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Galactic cosmic ray fluxes during the lifetime of a red dwarf star

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Exoplanets orbiting red dwarf stars in the habitable zone are easier to detect than those orbiting Sun-like stars. In recent years, there has been increased interest in modelling the Galactic cosmic ray fluxes reaching exoplanets orbiting stars other than the Sun. This is because Galactic cosmic rays can affect exoplanet habitability by for instance, driving the formation of prebiotic molecules, the building blocks of life, in the atmospheres of planets.

The stellar wind properties are important in determining the level of suppression that affects Galactic cosmic ray fluxes. Detecting the stellar wind from low-mass stars directly is extremely difficult due to their low density. As a result, we use a stellar wind model motivated by observations. First, we use a rotation evolution model to determine the rotation rate and X-ray luminosity of a red dwarf star during its life, from 600Myr - 6Gyr. Using these two quantities we calculate the large-scale stellar magnetic field strength, coronal temperature and mass loss rate of the star which are used as inputs for the stellar wind model.

I will present our results on the Galactic cosmic ray fluxes reaching the habitable zone of a red dwarf star during its life. For this study, we used a 1D diffusion-advection cosmic ray transport model. I will show our results of the Galactic cosmic ray fluxes in the habitable zone vary significantly on Gyr timescales and are different to the fluxes expected around a Sun-like star. I will also show how our results depend on the rotation evolution of the red dwarf. Finally, I will discuss briefly how observations with JWST, and upcoming missions such as Ariel, may probe the high-energy environment of gas giants and provide constraints for our models.

Collaboration(s)

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