Seeing the unseen universe

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A new method for incorporating astronomical observational data into computer simulations promises to be a significant advance in enabling future cosmological surveys aimed at understanding dark energy and dark matter. Dark matter and dark energy are theoretical forms of matter and energy thought to permeate all of space, with dark energy producing a large-scale force that is believed to produce an effect that works against gravity.

By combining what are often very expensive simulations with data from observational instruments, like optical and radio telescopes, scientists at Los Alamos National Laboratory are able to calibrate the computer simulations and create better predictive models of the universe.

In research published recently in *Astrophysical Journal Letters*, Los Alamos scientists Katrin Heitmann, David Higdon, Charles Nakhleh, and Salman Habib describe their method for creating a statistical framework for astrophysical simulations. The framework includes methods for calibrating observations with simulations and for using the calibrated cosmic simulator to predict the results of new astronomical observations.

According to Habib, a theoretical physicist who specializes in dark matter and dark energy, "this new method has already piqued the interest of potential collaborators from major universities and other national laboratories. Such collaborations will allow us to extend the technique and to apply it to the very latest observational data."

The new Los Alamos method provides statistical tools for overcoming

the challenges inherent to incorporating observational datasets and results from large-scale simulations that can be processed using conventional computing resources. The development of this new methodology was brought about by a recent transition in astronomical research toward "precision cosmology," which uses increasingly sensitive instruments to gather massive amounts of precise data about the cosmos. Uniting this new wealth of data with computer simulations that have traditionally not had the same levels of precision or resolution has been nearly impossible given the current levels of computing power and simulation size.

By combining simulation and observational data, Los Alamos scientists believe it will be possible to construct an efficient emulator (a form of computer software or hardware that permits the computer to perform the functions of a different system) that can be used instead of current computer processor-intensive simulations for planning astronomical observations and for data analysis.

Source: Los Alamos National Laboratory