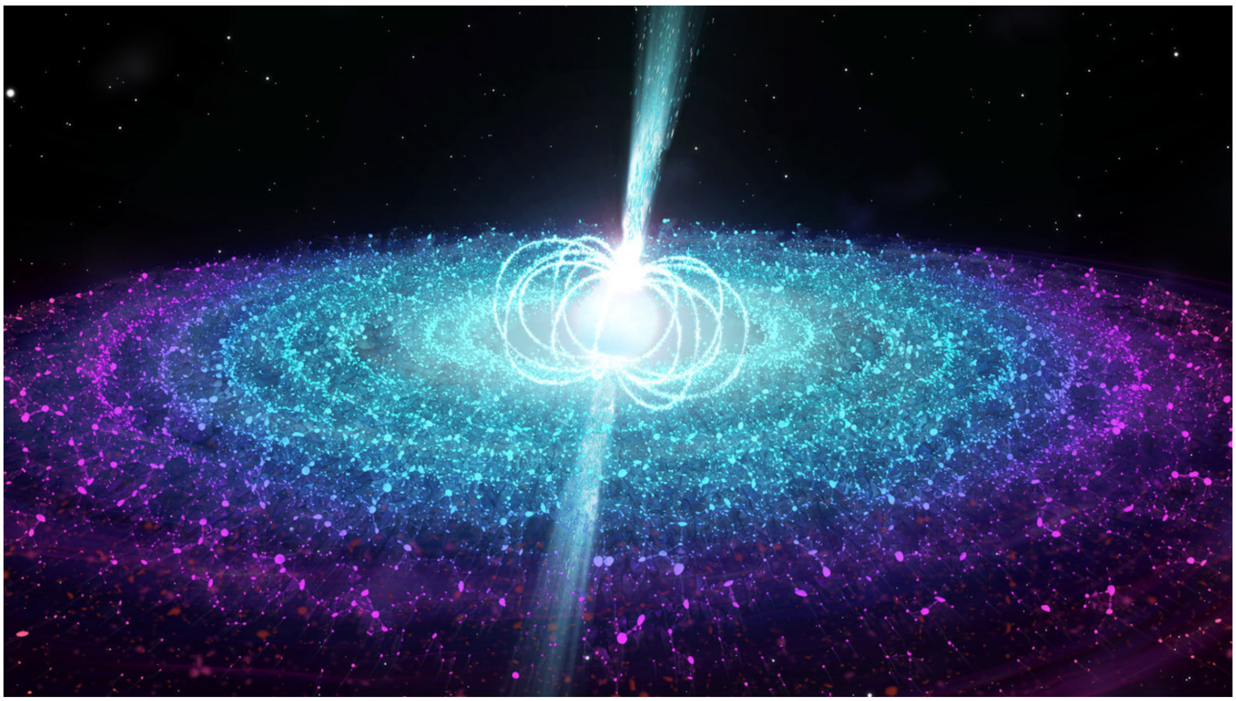
Neutron star jets shoot down theory

September 26 2018



An artist's impression of the strong magnetic field neutron star in Swift J0243.6+6124 launching a jet. During the bright outburst event in which it was first discovered, the neutron star in Swift J0243.6+6124 was accreting at a very high rate, producing copious X-ray emission from the inner parts of the accretion disk. At the same time, the team detected radio emission with a sensitive radio telescope, the Karl G. Jansky Very Large Array in the USA. By studying how this radio emission changed with the X-rays, we could deduce that it came from fast-moving, narrowly-focused beams of material known as jets, seen here moving away from the neutron star magnetic poles. Credit: ICRAR/University of Amsterdam.

Astronomers have detected radio jets emitted by a neutron star with a strong magnetic field—something not predicted by current theory, according to a new study published in *Nature* today.

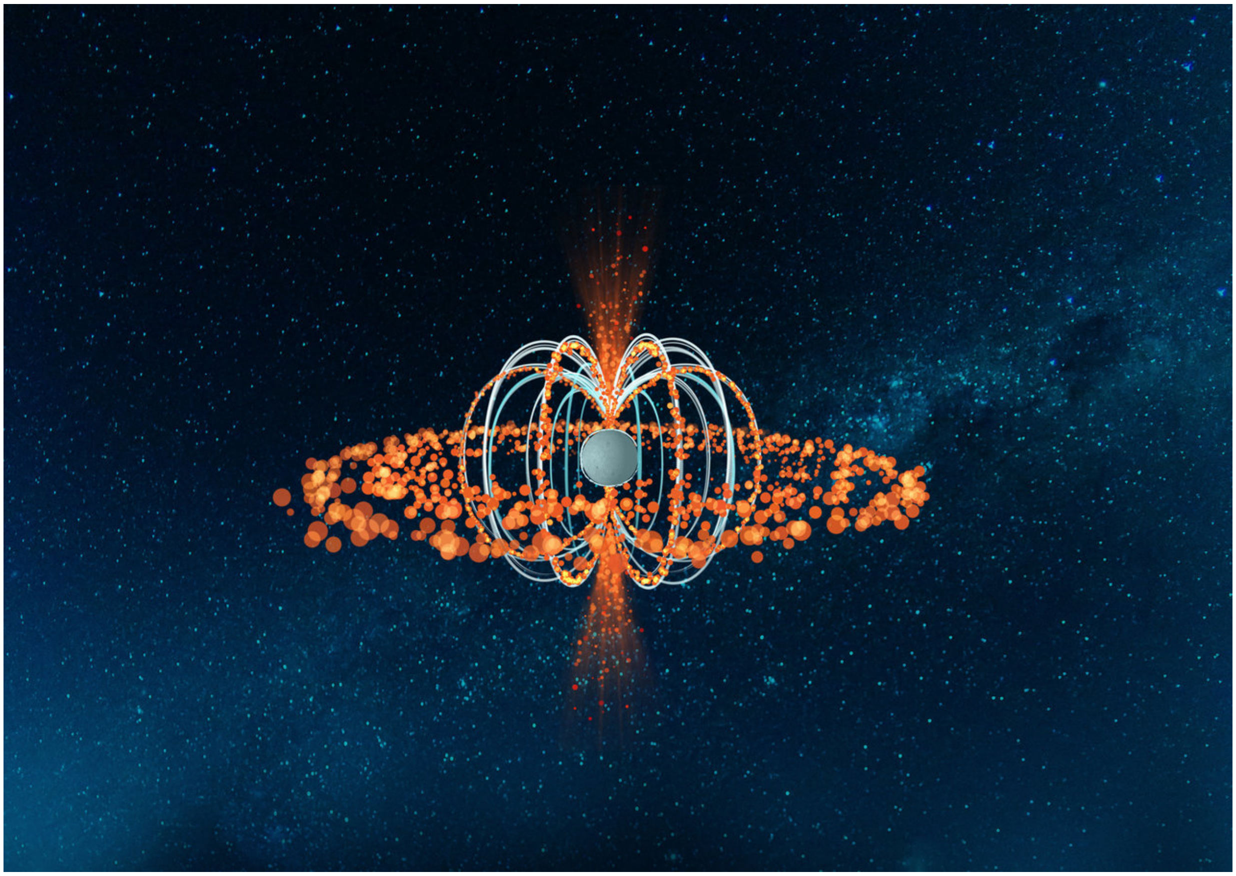
The team, led by researchers at the University of Amsterdam, observed the object known as Swift J0243.6+6124 using the Karl G. Jansky Very Large Array radio telescope in New Mexico and NASA's Swift space telescope.

"Neutron stars are stellar corpses," said study co-author Associate Professor James Miller-Jones, from Curtin University's node of the International Centre for Radio Astronomy Research (ICRAR).

"They're formed when a massive star runs out of fuel and undergoes a supernova, with the central parts of the star collapsing under their own gravity.

"This collapse causes the star's magnetic field to increase in strength to several trillion times that of our own sun, which then gradually weakens again over hundreds of thousands of years."

University of Amsterdam Ph.D. student Jakob van den Eijnden, who led the research, said neutron stars and black holes are sometimes found in orbit with a nearby "companion" star. "Gas from the companion star feeds the neutron star or black hole and produces spectacular displays when some of the material is blasted out in powerful jets traveling at close to the speed of light," he said.



An artist's impression of the neutron star in Swift J0243.6+6124.The neutron star has a very strong magnetic field which prevents the accretion disk from making it all the way in to the neutron star surface. Some of the gas in the disk is channeled along the magnetic field lines onto the neutron star's magnetic poles, giving rise to X-ray emission that we see as brief, regular pulses of X-rays as the star spins around once every 10 seconds. Credit: ICRAR/University of Amsterdam.

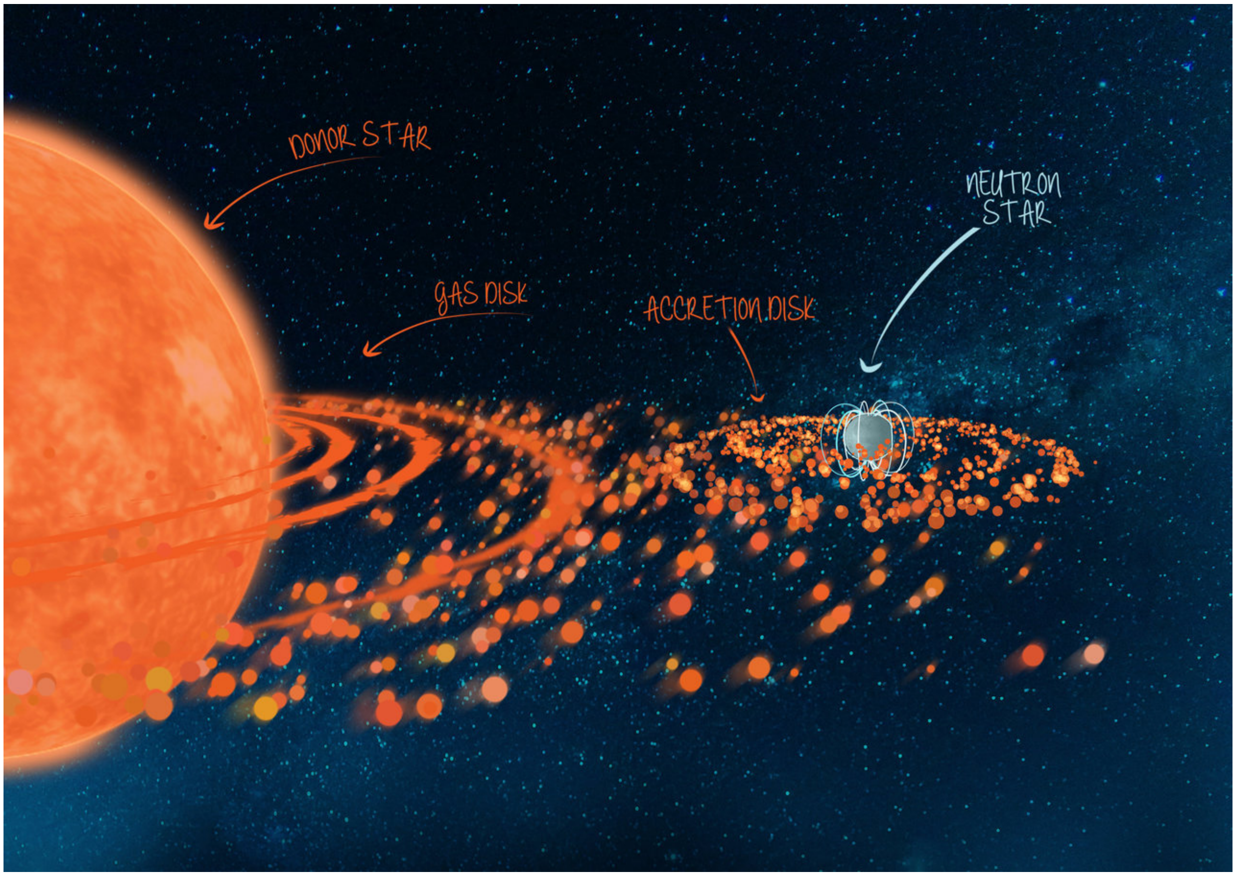
Astronomers have known about jets for decades, but until now, they had only observed jets coming from neutron stars with much weaker magnetic fields. The prevailing belief was that a sufficiently strong magnetic field prevents material getting close enough to a neutron star to form jets.

"Black holes were considered the undisputed kings of launching powerful jets, even when feeding on just a small amount of material from their companion star," Van den Eijnden said.

"The weak jets belonging to neutron stars only become bright enough to see when the star is consuming gas from its companion at a very high rate.

"The magnetic field of the neutron star we studied is about 10 trillion times stronger than that of our own Sun, so for the first time ever, we have observed a jet coming from a neutron star with a very strong magnetic field.

"The discovery reveals a whole new class of jet-producing sources for us to study," he said.



An artist's impression of the binary system Swift J0243.6+6124.A binary system with a neutron star in a 27-day orbit and a more massive, rapidly-rotating donor star. The rapid rotation of the donor star throws off a disk of material around the stellar equator. As the neutron star passes through the disk during its orbit, it picks up some of this outflowing gas, which then spirals in towards the neutron star in an accretion disk. Credit: ICRAR/University of Amsterdam.

Astronomers around the world study jets to better understand what causes them and how much power they release into space.

"Jets play a really important role in returning the huge amounts of gravitational energy extracted by neutron stars and black holes back into the surrounding environment," Associate Professor Miller-Jones said.

"Finding jets from a neutron star with a strong magnetic field goes against what we expected, and shows there's still a lot we don't yet know about how jets are produced."

"An evolving jet from a strongly-magnetised accreting X-ray pulsar" was published in *Nature* on September 26th, 2018.

More information: An evolving jet from a strongly magnetized accreting X-ray pulsar, *Nature* (2018). DOI: 10.1038/s41586-018-0524-1 , www.nature.com/articles/s41586-018-0524-1

Provided by International Centre for Radio Astronomy Research

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