

Sapphires and rubies in the sky

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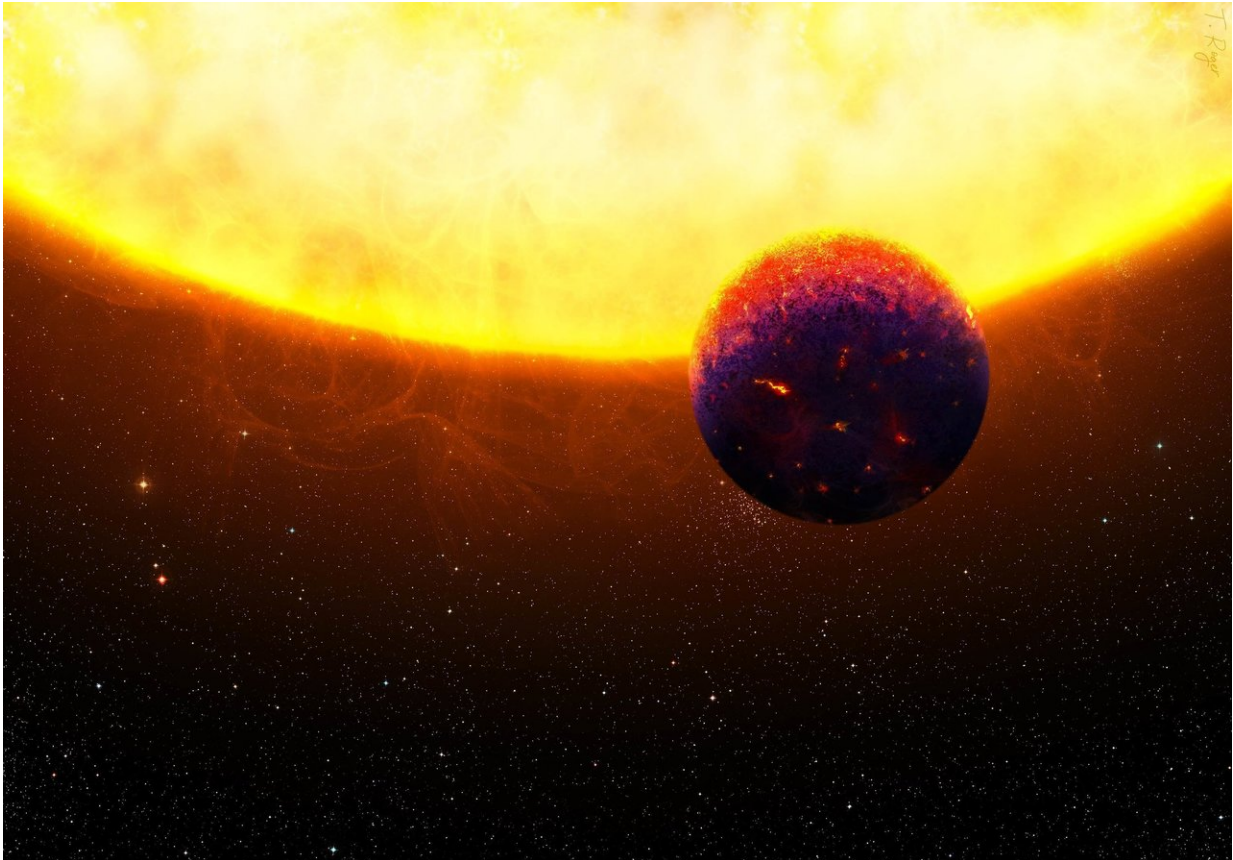


Illustration of one of the exotic super-Earth candidates, 55 Cnc e, which are rich in sapphires and rubies and might shimmer in blue and red colors. Credit: Thibaut Roger

Researchers at the Universities of Zurich and Cambridge have discovered a new, exotic class of planets outside our solar system. These

so-called super-Earths were formed at high temperatures close to their host star and contain high quantities of calcium, aluminium and their oxides—including sapphire and ruby.

Twenty-one light years away from Earth in the constellation Cassiopeia, a planet orbits its star with an orbital period of just three days. Its name is HD219134 b. It is a so-called "super-Earth," with a mass almost five times that of Earth. Unlike the Earth however, it most likely does not have a massive core of iron, but is rich in calcium and aluminium.

"Perhaps it shimmers red to blue like rubies and sapphires, because these gemstones are aluminium oxides which are common on the exoplanet," says Caroline Dorn, astrophysicist at the Institute for Computational Science of the University of Zurich. HD219134 b is one of three candidates likely to belong to a new, exotic class of [exoplanets](#), as Caroline Dorn and her colleagues at the Universities of Zurich and Cambridge now report in the British journal *MNRAS*.

The researchers study the formation of planets using theoretical models and compare their results with data from observations. It is known that during their formation, stars such as the sun were surrounded by a disc of gas and dust in which planets were born. Rocky planets like the Earth were formed out of the solid bodies left over when the proto-planetary gas disc dispersed. These building blocks condensed out of the nebular gas as the disc cooled. "Normally, these building blocks are formed in regions where rock-forming elements such as iron, magnesium and silicon have condensed," explains Dorn who is associated to the NCCR PlanetS. The resulting planets have an Earth-like composition with an iron core. Most of the super-Earths known so far have been formed in such regions.

The composition of super-Earths is more diverse than

expected

But there are also regions close to the star where it is much hotter. "There, many elements are still in the gas phase, and the planetary building blocks have a completely different composition," says the astrophysicist.

With their models, the research team calculated what a planet being formed in such a hot region should look like. Their result: Calcium and aluminium are the main constituents alongside magnesium and silicon, and there is hardly any iron. "This is why such planets cannot, for example, have a magnetic field like the Earth," says Dorn. And because the inner structure is so different, their cooling behavior and atmospheres will also differ from those of normal super-Earths. The team therefore speak of a new, exotic class of super-Earths formed from high-temperature condensates.

"What is exciting is that these objects are completely different from the majority of Earth-like planets," says Dorn, "if they actually exist." The probability is high, as the astrophysicists explain in their paper. "In our calculations, we found that these [planets](#) have 10 to 20 percent lower densities than the Earth."

Other exoplanets with similarly low densities were also analyzed by the team. "We looked at different scenarios to explain the observed densities," says Dorn. For example, a thick atmosphere could lead to a lower overall density. But two of the exoplanets studied, 55 Cancri e and WASP-47 e, orbit their star so closely that their surface temperature is almost 3000 degrees and they would have lost this gas envelope long ago.

"On HD219134 b, it's less hot, and the situation is more complicated," explains Dorn. At first glance, the lower density could also be explained by deep oceans. But a second planet orbiting the star a little further out

makes this scenario unlikely. A comparison of the two objects showed that the inner planet cannot contain more water or gas than the outer one. It is still unclear whether magma oceans can contribute to the lower density.

"So we have found three candidates that belong to a new class of super-Earths with this exotic composition," says Dorn. The researchers are also correcting an earlier image of super-Earth 55 Cancri e, which had made headlines in 2012 as the "diamond in the sky." Researchers had previously assumed that the planet consisted largely of carbon, but had to abandon this theory on the basis of subsequent observations. "We are turning the supposed diamond planet into a sapphire planet," laughs Dorn.

More information: C Dorn et al. A new class of Super-Earths formed from high-temperature condensates: HD219134 b, 55 Cnc e, WASP-47 e, *Monthly Notices of the Royal Astronomical Society* (2018). [DOI: 10.1093/mnras/sty3435](https://doi.org/10.1093/mnras/sty3435)

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