ADLER
PLANETARIUM

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COSMIC COLLISIONS

MAKING OF THE SPACE SHOW

Cosmic Collisions, the spectacular new Space Show that premieres on June 6, 2008, at the Adler Planetarium, is the result of a complex **fusion of cutting-edge astrophysics research and state-of-the-art science visualization expertise**. The production process started, for nearly all of the show's sequences, with the scientific endeavor called **simulation**. This involved mathematically describing and computationally modeling the complex physical events the Space Show portrays—such as the impact of an asteroid with Earth or the collision of the Milky Way and Andromeda galaxies. The next step was to turn numerical simulations or data sets into graphic animations called **visualizations**. The Show's production team built flight paths that create the experience of flying through space and made illustration decisions, including color and lighting assignments. As production proceeded, visualizations were **rendered** for viewing at successively higher and more detailed resolutions for display on Difiniti's 9.500 square foot dome. The production team wrote multiple pieces of software to transform complex, dynamic data sets, such as 2-D image files of the M51 and Whirlpool galaxies taken by NASA's Hubble and Spitzer space telescopes, into 3-D volumes moving through time.

Astrophysics has entered a phase of tremendous discovery and expansion in the past ten years thanks to advances in observing and computing technology. As a result, mathematical and visual models of the Universe and its physical processes, like those that form the basis for ***Cosmic Collisions***, now are built from enormous observational and theoretical sets of data. Cluster supercomputers, made up of individual computers or computer chips and boards hooked together, are ideally suited to manipulate those data in order to get results in matters of weeks and months rather than years or centuries. By dividing large data sets across multiple storage and computation sites and running operations on them simultaneously, these cluster supercomputers can manipulate extremely complex data sets at speeds far exceeding those of an ordinary desktop computer.

Hardware involved in the rendering of ***Cosmic Collisions*** includes an array of graphic workstations, a Linux-based cluster with 100 processors used to render graphic images, and a multichannel digital dailies system donated by the NVIDIA Corporation with which to preview the high-resolution graphic images on the domed theater screen.

Simulations

The creation of simulations involves applying the laws of physics to predict how nature behaves. Scientists then compare observational data with competing predictions to advance and refine their descriptions.

For instance, scientists computed the behavior of stars, gas and dark matter in the colliding galaxies, modeling the force of gravity distributed across millions of virtual particles and following pressure gradients and shock waves in the gas. These computations required more than four CPU-years of computer time (a CPU-year is the run time of one central processing unit, or CPU, in a cluster running continuously for a year), but took less than a month to complete on 64 processors.

Other simulations in the Space Show were computed by Jon Genetti and Syun Akasofu of the University of Alaska Fairbanks, Charles Goodrich and Timothy Guild of Boston University, Robin Canup of the Southwest Research Institute, James Lombardi of Vassar College, Jarrod Hurley of Monash University, Eiichiro Kokubo of the National Astrophysical Observatory of Japan, and Galen Gisler and Robert Greene of Los Alamos National Laboratories. Steele Hill of NASA provided important Solar and Heliospheric Observatory (SOHO) satellite imagery used in the Show.

Cosmic Collisions was developed by the American Museum of Natural History, New York, in collaboration with the Denver Museum of Nature & Science; GOTO, Inc., Tokyo, Japan; and the Shanghai Science and Technology Museum, China. ***Cosmic Collisions*** was created by the American Museum of Natural History with the major support and partnership of the Heliophysics Division of NASA's Science Mission Directorate and was made possible with the generous support of CIT.