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Emission from Ordered Magnetospheres of Low-Mass Stars, UCDs, and Massive Star

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The ordered magnetospheres of chemically peculiar (CP) massive stars and ultracool dwarfs (UCDs) provide ideal environments for non-thermal particle acceleration. In CP stars, radiatively driven winds are trapped into rigidly rotating magnetospheres until centrifugal breakout (CBO) occurs, when centrifugal forces overwhelm magnetic tension. These breakout events trigger reconnection and inject energetic electrons that radiate broadband incoherent emission via the gyro-synchrotron mechanism. Recent observations have demonstrated that the radio luminosity of CP stars scales with the available CBO power, establishing a robust link between magnetospheric dynamics and radio output.

Intriguingly, the few UCDs detected in quiescent radio emission also follow the same $L_{\text{rad}} \propto L_{\text{CBO}}$ relation, despite lacking the strong stellar winds that feed CP star magnetospheres. This raises a fundamental question: how do UCDs maintain a reservoir of ionized matter capable of sustaining CBO-driven processes?

The Square Kilometre Array (SKA), with its sensitivity and wide spectral reach, will provide the first opportunity to test the CBO paradigm in UCDs, constrain their plasma sources, and extend scaling laws of magnetospheric radio emission from massive stars down to the substellar regime.

Topics

Cradle of Life & Our Galaxy

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