TURBULENT LINE-WIDTHS OF RESOLVED MOLECULAR CLOUDS IN A GALACTIC POTENTIAL

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ABSTRACT

We present a statistical analysis of the turbulent line-widths of molecular clouds extracted from high-resolution regions from our "Cloud Factory" galactic scale ISM simulation suite. The clouds are at similar evolutionary states but **the turbulence is self-consistently generated by different physical processes**:

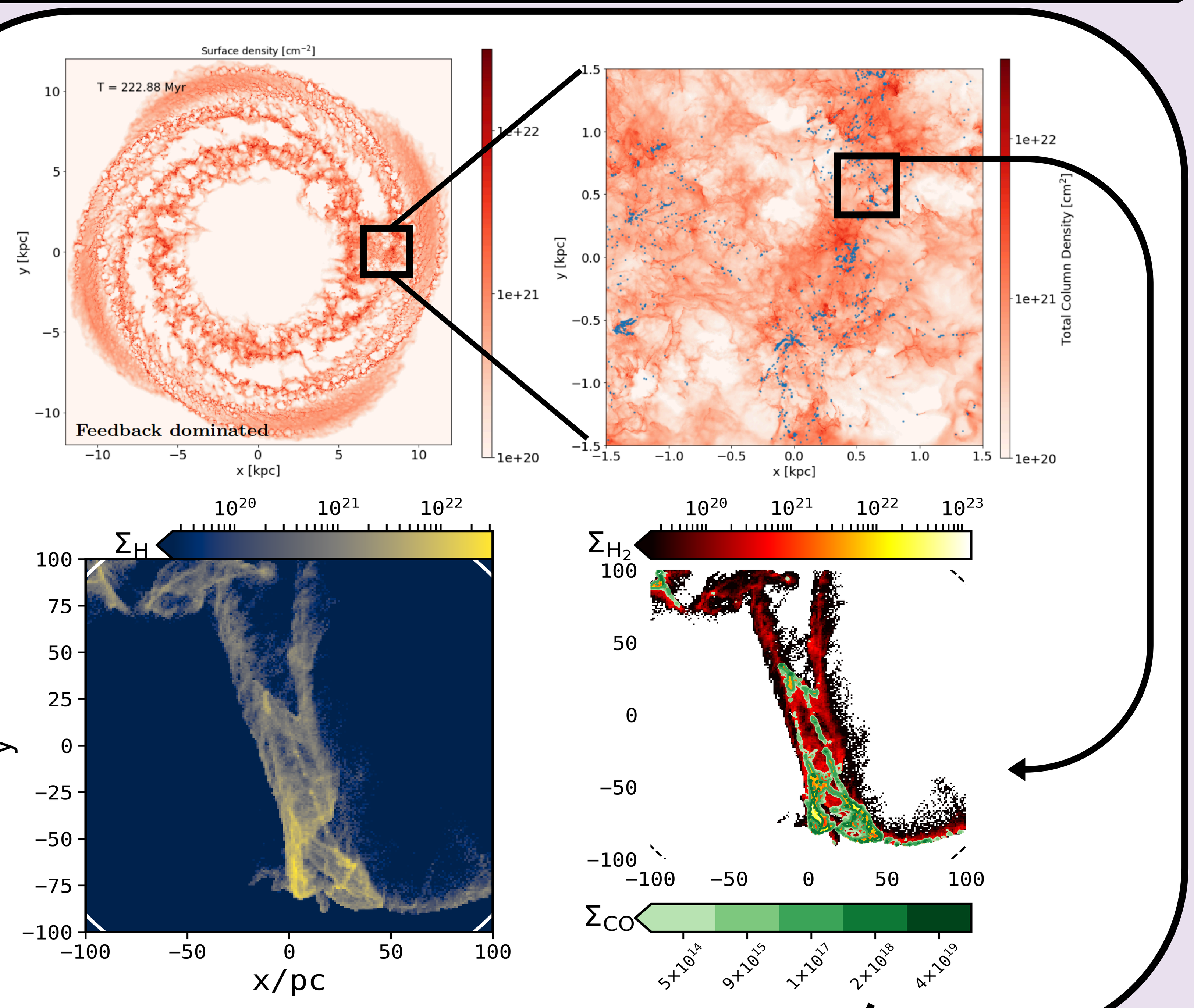
a. The ISM dynamics are dominated purely by the large-scale potential of the galactic disc, differential rotation, and random supernovae feedback.

b. The galactic potential and supernovae feedback are as above but gas self-gravity is turned on.

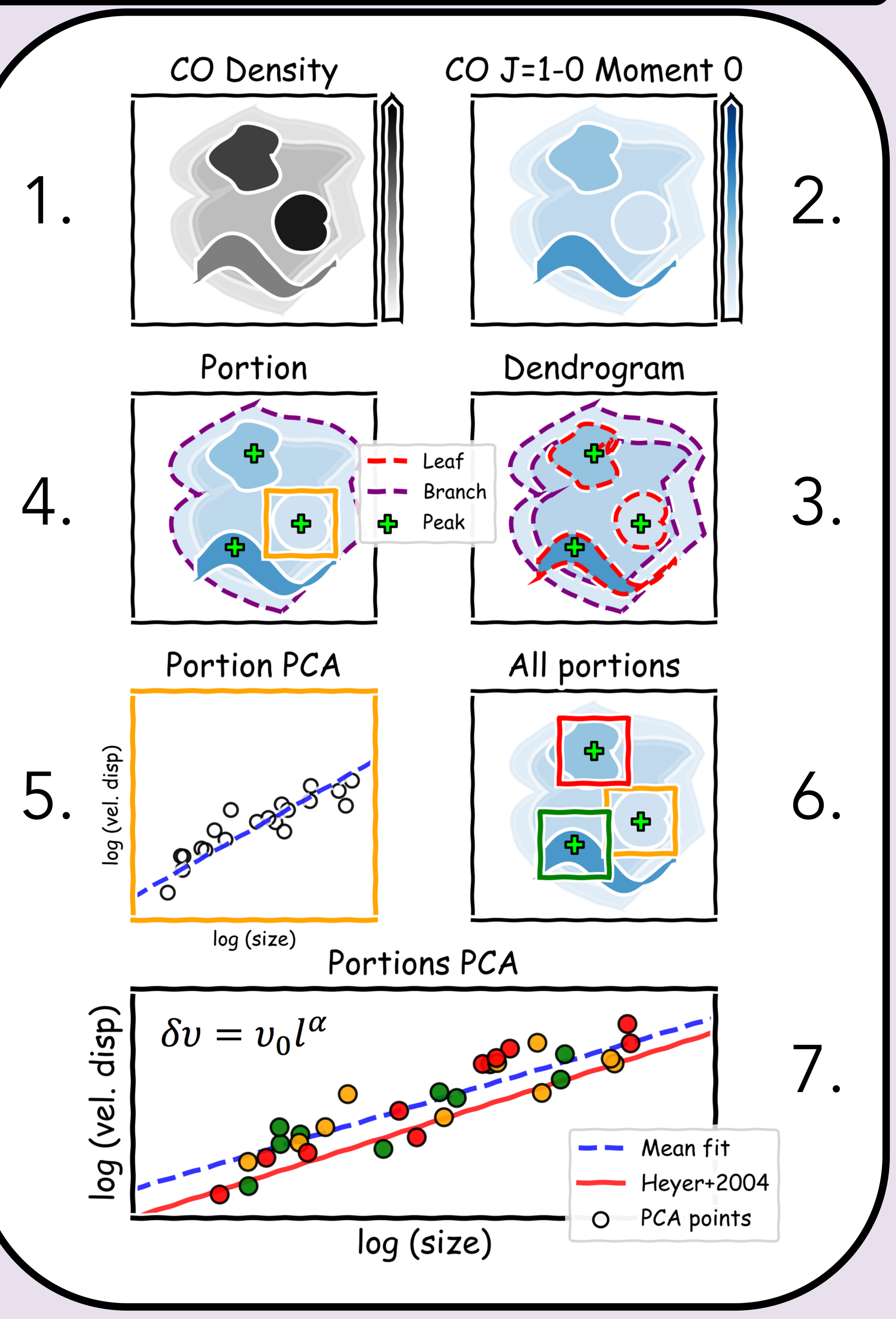
c. The galactic potential and the self-gravity are turned on but now the supernovae feedback is clustered and tied to sites of star formation.

To compare to observations, we perform radiative transfer simulations to predict the ^{12}CO J=1-0 line emission of the representative molecular clouds. Using the synthetic images we then apply the Principal Component Analysis (PCA) reduction technique and estimate a structure size--line width relation for each of the physical scenarios. The statistical analysis suggests that, even though purely gravitational effects are necessary to reproduce the standard observational laws, they are not sufficient. An extra injection of energy from Supernovae events seems to play a key role in establishing the global turbulent field and the local dynamics and morphology of molecular clouds in Milky Way-like galaxies. Once this is included, our Cloud Factory simulations generate molecular clouds matching observed scaling laws self-consistently, without the turbulence being put in by hand.

THE CLOUD FACTORY



METHODOLOGY



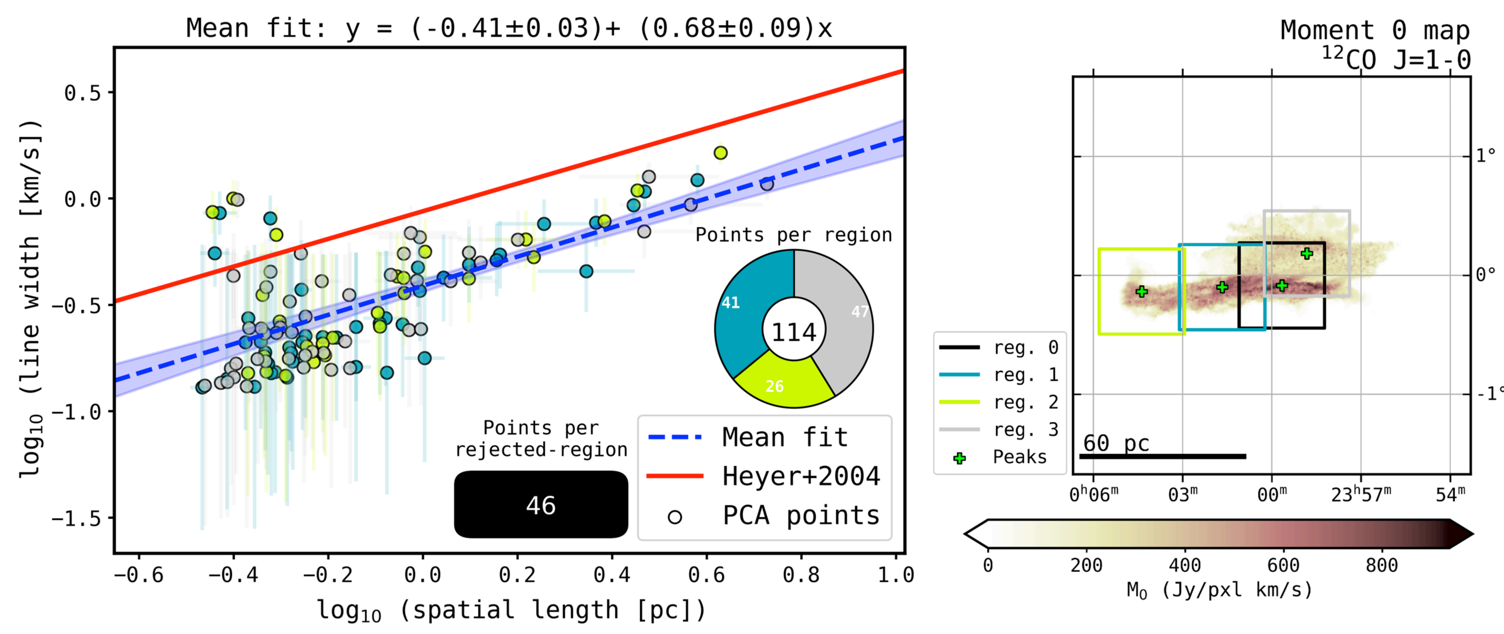
SOFTWARE

- Arepo (1)
- sf3dmodels (1⟶2)
- Lime or Polaris (2)
- astrodendro (3)
- astropy (4, 6)
- Turbustat (5, 7)

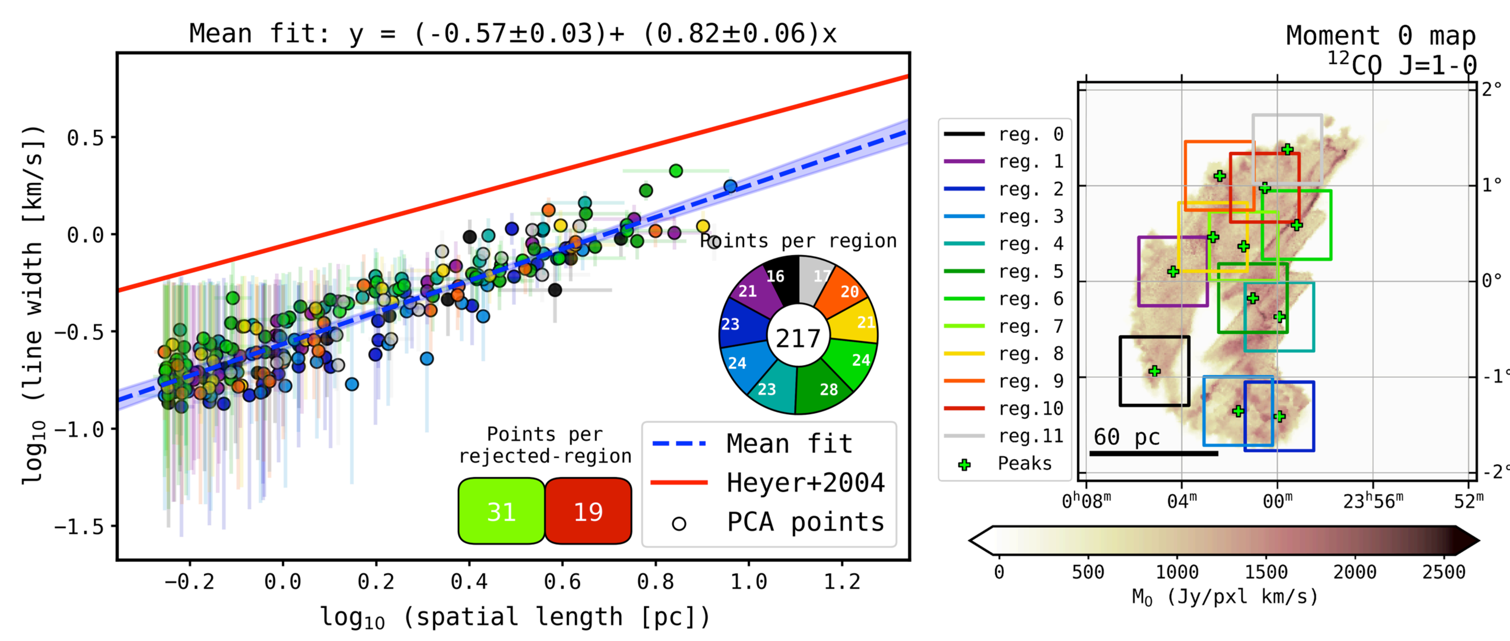
GitHub
andizq

PCA RESULTS FOR 1 SAMPLE

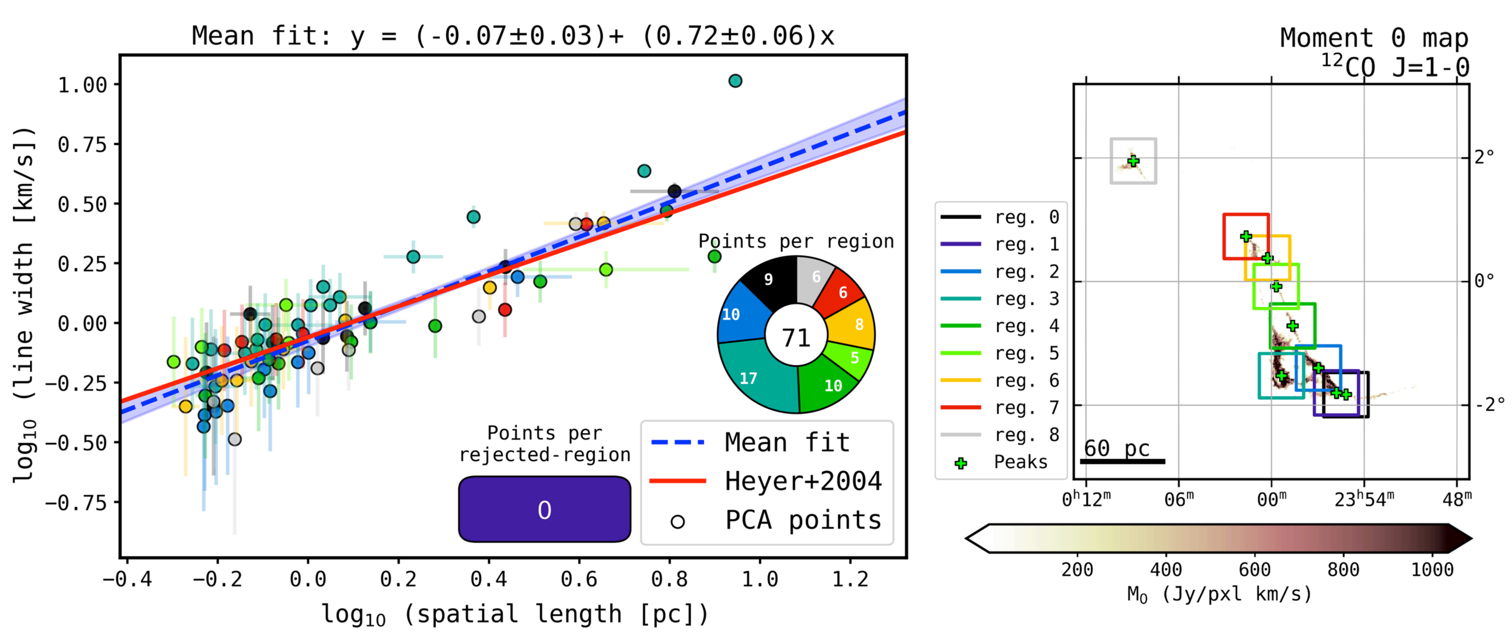
a. Potential dominated, random supernovae



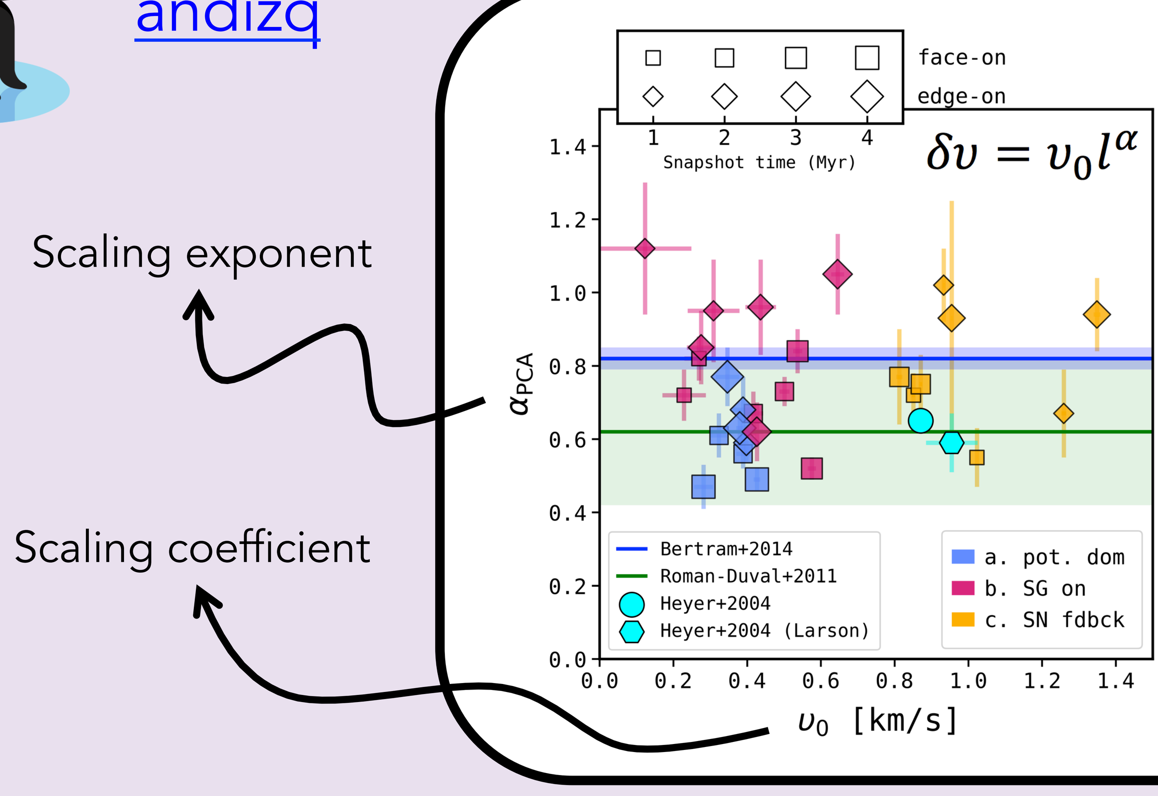
b. Potential, self-gravity, random supernovae



c. Potential, self-gravity, clustered supernovae



PCA SUMMARY & CONCLUSIONS



Regardless of the physical scenario, 25 out of the 28 clouds analysed from our Cloud Factory zooms agree with turbulent scaling exponents reported in the literature (approx. 0.4-0.8). Clearly large scale gravitational forces alone when combined with turbulent decay are enough to explain this behaviour. However, we emphasize that the clustered supernovae feedback-dominated scenario is the only one able to self consistently make clouds that reproduce **both** the scaling exponent and coefficient of the line width-size relation extracted from observations with similar scale sizes and resolutions to those used in our simulations. These simulations produce self-consistently generated clouds that can be used in future for studies of clustered star formation in a galactic context.

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