of predicting the effect of rocket exhaust gas impinging on sandy surfaces during rocket-powered descent of space-flight vehicles. The need for solving this problem will be discussed. In addition, examples of the SPH code applied to large-scale granular column collapse and other loading configurations will be presented. Future applications of the code to engineering problems such as liquefaction and landslides will be discussed.

REFERENCES

[1] Laibe, Guillaume, and Daniel J. Price. "Dusty gas with smoothed particle hydrodynamics–I. Algorithm and test suite." *Monthly Notices of the Royal Astronomical Society* 420.3 (2012): 2345-2364.