Exploding stars prove Newton's gravity unchanged over cosmic time

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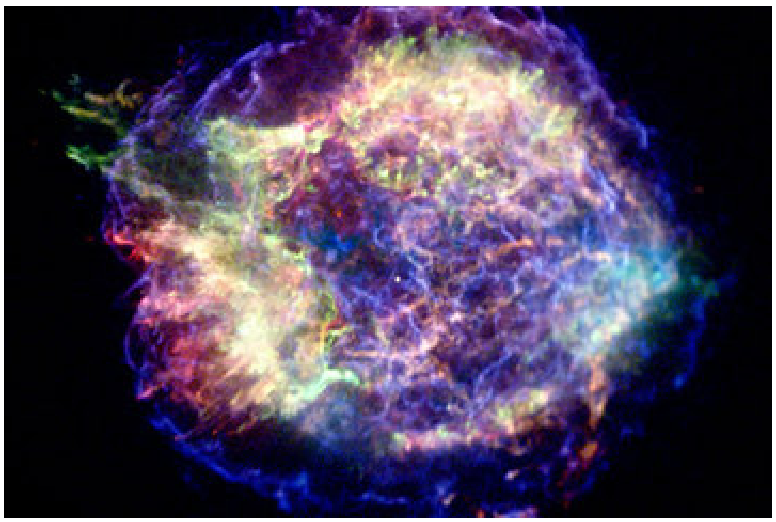

Credit: NASA

(Phys.org) —Australian astronomers have combined all observations of supernovae ever made to determine that the strength of gravity has remained unchanged over the last nine billion years.

Newton's gravitational constant, known as G, describes the attractive force between two objects, together with the separation between them and their masses. It has been previously suggested that G could have been slowly changing over the 13.8 billion years since the Big Bang.

If G has been decreasing over time, for example, this would mean that the Earth's distance to the Sun was slightly larger in the past, meaning that we wouldexperience longer seasons now compared to at much earlier points in the Earth's history.

But researchers at Swinburne University of Technology in Melbourne have now analysed the light given off by 580 supernova explosions in the nearby and far Universe and have shown that the strength of gravity has not changed.

"Looking back in cosmic time to find out how the laws of physics may have changed is not new" said Professor Jeremy Mould. "But supernova cosmology now allows us to do this with gravity."

A Type Ia supernova marks the violent death of a star called a white dwarf, which is as massive as our Sun but packed into a ball the size of our Earth.

Our telescopes can detect the light from this explosion and use its brightness as a 'standard candle' to measure distances in the Universe, a tool that helped Australian astronomer Professor Brian Schmidt in his 2011 Nobel Prize winning work, discovering the mysterious force Dark Energy.

Professor Mould and his PhD student Syed Uddin at the Swinburne Centre for Astrophysics and Supercomputing and the ARC Centre of Excellence for All-sky Astrophysics (CAASTRO) assumed that these supernova explosions happen when a white dwarf reaches a critical mass or after colliding with other stars to 'tip it over the edge'.

"This critical mass depends on Newton's gravitational constant G and allows us to monitor it over billions of years of cosmic time – instead of only decades, as was the case in previous studies." said Professor Mould.

Despite these vastly different time spans, their results agree with findings from the Lunar Laser Ranging Experiment that has been measuring the distance between the Earth and the Moon since NASA's Apollo missions in the 1960s and has been able to monitor possible variations in G at very high precision.

"Our cosmological analysis complements experimental efforts to describe and constrain the laws of physics in a new way and over cosmic time." Mr Uddin said.

In their current publication, the Swinburne researchers were able to set an upper limit on the change in Newton's gravitational constant of 0.00000001% per year over the past nine billion years.

The ARC Centre of Excellence for All-sky Astrophysics (CAASTRO) is a collaboration between The Australian National University, The University of Sydney, The University of Melbourne, Swinburne University of Technology, the University of Queensland, The University of Western Australia and Curtin University, the latter two participating together as the International Centre for Radio Astronomy Research. CAASTRO is funded under the Australian Research Council Centre of Excellence program, with additional funding from the seven participating universities and from the NSW State Government's Science Leveraging Fund.

This research is published this month in the *Publications of the Astronomical Society of Australia*.

More information: Mould & Uddin "Constraining a possible variation of G with Type Ia supernovae" in PASA 2014. arxiv.org/abs/1402.1534

Provided by Swinburne University of Technology