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Probing the Radio Emission from WR Nebulae: Investigating Non-Thermal Emission Mechanisms

Abstract

Wolf-Rayet stars (WRs) are highly massive stars in the final stages of their life, just preceding the catastrophic core-collapse Supernovae explosion. During their post-main sequence evolution, they inject into the surrounding environment a huge amount of mass and energy. Such ejection can produce extended envelopes detected in many spectral bands, from the infrared to the radio. The radio nebula usually emits via optically thin free-free thermal emission, characterized by an almost flat spectrum. The new MeerKAT galactic plane survey detected many radio nebulae surrounding massive evolved stars. The analysis of the in-band spectral behavior provides hints that also a non-thermal emission mechanism is in the act inside some radio nebulae, which implies an acceleration of relativistic electrons and the presence of magnetic fields. The confirmation of the presence of a non-thermal radio emission component within the radio nebulae surrounding massive evolved stars provides crucial indications regarding their potentiality as cosmic rays factories. Further, the detection of non-thermal radio emission is an indirect clue of the possible magnetic nature of the central massive evolved star, which could be a magnetar progenitor. We propose MeerKAT S band observations of the radio nebulae surrounding evolved massive stars to definitively confirm (or reject) the presence of non-thermal emission evidenced at 1.3 GHz. Our proposed study aims to confirm the presence of energetic electrons in magnetized regions around evolved stars, which can provide evidence of the extended spatial scale of their magnetic fields and the magnetic nature of these evolved stars.