Open Internship in the ESA Advanced Concepts Team in 2016

on

Massively parallel particle propagation on GPUs

Topic description

The recent emergence of powerful general purpose computing units (GP-GPUs) from the graphics market allows a significant speed-up of certain data-parallel computations in the scientific field. This is particularly useful in the context of a highly parallel ODE propagator for arbitrary dynamical systems. Such a code allows the efficient propagation of thousands of particles at the same time, leading to large speed-up compared to regular CPU implementations. Applications of interest include ray tracing in non-cartesian space for the visualization of black holes, as well as the efficient calculation of Lagrangian Coherent Structures in various dynamical systems.

Candidate's tasks

The successful candidate will work on an implementation of an optimized framework of general ODE solvers on a GP-GPU or a heterogeneous computing environment. The goal is to obtain a highly parallel propagator for arbitrary dynamical systems on a state of the art high performance computing GPU. Different integration schemes (Runge-Kutta, symplectic, Taylor) shall be considered. The GPU propagator will then be applied in various projects including the visualization of black holes as well as the efficient calculation of Lagrangian Coherent Structures in various dynamical systems.

In detail, the candidate will be asked to:

- design and implement a general framework for GPU based integrators taking into account the particular structure of GPUs;
- implement within the framework a Runge-Kutta integrator as well as a symplectic integration scheme;
- implement several dynamical systems of interest;
- validate and compare the integrator results with existing CPU based codes in terms of accuracy and performance;
- perform parallel computations to compute black hole visualizations and LCS.

The ideal candidate

Mandatory:

- Excellent programming skills (C/C++/C#)
- Experience with GPU programming
- Interest in applied mathematics and/or computational physics

Desirable:

- Knowledge of OpenCL and OpenGL
- Knowledge of numerical methods
- Knowledge in general relativity