

NBodyLab Simulations with GRAPE-6a and MD-GRAPE2 Acceleration

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What is NBodyLab?

- Easy to use N-body simulation testbed with a web interface
- Incorporates GRAPE desktop supercomputer accelerators
- Interfaces to NEMO, an advanced stellar dynamics toolbox
- Supports Hipparcus and Sky2000 catalog searches

What is a GRAPE card?

- PCI Card with supercomputer-class chips, developed in Japan
- Designed to accelerate inter-particle force calculations
- Grape-6a performance comparable to 50+ node Beowulf cluster
- GRAPE systems have won 6 Gordon Bell prizes for fastest supercomputer



MD-GRAPE 2 64 Gflops



GRAPE-6a 125 Gflops

Input Parameters

- Models
- Data set specifications
- Transforms and analyses

Model Generation Or Catalog Extraction

- Generate models with NEMO
- N-body format translations

GRAPE-6a NBodyLab Single Model Simulator Overview

Galaxy model / :
 Model: [starmem NEMO model]
 Number of particles for NEMO models (= 50000) [500]
 OS: Upload ASCII model file (see 1# of particles, item 2# in NEMO_VEL_VID)
 Sub-resolution:
 Resolution about axis (e.g. 0.50, 0) none order (e.g. 2nd) none
 Shift (e.g. 0, 5, 0) position none velocity none
 Z-spin angular frequency (+ or counter-clockwise) none

Integrators:
 Type: [1st and 4th-order predictor-corrector, individual time step with GRAPE6a acceleration]
 Number of iterations (= 10000) [10000]
 Output state every nth iteration, n= [1]
 dt (= 1) [1]
 dt-scaling factor (= 1) [0.75]

Display:
 Plot observation plane [yes] Plot range (x-ax) for all axes [yes] Animate GOF of evolution [yes]
 Image and velocity range [yes] Radial profiles [yes]
 Star spectrogram simulation [yes] position angle [no] origin (x,y,z) [0,0,0] width [100]

Hipparcus and Sky2000 Catalog Search for Input to NBodyLab Overview

Catalog [none]
 Star selection: [DWARF+RED+WHITE]
 All (k): [] Lower bound: [0] Upper bound: [100]
 Core (k): [] Lower bound: [0] Upper bound: [100]
 Distance (pc): [] Lower bound: [0] Upper bound: [100]

MD-GRAPE2 Integrators

NEMO hackcode1 integrator without MD-GRAPE2 acceleration
 Leapfrog 2nd-order with MD-GRAPE2 acceleration
 Symplectic 2nd-order with MD-GRAPE2 acceleration
 Leapfrog 3rd-order host CPU
 Leapfrog 3rd-order with MD-GRAPE2 acceleration
 Leapfrog 4th-order host CPU
 Symplectic 2nd-order host CPU
 Symplectic 4th-order host CPU
 Symplectic 6th-order host CPU

GRAPE-6a Integrators

1st and 4th-order predictor-corrector, individual time step with GRAPE6a acceleration
 Leapfrog 2nd-order with MD-GRAPE2 acceleration
 Leapfrog 3rd-order host CPU
 Leapfrog 3rd-order with MD-GRAPE2 acceleration
 Leapfrog 4th-order host CPU
 Symplectic 2nd-order host CPU
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Vicki with Jun Makino, GRAPE designer and Gordon Bell winner



N-body Evolution Analyses and Displays

- Integration options
- Optional GRAPE
- Nemo analyses

GRAPE pipelines

Particle positions
 Forces, potentials

Evolution

Animations

OpenGL 3D viewer

Energy conservation

Trajectories

HR Diagrams

Density vs radius

Maps of intensity, velocity

Simulation of slit spectrogram

Student Research Performed with NBodylab

N-body simulations and HR Diagrams of Nearby Stars



N-body simulations to study geometric evolution of Collinder 70 and Ursa Major

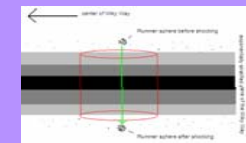
N-body simulations of star clusters and observational comparisons

Hyades cluster from Pomona College Observatories

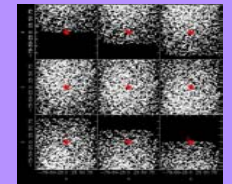


Views of cluster from Sky Catalog 2000 at t=0 and after N-body evolution

Tidal Shocking of Globular Clusters



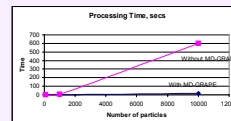
Tidal shocking and relaxation stages in the Milky Way



Cosmology Courses at Pomona College

- dynamics of single galaxies: relaxation, scattering and collapse
- interacting galaxies: collisions and mergers
- interesting structures like tidal tails

300 MFlops AMD host
 1st order method
 100 iterations



Selected References

- N-body simulations and HR Diagrams of Nearby Stars, A. Ates, 2004
- Tidal Shocking of Globular Clusters, J. Wertheimer, 2003
- NBodyLab: A Testbed for Undergraduates Utilizing a Web Interface to NEMO and MD-GRAPE2 Hardware V. Johnson, P. Teuben, B. Penprase, ADASS 2002
- The Stellar Dynamics Toolbox NEMO, P. Teuben, ADASS 1995
- Scientific Simulations with Special-Purpose Computers--the GRAPE System, J. Makino and M. Tajiri 1998