Cosmological simulations key to understanding the universe

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Tiziana Di Matteo, associate professor of physics at Carnegie Mellon University is harnessing the power of supercomputing to recreate how galaxies are born, how they develop over time and, ultimately, how they collapse.

Di Matteo presented an overview of her cosmological simulations as part of the "Big, Small, and Everything in Between: Simulating Our World Using Scientific Computing" session at the 2009 American Association for the Advancement of Science (AAAS) Annual Meeting in Chicago.

Working with machines at Carnegie Mellon's Bruce and Astrid McWilliams Center for Cosmology and the Pittsburgh Supercomputing Center, Di Matteo crafts computer simulations to better understand the physics of black holes and the role they play in galaxy formation. The superior computing power available using computers like the Cray XT3 system allow Di Matteo to input the extensive calculations necessary to incorporate black hole physics into such simulations. In fact, such computing power has enabled Di Matteo to complete the most detailed and accurate recreation of the evolution of the universe to date.

The simulation begins with conditions seen at the birth of the universe as evidenced by observed cosmic microwave background radiation. Seeded with a quarter of a billion particles that represent everyday measurable matter, and factoring in gravity exerted by dark matter and other forces associated with various cosmic phenomena, including cooling gas, growing black holes and exploding stars, the simulation progresses, providing snapshots of galaxy development in frames of half a million years each. Strung together, the frames create a movie of cosmic evolution over the past 14 billion years. The high-resolution afforded to the researchers by the state-of-the-art computers allows them to zoom into a particular event in the galaxies formation, like the formation of a black hole.

Using data from such simulations, Di Matteo and colleagues have been able to get a better understanding of the role black holes play in galaxy regulation. The researchers hope that the theoretical simulations can be used to aid observational astrophysics by helping to predict what the next-generation telescopes should see as they peer back to the Big Bang, and by providing guidance to observational astrophysicists as they look to locate the earliest cosmic events and untangle the origins of the universe.

Source: Carnegie Mellon University

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