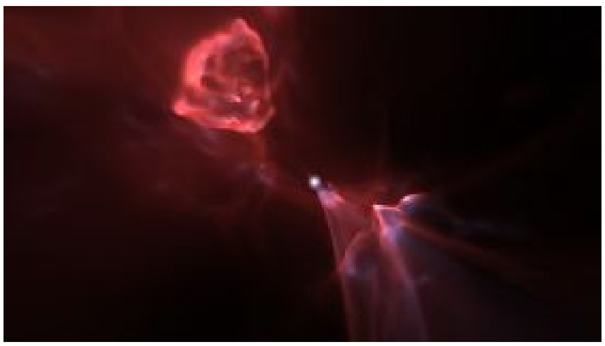
PHYS.ORG

Lights, Camera, Render: Visualizing the Universe

December 9 2008, by Michael Torrice



Scientists at the KIPAC Computational Physics Department simulate the birth of a galaxy. The red plumes represent ionized hydrogen gas that condenses into bright white glowing stars. (Image courtesy of the Ralf Kaehler)

(PhysOrg.com) -- A red plume of hydrogen gas streams in three dimensions across a movie screen that almost spans the width of a dark conference room. Within the plume a brilliant white spot forms. The spot expands and quickly explodes into an orange and red cloud. Soon this cloud dissipates and a new bright dot grows elsewhere on the screen. In less than a minute, the movie has told the story of a young galaxy forming.

Three-dimensional movies of galactic birth are just some of the stunning visuals at the Schwob Computing and Information Center, a resource at the Kavli Institute for Particle Astrophysics and Cosmology's Computational Physics Department. The center allows scientists and visitors at SLAC National Accelerator Laboratory to visualize the physics of the evolving universe.

"The idea is to understand how the universe works," said KIPAC computational department member Ralf Kaehler, who produces the astrophysics videos. "These are visualizations of simulation data that follow the laws of physics, not some imaginary models as are often used in science TV shows or documentaries."

Scientists in the department, which is led by SLAC and Stanford Associate Professor of Physics Tom Abel, simulate astrophysical events such as the birth of galaxies and the formation of the first stars in the universe. Each simulation is packed with data at an extremely high resolution. Matthew Turk, a physicist in Abel's group, describes this level of detail as equivalent to watching flu viruses within a volume the size of the earth. Data with such large scale and fine detail can be difficult to analyze in static, flat pictures.

"Without creative and useful visualization techniques, we could never mine that data for useful information," Turk said. Physicists in Abel's group produce animations of their data with a combination of pre-existing visualization software and new computer programs that Kaehler writes from scratch. They then watch their simulations unfold on a high-definition screen more than 13 feet wide and seven feet tall. Behind the screen, two digital projectors shine images separately for the left and right eye, to produce the three-dimensional picture.

The astrophysicists can rotate the three-dimensional models and watch the movie from different perspectives to extract more information from the simulations. They can also highlight specific events in the simulation by changing the colors associated with the data. "We have a lot of sessions where we just sit in front of the screen and look at the data interactively," Kaehler said.

But the movie screen isn't used only for data analysis. Abel's group also participates in outreach programs for groups outside SLAC. "It's much easier to communicate what's going on at KIPAC to non-experts who aren't into all the equations and details by showing these colorful animations," Kaehler said.

Visitors ranging from elementary school students to former Secretary of State George Schultz have sat in this physics cinema, donned 3-D glasses and watched astrophysics movies. In their demonstrations, the physicists mix KIPAC's simulations with recent pictures snapped by ground and space telescopes to tell the story of the universe's development.

To expand the center's visualization tools, Kaehler says the group plans to construct a wall-size computer screen that comprises 15 individual monitors, tiled in a five-by-three display. The Scientific Computing and Computer Services department presented an example of these tiled monitors last month at the International Conference for High Performance Computing, Networking, Storage and Analysis in Austin, Texas. Physicists will be able to observe an even deeper level of detail in their simulations with this screen because it will display static pictures at a resolution of 6,000 by 6,000 pixels—a resolution 15 times greater than high-definition TV.

Provided by SLAC