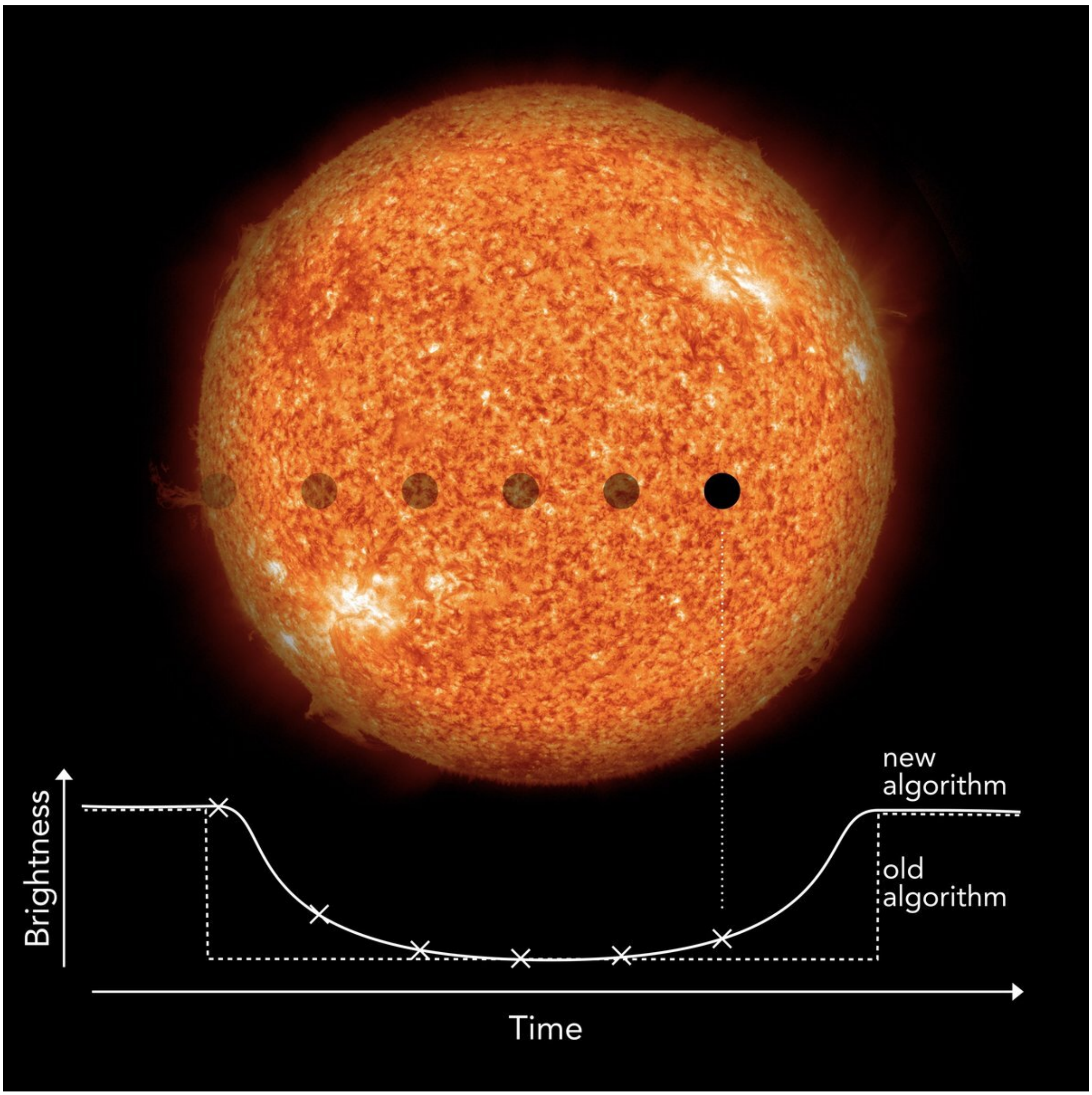
Researcher discusses discovery of exoplanets and his special method

June 4 2020, by Birgit Krummheuer



Star eclipse: When an exoplanet passes in front of its sun, its brightness changes in a characteristic way. This transit method is one of the most popular tools for astronomers. Credit: © MPS / René Heller

René Heller from the Max Planck Institute for Solar System Research already made the scientific community take notice when he and his team discovered no fewer than 18 previously overlooked exoplanets in the data from the Kepler Space Telescope. Now they succeeded again, this time in finding a somewhat Earth-like planet orbiting a sun-like star. What is so special about the new method of Dr. Heller and his team?

Most exoplanets have so far been found using the so-called transit method. How does this method work and why is it so successful?

René Heller: In using the transit method we look for repetitive short dimmings of a star, which are caused by a planet passing in front of the star when viewed from Earth. This event is called a transit. When you look at a randomly chosen star, however, you typically don't know if it has a transiting planet or even a planet at all. In order to find new transits, we typically have to look at a star for a very long time and without pause, typically for weeks and sometimes for years. But that's not enough: For the transit method to work, we need to be in the orbital plane of the planet around its star, when seen from Earth. On average, this is only the case for about every hundredth exoplanet. And so we need to observe hundreds and thousands of stars continuously.

The transit method is therefore not more promising than other methods, but rather resembles the proverbial search for a needle in a haystack. Its success is based primarily on the continuous observation of a large number of stars by NASA's Kepler Space Telescope. Kepler has discovered thousands of exoplanets since 2009, in total more than half of all the exoplanets known today.

In recent years, you have succeeded in improving the usual transit method. What is your trick?

Until a few years ago, the large amounts of data transmitted to us by telescopes made it necessary to simplify our computer-assisted search algorithms here and there. In fact, some standard search algorithms first degraded the quality of the data using what is called data 'binning', and then searched for transits in the low-resolution data. Only this made it possible to analyze the huge amounts of stars, each with years of continuous brightness measurements within tolerable periods of time, like a few days or weeks. In the past few years, however, progress in computing power has allowed us to use a refined algorithm.

My colleague and IT specialist Michael Hippke and I have now refined the standard procedure for exoplanet transit searches by simply refraining from the data binning. Part of the increased computer workload can be absorbed by modern CPU power, but we also had to design the computer code from scratch to make it as efficient as possible. Now it even works on a standard laptop. So you can even find an exoplanet on a train journey with a laptop on your knees.

How many overlooked exoplanets have you been able to track down?

So far, we have published 18 discoveries in the Kepler data. KOI-456.04 is now the 19th exoplanet that we have identified and that has previously been overlooked by the standard search techniques. In fact, we have detected another few dozen candidates, which we are currently studying in more detail before we report them to the community. After all, we don't want to sell a measurement error as a planet. Beyond our own searches with the upgraded algorithm, we've even seen other research teams downloading our code and using them for their own searches. I wouldn't be surprised if our algorithm became the new standard for exoplanet transit searches.

The data from the Kepler Space Telescope have probably been thoroughly and conclusively analyzed by now. Do you nevertheless expect further discoveries of smaller planets, perhaps as large as Earth?

Using traditional methods, the possibilities of finding exoplanets in Kepler data have likely been exhausted, I agree. That said, our first searches with our new algorithm show that with this method there are still exciting discoveries to be made in the data. It's like everybody has swept their brooms through the data and we're now collecting the remaining crumbs with a meticulous dustpan and brush set. But different from the waste that you would pick up from the floor, it's these tiny crumbs, Earth-sized planets, which are the most precious findings in exoplanet science.

During the nine years of operation, Kepler recorded measurement data from about 150,000 stars. How do you decide which stars are worth a second, closer look?

The careful selection of the stars to be re-examined was crucial to our previous discoveries. We used a small but valuable trick: we did not just randomly choose one of the 150,000 stars from the Kepler mission; instead, we focused on the second part of the mission, the so-called K2 mission, in which transiting planets had already been discovered around a total of 517 stars. To check if our method is truly better than the previous methods, we simply revisited all the brightness measurements of these 517 stars and looked for additional planets that might have been missed so far.

As a result, we not only found all the previously known exoplanets, but we also discovered 18 new ones. That may not sound like much, 18 out of 517. It's not just the number of planets that's important though. More important is the fact that all of our newly discovered planets are about the same size as Earth and thus much smaller than most known exoplanets. Of course that's why they had initially been missed.

After sifting through the K2 data, we have now extended our search to the more than 4000 light curves from the first Kepler mission from 2009 to 2013. And again we were successful. The 1.9 Earth radius planetary candidate KOI-456.04 around the sun-like star Kepler-160 is only our first publication.

Why do you speak of KOI-456.04 as a planetary candidate?

Formally speaking, the signal of this presumed planet passes one of our statistical tests with a probability of 85 percent. That means the chances are 85:15, or almost six to one, that this signal is genuinely caused by a planet and not by a random statistical variation of the data or by an instrumental effect. Six to one, I'd say that's a good bet. But as astronomers we want the signal to have a probability of 99 percent, a chance of ninty-nine to one, before we would formally grant the planetary status to the candidate. For now, KOI-456.04 remains a good candidate.

Why is it important to examine a single star system so closely? What do we learn from such an individual

case?

Humanity invests considerable funds and work but also heart & soul in follow-up observations of the most interesting exoplanets or planetary candidates. Even though financial investments in space research are only about one thousandth of the military budget, we do not want to waste the valuable observation time. In some sense, observation time of ground- and space-based telescope is worth billions of Euros or Dollars and we certainly want to avoid spending that time on an interesting observational target—only to find that the target does not exist.

That's why we went to great pains in our study to statistically determine the planetary status. Strictly speaking, this characterization of the planet—or planet candidate—was by far the most time-consuming part. My colleague Michael Hippke and I had already succeeded in discovering KOI-456.04 in May 2019, after only a few days of computer-aided searches of the data. The next step, the extremely complex characterization of the planetary system around the star Kepler-160, took a long time, but we learned a lot with regard to the automation of our methods. Next time we will be faster and it won't take us another year to do the candidate vetting after first detection. And the good news is that we have already found a few dozen more promising candidates in the Kepler data.

Provided by Max Planck Society

Citation: Researcher discusses discovery of exoplanets and his special method (2020, June 4) retrieved 26 April 2024 from
https://phys.org/news/2020-06-discusses-discovery-exoplanets-special-method.html

provided for information purposes only.