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Spectral mapping of galactic PDRs : cooling and molecular diagnostics

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As part of the Herschel Key programme (SAG 4), we have produced one of the most detailed spectroscopic maps of the local PDRs ever performed in the FIR. This programme comprises a representative sample of PDRs covering a wide range of excitation conditions with varying incident radiation fields ($10 < G_0 < 10000$ in Habing units) and densities (10^3 cm^{-3} $< n <$ 10^6 cm^{-3}). We study the fine structure lines of [C II] (158 μm), [O I] (63 and 145 μm) and compare their emission to molecular tracers including rotational and rovibrational H_2, and high-rotational lines of CO, OH and CH^+ when available.

Each lines show a specific morphology and by spatially resolving the lines we establish their origin, excitation mechanisms and contribution to the cooling as a function of the density structure and the energetics associated with the illuminating stars. Our main results concern: $\mathbf{1}$) the origin of the [CII]158 μm line (neutral vs. ionized) and its increasing contribution to the total cooling in low excited PDRs (reaches up to 50% in PDRs with $G_0 < 50$); $\mathbf{2}$) an important overestimation by PDR models of the [OI] 63 μm line self-absorbed; $\mathbf{3}$) an unexpected large amount of H_2 rotational emission in the lower excited PDRs; $\mathbf{4}$) the direct evidence of high-J CO excitation by UV photons only in the high excited PDRs; $\mathbf{5}$) the impact of the chemical reaction with FUV-pumped vibrationally excited H_2 on the abundance and excitation of molecules such as CH^+ and OH in high excited PDRs.

Enhanced emission of the far-IR lines trace the presence of condensations at high thermal pressure inside PDRs, where strong dust emission in the far-IR and submm are also detected. We study the bulk of cool/warm dust and gas together in order to derive the dust density profile and investigate how these populations spatially coincide and how evolve the small dense structures found in PDRs (photo-evaporation vs star formation).

REFERENCES

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