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Dynamical effects of the radiative stellar feedback on the HI-to-H2 transition.

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Molecular clouds are surrounded by an atomic layer where hydrogen is in atomic form (H) instead of molecular form (H₂). As one looks deeper into the cloud, the position where H₂ becomes more abundant than HI is called the H/H₂ transition. This transition controls the fraction of molecular gas, which constitutes the mass reservoir for star formation, as evidenced by the Schmidt-Kennicutt law. Theoretical descriptions of this H/H₂ transition have been proposed in the case where the gas is assumed static. In star forming regions, however, Herschel and spatially-resolved ALMA observations have revealed important dynamical effects at the PDR edges of molecular clouds, which could be explained by photo-evaporation resulting in an advance of the ionization front into the neutral gas, or, equivalently, to neutral gas being advected through the PDR.

In a new paper, we extend the analytic theory of the H/H₂ transition to include the dynamics of the gas induced by photo-evaporation and find its consequences on the total atomic hydrogen column density at the surface of clouds in presence of a strong UV field, and on the properties of the H/H₂ transition. We also include H₂ formation on grains, H₂ photodissociation, H₂ self-shielding and metallicity. The advection of gas through the H/H₂ transition caused by photoevaporation reduces the width of the atomic region compared to static models. The atomic region may disappear if the ionization front velocity exceeds a certain value, leading the H/H₂ transition and the ionization front to merge. We provide analytical expressions to determine the total HI column density. Finally, we compare our results to observations of PDRs illuminated by O-stars, for which we conclude that the dynamical effects can be strong, especially in low excitation PDRs such as the Horsehead. This new model is tested on recent ALMA observations of a PDR showing the transition between ionized, atomic and molecular gas.

Field

InterStellar Medium

Day constaints

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