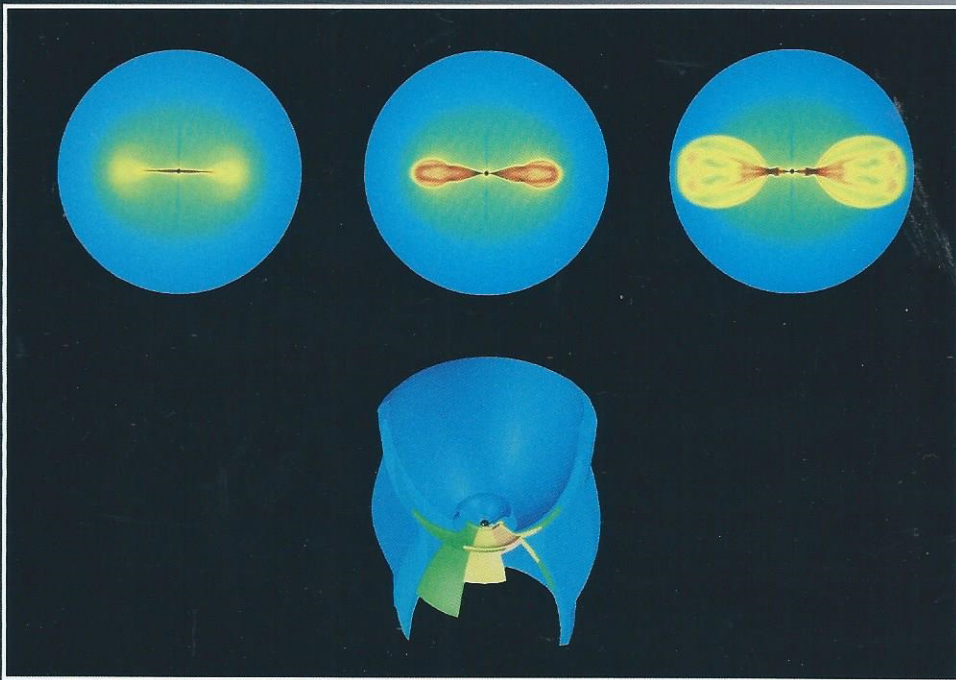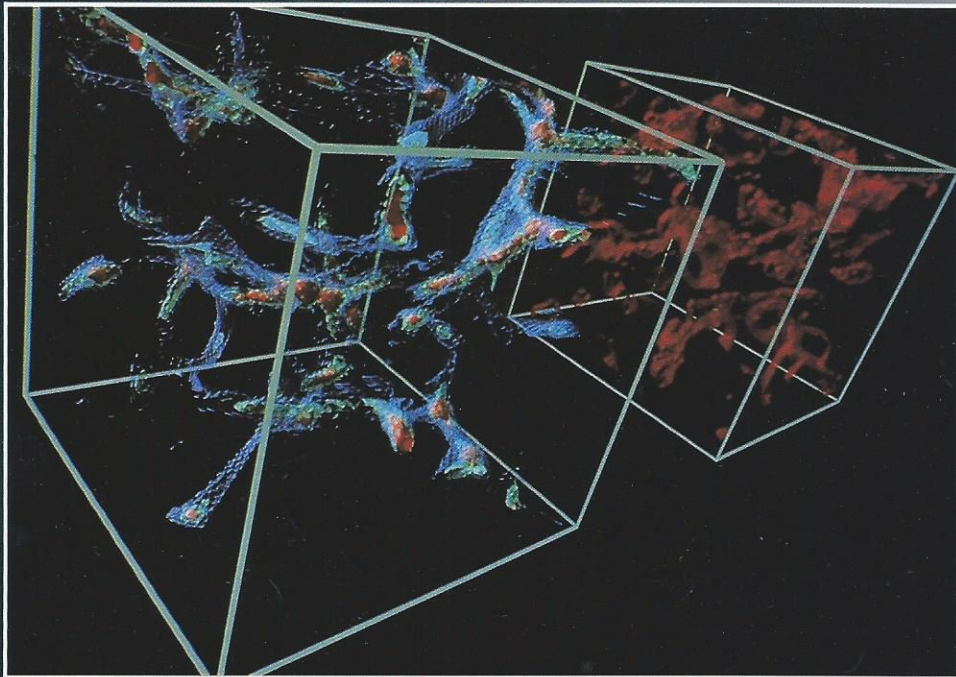# The Imagined Becomes a Reality...

Astrophysics

Computational astrophysics, where theory and observation meet, provides an experimental laboratory otherwise unavailable to stellar scientists. CRAY X-MP and CRAY-2 supercomputers provide the computational space and speed necessary to model structures on the scale of superclusters of galaxies, black holes, and neutron stars. High-quality computer graphics can highlight subtle phenomena hidden in the huge numerical output of these computational experiments. Simply put, computer graphics can lead to scientific insight.

Gravitation of visible particles accounts for structures like stars and galaxies. But what about superclusters of galaxies observed by astronomers? Looking for a new approach, astrophysicist Joan Centrella and her colleagues modeled other particles. Abundant neutrinos, recently theorized to have a minuscule mass, provide sufficient gravitation to form the relatively dense clumps and stringy filaments connecting those clumps, as seen in the image at upper left.

Centrella's simulation, restricted to 16-cubed data points on smaller machines, initially ran on a 64-cubed model on the CRAY X-MP/48 supercomputer. Centrella recently ran a 128-cubed simulation on the CRAY-2 supercomputer.

Astrophysicists John Hawley, Larry Smarr, and James Wilson wanted to model gas flow in the vicinity of a black hole. This gas flow is believed to provide the power source for quasars and radio galaxies. They required the power of a Cray supercomputer to solve the complex nonlinear partial differential equations which confirm and extend previous analytic work.

In Hawley's graphics at lower left, the series of three images shows how streams of inflowing fluid intersect at the equator of the cross-section, forming a pancake-shaped shock. Then the shocked region inflates a high-density torus orbiting the black hole. Finally, low-angular-momentum material flows into the hole, but higher-momentum fluid splashes back due to centrifugal force, creating the complicated internal structure of the torus in the third image. The fourth image is a three-dimensional representation of the high-density splash-back near the hole and the resulting evacuated funnel along the orbital axis.

Scientists like Centrella and Hawley push the limits of even the biggest computer systems. The Cray computers of today made the imagined a reality for these scientists. The Cray computers of tomorrow will provide the computing power to solve the scientific problems being conceived of today.

Making the Imagined a Reality. . .

Making the imagined a reality has become commonplace using Cray supercomputers. Previously insolvable problems in the aerospace, petroleum, and automotive industries and in science, engineering, and graphics are being solved today using the power and flexibility of Cray supercomputer systems. In each discipline the Cray supercomputer is used to simulate a real-world process in less time and at less cost.

To support these applications, a wide range of graphic software systems is offered for Cray supercomputers by third-party vendors. Device-independent line-drawing systems like GK-2000 and DI-3000 from Precision Visuals, Inc., TEMPLATE from Megatek, Inc., and DISSPLA from ISSCO, Inc., are being used now on many Cray supercomputers.

Systems for CAD/CAM and pre- and postprocessing like PATRAN from PDA Engineering and MOVIE.BYU from Brigham Young University support a variety of engineering design activities. In those cases where photographic-quality scene generation is the objective, the designers, artists, scientists, and movie-makers are turning to Cray systems to do what could not otherwise be done.

If your application or graphics task requires extraordinary computer power . . . the problems you **can** do are much smaller than the problems you **would** like to do . . . if you need a general purpose powerhouse to run a variety of simulation, engineering, or scientific codes . . . you need a Cray supercomputer!