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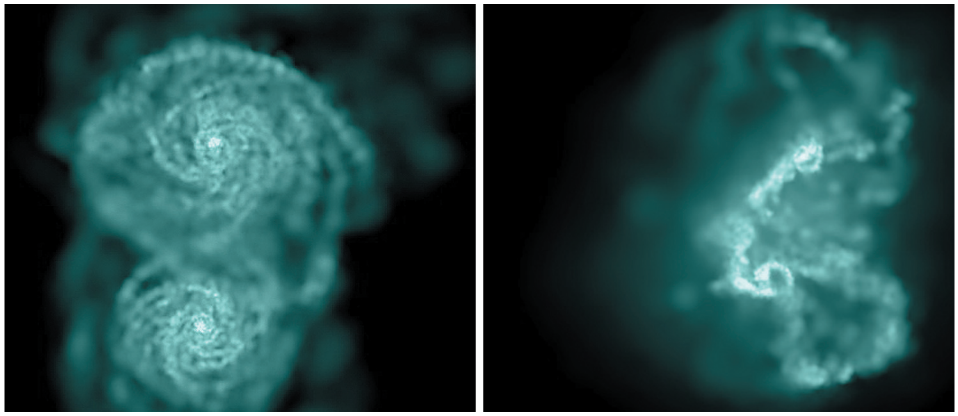

SGI Altix simulation of colliding galaxies - before and after

Using SGI® Altix® to Detect the Origins of the Milky Way

"These problems and models will only grow more complex. It's easy to see how we may need additional processors and memory in the future, and the Altix can easily accommodate that."

– Tom Quinn, Astronomy Professor at the University of Washington

At the University of Washington, students and researchers are hard at work trying to unravel the mystery of how an ocean of dark matter came to form the galaxies that populate the universe today.

While the task sounds daunting – it's an exercise in detecting cataclysmic changes that occurred across more than 13 billion years – University of Washington astronomers have some powerful tools at their disposal. For one, there is the Wilkinson Microwave Anisotropy Probe (WMAP), a microwave-based space telescope that, like the Hubble Space Telescope, is capable of peering deep into space and capturing pictures of the universe in its infancy.

Looking Back in Time

"When you look out into space, you're looking back in time," explains Tom Quinn, astronomy professor at the University of Washington and head of a research team devoted to identifying the origins of our Milky Way. "If what you see is a star that is 1,000 light years away, then the image you're looking at is 1,000 years old, because it's taken that long for the picture of that star to reach us. The farther you can see, the farther back in time your eyes travel."

WMAP, in fact, "looks back as far as we can see," says Quinn, revealing the state of the universe when it was only 100,000 years old. At that point, the universe was opaque, so crammed with what scientists call "dark matter" that no galaxies, stars, planets or gases are visible. "Ninety percent of the universe is made up dark matter," says Quinn, "but we have no idea what it is."

In the opaque edges of space, Quinn says, "protons and neutrons are evenly distributed. But over time, something pulled them together so they became stars. By understanding how stars form in this cosmological context, we can determine how hydrogen gas became this massive heavenly body that, in effect, lights up. We can learn how galaxies are born."

SGI Altix: Modeling the Milky Way

With WMAP survey data revealing an infant universe, the University of Washington team sets to work determining how it grew up. And they ask hard questions. How, for instance, did uniformly dispersed matter congeal to create billions of stars in the Milky Way, which itself is only one of billions of galaxies? "In our studies, we have to form these stars by the billions because that's the best way to look at things on cosmological scales," Quinn says. "But first we have to ask how stars themselves are formed."

To do that, the University of Washington relies on an SGI® Altix® 3000 system powered by 24 Intel® Itanium® 2 processors. With the Altix system Quinn and his colleagues run a series of models of the Milky Way, in hopes of defining how stars in our galaxy were formed. "We use various recipes for star formations so we can understand how star formations work in a cosmological context," Quinn says. "From a computational point of view, Altix gives us 24 processors and 48GB of memory locally. This helps us study our detailed model many times over, each time adjusting our parameters."

The astronomers then compare their galaxy formation models against a larger context, performing "cosmological runs" on shared supercomputer systems with thousands of processors. Here, the models generated on the university's Altix system are fit into a larger survey of billions of galaxies. With each cosmological run, the team learns more about the process of star formation and galactic evolution.

"The Altix gives us a powerful, dedicated resource to run and adjust our models on a day to day basis," Quinn says. "We can't do this at a national supercomputer center. It must be worked on and tweaked constantly, so offloading isn't an option."

Big Data to Solve Big Problems

With the astronomical models generating massive data sets in excess of 10GB, the University of Washington's Department of Astronomy knew it required a system with a low-latency, high-bandwidth architecture capable of addressing huge amounts of data and moving it quickly into and out of the system. The Altix system was an ideal fit.

The university installed the Altix in August of 2003. The Altix family leverages the built-in SGI® NUMAlink™ interconnect fabric, which allows global addressing of all memory in the system and delivers data across nodes up to 200 times faster than conventional clustering interconnects. For the first time, more complex data sets and complete workflows can be driven entirely out of memory, enabling productivity breakthroughs that traditional Linux clusters or repurposed e-commerce UNIX® servers can't tackle. Altix systems feature a fully supported, standard 64-bit Linux® operating system and advanced development environment specifically optimized for technical applications.

The Altix architecture also enables easy installation and administration. "One of the advantages of going with Altix over a more Beowulf-type configuration was that the Altix installation was trivial compared to a cluster of PCs," says Quinn. "Programming is much easier on Altix, and it fits it nicely with our network of Linux desktop systems, which have migrated from Sun machines."

With the Altix system Quinn and his team can spend more time on their science, and less on system management. "The advantage of Altix is that we don't have to worry about it," he says. "I collaborate with computer scientists because I have a need for doing state-of-the-art computational work. Altix gives us a powerful platform for doing just that."

Quinn also says the scalability of the Altix family helped drive the university's purchase decision. Ranking as the world's most scalable Linux servers and supercomputers, SGI Altix systems are capable of running a single Linux OS image with 256 Intel Itanium 2 processors and up to 8 terabytes of memory. With global shared memory across nodes, SGI Altix 3000 servers and supercomputers can scale to up to hundreds of processors.

"These problems and models will only grow more complex," Quinn notes. "It's easy to see how we may need additional processors and memory in the future, and Altix can easily accommodate that."

Pushing the Science Forward

For the astronomers at the University of Washington, the work of determining how stars and galaxies developed proceeds apace. "In this type of science, you don't know if you have the right answer until you've gone through the whole process," Quinn says.

"Each day, we push the science forward, creating an increasingly constrained and precise depiction of the galaxy, and then we test it to see if our conclusions are correct. At some point, we think we'll be able to model the Milky Way throughout the entire history of universe."

And today? "We're getting very close to a good model," says Quinn. "This would have taken a lot longer without Altix."

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