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Research Summary:

Observational cosmology has made significant advances in the last decade and these observations provide useful constraints for theoretical models. Large-scale properties of the Universe can be understood using perturbation theory while small scale inhomogeneities become non-linear early on in their evolution and have to be studied using N-body simulations. There are further complications introduced by limitations of observations at these scales. The next generation of telescopes will reveal much on the formation of structures at these scales.

To understand structure formation and make proper predictions for these telescopes one requires N-body algorithms which are not only accurate and efficient but have a large dynamic range.

N-body Simulations: We are working on the Adaptive TreePM algorithm (ATreePM), an improvement over the existing TreePM algorithm of Bagla, J.S. (JAA.23:185-196, 2002), by introducing a variable softening length for the force, which will help resolve smaller scales. To do this one has to compute the local density around every particle. We are in the process of incorporating an efficient density routine in the existing TreePM algorithm.

Before implementing ATreePM with all the modules that are in hand now, it would be wise to further optimize them. We have managed to speedup TreePM by a factor of $\sim 2 - 3$ by introducing a hierarchy of timesteps to integrate the trajectories of particles. Further work is on to empirically determine the optimal values of the simulation parameters, which are crucial for speeding up the code.

The cost for going from TreePM to ATreePM, in terms of memory and speed, will be 2-3 times that of TreePM. But the resolution that we improve upon will be effectively that of an order of magnitude larger (8-10) TreePM simulation. In addition, introducing a variable softening length for computing forces will keep the same errors (in force, potential, density etc.) for all particles (i.e in overdense as well as underdense regions) We hope to have a sequential implementation of ATreePM ready in a few months time.

Conference/Workshops Attended:

1. *Workshop on Study of Emission from Hot Diffuse Gas with Astrosat*, Christ College and Raman Research Institute, Bangalore, 27 December 2006 - 3 January 2007
2. *Young Astronomer's Meet*, IIA Bangalore, 3-5 January 2007

Invited Lectures/Seminars:

1. *Adaptive TreePM, A High Resolution Collisionless Code for Cosmological N-Body Simulations*, Young Astronomer's Meet, Indian Institute of Astrophysics, Bangalore, India, January 2007.