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CORE: linking sites of high-mass star formation with their surroundings

J. C. Mottram, H. Beuther, A. Ahmadi, F. Bosco , and the CORE Team

Max Planck Institute for Astronomy, Königstuhl 17, 69117, Heidelberg, Germany
e-mail: mottram@mpia.de

Abstract.
We present initial results from an ongoing case-study of the W3 IRS4 high-mass star forming region as part of the CORE large program with NOEMA and the IRAM 30m, with particular attention to the structure and dynamics of the gas between and around the protostars on scales of a few 1000 AU. Such studies are able to reveal whether the environment is likely to influence the formation and evolution of stars on disk (~1000 AU) scales.

1. Introduction

Star forming regions are often complex, particularly those forming high-mass stars ($M \geq 8 M_{\odot}$). New large-scale and high-resolution data are revealing this complexity in ever greater detail. However, the question remains as to how much the evolution and outcome of an individual site of star formation is affected by its neighbours and surroundings. The two main theories of how high-mass stars form have taken opposing views on the importance of cloud-scale processes to the formation and evolution of protostars. The turbulent core scenario (e.g. McKee & Tan, 2003) assumes that the star formation takes place in a massive core with no further contribution from cloud-scale processes, while the competitive accretion scenario (e.g. Bonnell et al., 1997, 2001) assumes that the cloud-scale gravitational potential has a defining role in the accumulation of mass, with both gas and stars being dynamically active during the star formation process.

Understanding the link between sites of high-mass star formation and the surroundings within which they are forming is one of the principle aims of the CORE large program, which is studying 20 nearby high-mass star forming regions using with the IRAM Northern Extended Millimeter Array (NOEMA) and 30m telescope. More details can be found in the contributions by Beuther et al. and Ahmadi et al. in this proceeding, on the CORE website[1], and will be provided in upcoming papers.

2. W3 IRS4

As an example of the promise of the CORE program, we present in Fig. 1 an overview of the target W3 IRS4, which lies in the W3 star forming region (see Megeath et al., 2008, for an overview) at a distance of 2 kpc (Hachisuka et al., 2006).

From the continuum image alone, one might conclude that the cold density enhancements near the hot core will soon form a number of surrounding lower-mass stars. However,

[1] http://www.mpia.de/core

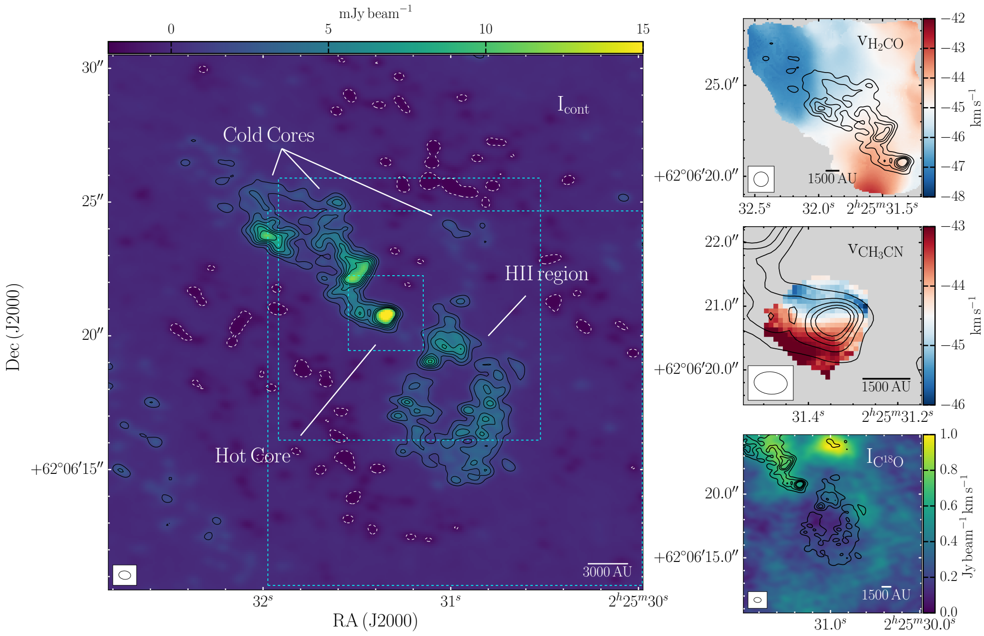

Fig. 1. Left: NOEMA 1.36 mm continuum emission for W3 IRS4 with black solid and white dashed contours indicating 5σ steps. White labels are used to indicate the key features of the region. The ring in the lower-right is associated with free-free emission from an UCH II region. The cyan dashed squares indicate the regions in the three right-hand panels. Top-right: Intensity-weighted velocity from XCLASS fitting to combined NOEMA and 30m data of H_2CO $3_{03}-2_{02}$ and $3_{22}-2_{21}$, showing a velocity gradient in the cold material. Middle-right: Intensity-weighted velocity of combined NOEMA and 30m data of CH_3CN 12_4-11_4, showing rotation in the hot core. Lower-right: Integrated intensity of combined NOEMA and 30m data of $C^{18}O$ 2−1, showing a molecular ring surrounding the UCH II region.

the large velocity gradient observed in H_2CO towards the rotating structure seen in CH_3CN around the hot core suggests that they may not survive long enough to form stars. Indeed, the combination of the velocity gradient seen in H_2CO and the ring of gas surrounding the more evolved UCH II region suggest that the location of the central hot core is due to the interaction of the flow with the expanding H II region.

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