Studying the early phases of high-mass star formation

M. Valeille-Manet 1, S. Bontemps 1, T. Csengeri 1, N. Brouillet 1, F. Motte 2, A. Ginsburg 3, N. Cunningham 4 and the ALMA-IMF consortium

1 Laboratoire d’Astrophysique de Bordeaux, Univ. Bordeaux, CNRS, 33615 Pessac, France
2 Univ. Grenoble-Alpes, CNRS, IPAG, 38000 Grenoble, France
3 Department of Astronomy, University of Florida, PO Box 112055, USA

As part of the large program ALMA-IMF, we constrain the scenario of high–mass star formation by searching for massive pre-stellar core (MPSC) candidates in the population of cores extracted from 15 massive protoclusters.

ALMA-IMF Dataset
- 15 massive protoclusters
- \( D \leq 5.5 \) kpc
- Same spatial resolution of 2000 AU
- 700 dust cores
- 15 to 20% massive cores
- Young to evolved regions
- 12 PPV cubes per field
- A lot of molecular content available

Aims
- Use the large ALMA-IMF dataset in order to constrain the scenario of high-mass star formation
- Discriminate proto-stellar from pre-stellar cores
- Search for massive pre-stellar core candidates \((M > 8 M_\odot)\) and study their properties

Need to build an automated outflow detection method

On-Off automatic method
- A simple idea: excess on source compared to background in an annulus (Bontemps et al, 1996)
- CO(2-1) and SiO(5-4) lines used to trace outflows

On-Off RMS estimation
- 1 channel
- Full cube
- We estimate the RMS by taking into account the detection method
- 150 On-Off random selections in the field
- Compute one RMS for every channel
- Significant emission can now be detected

Accurate Noise estimation is essential in an automated detection method!

Sources detection
- Proto-stellar core
- Pre-stellar core
- Automatic detection of CO outflow in the ON-OFF spectrum
- Clear CO line wings in the spectrum
- CO and SiO contours show bipolar outflow pointing on source
- No automatic detection
- Spectra don’t show any outflow emission
- No contour pointing on source

Preliminary results and perspectives
- Around 20 MPSC candidates are found in the dataset so far.
- Most massive candidates tend to form in the denser regions where analysis is a lot more difficult due to crowding of cores.
- It is crucial to use both detection on spectra and contours to improve determination of the status of cores.
- After the validation of MPSC candidates, a chemical study will be needed in order to complete the work on their evolution status

TO BE CONTINUED ...