Dark Energy And The Inverse Square Law

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“Newton’s inverse-square law has been around for a while,” Daniel Kapner tells *PhysOrg.com*. “But, by testing this law, we’re looking for new physics.” The new physics Kapner and his colleagues are looking for in their recent *Physical Review Letters* submission deals with dark energy.

“Dark energy is an unknown driving force behind the acceleration of the universe, and we’re measuring the inverse-square law below the dark-energy length scale to look for a possible new gravitational phenomenon.”

Kapner and his colleagues are associated with the Center for Experimental Nuclear Physics and Astrophysics at the University of Washington in Seattle. Their Letter, “Tests of the Gravitational Inverse-Square Law below the Dark-Energy Length Scale,” addresses questions of dark energy gravity possibilities.

“As the universe expands, gravity should be slowing down that expansion,” explains Kapner. “But that’s not what is happening. Astrophysical measurements show that the expansion is speeding up. The unknown mechanism behind this accelerated expansion is termed Dark Energy.”

Kapner and his colleagues use a sensitive device called a torsion balance to test the inverse-square law, attempting to shed some light on dark energy. “This is one step more complicated than the old mass on the end of a spring,” Kapner says, referring to the classic physics class demonstration of measuring a force by the distance a spring stretches.

While the earth's gravity pulls straight down, a sideways force can induce a very small twist of the balance. "This is done a vacuum chamber," explains Kapner, "so there is no friction. This is essentially the best you can do with a direct measurement. If standard physics has new particles or exchange forces which act at this length scale, this apparatus would be sensitive to it." The group's torsion balance can measure gravity-strength forces down to distances of 55 microns.

And the results regarding the dark-energy length scale? "There are no deviations from the inverse-square law," Kapner insists. "We see it behaves just as Newton predicted." The test, he says, establishes that there is nothing new at the dark-energy length scale. So the continuing acceleration of the universe remains a mystery.

But the test used by Kapner and his colleagues is not limited to questions of dark energy. The torsion balance measurements can be used to constrain other models that suggest new exchange forces and particles. "We've used this to test other models, such as large extra dimensions in string theory," he says. "And we could test any other models which predict deviations from the inverse-square law."

Kapner says that the next version of the project is being built now. "We can go to even smaller lengths, and get results that are 100 times better." Kapner thinks that the current test pretty well ruled out that dark energy holds nothing new regarding short-distance gravity, but another test would make the team's assertion stronger. "We want to keep refining this technique as far as technology will allow."

After all, Kapner points out, "Even though the obvious answer wasn't there, this technique still holds promise for discovering something new."