A sub-arcsecond study of the hot molecular core in G23.01-0.41

A.Sanna [1] (asanna@mpifr-bonn.mpg.de), R.Cesaroni[2], L.Moscadelli[2], Q.Zhang[3], K.M.Menten[1], S.Molinari[4], A.Caratti o Garatti[1], and J.M. De Buizer[5]

([1]MPIfR, Germany; [2]INAF OA, Italy; [3]CfA, USA; [4]INAF-IFSI, Italy; [5]SOFIA-USRA , USA)

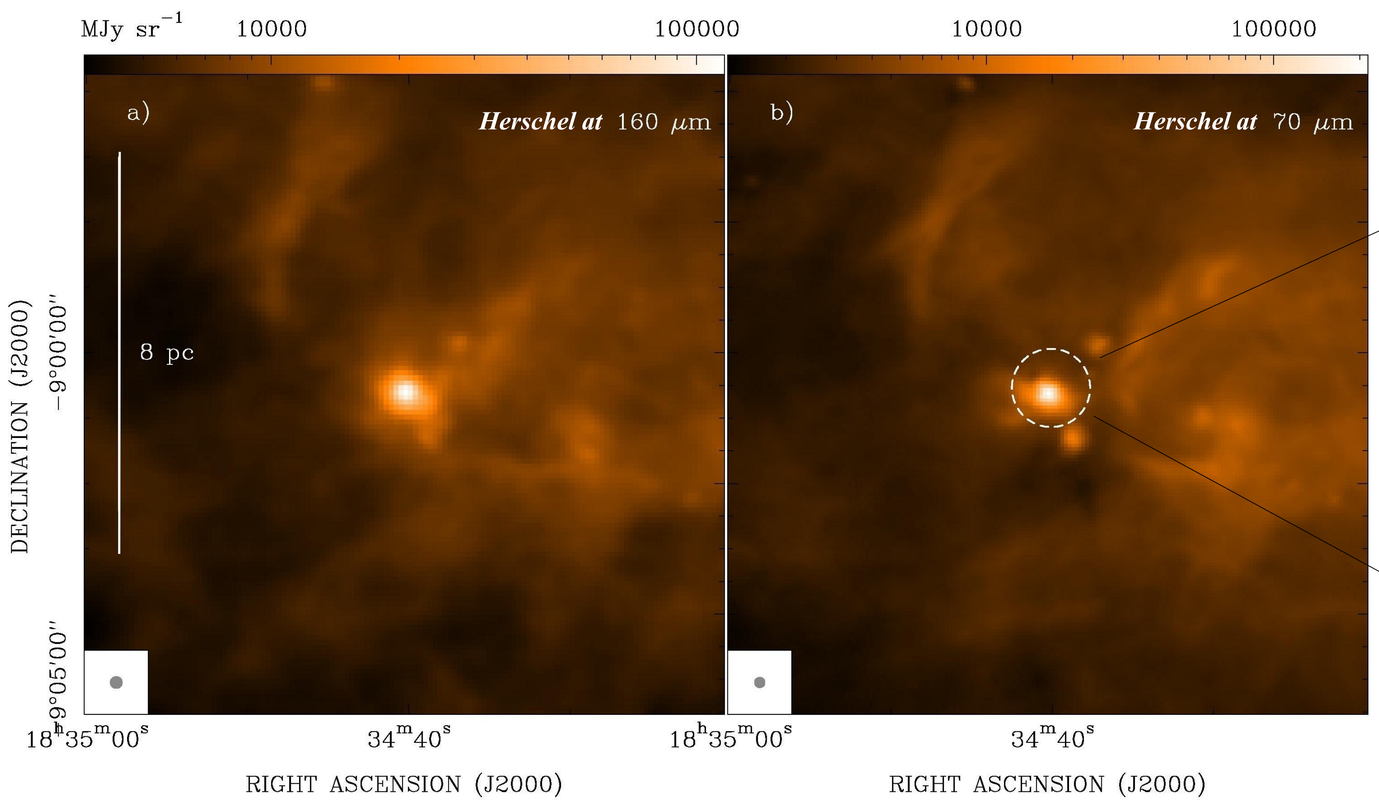
Max-Planck-Institut für Radioastronomie

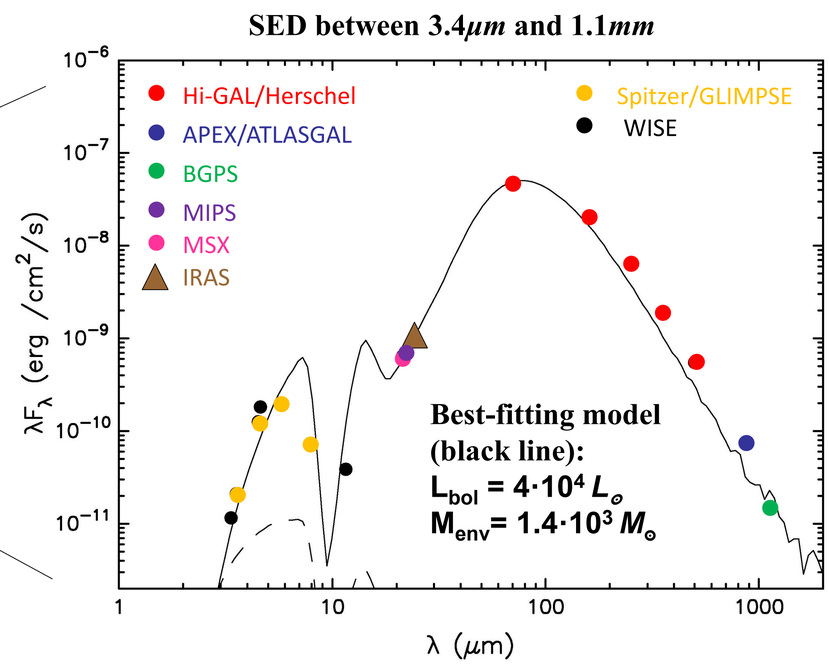
European Research Council Executive Agency
Advanced grant no. 247078 "GLOSTAR"

We present new results of our recent SMA observations at 1.3 *mm* toward the high-mass star-forming region (HMSFR) G23.01-0.41, providing sub-arcsecond and high sensitivity maps of various molecular lines, including both hot-core and outflow tracers (e.g., CO isotopomers, SiO, CH_3CN, and CH_3OH). We also complement this dataset with the spectral energy distribution (SED) between 3.4 *μm* and 1.1 *mm*, including the far-IR images from the Hi-GAL/Herschel survey. Our purpose is twofold: 1) to image at high angular and spectral resolution the flattened, hot molecular core (HMC) detected toward G23.01-0.41, which contains strong masers and a radio continuum source; 2) to compare the spatial distribution and velocity field of gas close to the central YSO with that of the associated molecular outflow.

RESULTS. Our interferometric observations reveal that the distribution of dense gas and dust in the HMC is significantly flattened and extends up to a radius of 8000 *AU* from the center of radio continuum and maser emission in the region. The equatorial plane of this HMC is strictly perpendicular to the elongation of the collimated bipolar outflow (momentum rate ~$6\cdot10^{-3}$ $M_\odot$ *km* s^{-1} yr^{-1} and outflow rate ~$2\cdot10^{-4}$ $M_\odot$ yr^{-1}), as imaged on scales of ~0.1-0.5 *pc* in the main CO isotopomers as well as in the SiO(5-4) line. In the innermost HMC regions (~1000 *AU*), the velocity field traced by the CH_3CN (12_K-11_K) line emission shows molecular gas both expanding along the outflow direction and rotating about the outflow axis. The velocity field associated with rotation, also traced by the high excitation-energy CH_3OH (15_4-16_3)E line, indicates a dynamical mass of 19 $M_\odot$ at the center of the core. The latter is likely to be concentrated in a single O9.5 ZAMS star, consistent with the bolometric luminosity derived from the SED of $4\cdot10^4$ $L_\odot$ (**Sanna et al. 2014, A&A, 565, 34**).

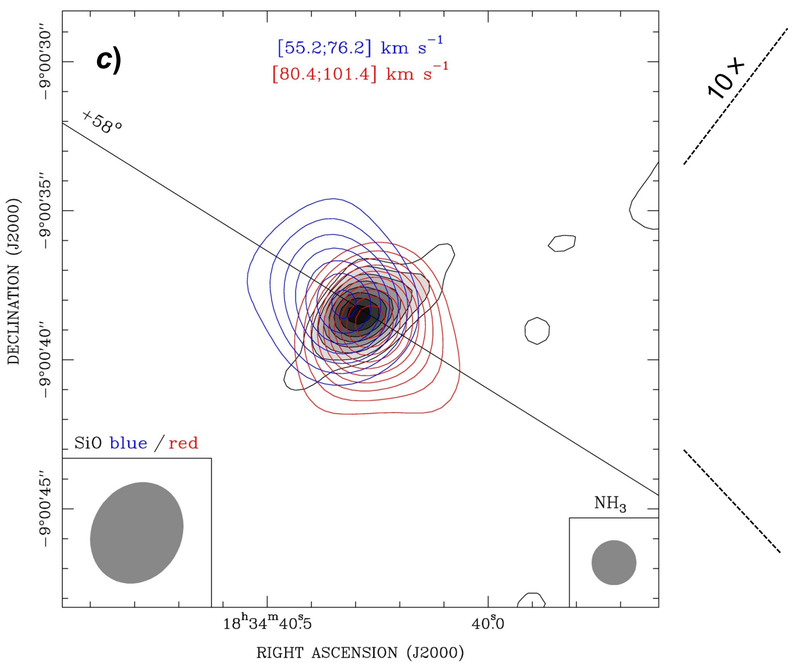
An Infrared view toward the HMC

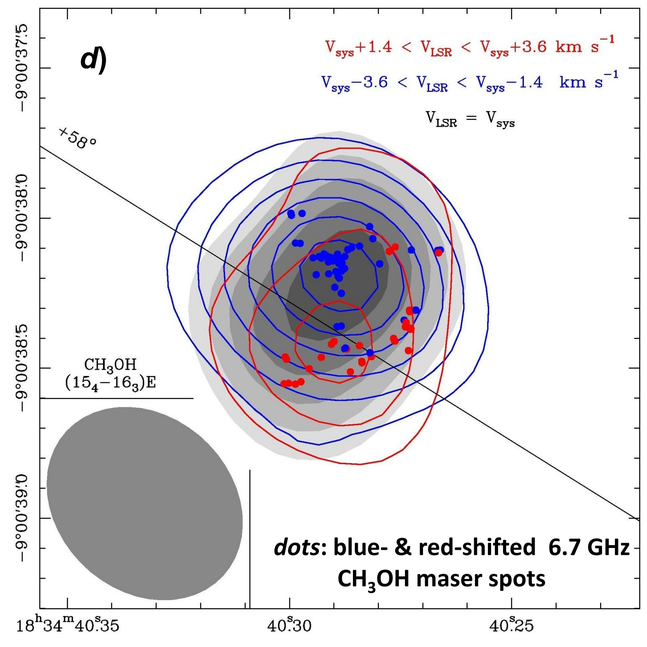




UPPER PANELS. Parsec-scale structure of the star forming region obtained with the PACS camera on board of the Hershel satellite at 160 *μm* and 70 *μm* (color log.-scale on top of each panel). The linear scale is drawn on the left side of panel a). The white dashed circle in panel b) marks the region inside which the SED associated with the HMC was measured (right). For each plot, the beam size of the Herschel images is shown on the bottom left corner. The SED of G23.01-0.41 was reconstructed with ancillary archival data as color-coded in the right panel, where dots and triangles indicate measurements and lower limits, respectively. The SED was fitted with the radiative transfer model developed by Robitaille et al. (2007, ApJS, 169, 328).

Analysis of the HMC velocity field





Integrated velocity maps

Panel c): SMA integrated maps of the SiO(5-4) line emission (blue & red) superposed to the VLA-C NH_3(3,3) map (grayscale) obtained by Codella et al. (1997, A&A, 325, 282). Integrated velocity ranges are reported on top of the panel. Contour levels start from 5σ by 3σ for the SiO map and from 3σ in steps of 1σ for the NH_3 map. **The NE-SW line in each panel shows the outflow direction as inferred from the ^{12}CO(2-1) and SiO(5-4) line emission.** Synthesized beams are shown on the bottom of each panel.

Panel d): Maps of the CH_3OH (15_4-16_3)E line emission, the strongest observed in the SMA VEX configuration. Grey, blue, and red contours are, respectively, maps of emission at the systemic velocity (V_{sys}), and in the blue- and red-shifted wings of the line (the velocity ranges are indicated in the upper right). Grey contours start at 3σ and increase in steps of 1σ, whereas the blue and red contours start at a 5σ level in steps of 2σ. Blue and red dots mark the positions of the blue- and red-shifted methanol maser spots at 6.7 *GHz* detected by Sanna et al. (2010, A&A, 517, A78).

P-V analysis

Panel e): p-v cut of the CH_3CN (12_3-11_3) line along the major axis of the elongated HMC (-32°); east offsets are measured along this cut. Contours start at 90% of the peak emission by 10% steps; colors are drawn according to the wedge on the right side. The dashed line represents the best linear fit to the emission.

Panel f): p-v distribution of the peaks of the CH_3CN emission (black dots with error bars) at different velocities (only the K=0 to 4 components have been used) along the major axis of the elongated HMC (-32°); east offsets are measured along this cut. The vertical dashed lines mark the limits of the FWHM of the CH_3CN (12_K-11_K) lines. The dotted pattern encompasses the region where emission is expected from a Keplerian disk rotating about a 19 $M_\odot$.