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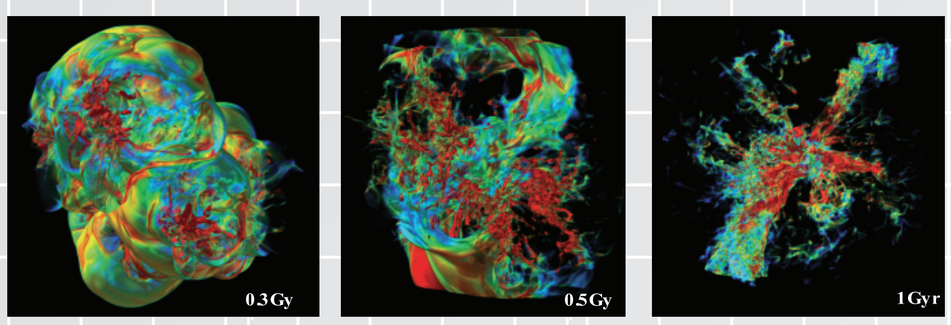
FIRST
The Origin of FIRST Generation Objects

Computational Astrophysics

In the computational astrophysics group, we have explored the structure formation in the universe, concentrating on the coupling effects of radiation and matter. For the purpose, the methods of multi-dimensional radiative transfer and radiation hydrodynamics (RHD) have been developed. Also, to utilize the potentiality of CPU to the maximum, an SPH scheme with SSE (Streaming SIMD extension), which is equipped in x86 architecture, has been developed.

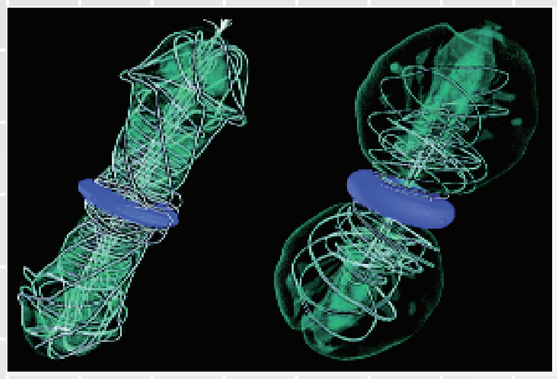
Origin of Elliptical Galaxies

Ultra-high-resolution hydrodynamic simulation follows evolution from the earliest stages of galaxy formation. The bubble structures produced by multiple supernovae at an early evolutionary stage (< 3×10^8 years) resemble closely the high-redshift Lyman α emitters (LAEs). After 10^9 years these bodies are dominated by stellar continuum radiation and look like the Lyman break galaxies (LBGs) After 1.3×10^10 years, these galaxies resemble present-day elliptical galaxies.

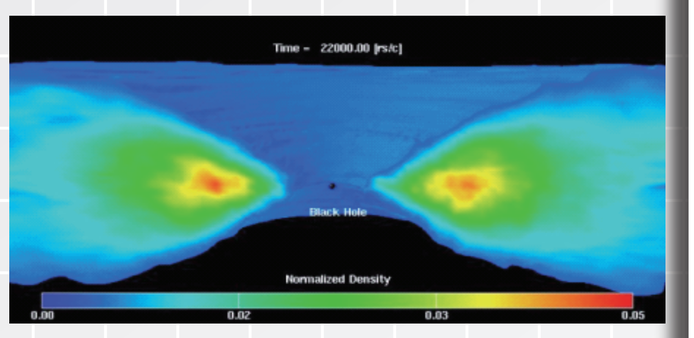


Magnetohydrodynamic accretion flows and jets around a BH

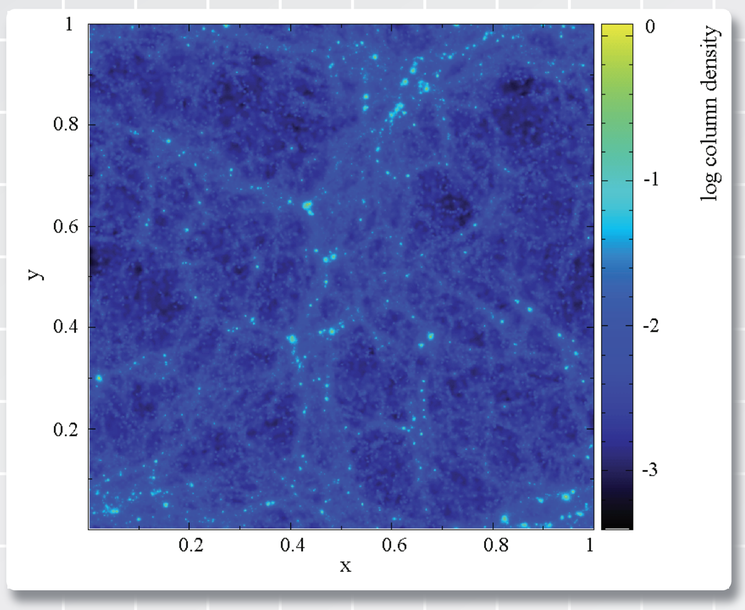
Magnetic-tower jets: MHD simulations have revealed magnetic fields associated with stars and accretion disks deform themselves into a magnetic tower above the accretion disk. The magnetic-tower can drive sub-relativistic jets, up to 50 percent of the speed of light, from the dynamo-active accretion disk.



Magnetohydrodynamic accretion flows: Disk oscillations in magnetized accretion flows are investigated by using 3-D MHD simulations. We found resonant oscillations between Kepler frequency and epicyclic frequency can account for quasi-periodic X-ray brightness oscillations (QPOs) observed in many X-ray binaries.

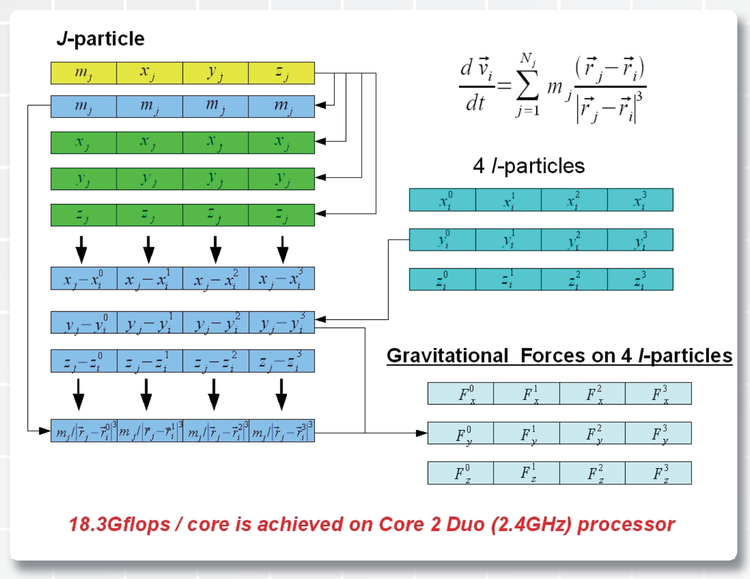


Structure in the Universe



With the formation of galaxies, a large-scale structure develops in the universe through the gravitational instability of dark matter. A simulation with 16.77 million dark matter particles and gas particles of the same number shows the formation of hierarchical structure including galaxy clusters.

Phantom GRAPE



Using the capability of SSE, a numerical library to accelerate the computation of N-body gravitational forces is developed, which is named “Phantom GRAPE” after the conventional GRAPE system, and achieved 18GFLOPS performance on a single core of Core2Duo (2.4 GHz) processors.