Probing the role of PAHs in the photoelectric heating in star-forming regions

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The photoelectric heating is a major heating process in photodissociation regions (PDRs), and its efficiency is one of the key parameters to understand the energy balance there. Wide variations of the heating efficiency is found in different sources as well as in individual spatially resolved sources (Vastel et al. 2001, Habart et al. 2001, Mizutani et al. 2004). These variations have been attributed to differences in the mean charge state of the grains, i.e. a positive grain charge results in a decreased efficiency, and the correlation with the intensity of the UV radiation field supports this interpretation. In particular the ionization state of polycyclic aromatic hydrocarbons (PAHs) is supposed to play a dominant role in the heating efficiency. However, the observational exploration of the direct relation between the heating efficiency and the charge of small grains and PAHs is not fully conclusive yet (Joblin et al. 2010).

Observationally the heating efficiency can be traced by the ratio of ([O I] 63 μm+[C II] 158 μm) to the total infrared flux. Using high spatial resolution spectroscopy with the Photodetector Array Camera and Spectrometer (PACS) onboard *Herschel* and the Infrared Spectrograph (IRS) onboard *Spitzer*, we investigate the relation between the heating efficiency and the charge of PAHs in 5 star-forming regions observed in the WADI (Warm And Dense ISM; Ossenkopf et al. 2011) guaranteed time key program.

To derive the fraction of the charged PAHs, we decomposed the mid-infrared PAH emission into that of neutral (PAH^0) and ionized PAHs (PAH^+), and evaporating very small grains (eVSGs) using the fitting procedure based on a set of template spectra (Pilleri et al. 2012). The result (Figure below) shows that the regions with a high PAH^+ fraction have a low heating efficiency, supporting the scenario in which a positive grain charge results in a decreased efficiency. However the theoretical estimate of the photoelectric heating efficiency as a function of the PAH^+ fraction (Bakes & Tielens 1994) is systematically higher than the observed efficiency reported in our study (Okada et al., submitted).

References:

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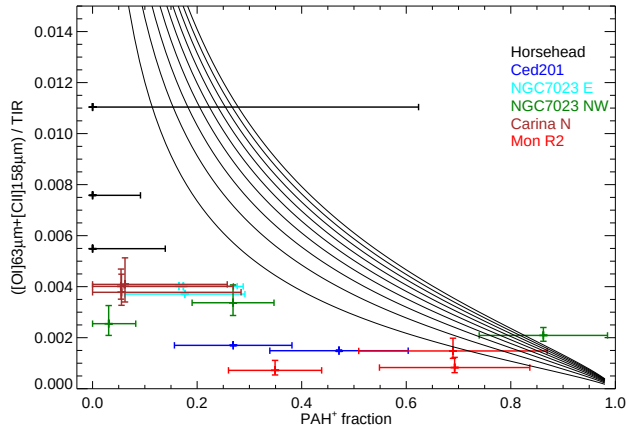

The heating efficiency versus the fraction of PAH^+. The black lines are the theoretical estimate from Bakes & Tielens (1994).