Many Core Accelerated (GPU) Supercomputing in China and elsewhere - black holes and gravitational waves from galactic nuclei

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New powerful supercomputers have been built using graphical processing units (GPU) for general purpose computing. China has obtained top ranks in the list of the fastest supercomputers in the world with a GPU based system.

The research of Chinese Academy of Sciences and National Astronomical Observatory in Beijing with such GPU clusters will be reviewed, present and future applications in computer simulation and data processing discussed. We present particle- and mesh-based algorithms for astrophysics using hundreds to thousands of GPUs for one single application run in a parallel message passing environment, some with detailed timing models. Future perspectives for GPU and FPGA accelerated computing will be discussed and international collaboration in the ICCS (International Center for Computational Science).

GPU and other 'green' supercomputing hardware is a stepping stone on the path to reach Exascale supercomputing.

An application to astrophysical Computer Simulations of Dense Star Clusters in Galactic Nuclei with Supermassive Black Holes is presented. We use large high-accuracy direct N-body simulations with Hermite scheme and block-time steps, parallelized across a large number of nodes on the large scale and across many GPU thread processors on each node on the small scale. We reach a sustained performance of more than 350 Tflop/s for a science run on 1600 Fermi C2050 GPUs; a performance model is presented and studies for the largest GPU clusters in China with up to Petaflop/s performance and 7000 Fermi GPU cards. Our simulation proceeds to the complete relativistic merger of the black holes, including Post-Newtonian corrections to gravitational forces and the relevance of the results for the cosmological background of gravitational radiation is briefly touched.

We discuss the relevance of this for pulsar timing bands and for frequency bands of new space based gravitational wave missions in China and Europe.