Paris, January 15th, 2014

Press release

Star clusters: new places to search for exoplanets

Of the thousand or so exoplanets discovered to date, only a very small number have been found in star clusters. It took xix years for a European team (which includes a CNRS researcher from the laboratory for Galaxies, stars, physics and instrumentation - GEPI[1] at the Paris Observatory (Observatoire de Paris/CNRS/Université Paris Diderot) to check a large sample of stars in the cluster Messier 67, and find three exoplanets. A notable fact is that one of them orbits a star which is almost identical to the Sun. This result marks a turning point in exoplanet research : they can be hunted in a more systematic way in star clusters. It also opens the door to new scenarios for the formation and evolution of planetary systems around Sun-like stars. This work is published in the January 15th issue of the journal Astronomy & Astrophysics.

Recherche
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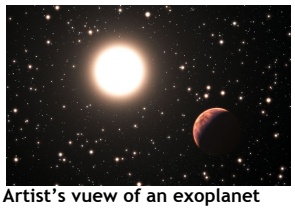

Artist's vuew of an exoplanet orbiting a Sun-like star, in the cluster Messier 67.
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To-day, we know of many planets which orbit stars other than the Sun within our galaxy. These exoplanets turn around stars which are all over the celestial sphere. However, to date, very few planets have been found within star clusters; this is mainly due to a lack of systematic stellar observation covering sufficiently long periods of time. This lack seems particularly surprising, since most stars are born within these clusters.

In view of this absence, a team of scientists asked themselves if the process of planetary formation is different in star clusters. A carefully chosen sample of 88 stars in the cluster Messier 67[2] was studied over a long period of time, for six years in fact. The pupose was to detect, using radial velocity measurement, the minute stellar motions which reveal the presence of orbiting planets.

Anna Brucalassi (Max Planck Institute for Extraterrestial Physics in Garching, Germany), lead author of this work, explains why this cluster was chosen: « *The ages and the compositions of the stars in the cluster Messier 67 are all comparable to those of the Sun. This cluster is thus a perfect laboratory for studying planetary formation in an overpopulated environment: how many planets might be formed there? Are they formed mainly in the vicinity of very massive stars, or of less massive stars?* »

The cluster Messier 67 is roughly 2 500 light years from the Earth, in the constellation of the Crab, and has on the order of 500 stars. The stars in the cluster are for the most part less bright than those generally studied by exoplanet hunters.

For this work, the astronomers used four spectrographs on ground based telescopes; the spectrographs are designed for exoplanet hunting, and in particular the SOPHIE[3] instrument on the 1,93 m telescope at the Haute-Provence[4] Observatory. «*The 1,93 m*

[1] The GEPI (Galaxies, Etoiles, Physique et Instrumentation – Galaxies, Stars, Physics and Instrumentation) is a department of the Paris Observatory, a « unité mixte » of the CNRS (UMR 8111) and is associated with the Paris Diderot University.

[2] Most open star clusters dissipate after several tens of millions of years. However, rich star clusters can survive much longer. Messier 67 is an example of an old cluster, which has survived for many millions of years – in fact, it is the oldest and the best studied of all the clusters of this type in the vicinity of the Earth.

[3] This work also exploited observations made using the HARPS instrument on the 3,6 m telescope at ESO's La Silla observatory in Chile, the 1,20 m Léonhard Euler Swiss telescope at ESO's La Silla Observatory in Chilei, and the Hobby Eberly telescope in Texas, USA.

[4] The Haute Provence Observatory - UMS Pythéas is in INSU observational site of the CNRS for astronomy, the environment and the study of the atmosphere.

telescope at the OHP enabled the first exoplanet to be discovered in 1995. In this breathless hunt, it continues to play a leading part, since it has been equiped with an advanced first class instrument such as SOPHIE» points out Piercarlo Bonifacio, CNRS research director at the Paris Observatory, co-author of the paper.

Three planets have thus been found: the first turned out to be in orbit around a quite remarkable star which is to date one of the stars most like the Sun. This is thus the very first twin of the Sun[5] accompanied by a planet, and which is moreover inside a star cluster.

The second planet also orbits a Sun-like star. The mass of these first two planets is about one third of the mass of Jupiter, and they orbit their host stars with a period of, respectively, seven and five days.

The third turns around a much more evolved red giant. Rather more massive than Jupiter, it takes over 122 days to turn around its host star.

Two of these three planets are "hot Jupiters", i.e. planets comparable in size to Jupiter, but much hotter since they are much closer to their host stars. Moreover, these three planets are in fact much too close to their respective suns to be in the habitable zone within which water could exist as a liquid.

« From the scientific point of view, two important lessons can be drawn from this discovery», emphasizes Piercarlo Bonifacio. *«Firstly, exoplanets are as frequent in star clusters as elsewhere in the Galaxy[6]; furthermore, the discovery of a "hot Jupiter" type planet around a star which is identical to the Sun is in direct opposition to current ideas which try to deduce, from the properties of the host star, the structure of its planetary system.»* In other words, the formation and evolution of our solar system as we know it, does not necessarily constitute a unique scenario for the formation and evolution of planetary systems around stars which are solar twins.

Reference

This research is published in a paper entitled *« Three planetary companions around M67 stars »*, by A. Brucalassi et al., in the January 15th issue of the journal Astronomy & Astrophysics (2014, A&A, 561, L9).

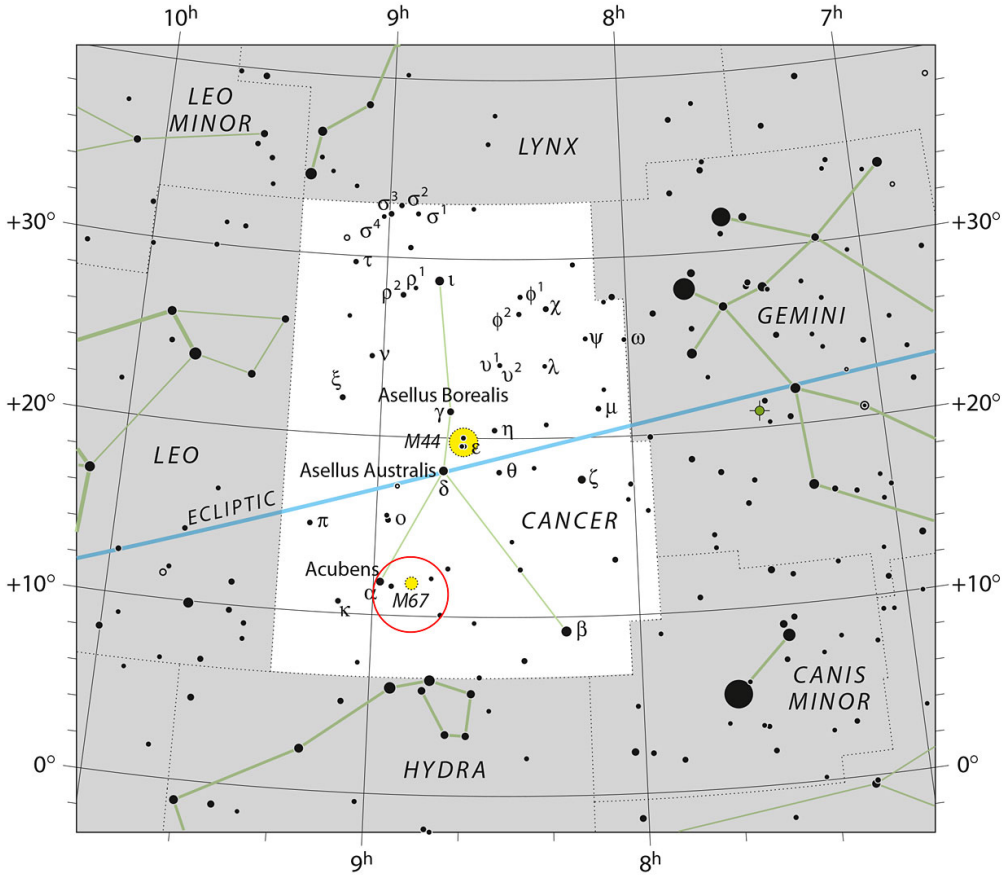
Collaboration

The team consists of A. Brucalassi (Max Planck Institute for Extraterrestrial Physics, Garching, Germany [MPE] ; Munich Observatory, Germany), L. Pasquini (ESO, Garching, Germany), R. Saglia (MPE ; Observatory), M.T. Ruiz (Chile University, Santiago, Chile), P. Bonifacio (GEPI : Paris Observatory/ CNRS / Paris Diderot University, France), L. R. Bedin (INAF – Padova Astronomical Observatory, Padova, Italy), K. Biazzo (INAF – Catania Astronomical Observatory, Catania, Italy), C. Melo (ESO, Santiago, Chile), C. Lovis (Geneva Observatory, Switzerland) et S. Randich (INAF – Arcetri Astrophysical Observatory, Florence, Italy).

Image

[5] The estimates for the planetary masses derived from radial velocity measurements are lower limits: if the planetary orbit is strongly inclined, a higher mass leads to the same observations.

[6] This detection rate of 3 planets in a sample of 88 stars in the Messier 67 cluster is close to the mean frequency of planets detected around isolated stars.



Légende : the star cluster Messier 67 in the Crab constellatlion.
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