Are Cool Stars Popular? Better Ask Sol

Tessa D. Wilkinson

There are a billion stars in the sky, yet the close proximity of the sun makes it the best for studying a star's dynamic and ever changing surface activity. Understanding how this activity affects planets in our solar system is important for determining if far away planet systems could support life. Yet, 70% of the observable universe is made up of red stars that are too dim to see with the naked eye, because they have cooler surfaces and are less than half the size of our sun. These stars are classified as M dwarfs (as depicted in Figure 1) and their lower surface temperature means they last trillions of years as they slowly burn away their hydrogen fuel. Being the most common and lasting for so long, one would think these stars would be a great place to search for planets suitable for life. So, how does studying our own star help to determine if a planet could host life around one of these common cool stars?

Observing the Sun's activity is the first step to understanding what makes a planet like Earth. Satellites such as NASA's Solar and Heliospheric Observatory have been observing the sun for 20 years to study

Figure 1 (Phys.org)

surface features such as sunspots, which are cool dark spots on the surface that are footprints of magnetic activity, and the solar wind, which is the flow of particles that get ejected from the sun's outer layers. More recently, the Solar Dynamics Observatory (SDO) has provided continuous observation of the sun in a broad range of colors, or wavelengths. The data from these satellites are used to better understand high energy

events called solar flares, and explosions of solar plasma called coronal mass ejections (CME).

Scientists use these observations to gauge the effect of energetic particles on planets in our solar system. A large flare, which is often associated with CMEs, can cause a flood of excited particles to lash out into space. When directed at Earth, the high energy of these particles interacts with satellites, causing radio communication problems. More visibly, the particles excite the Earth's magnetic field, and cause what we see as aurora in our atmosphere. Beyond Earth, NASA scientists reported that a solar storm from the young Sun may have stripped Mars atmosphere, making the planet unable to support life.

In recent years, we've learned that planets outside of our solar system, called exoplanets, exist in a multitude of systems thanks to the Kepler Satellite. It collected light from stars in one spot of the sky for several years in an effort to find planets around stars like our Sun. Being sensitive enough to pick up tiny fluctuations in the brightness of stars, Kepler has found thousands of exoplanet candidates. This is how most planets are found: we observe brightness dips over time that happen periodically when a planet's orbit crosses the face of the star. To determine if a planet is 'Earth-like', astronomers often calculate if a planet is in the 'habitable zone' of its star. Commonly referred to as the 'Goldilocks zone', this is the region in space some distance from the host star where a planet's temperature is not too hot and not too cold. Ideally, the right temperature and pressure make for a suitable atmosphere and liquid water, both critical for life on Earth.

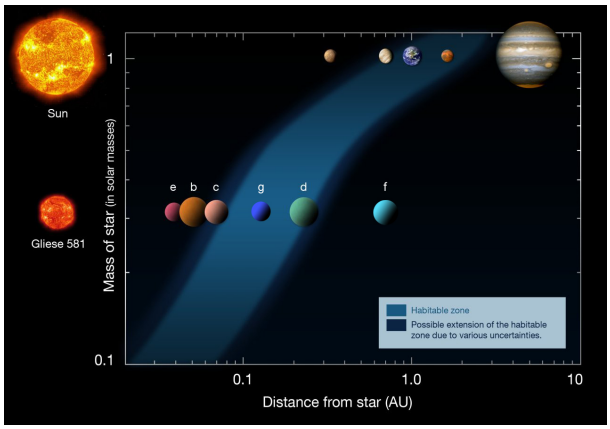

Figure 2 (commons.wikimedia.org)

Common cool M dwarfs that make up most of our stellar neighborhood are naturally dim, adding to the difficulty in confirming a planet detection, but can also be extremely active in comparison to our own Sun. Due to their convective inside (like a pot of boiling water), these cool stars

can have flares three times larger than ones observed on the Sun. Bigger flares mean many more energetic particles are ejected during the cool stars long life. Therefore, a planet that is calculated to be in the habitable zone of a cool red star (like planet g in Figure 2), may still be scorched due to the strong flares that could reach out and strip its atmosphere similar to Mars. We cannot study these exoplanets in such detail yet, so that's why it is important to fully understand how the solar activity affects the planets in our own system.

With larger telescopes being built, like the James Webb Telescope, we will be able to collect more light and gather more data on these common cool stars, bettering our understanding of their systems, and getting a better idea of the planets that they host. In the meantime, studying the Sun is the best way to see up close the changes high energy events can cause on various types of planets. Only then can we better constrain if a planet candidate around a common red star could be in the habitable zone and possibly Earth-like.

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