Chemical Complexity of AFGL 2591

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Molecular Content

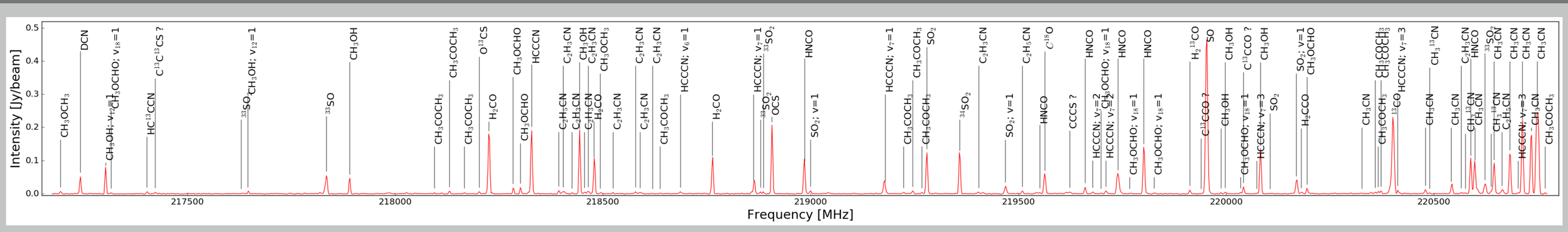

Figure 1: AFGL 2591 spectrum with all identified lines. Candidates are marked with a '?'.

Conclusions and Outlook

The aim of the CORE project is to study high-mass star formation and investigate disk formation and core fragmentation of in total 20 sources. In this study we focus on the physical and chemical structure of the hot core AFGL 2591 VLA 3 which shows many emission lines from simple and complex molecules.
We derived the temperature and density profile using CH_3CN, H_2CO and the dust continuum at a high spatial resolution (0.4", 1300 AU at 3.33 kpc) obtained by the NOEMA interferometer and the IRAM 30 m telescope. As seen in Figure 1 AFGL 2591 has a high molecular abundance (e.g. SO_2, HNCO, CH_3OH) and shows a rich diversity in complex molecules (C_2H_5CN, C_2H_3CN, CH_3OCHO, CH_3COCH_3, CH_3OCH_3). Some molecules show an asymmetric distribution around the protostar which indicates a complex structure on small scales due to disk accretion, shocks, and the outflow (see Figure 4).
As hot cores show a rich chemistry we want to further investigate the chemical abundance of AFGL 2591 with gas grain chemical models. The aim is to understand the formation processes of the molecules and to determine the chemical age of the source.

Physical Structure

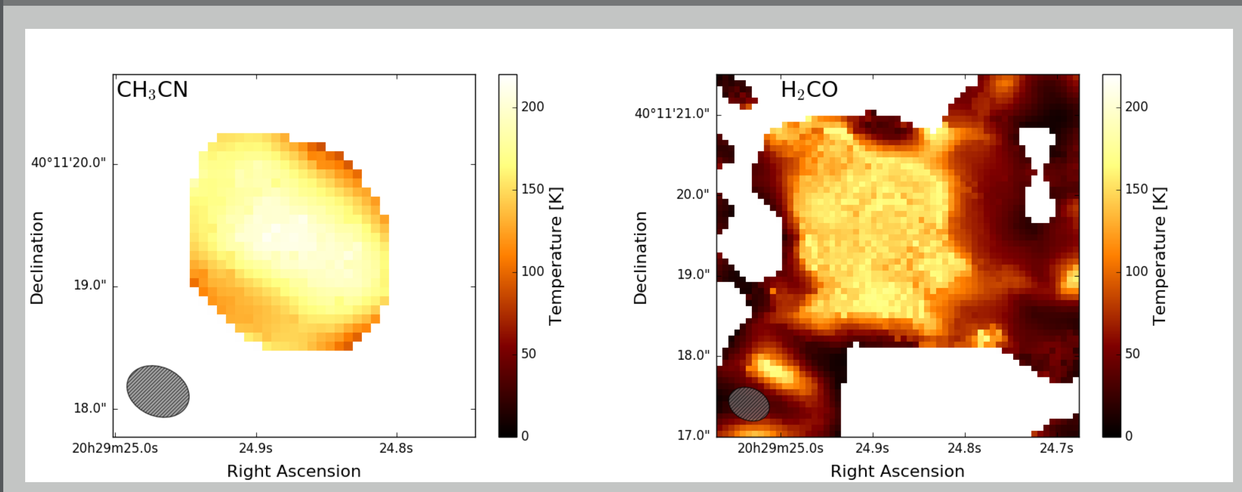

Figure 2: Temperature Maps of the high density tracer Methyl Cyanide and the low density tracer Formaldehyde derived with the XCLASS Software (xclass.astro.uni-koeln.de).

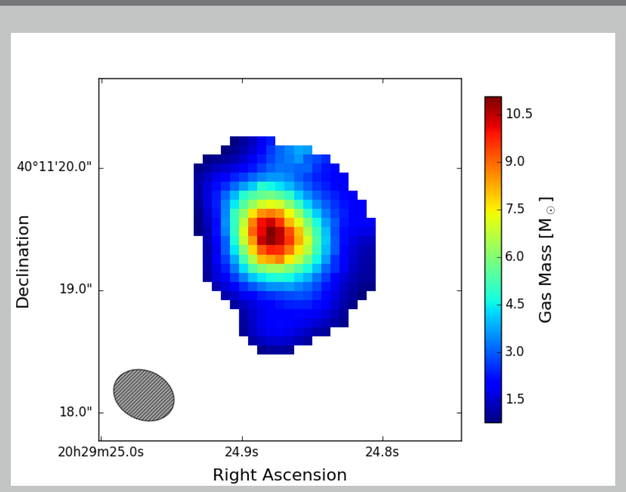

Figure 3: Gas Mass calculated from the continuum dust emission.

From the temperature maps we obtain $T \sim r^{-0.5 \pm 0.2}$ (Figure 2).
Using the 1.37 mm continuum data we derive the H column density and gas mass of the region and from the visibility analysis we infer $n \sim r^{-1.5 \pm 0.2}$ (Figure 3).

Chemical Segregation

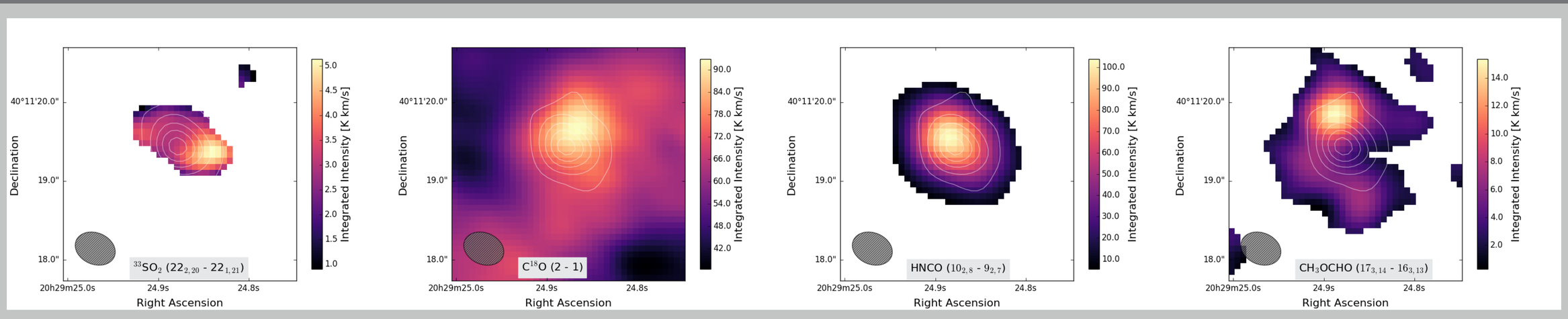

Figure 4: Integrated Intensity Maps with contours from the 1.37 mm continuum emission (levels at 0.01, 0.02, 0.03, 0.04 and 0.05 Jy/beam). $^{33}SO_2$ shows a double peaked distribution tracing the envelope, outflow interface or outflow shocks, while $C^{18}O$ traces the envelope and the outflow. HNCO has a spherical distribution around the continuum peak and complex organic molecules avoid the center with a ring-like structure similarly observed before by Jiménez-Serra et al. (2012).

The molecular distribution is shown in Figure 4. Species that peak at the dust emission peak include C_2H_3CN, C_2H_5CN, CH_3CN, HC_3N, HNCO and OCS. Molecules that are distributed off the emission peak are SO_2, SO, H_2CO, CO, DCN, CH_3COCH_3, CH_3OCHO and CH_3OH.

1d Model

We use the 1d MUSCLE code that includes several evolutionary stages of high-mass star formation (IRDC, HMYO, HMC, ucHII) and finds the best fit physical structure and the time dependent ALCHEMIC gas grain chemical model (both are described in Semenov et al. 2010) to reproduce the observed molecular abundances adopting the observed physical structure similar to Kaźmierczak-Barthel et al. (2015).

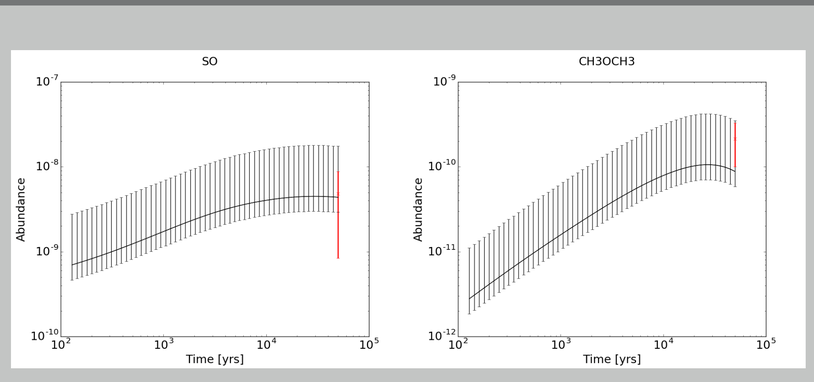

Figure 5: (Preliminary) modeled abundances (black) compared with the observed abundances (red).

References

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