AO disentangles Photodissociation Regions, Shocks and Dust in OMC1

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Observation of IR emission of H_2 in molecular clouds leads to a relatively direct determination of the physical conditions and structure in the emitting gas, as shown in previous work of our own and others (Field et al, Lemaire et al, Rouan et al, Schild et al). Use of the adaptive optics allows in addition a detailed analysis of the H_2 emission on a very small scale as demonstrated in the case of NGC 2023.

Observations in a variety of H_2 IR lines (indicated in figure 1) of the SW part of the Orion Molecular Cloud complex (OMC1) have been performed at the ESO 3.6m telescope taking advantage of the high spatial resolution given by adaptive optics (Adonis at 50 marcsec/pixel) combined with the high spectral resolution given by a Fabry-Perot (R=1000). Wavefront sensing uses θ^1 Ori^B located 22" SE from the centre of the observed region. The full image is made up of adjacent overlapping fields which cover in total a region of ~33"x20", lying south of KL and BN around Peak 2(see figure 2 - Beckwitz 1978- where our observation region is marked with a dotted line).

Many deconvolution algorithms are available and have to be chosen according to the problem we are dealing with. None of them can take into account the variability of the PSF over the entire image, a problem which happens when the wavefront sensing star is not centered in the image. We use two different kinds of algorithms: first the Maximum Entropy (non linear) method, giving the advantage of increasing the contrast, is used to study the small scale structure of the nebula; secondly the SOLA method (subtractive Optimally Localized Averages), developed by Pijpers (1994, 1998) is prefered in our case for the spectroscopic studies. As a matter of fact, SOLA, a linear algorithm of deconvolution preserving the flux in the image, is particularly suitable for the second case. It consists in fitting a linear combination of the PSF to some « target function », for example a gaussian with a full width at half maximum equal to $(4\ln 2)^{1/2}$ Δ, where Δ determines the spatial resolution which may be achieved. The higher spatial and spectral resolution afforded by the present work gives additional insight into the nature of this part of OMC1, in comparison with earlier data.

The physical structure of the material, seen via the H_2 emission (see false color picture) in the S(1) v=1-0 line, is composed of several features: compact and bright spots (or knots) and jet-like structures or collimated outflows (ejecta from BN or IRc2) embedded in a weak underlying diffuse nebulosity or colliding with the dense surrounding gas. The clumpy appearance of the H_2 emission on the very small scale (<~100AU) allowed by the adaptive optics will be analyzed using wavelet transform algorithms, which give access to the scaling exponent and the mean fractal dimension. This can lead to the role played by turbulence in the H_2 excitation. Several mechanisms, observed at different scales, may contribute to explain the clumpy and knotty structure in this very complex region.

Images taken for several H_2 lines in the K band give access to fine detail in the vibrational and rotational temperature variations within the different features. The high spatial resolution can help to disentangle the nature of the excitation processes in the different emitting regions: photon dominated regions (PDRs) and shock-dominated regions. In this preliminary work, we can distinguish two kinds of regions (see figure 1). For one of them (figure 1-a) corresponding to the region marked with circle A on figure 2, the population distribution of H_2 is a Boltzmann distribution (with a temperature of about 2400K) whereas the second Boltzmann diagram (figure 1-b) corresponding to location B on figure 2 clearly shows two components (one corresponding to a temperature of about 2000 K and the second one very hot).

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