Highlights of Astronomy, Volume 15
XXVIIth IAU General Assembly, August 2009
Ian F. Corbett, ed.

doi:10.1017/S1743921310011051

The "Living with a Red Dwarf" program: XUV radiation and plasma environments of hosted planets and impacts on habitability

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Abstract. We describe the LWARD program on dM stars and habitability in their environment.

Red dwarf (dM) stars are overwhelmingly the most numerous stars in our Galaxy. These cool, low-luminosity, low-mass stars comprise >75% of all stars. They have very long lifetimes of 30–200+ Gyr and have nearly constant luminosities for tens of Gyrs. Because of this, red dwarfs have essentially fixed (but close-in) Habitable Zones (HZs). Determining the number of dM stars with planets and assessing planetary habitability is critically important because such studies can indicate how common life is in the universe. Due to their longevity, nearby old dM stars are obvious targets for SETI programs.

Our program – "Living with a Red Dwarf" – addresses these questions by investigating the nuclear evolution and rotation-age dependent magnetic-dynamo coronal and chromospheric XUV properties of dM stars for stellar ages ranging from ∼10 Myr to ∼12 Gyr (and corresponding rotation rates). Indeed, this study shows that, like our Sun and solar-type stars, young dM stars spin rapidly (and have robust dynamos) but lose angular momentum over time (via magnetic winds) and spin down. Also studied is how the stellar emissions (radiances as well as stellar wind fluxes) affect hosted planets and impact on the suitability for life. In this pilot study, we have selected ∼25 red dwarfs (dM0–5 stars) as proxies for red dwarfs with different ages and spectral types.

Our initial results indicate that, under certain circumstances, the more luminous dM0–3 stars can be suitable hosts for habitable planets. However, the HZs for such planets will be close to the host star (<0.5 AU) and result in tidally-locked HZ planets. Habitability of such planets may require a thick (UV shielding) atmosphere and protective magnetosphere. For instance, a super-Earth (2–10 $M_{\oplus}$ for sufficient gravity) with a liquid iron-nickel core may retain its atmosphere by generating strong magnetic fields, even with slow rotation - Guinan & Engle 2009, Guinan, Engle & Dewarf 2009.

Acknowledgements

This research is supported by grants from NASA/FUSE (NNX06AD38G) and NSF (AST-0507542 & AST-0507536) which we gratefully acknowledge. The "Living with a Red Dwarf" Program is on the web at: http://astronomy.villanova.edu/LWARD/

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