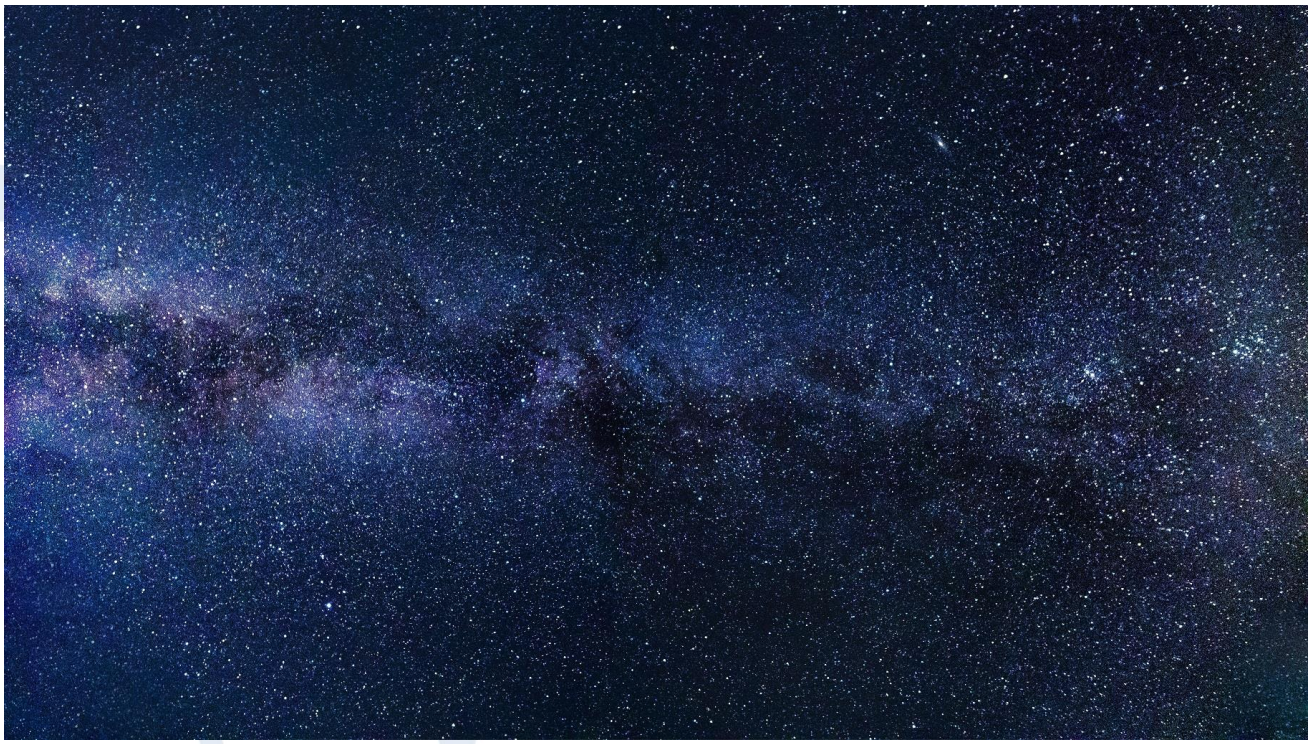
PRESS RELEASE

A new kind of star



Together with gravity, the polarization of the quantum vacuum may allow stars to exist in unconventional configurations. This research, published in Physical Review Letters, opens new directions in the study of ultracompact stars, which share several observational features with black holes

07 March 2018

A new kind of star comes up from a study by SISSA's postdoctoral researcher Raúl Carballo-Rubio. In a piece of research recently published in Physical Review Letters, Carballo-Rubio has developed a novel mathematical model that combines general relativity with the repulsive effect of quantum vacuum polarization. The inclusion of this repulsive force allows describing ultracompact configurations of stars, which were previously considered by scientists not to exist in equilibrium.

«As a consequence of the attractive and repulsive forces at play, a massive star can either become a neutron star, or turn into a black hole» says Carballo-Rubio. In neutron stars, stellar equilibrium is the result of the "fight" between gravity, which is an attractive force, and a repulsive force called degeneracy pressure, of quantum mechanical origin. «But if the star's mass becomes higher than a certain threshold, about 3 times the solar mass, the equilibrium would be broken and the star collapses due to the overwhelming pull of the gravitational force». In this study, the researcher has investigated the possibility that additional quantum mechanical forces that are largely expected to be present in nature, permit new equilibrium configurations for stars above this threshold. The additional force that has been taken into account is a manifestation of the effect known as "quantum vacuum polarization", which is a robust consequence of mixing gravity and quantum mechanics in a semiclassical framework. «The novelty in this analysis is that, for the first time, all these ingredients have been assembled together in a fully consistent model. Moreover, it has been shown that there exist new stellar configurations, and that these can be described in a surprisingly simple manner». There are still several important issues that remain to be studied, including the observational applications of these results. «It is not clear yet whether these configurations can be dynamically realized in astrophysical scenarios, or how long would they last if this is the case». From an observational perspective, these "semiclassical relativistic stars" would be very similar to black holes. However, even minute differences would be perceptible in the next generation of gravitational wave observatories: «If there are very dense and ultracompact stars in the Universe, similar to black holes but with no horizons, it should be possible to detect them in the next decades».

LINKS:

The paper in Physical Review Letters: goo.gl/2T9CyR

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