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SEARCHING FOR EXOPLANETS: DETECTION AND MODELLING MAGNETIC INTERACTIONS WITH HOST STARS

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Abstract

Gravitational techniques such as the transit and radial velocity methods have dominated exoplanet detection, but they fail to provide insight into magnetic fields an essential part of understanding planetary protection and habitability. This research explores the magnetic interaction between host stars and their planets, known as star planet interactions (SPIs), as an alternative detection technique. Such interactions stretch and twist stellar magnetic field lines, producing reconnection events and releasing energetic particles that can manifest as observable emissions. Results and Discussion Through a detailed review of Strugarek's classification of SPI mechanisms, Su's correlation of stellar activity with close-in planets, and Kavanagh's geometrical analysis of radio signal visibility, this work demonstrates how SPIs leave detectable traces in the form of radio bursts, X-ray dips, and enhanced chromospheric activity. In extreme systems like X-ray binaries, orbiting planets may partially block or disturb X-ray emissions, offering further indirect evidence of their presence. Additionally, synchrotron radiation and inverse Compton scattering, triggered by accelerated particles, are identified as key markers of magnetic activity in such systems. Methodology Magnetohydrodynamic (MHD) simulations using the PLUTO code are employed to model planetary magnetic fields interacting with stellar winds. The simulations include Alfvén wing formation and bow shock dynamics, alongside cosmic-ray propagation physics to track high-energy particle behavior and emission signatures. Real observational data from missions such as TESS and LAMOST provide empirical support for the modeled interactions.