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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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