The Evolution of High Energy Environments of Low-mass Stars and their Planets.

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Introduction: Low-mass stars, or M dwarfs (0.1-0.6 M_{Sun}), make up the vast majority of stellar constituents of the Solar neighborhood. Recent results have shown that the majority of M dwarfs host planets, with ~25% hosting an Earth-size or super-Earth-size planet within their habitable zone[1]. These statistics, combined with advantageous observational characteristics, make it likely that the first habitable planet suitable for follow-up observations will be found orbiting a nearby M dwarf. However, because M dwarfs have active chromospheres and coronae that produce high-energy radiation that may be harmful for life, determining the habitability of planets orbiting M dwarfs is not straightforward. The Habitable Zones and M dwarf Activity across Time (HAZMAT) program was initiated specifically to determine the time-dependent habitability around such perpetually UV-active stars. Using high-resolution optical spectroscopy, we are finding, characterizing, and age-dating hundreds of young M dwarfs in the Solar neighborhood to measure the change in stellar activity over planet formation and evolution timescales.

Methods: Because stellar activity can be used as an indicator of youth, near- and far-ultraviolet photometry from the Galaxy Evolution Explorer (GALEX) and X-ray data from ROSAT provide invaluable resources for identifying young, nearby, low-mass stars ([3],[4]). With a GALEX and ROSAT selected sample of low-mass stars, we are using high-resolution optical spectroscopy to determine their ages through activity (e.g., Hα), lithium absorption, gravity indicies, and kinematics. These data will allow for the identification of new members of nearby moving groups whose ages span 10 to 600 Myr. By combining this sample of young low-mass stars with near- and far-ultraviolet photometry from GALEX and X-ray data from ROSAT, we are mapping out the high-energy environment, and thus potential habitability of planets, revolving and evolving around M dwarfs.

Results: In a preliminary study of the evolution of early type (<M3) M dwarfs [2], it was shown that the median of GALEX near- and far-UV fluxes drops by a factor of 25 and 20, respectively, from 10 Myr to a few Gyr. We are extending this work to lower mass M dwarfs (>M2), which are especially valuable since they have closer-in habitable zones and remain active for even longer with greater flare variability. We will show our progress identifying nearby, low-mass young stars, as well as assess how the UV radiation of these potential planet hosts varies with time during critical planet formation and evolution timescales.

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References:

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