Interactions between the massive YSOs and starless cores in IRAS22134+5834

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Abstract

The initial conditions of clustered star formation are still under debate. The protocluster associated with IRAS 22134+5834 represents an excellent laboratory to study the influence of massive YSOs on nearby starless dense cores. Our VLA, SMA, CARMA and PdBI molecular line and millimeter continuum observations revealed the physical and chemical properties of the massive YSOs and the starless cores. Two N_2D^+ cores are detected next to the ultracompact (UC) HII region, but no N_2H^+ emission is detected towards these cores. These are the closest N_2D^+ cores to an UCHII region detected so far (~8000 AU). However, our observations show these N_2D^+ cores are associated with an ammonia filament, and this proximity of the deuterated cores to the UCHII region could just be a projection effect. Molecular line observations show that the UCHII region is expanding and interacting with the ambient gas.

Continuum and outflows

Situated at a distance of 2.6 kpc (Sridharan et al. 2002), IRAS 22134+5834 is an UCHII region with a luminosity of $1.2\times10^4 L_\odot$. This source is also known to drive a massive molecular outflow detected with single-dish telescopes in CO (Dobashi & Uehara 2001, Beuther et al. 2002) and HCO^+ (López-Sepulcre et al. 2010).

Our SMA and PdBI observations resolved several millimetre continuum sources associated with multiple blue- and red-shifted outflow components (Wang et al. in prep, Fig. 1).

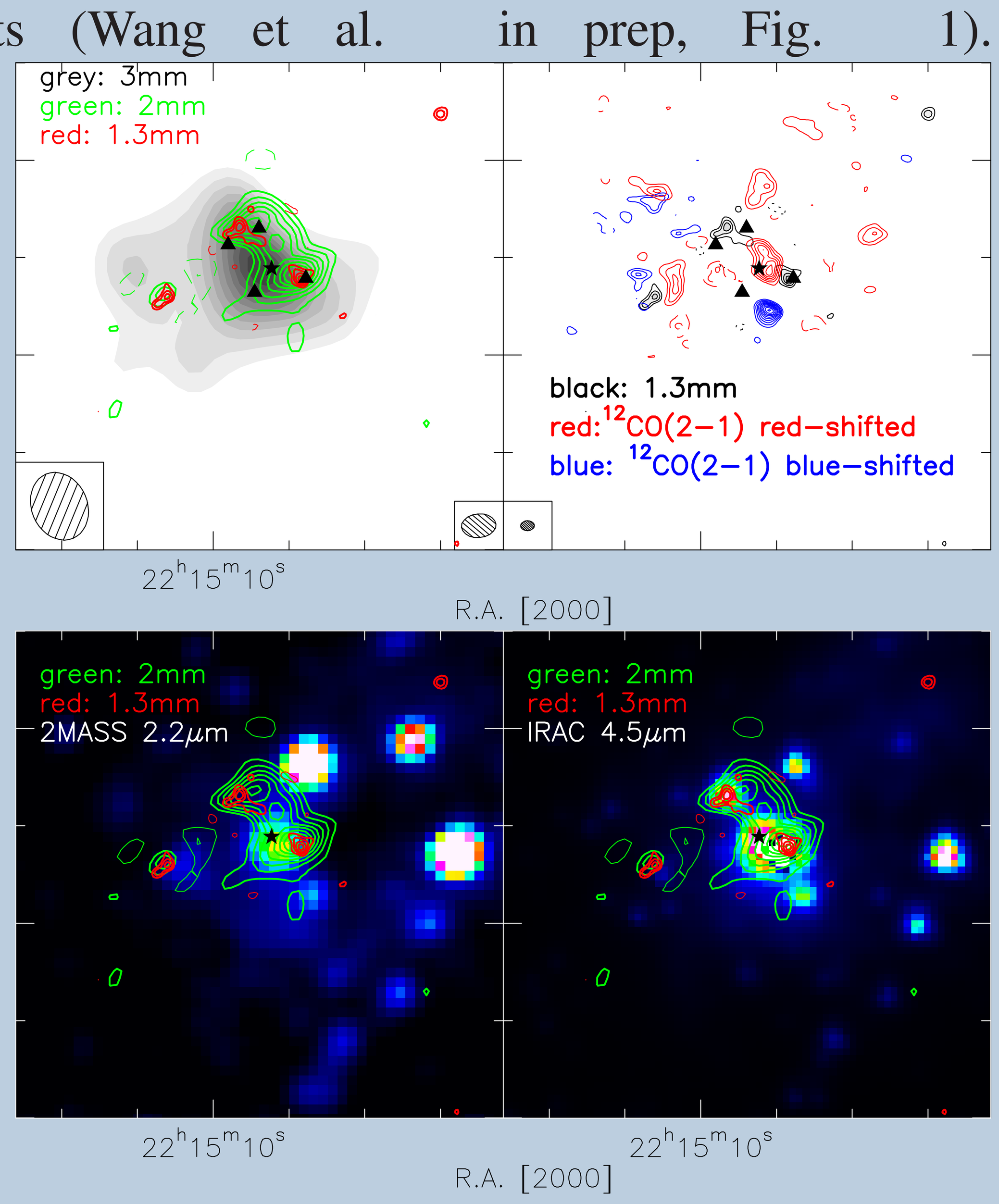

Fig.1. The SMA 1.3 mm (red), PdBI 2 mm (green) continuum contours overlaid with CARMA 3 mm continuum map (grey), 2MASS 2.2 μm and IRAC 4.5 μm, and SMA CO(2–1) outflow map. The triangles mark the 1.3 mm continuum sources resolved by Palau et al. (2013). The star marks the position of the UCHII region.

Molecular line emissions

Figure 2 shows the UCHII region is surrounded by several gaseous condensations detected in NH_3 and N_2H^+, and the average column density of the N_2H^+ emission structure is 1.3×10^{13} cm^{-2}. Assuming a typical abundance of 10^{-11} of N_2H^+, the average H_2 column density of the N_2H^+ clumps is ~ 4 g cm^{-2}, above the proposed threshold for high-mass star formation of 1 g cm^{-2} (Krumholz & McKee 2008). Furthermore, none of these condensations show embedded IR sources and/or other signs of star formation activity, thus we name these two main N_2H^+ clumps as high-mass starless clump east (HMSC-E) and west (HMCS-W).

Two N_2D^+ cores are detected next to the UCHII region, and are associated with an NH_3 filamentary structure. Still these are the closest N_2D^+ cores to an UCHII region detected so far (~8, 000 AU).

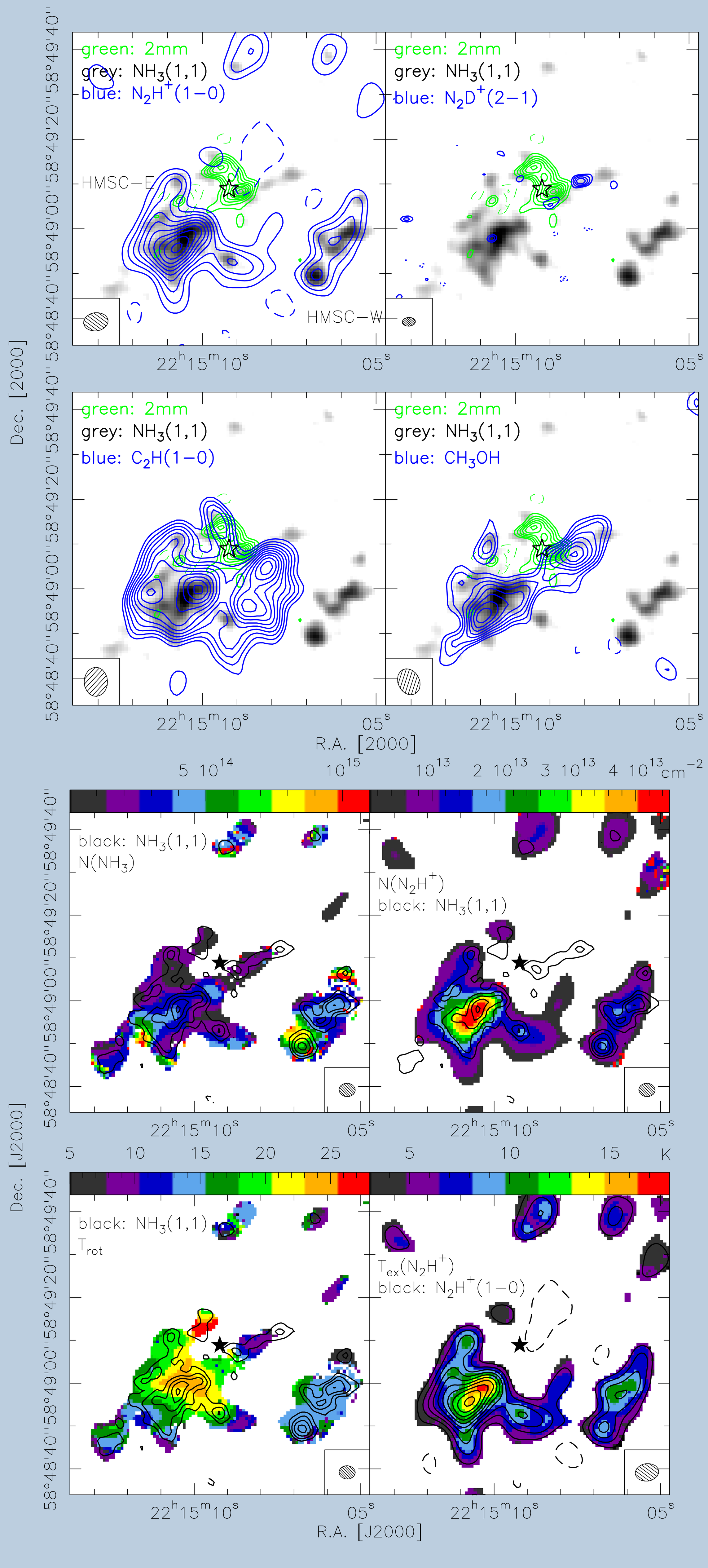

Fig.2. Molecular line integrated intensity maps overlaid with 2 mm continuum map. Column density maps of NH_3 and N_2H^+, T_{rot} from NH_3 observation and T_{ex} of N_2H^+.

Kinetic properties

The C_2H velocity map (Fig. 3) shows a clear velocity gradient along the line pv-1. The position-velocity (PV) diagram along the line pv-2 shows an expanding velocity structure, **which may indicate the UCHII region itself is expanding and pushing the ambient material away.**

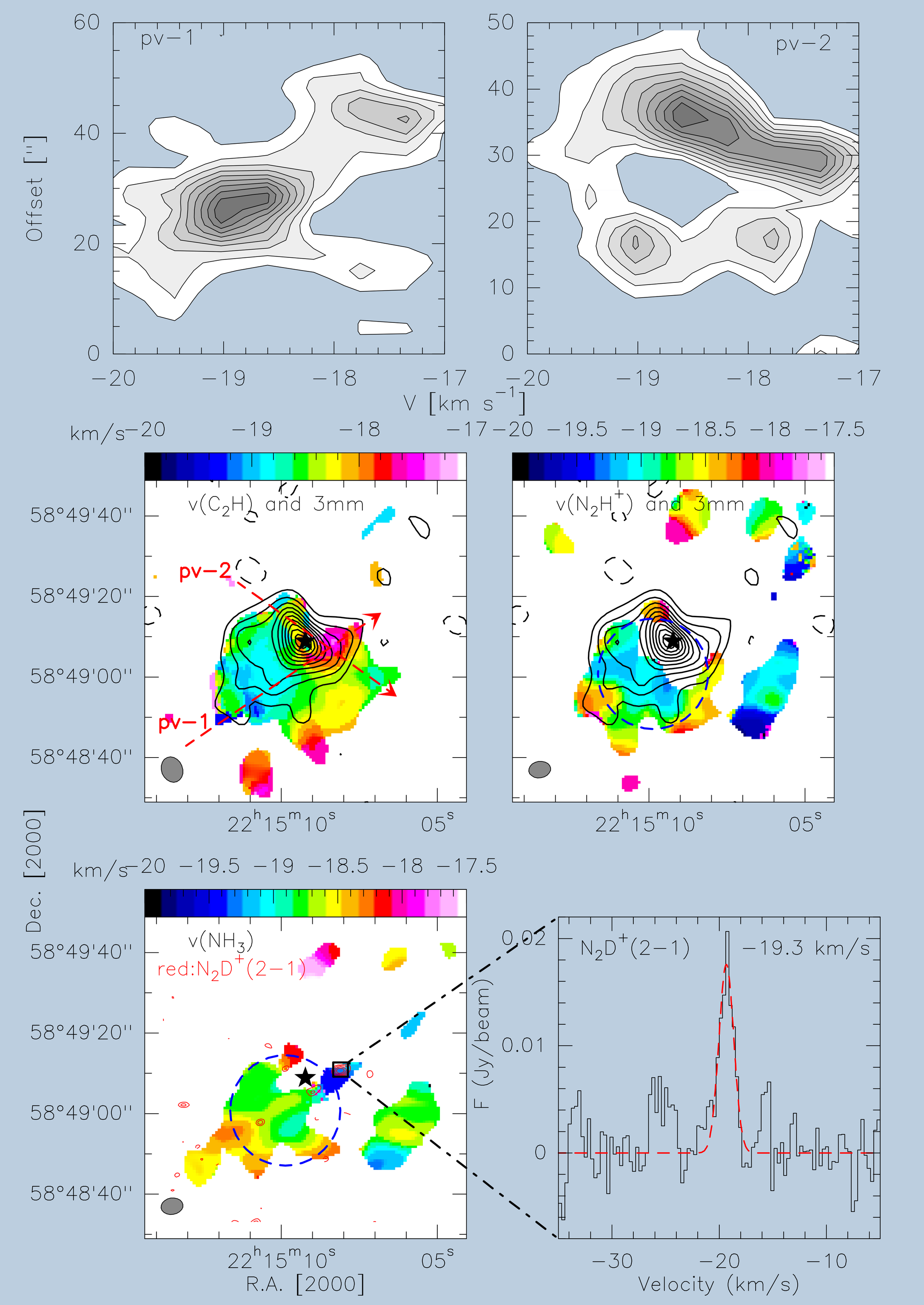

Fig.3. Velocity maps and PV diagrams, $N_2D^+(2-1)$ spectrum.

The velocity maps of NH_3 and N_2H^+ indicate that the expanding UCHII region is interacting with the HMSCs. The N_2D^+ core is associated with the NH_3 filamentary structure, which shows different velocity from the main NH_3 starless clump. **This N_2D^+ core is associated with the UCHII region, but it is in front of the main NH_3 emission structure. The proximity of the deuterated cores to the UCHII region could just be a projection effect.**

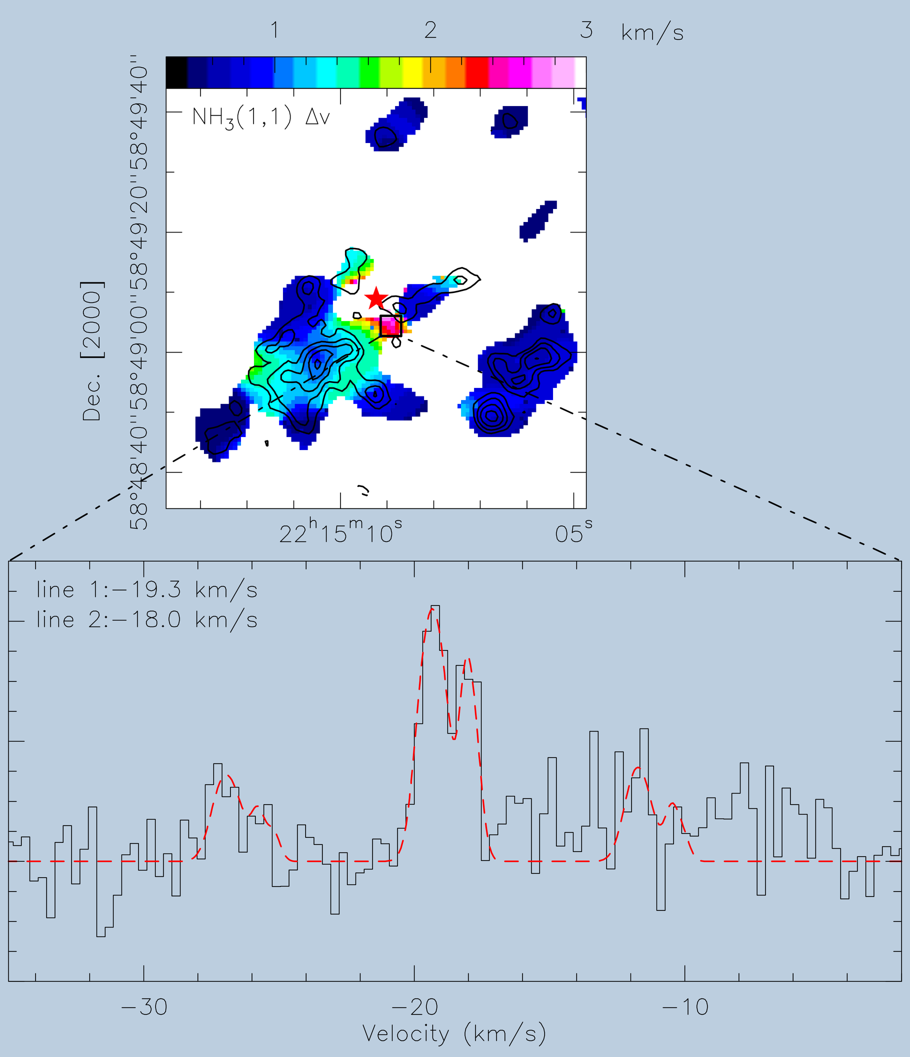

Fig.4. The $NH_3(1,1)$ line-width map overlaid with the $NH_3(1,1)$ integrated intensity map. The average and fitted $NH_3(1,1)$ spectrum.

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