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Review of a scientific article

Calla Cofield for Space.com - *What are Pulsars?*

Ever since 1967 pulsars have been proving to be a fascinating and very useful discovery, being helpful in studies of extreme matter, searching for alien planets and measuring cosmic distances. These celestial objects are a special type of a neutron star - an object so dense that the protons and electrons building it merge into neutrons and form a sphere which is merely 25 kilometers in diameter, while having a mass equal to that of several suns.

Neutron stars and pulsars originate from most extreme stellar events known to us - supernovae. They are what's left after a star that is more massive than the sun, burns out its fuel and collapses in on itself.

The naming of pulsars comes from their appearance on the sky - from the perspective of an astronomer these objects seem to be flickering in a very regular manner. What's causing these pulses are not the actual changes in star's brightness, but rather it's spin. Pulsars emit two narrow beams of light, which are not aligned with their axis of rotation. Measuring the rate at which these beams sweep through telescope's field of view tells astronomers how fast the pulsars rotate. Slowest rate, which is also most commonly observed, is about 1 rotation per second, while the fastest stars achieve speeds of nearly 700 rotations per second. These tremendous velocities are the effect of conservation of momentum - during a supernova star radically decreases in size, while still maintaining the majority of its mass, causing it to spin much faster, similarly to figure skaters bringing their arm closer together.

It is still not entirely clear why pulsars emit these beams of light. In order to radiate them, the star has to be rotating at right speed as well as have certain strength of magnetic field. By achieving that balance the particles can be accelerated to extremely high velocities which causes them to radiate light, ranging all the way from radio waves up to gamma rays. Although the light emited by the pulsars covers pretty much all of the electromagnetic spectrum, it is still difficult to detect these objects. The more energetic is the beam, the more dispersed is its light, so radio waves, being the most concentrated, are the primary sign of pulsar's presence on the sky. So far, more than 2300 of these magnificient objects have been discovered and this number increases rapidly as the time passes.

Pulsars' properties make them very useful in cosmic studies. Thanks to them, we discovered some of the most extreme states at which matter can exist.

Their regular spinning behavior makes them also the most accurate natural clocks in the universe. Using this fact scientists managed to observe presence of extrasolar planets and made the most accurate cosmic distance measurements. Pulsars also had their place in proving Einstein's prediction about the gravitational waves - one of the most important astronomical discoveries of the twenty-first century.

Over time, all pulsars lose their velocity and eventually enter a phase called "pulsar graveyard". At this point, they emit very little radiation and may be considered regular neutron stars. Most of these objects have yet to reach this point though, and tens of millions of years have to pass before they do so.

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