Predicting the Impact of Stellar Kinematics and Dynamics on Habitability in the Milky Way

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When exploring the potential for life in the Universe, a star system's habitability depends on both its internal structure, which sets up the building blocks for life, and its external environment, which allows life to evolve and flourish. While most habitability research is focused on internal factors, such as the Circumstellar Habitable Zone, our understanding of the external galactic hazards that could jeopardize life is limited. The Galactic Habitable Zone (GHZ) is a relatively new concept that accounts for galactic hazards such as radiation and gravitational perturbations. However, existing GHZ models are not consistent with each other, most are based on either simulations or general trends, and none have fully addressed the contribution of stellar kinematics. Thus, based on well-accepted constraints to habitable galactic environments, this project formulates a model in terms of three probabilities: avoiding close encounters with other stars that could perturb planetary orbits, avoiding close-range supernovae which could wipe out all life, and sufficient stellar metallicity to form terrestrial planets. This model was applied to stellar data from the Gaia satellite on over 6 million stars, including over 1,000 confirmed exoplanet systems, by calculating each star's path through the Milky Way and predicting its probability of sustaining life at each point in space and time. This work predicts that there are habitable planets located throughout the Galaxy and that most confirmed exoplanet systems have a hospitable external environment that could sustain life, thus contributing to our understanding of the constraints on life in the Milky Way.

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