SPH Simulations using Special Hardware

G. Marcus[1], P. Berczik[2], A. Kugel[1], R. Männer[1], R. Spurzem[2], A. Crespo[3], and M. Gomez-Gesteira[3]

Abstract: Smoothed Particle Hydrodynamics (SPH) is a relatively new, meshless particle method to simulate fluid dynamics. It was originally developed for astrophysical simulations but it is currently used in a great deal of applications ranging from astronomy to oceanography to even vehicular traffic. Being meshless makes the method particularly attractive to simulate fluids with complex boundaries.

However, each code has its own characteristics and unique improvements. In particular, astrophysical simulations prefer complex time-stepping schemes in order to cope with very high particle numbers, but adhere to the classical implementation of the method. On the other hand, fluid simulations tend to be of much lower particle numbers, with simple time-stepping schemes but with very elaborate options like adaptive kernels, multiple boundary condition criteria and laminar flows.

In this paper we compile our experience with 3 different SPH codes: a simple astrophysical simulation adapted for our FPGA-based accelerator and later, to a GPU-based implementation; our experience with GADGET2, a high performance, MPI parallel, astrophysical simulation; and SPHYSICS, a fluid simulator aimed for oceanographic research. We present several strategies to deal with the different requirements of each code, focusing on algorithms for use with last-generation GPUs.

[1] Department of Computer Science V
Institute of Computer Engineering (ZITI), University of Heidelberg
B6, 26, 68131 Mannheim, Germany
{*guillermo.marcus, reinhard.maenner*}*@ziti.uni-heidelberg.de*

[2] Institute of Astronomical Computation
Center for Astronomie, University of Heidelberg
Mönchhofstrasse 12-14, 69120 Heidelberg, Germany
{*berczik, spurzem*}*@ari.uni-heidelberg.de*

[3] Physics of the Ocean and Atmosphere Group
Faculty of Science, University of Vigo
Campus Ourense, 32004 Ourense, Spain
{*alexbexe, mggesteira*}*@uvigo.es*