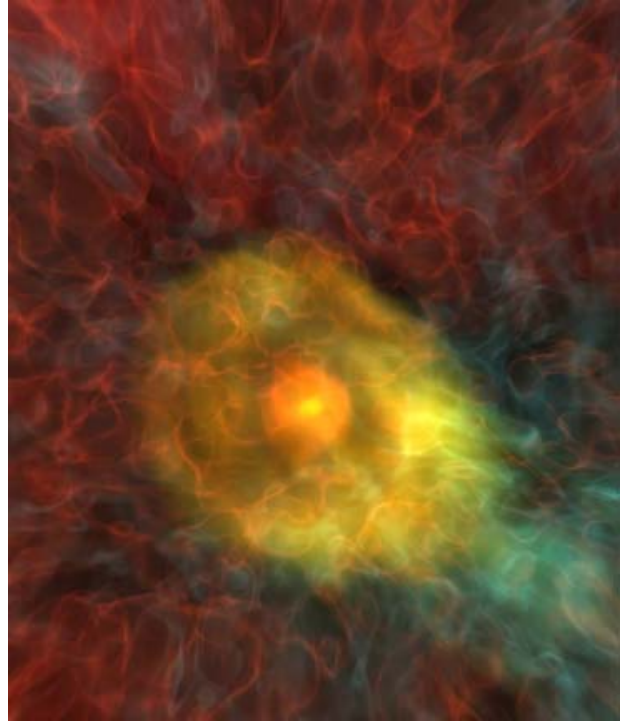


## NCSA visualizes complex AMR data to illustrate wonder of black holes

High-resolution scientific visualizations created at the National Center for Supercomputing Applications illustrate spectacular cosmic wonders as part of a planetarium show called *Black Holes: The Other Side of Infinity*. The show, which debuted in February 2006 at the Denver Museum of Nature & Science and will be distributed, provides a groundbreaking, scientifically accurate perspective on black holes and presents the latest compelling evidence that black holes are real.

NCSA collaborated with Michael Norman from the University of California, San Diego and Brian O'Shea of Los Alamos National Laboratory to develop one of the most challenging visualizations, a rendering of the formation of a Population III star in the early universe, going supernova, and forming a black hole. Norman and O'Shea simulated this chain of events--extending from 16 million years after the Big Bang until the collapse of the first primordial protostellar cloud approximately 150 million years later--using the ENZO adaptive mesh refinement (AMR) cosmology code on NCSA's SGI Altix system, named Cobalt.



To render this data, the NCSA visualization team created new AMR visualization techniques, part of a broader effort to develop an integrated AMR visualization pipeline.

AMR generates extremely large datasets that are challenging to visualize due to the radical, unpredictable temporal-spatial changes at the multidimensional nested sublevels. The AMR visualizations created for the planetarium show, for example, reveal 23 levels of nested grid refinement in a seamless transition in ultra-high resolution. These sub-grids provide higher resolution at specific areas of interest within the simulation, but it is difficult to render these multiple nested grids in a smooth transition while avoiding temporal and spatial artifacts.

Along with other NCSA visualization projects that have appeared on television and on museum domes, the black hole planetarium show represents significant contributions to science education and outreach. These exciting depictions of natural phenomena, built on the latest scientific data, engage and educate thousands of planetarium visitors and millions of television viewers.

