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Intermediate-mass star formation in young embedded stellar clusters

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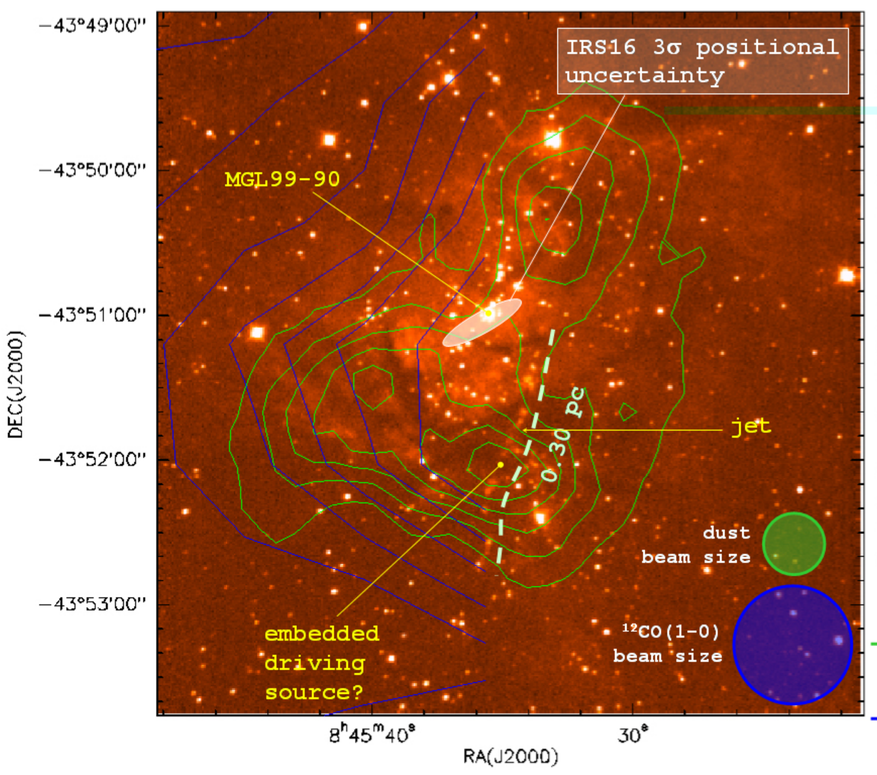
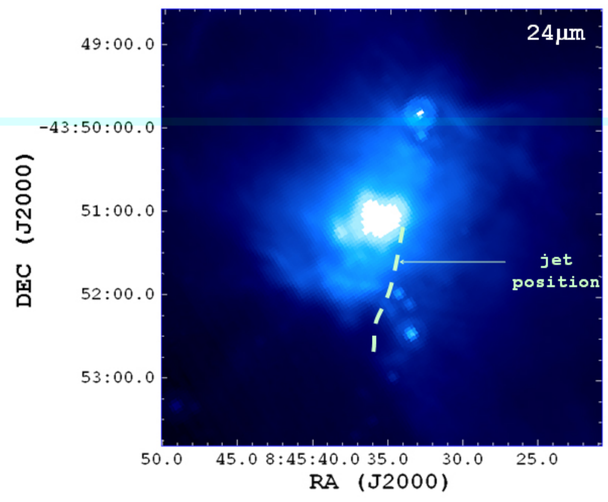
Vela Molecular Ridge - Cloud D (VMR-D), located on the Galactic plane (700 pc distant) represents one of the most active star forming regions in the southern sky. In the framework of a multi-wavelength observational study of this cloud, we have identified a number of star forming sites hosting small (~100 members), embedded and compact (radius ~0.1-0.2 pc) young stellar clusters[1]. Observations have been collected from NIR to mm wavelengths that are clarifying the star formation histories within these sites. We present here observations of three young clusters associated with intermediate luminosity IRAS sources (L_{bol}~10^3 $L_\odot$). These clusters are found within both clumps of molecular (^{12}CO(1-0)) emission[2] [SEST-ESO] and dust cores[3] (1.2 mm continuum, [SIMBA @SEST-ESO]). H_2 jets (2.12μm, [SofI @NTT-ESO]) testify the ongoing star formation activity in the cluster neighborhood[4].



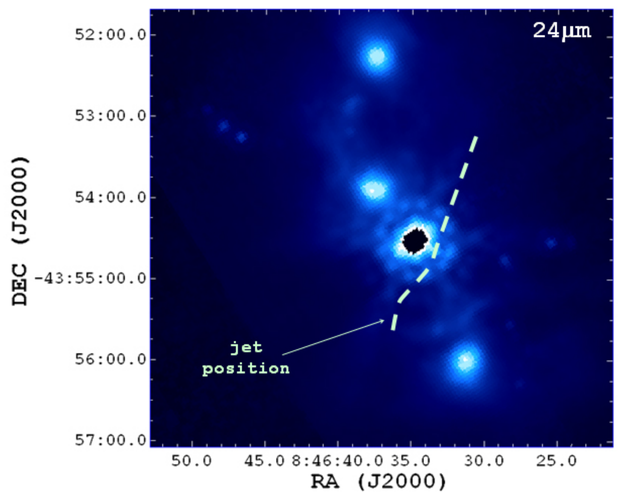
IRS16

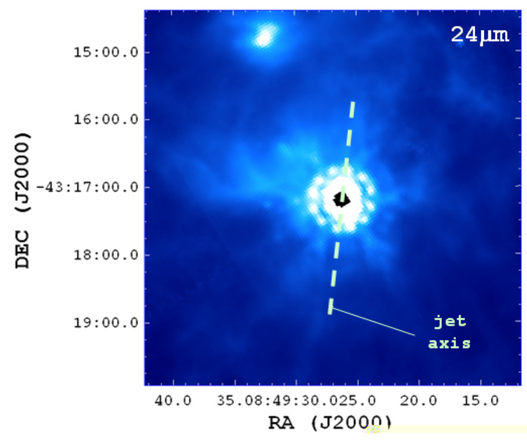
H_2 image of the region surrounding the IRAS source 08438-4340 (IRS16)[5], coincident with diffuse mid infrared emission (10μm, [Timmi2 @3.6m-ESO]) and with an HII region, likely due to warm circumstellar matter associated with the most massive cluster member (MGL99-90)[6]. Three dust cores and a collimated jet are located at the borders of this region.

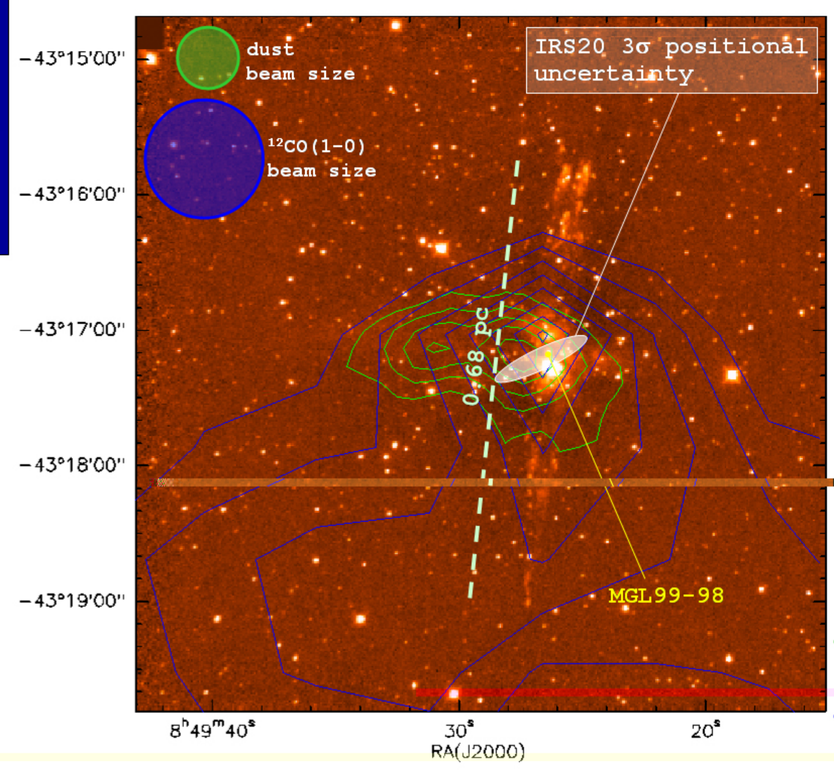
Dust contours: 100 to 600 mJy/beam, step of 100 mJy/beam
^{12}CO(1-0) contours: 10 to 60 K km/s, step of 10 K km/s



H_2 images are corredated with the recent Spitzer-MIPS observations at 24μm[7] that reveal intense mid infrared emission towards the cluster centers.
While in the cases of IRS17 and IRS20 the emission is dominated by a point-like object (their PSF is well recognizable), the HII region of IRS16 produces a more diffuse emission.



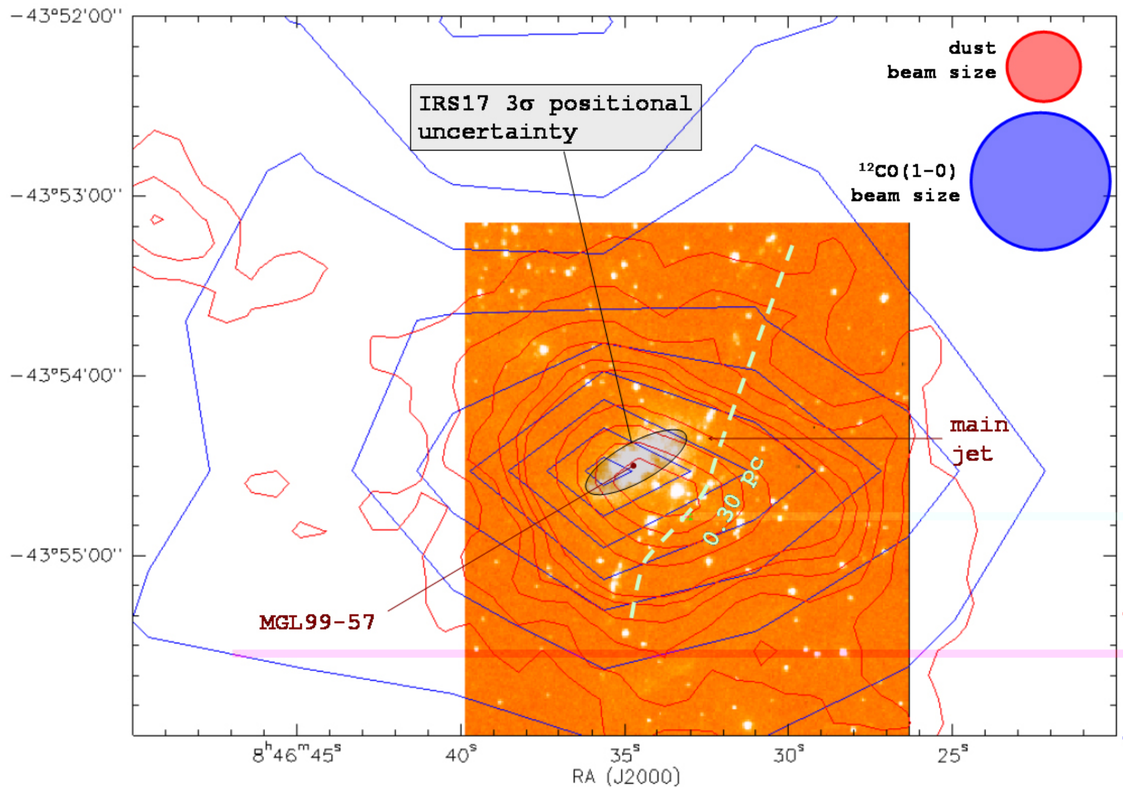




IRS20

H_2 image of the region surrounding the IRAS source 08476-4306 (IRS20)[5]. The most massive object (MGL99-98)[6] is accompanied by extended nebulosity crossed by an obscuring dust lane. It is located approximately in the center of a young cluster and its colours are typical of Class I objects. It represents also the best candidate driving source of the powerful bipolar jet.

Dust contours: 100 to 500 mJy/beam, step of 100 mJy/beam
^{12}CO(1-0) contours: 40 to 110 K km/s, step of 10 K km/s



IRS17

H_2 image of the region surrounding the IRAS source 08448-4343 (IRS17)[5]. Multiple, well collimated jets originate in a compact region at the cluster center. The dust peak, slightly shifted with respect to the IRAS source, can be associated with the driving source of the main jet in the field.

Dust contours: 50, 100, 200, 300 mJy/beam & 300 to 1500 mJy/beam, step of 300 mJy/beam
^{12}CO(1-0) contours: 10 to 60 K km/s, step of 10 K km/s

The association of the presented young clusters with molecular clumps detected in the ^{12}CO(1-0) line suggests they are younger than 1 Myr. By means of Spectral Energy Distributions and Colour-Colour diagrams we located the most massive cluster members. These are intermediate-mass stars (5-7 $M_\odot$) in an early evolutionary stage (likely precursors of Herbig Ae stars), less evolved with respect to the great majority of other cluster members. They are always located in the cluster center.
However, low-mass star formation is still ongoing, as testified by the occurrence of mm dust cores crossed by collimated jets (IRS16, IRS17).
Detailed analysis of both Spitzer MIPS and IRAC observations of these fields is now in progress.

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[3] Massi, F., De Luca, M., Elia, D., et al. 2007, A&A, 466, 1013
[4] De Luca, M., Giannini, T., Lorenzetti, D., et al. 2007, A&A in press
[5] Source identification according to the list of IRAS sources reported in Liseau, R., Lorenzetti, D., Nisini, B. et al. 1992, A&A 265, 577
[6] Source identification according to the list of VMR-D NIR sources reported in Massi, F., Giannini, T., Lorenzetti, D. et al. 1999, A&A 136, 471
[7] Giannini, T., Lorenzetti, D., De Luca, M., et al. 2007, ApJ in press