Dynamical properties of warm and dense photodissociation regions: from the interstellar medium to protoplanetary disks

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The surface layers of molecular clouds and protoplanetary disks harbor photodissociation regions (PDRs) where neutral gas is heated by the ultraviolet photons (UV) of nearby stars. The balance between heating mechanisms (mainly photo-electric heating, and heating by H2 de-excitation and formation), and cooling in far-infrared lines (mainly [CII] and [OI] fine structure lines), determines the structure of PDRs and therefore of a large fraction of the interstellar medium. While the thermal balance of PDRs has been largely investigated in the past, and now with Herschel, little is known about the dynamical properties of PDRs. Here we present spatially and spectrally resolved HIFI maps of the [CII], 12CO(8-7) and 13CO(8-7) emission of two prototypical PDRs: the NGC 7023 and Horsehead nebulae, which allow us to study gas kinematics in PDRs. The analysis, using blind signal separation algorithms, of the [CII] maps and comparison to the molecular lines indicates that these PDRs are dynamically active. In particular, we find evidence (especially in NGC 7023) that photo-evaporation is occurring. This process can have a significant impact on the density and thermal structure of highly irradiated PDRs and perhaps play a role in triggered star-formation. In addition, the detection of photo-evaporation flows in extended PDRs of star-forming regions offers the possibility to study this mechanism in details, as a template for photo-evaporation in protoplanetary disks. I will also briefly present the recent results obtained with Herschel (see J. Champion et al., this conference) for a protoplanetary disk in the Carina nebula where external irradiation is suspected to ignite photo-evaporation. We used the techniques developed for extended PDRs to interpret the observations of high-J CO, [CII] and [OI] lines in this source, and found that the surface of this disk is indeed at very high pressure and therefore unstable against photoevaporation. However, we found that the mass-loss rate through photoevaporation is limited, either by gravitational forces or magnetic fields.