# Statistical modeling could help us understand cosmic acceleration

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(PhysOrg.com) -- While it is generally accepted by scientists that the universe is expanding at an accelerated rate, there are questions about why this should be so. For years, scientists have been trying to determine the cause of this behavior. One of the theories is that dark energy could be the cause of cosmic acceleration.

In order to test theories of dark energy, a group at Los Alamos National Laboratory in New Mexico and the University of California Santa Cruz came up with a technique designed to test different models of dark energy. “We are trying to investigate what could be behind the accelerated expansion of the universe,” Katrin Heitmann, one of the Los Alamos scientists tells *PhysOrg.com*. “Our technique is based on data, and can be used to evaluate different models.”

Heitmann and her collaborators created their method based on Gaussian process modeling; the implementation was led by Tracy Holsclaw from UC Santa Cruz. “We’re using statistical methods rather than trying to come up with different models. Our process takes data from different sources and then uses it to look for certain deviations from what we assume in a cosmological constant.” The group’s work can be seen in Physical Review Letters: “Nonparametric Dark Energy Reconstruction from Supernova Data.”

“Many scientists think that dark energy is driving the accelerated expansion of the universe,” Heitmann says. “If this is the case, it is possible to characterize it via its equation of state w(z). The redshift

evolution of the equation of state parameter w(z) would show some indication of a dynamical origin of dark energy."

Heitmann points out that in such a case, there could be an infinite number of models. "We can't test all those models," she says, "so we have to do an inverse problem. We have data and we can characterize the underlying cause of the accelerated expansion. It assumes that w is a smoothly varying function, and a dynamical dark energy theory would fit that. We can use data and analyze it to see if we can find indications that dark energy really is behind accelerated expansion."

The Los Alamos and University of California, Santa Cruz team first tested their statistical technique on simulated data in order see whether the method was reliable. "After we saw that it was," Heitmann says, "we tried it on currently available supernova data."

So far, their analysis has not revealed that a dynamical dark energy is behind the accelerated expansion (the cosmological constant is a very special case of dark energy and is still in agreement with the data), but Heitmann doesn't think that means that the door is closed on dynamical dark energy theories as the cause of acceleration in the expanding universe. "The data so far is limited, and better data is coming in every day," she says. Additionally, the group hopes to include other data in their statistical analyses. "Our technique allows for the input of data from cosmic microwave background and baryon acoustic oscillations as well, and that's what we want to add in next."

If this technique does identify a dynamical dark energy as the reason behind accelerated expansion of the universe, it could mean revisiting the basics of what we know about the workings of the universe. "If we do find the time dependence that supports the idea of dark energy as this mechanism, then we can go back to the theory approach. We would have an idea of which models could better explain universe's expansion

history and ultimately develop a self-consistent theory with no ad hoc assumptions."

**More information:** Tracy Holsclaw, Ujjaini Alam, Bruno Sansó, Herbert Lee, Katrin Heitmann, Salman Halbib, and David Higdon, "Nonparametric Dark Energy Reconstruction from Supernova Data," *Physical Review Letters* (2010). Available online: link.aps.org/doi/10.1103/PhysRevLett.105.241302