Can Newton's 2nd Law be Violated on Earth?

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Astrophysicists have found evidence that a corrected version of Newton's 2nd Law (which deals with the acceleration of mass) works well on the grand scale of the universe. These modifications to Newtonian physics are known as "modified Newtonian dynamics (MOND). "Newton offers a foundation for classical mechanics in the relationship of force, mass and accelerations," Alex Ignatiev explains to *PhysOrg.com*. "These are always true, except in special cases."

Ignatiev has devised a way of detecting one such special case, dealing with small accelerations on earth. This type of experiment is something widely considered so difficult that it has been dismissed in the past as impossible. "We already have observation of this theory in astrophysical evidence," Ignatiev, a scientist at Melbourne's Theoretical Physics Research Institute in Australia, points out. "I want to look at how it works on earth." Ignatiev's Suggestion on how this could be accomplished has been published in *Physical Review Letters* as "Is Violation of Newton's Second Law Possible?"

And the implications if Newton's 2nd Law is violated under special conditions on earth? "Well," says Ignatiev, "this is dealing with fundamental physics. If Newton's Law can be seen to be violated on Earth, then everything we know has to be re-evaluated."

But this is where the difficulties with Ignatiev's Suggestion begin. "The conditions for testing this are really special," he explains. "Time and place have to be accounted for." According to Ignatiev, the possible places to conduct this experiment lie 80 degrees north and south of the

equator. “These are latitudes in places like Antarctica and Greenland — not exactly hospitable areas.” But timing is important as well. “It must be very finely tuned,” Ignatiev insists. “Only two instances during the year, around the two equinox dates, for about 1/1000th of a second.”

If these experiments were to take place, Ignatiev says that scientists would look for what he calls the SHLEM effect. This acronym stands for static high latitude equinox modified inertia and would be noticed in a condition where the forces of the earth’s rotation on its axis, and of the orbital force of the earth as it moves around the sun, would be canceled out. “This would lead to a tiny shift to be detected,” Ignatiev explains.

But how feasible is this? Aside from the calculations that he says he already has for figuring the dates, times and locations for the SHLEM effect to manifest, Ignatiev says that the experiment could be done — it’s not impossible as previously thought.

“Gravitational wave detectors are great starting points,” he says. Ignatiev explains that searching for tiny shifts in gravity could help understand tiny displacements, or accelerations. “Even though we are looking at different forces,” Ignatiev says, “the methods of detecting for gravity can be borrowed for this research. After all, gravity is a weak force with all sorts of tiny shifts, and the acceleration shifts are likewise weak and tiny.” And, he adds, there are plenty of these gravitational wave detectors in use and more being built. “There are many of them available, and they could further this research.”

Despite the special conditions needed to test for violations of Newton’s 2nd Law on Earth, Ignatiev feels that it would be worthwhile. “This would be difficult, but not impossible. The SHLEM effect is the key. And if we can find a violation, it would be huge for fundamental physics.”

Ignatiev's paper is available free online at arxiv.org/abs/gr-qc/0612159 .

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