

Weekly Seminar: Spring 2011

Date: **Friday, February 18, 2011**

Time: 11:00 AM

Location: Gilman Hall 50 (Marjorie M. Fisher Hall)

Speaker: **Alexis Hérault** | Conservatoire National des Arts et Métiers, Paris, France and Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania, Catania, Italy. Introduced by Prof. Robert A. Dalrymple (JHU | Department of Civil Engineering)

Title: *"Modeling Lava Flows Using Smoothed Particle Hydrodynamics and GPUs"*

Abstract

Smoothed particle hydrodynamics (SPH) has been used for astrophysics, solid mechanics, and fluid flows. This talk will discuss this method as well as discussing its implementation on graphics processing units (GPU), which permits massively parallel computing at low price.

For lava flows, the classic SPH model for fluid dynamics is integrated with the thermal model by Cleary and Monaghan [1] and the phase transition model similar to that of Monaghan et al. [2]. The implementation is based on the GPUSPH code described in [3], and executes on modern NVIDIA graphic processors, with a speed-up of two orders of magnitude over equivalent CPU code.

In addition to the work previously presented in [4], the model also includes a preliminary model for particle aggregation, restricted to the accretion of the topography from solid lava; this is implemented by introducing an additional property for each particle, that flags when the particle is to be merged with the terrain and thus remain fixed for the rest of the simulation. A wider variety of different rheology laws have also been implemented, including classic Newtonian, Bingham, power-law and Hershell-Bulkey, which will allow our model to be used as a research instrument to assist in the development of a better understanding of the lava rheology.

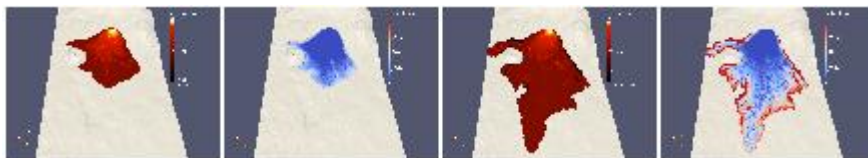


Figure 1: Example of temperature and latent heat evolution during a simulation with GPU-LAVA

References

[1] Cleary P.W., Monaghan J.J. (1999) Conduction Modelling Using Smoothed Particles Hydrodynamics, *J. Comp. Phys.* 148: 227.

- [2] Monaghan J.J., Huppert H.H., Worster M.G. (2005) Solidification using smoothed particle hydrodynamics, *J. Comp. Phys.* 206: 684.
- [3] H rault A., Bilotta G., Dalrymple R.A. (2010) SPH on GPU with CUDA, *J. of Hydraulic Research* 48 (supplement 1).
- [4] H rault A., Bilotta G., Del Negro C., Russo G., Vicari A. (2010) SPH modeling of lava flows with GPU implementation, in **From physics to control through an emergent view** (Fortuna L., Fradkov A., Frasca M. eds.), WSPC, 183–188.