SIMULATION AND MODELLING OF GRAVITATIONAL MICROLENSING EVENTS USING GRAPHICAL PROCESSING UNITS

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Abstract

This thesis presents the results of a study into the use of graphical processing units (GPUs) in the simulation and modelling of gravitational microlensing. Two simulation approaches were investigated: magnification maps and the use of a dynamic engine for directly simulating gravitational microlensing light curves. It was found that the GPUs are able to speed up the generation of magnification maps dramatically. Very high performance in light curve extraction from magnification maps using GPUs is also achieved. Furthermore, the use of texture memory speeds up the extraction of light curves in a further 75% improvement in performance. They provide a speed up of over a 100× faster than CPUs in light curve simulations with finite source effects. The dynamic engine approach use a hybrid computation method with both CPUs and GPUs to simulate light curves for complex microlensing events. It allows us to model microlensing events with orbital motion effects, which are usually done on a cluster computer, on just a desktop computer with GPUs. Modelling strategies and optimization techniques are developed and applied to model different types of microlensing events.

GPU architectures show great promise for tackling the computationally expensive task of numerical modelling of microlensing events. With the modelling strategies developed here, microlensing modelling can be performed on a desktop computer at only a fraction of the cost of a cluster computer. The approach in this thesis provides a very cost-effective solution for the microlensing modelling challenge.

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