Core-collapse supernovae exploding in turbulent molecular clouds

Martín Solar†, Michał Michałowski & Jakub Nadolny
Adam Mickiewicz University in Poznań, Poland
†martin.solar@amu.edu.pl

Molecular gas as stellar nurseries

Stars are form after the gravitational collapse of a molecular cloud. However, it is not clear which are the molecular gas conditions and their connection with the diversity of massive stars (> 8 $M_\odot$) exploding as core-collapse supernovae (CCSNe). In this work, we plan to constrain the molecular gas turbulence at the moment of the explosion for CCSNe in order to constrain their progenitors.

Data sample

We made use of ALMA carbon monoxide (2-1) [hereafter CO(2-1)] emission line observations, as a proxy the molecular hydrogen (Bolatto et al. 2013). In order to reach the resolutions of giant molecular clouds (GMCs) a spatial resolution comparable to ~100 pc is needed (Leroy et al. 2016). Our final sample consists of 20 Type II and 15 SESNe.

References

[1] Bolatto A. D. et al., 2013, ARA&A, 51, 207.
[2] Leroy A. K., et al., 2016, ApJ, 831, 16.
[3] Sana H., et al., 2012, Sci, 337, 444.

CO(2-1) velocity dispersion as tracer of molecular hydrogen gas turbulence

The proxy for the molecular gas turbulence used is the CO(2-1) dispersion (moment 2), as $\sigma_{CO(2\text{-}1)}$ (in units of km/s). In Fig. 1 it is shown the empirical cumulative distribution function (eCDF) for our sample of CCSNe, plus the values from their galaxy host pixels (named as PHANGS). It is possible to appreciate that, on average, the distributions of CCSNe are located in higher molecular gas environments than their galaxy hosts. This is also confirmed in the Kolmogorov-Smirnov (KS) statistical test, comparing their distributions.

These CCSNe are not responsible to inject turbulence in the GMCs, as there are some external mechanisms that drives this effect. It is in agreement that binarity fraction increase in highly turbulent regions, as more massive stars. Also, the external mechanisms that affect the molecular gas could be a boost region for CCSN progenitors.

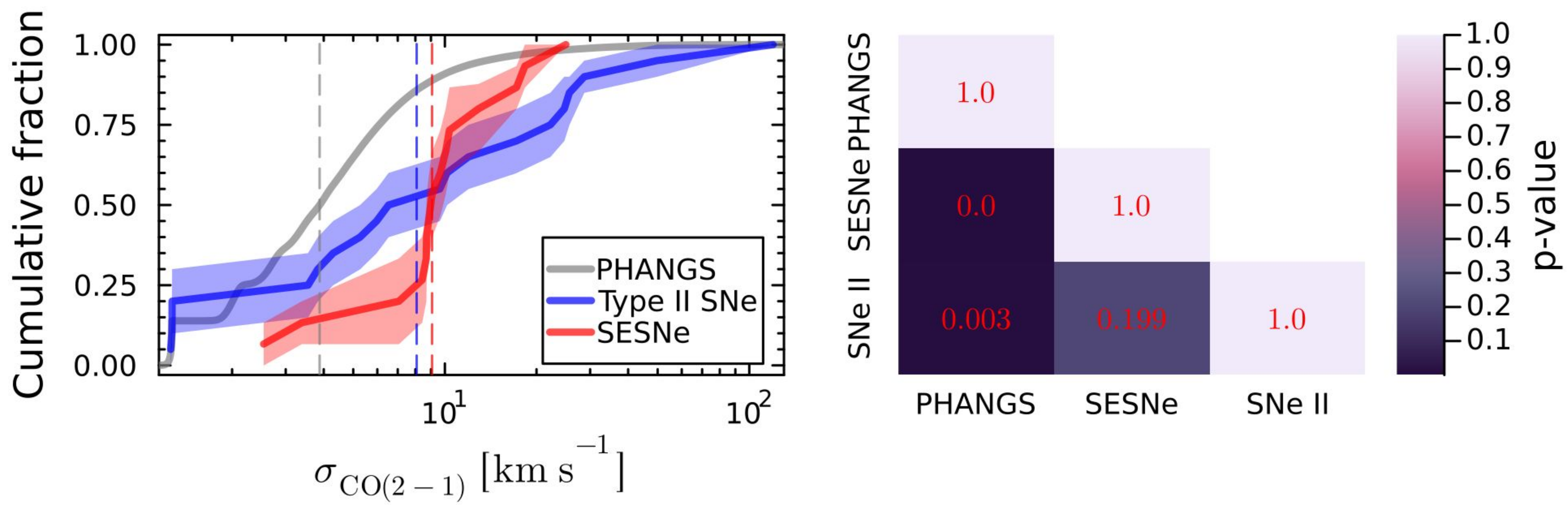

Fig. 1: eCDF of the CO(2-1) velocity dispersion (left panel) for our sample of Type II, SESNe and PHANGS galaxy pixels as blue, red, and gray 1σ regions, respectively. The dashed vertical lines represent the medians of the distributions. Their p-values from the KS are also shown.

Preliminary results

- As CCSNe are expected to form and evolve in binary systems (Sana et al. 2012), the highly turbulent molecular gas observed could be due to a cloud fragmentation, cradle for multiple stars
- Previous generation of CCSNe may be responsible to drive the local turbulence, enhancing regions of massive star formation exploding as CCSNe.