Free-floating planets may be born free

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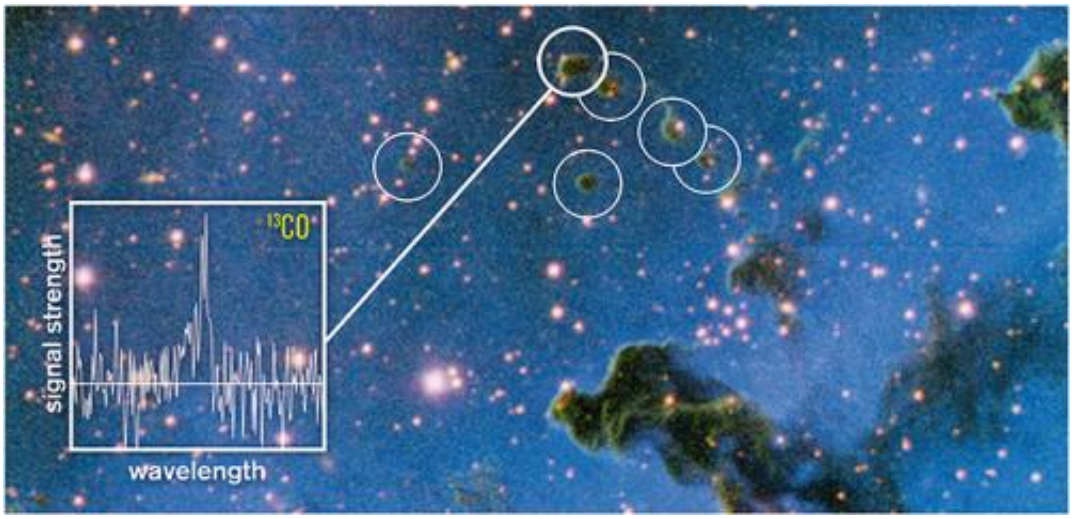

Astronomers have found that tiny, round, dark clouds called globulettes have the right characteristics to form free-floating planets. The graph shows the spectrum of one of the globulettes taken at the 20-metre telescope at Onsala Space Observatory. Radio waves from molecules of carbon monoxide (13CO) give information on the mass and structure of these clouds. ESO/M. Mäkelä

Tiny, round, cold clouds in space have all the right characteristics to form planets with no parent star. New observations, made with Chalmers University of Technology telescopes, show that not all free-floating planets were thrown out of existing planetary systems. They can also be born free.

Previous research has shown that there may be as many as 200 billion free-floating planets in our galaxy, the Milky Way. Until now scientists

have believed that such "rogue planets", which don't orbit around a star, must have been ejected from existing planetary systems.

New observations of tiny dark clouds in space point out another possibility: that some free-floating planets formed on their own.

A team of astronomers from Sweden and Finland used several telescopes to observe the Rosette Nebula, a huge cloud of gas and dust 4600 light years from Earth in the constellation Monoceros (the Unicorn).

They collected observations in radio waves with the 20-metre telescope at Onsala Space Observatory in Sweden, in submillimetre waves with APEX in Chile, and in infrared light with the New Technology Telescope (NTT) at ESO's La Silla Observatory in Chile.

"The Rosette Nebula is home to more than a hundred of these tiny clouds – we call them globulettes", says Gösta Gahm, astronomer at Stockholm University, who led the project.

"They are very small, each with diameter less than 50 times the distance between the Sun and Neptune. Previously we were able to estimate that most of them are of planetary mass, less than 13 times Jupiter's mass. Now we have much more reliable measures of mass and density for a large number of these objects, and we have also precisely measured how fast they are moving relative to their environment", he says.

"We found that the globulettes are very dense and compact, and many of them have very dense cores. That tells us that many of them will collapse under their own weight and form free-floating planets. The most massive of them can form so-called brown dwarfs", says team member Carina Persson, astronomer at Chalmers University of Technology.

Brown dwarfs, sometimes called failed stars, are bodies whose mass lies

between that of planets and stars.

The study shows that the tiny clouds are moving outwards through the Rosette Nebula at high speed, about 80 000 kilometres per hour.

"We think that these small, round clouds have broken off from tall, dusty pillars of gas which were sculpted by the intense radiation from young stars. They have been accelerated out from the centre of the nebula thanks to pressure from radiation from the hot stars in its centre", explains Minja Mäkelä, astronomer at the University of Helsinki.

According to Gösta Gahm and his team, the tiny dark clouds are being thrown out of the Rosette Nebula. During the history of the Milky Way, countless millions of nebulae like the Rosette have bloomed and faded away. In all of these, many globulettes would have formed.

"There are so many of them that they could be a significant source of the free-floating planets that have been discovered in recent years", he says.

Astronomers know of almost 900 planets which orbit around other stars than the Sun, but free-floating planets have also been found. Some have been discovered using a technique called microlensing, in which the planet is found when it passes in front of a background star, temporarily making it look brighter. This is an effect predicted by Einstein's theory of general relativity, in which the light from the star is bent when the planet passes in front of it, a so-called gravitational lens. Scientists have estimated that the number of free-floating planets in our galaxy may exceed 200 billion.

The study has been published in the article "Mass and motion of globulettes in the Rosette Nebula" in the July issue of the journal *Astronomy & Astrophysics*. The team observed radio waves from molecules of carbon monoxide using the 20-metre radio telescope at

Onsala Space Observatory, Sweden, and submillimetre light with the telescope APEX at 5100 metres altitude in the Atacama desert in northern Chile. APEX is a collaboration between the Max Planck Institute for Radio Astronomy in Bonn, Germany, Onsala Space Observatory and ESO, with operations of the telescope entrusted to ESO. Observations in infrared light were made using the 3.58 metre New Technology Telescope (NTT) at ESO's La Silla Observatory.

More information: dx.doi.org/10.1051/0004-6361/201321547

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