Resolved spectral variations of the centimetre-wavelength continuum from the ρ Oph W photodissociation region

- Casassus S.[a]
- Vidal M.[b],
- Arce-Tord C.[a],
- Dickinson C.[c, d],
- White G.J.[e, f],
- Burton M.[g],
- Indermuehle B.[h],
- Hensley B.[i]

Abstract

Centimetre-wavelength radio continuum emission in excess of free-free, synchrotron, and Rayleigh-Jeans dust emission (excess microwave emission, EME), and often called 'anomalous microwave emission', is bright in molecular cloud regions exposed to UV radiation, i.e. in photodissociation regions (PDRs). The EME correlates with infrared (IR) dust emission on degree angular scales. Resolved observations of well-studied PDRs are needed to compare the spectral variations of the cm-continuum with tracers of physical conditions and of the dust grain population. The EME is particularly bright in the regions of the ρ Ophiuchi molecular cloud (ρ Oph) that surround the earliest type star in the complex, HD 147889, where the peak signal stems from the filament known as the ρ Oph W PDR. Here, we report on Australia Telescope Compact Array observations of ρ Oph W that resolve the width of the filament. We recover extended emission using a variant of non-parametric image synthesis performed in the sky plane. The multifrequency 17-39 GHz mosaics reveal spectral variations in the centimetre-wavelength continuum. At ∼30 arcsec resolutions, the 17-20 GHz intensities tightly follow the mid-IR, Icm ∝ I(8μm), despite the breakdown of this correlation on larger scales. However, while the 33-39 GHz filament is parallel to Infrared Array Camera 8 μm, it is offset by 15-20 arcsec towards the UV source. Such morphological differences in frequency reflect spectral variations, which we quantify spectroscopically as a sharp and steepening high-frequency cutoff, interpreted in terms of the spinning dust emission mechanism as a minimum grain size acutoff ∼ 6 ± 1 Å that increases deeper into the PDR. © 2021 The Author(s) Published by Oxford University Press on behalf of the Royal Astronomical Society.

Author keywords

ISM: clouds; ISM: individual objects: ρ Oph, Rho Oph W filament, SR4, DoAr21; photodissociation region; radiation mechanisms: general; radio continuum: general; submillimetre: ISM