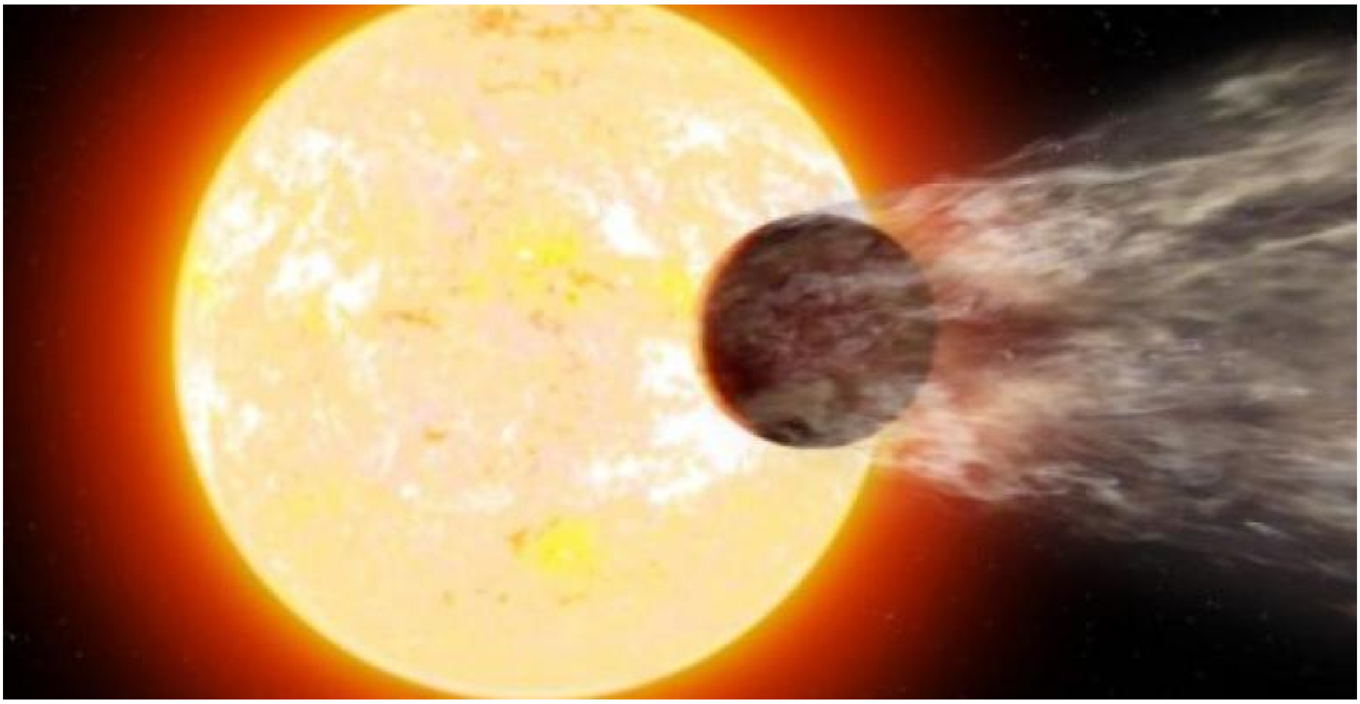
Under pressure: Extreme atmosphere stripping may limit exoplanets' habitability

03/07/2017



New models of massive stellar eruptions hint at an extra layer of complexity when considering whether an exoplanet may be habitable or not. Models developed for our own Sun have now been applied to cool stars favoured by exoplanet hunters, in research presented by Dr Christina Kay, of the NASA Goddard Flight Center, on Monday 3rd July at the National Astronomy Meeting at the University of Hull.

Coronal mass ejections (CMEs) are huge explosions of plasma and magnetic field that routinely erupt from the Sun and other stars. They are a fundamental factor in so called "space weather," and are already known to potentially disrupt satellites and other electronic equipment on Earth. However, scientists have shown that the effects of space weather may also have a significant impact on the potential habitability of planets around cool, low mass stars -- a popular target in the search for Earth-like exoplanets.

Traditionally an exoplanet is considered "habitable" if its orbit corresponds to a temperature where liquid water can exist. Low mass stars are cooler, and therefore should have habitable zones much closer in to the star than in our own solar system, but their CMEs should be much stronger due to their enhanced magnetic fields.

When a CME impacts a planet, it compresses the planet's magnetosphere, a protective magnetic bubble shielding the planet. Extreme CMEs can exert enough pressure to shrink a magnetosphere so much that it exposes a planet's atmosphere, which can then be swept away from the planet. This could in turn leave the planetary surface and any potential developing lifeforms exposed to harmful X-rays from the nearby host star.

The team built on recent work done at Boston University, taking information about CMEs in our own solar system and applying it to a cool star system.

"We figured that the CMEs would be more powerful and more frequent than solar CMEs, but what was unexpected was where the CMEs ended up" said Christina Kay, who led the research during her PhD work.

The team modelled the trajectory of theoretical CMEs from the cool star V374 Pegasi and found that the strong magnetic fields of the star push most CMEs down to the Astrophysical Current Sheet (ACS), the surface corresponding to the minimum magnetic field strength at each distance, where they remain trapped.

"While these cool stars may be the most abundant, and seem to offer the best prospects for finding life elsewhere, we find that they can be a lot more dangerous to live around due to their CMEs" said Marc Kornbleuth, a graduate student involved in the project.

The results suggest that an exoplanet would need a magnetic field ten to several thousand times that of Earth's to shield their atmosphere from the cool star's CMEs. As many as five impacts a day could occur for planets near the ACS, but the rate decreases to one every other day for planets with an inclined orbit.

Merav Opher, who advised the work, commented, "This work is pioneering in the sense that we are just now starting to explore space weather effects on exoplanets, which will have to be taken into account when discussing the habitability of planets near very active stars."