A new way to test general relativity

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"Atom interferometry is an exciting field which has been awarded three Nobel prizes in the last decade," Savas Dimopoulos tells *PhysOrg.com*. "It is a new precision tool with a variety of applications." Dimopoulos, a physics professor at Stanford University, wants to use atom interferometry to test general relativity.

"The unprecedented precision offered allows us to detect the small deviations that we were previously unable to detect on earth. We will be able to test Einstein's theory in the lab."

Dimopoulos and his coauthors, Peter Graham, Jason Hogan and Mark Kasevich, all of Stanford, explore atom interferometry's use in testing the small effects of general relativity in a Letter titled "Testing General Relativity with Atom Interferometry," published last month in *Physical Review Letters*.

Right now, scientists test general relativity by studying astronomical objects over long periods of time. The theory isn't tested to high levels of precision and accuracy on earth. "We can't control all the variables with astronomical tests," explains Dimopoulos. "We cannot shoot Mercury with different velocities and measure its precession at different rates. In contrast laboratory experiments have several control parameters, such as the speed of the atoms and the color of the laser, which allow us to isolate specific physical effects."

Dimopoulos points out that scientific theories are always evolving. "General relativity modifies Newton's ideas of gravity, and we may find something that modifies general relativity.” He continues: “If general relativity is valid when measured at these levels of precision, that would be great. But sometimes theories breakdown at higher levels of precision. A deviation from general relativity may suggest new particles whose exchange mediates corrections to the theory of Einstein. That would be exciting.”

Coauthor Kasevich’s group is already building an atom interferometry experiment to test the equivalence principle at 300 times the current limit. “We’re looking at a timeframe of within a year for this first experiment, which will test whether two objects fall the same way independent of their mass or constitution,” Dimopoulos says. But he and his colleagues won’t stop there. “More detailed experiments will take longer to develop, but they will come.”