Contribution ID: **32** Type: **Talk**

Measuring turbulence driving in the ISM with NLTE CO modeling

Measuring the driving mode of turbulence is important for characterizing its role in the ISM. The driving mode of turbulence is parameterized by b, the ratio of the width of the gas density PDF to the turbulent Mach number. b ~ 1/3, 1, and 0.4 correspond to turbulence driving that is purely solenoidal, purely compressive, and a natural mixture of the two, respectively. We use high-resolution (sub-pc) ALMA CO observations of the star-forming region N159E (Papillon Nebula) in the LMC to provide the first measurement of turbulence driving in an extragalactic region. As opposed to earlier studies that only focused on the Milky Way and used LTE modeling of CO emission to derive the density PDF, we use NLTE models and show how LTE can overestimate the column density due to subthermal excitation of CO. We find that the width of the log-normal part of the density PDF is comparable to the supersonic turbulent Mach number, resulting in b ~ 0.9. We speculate that the highly compressive turbulence could have been powered by HI flows that is proposed to have created N159E, which can be confirmed by high resolution HI observations (e.g., using ASKAP or SKA) in the future.

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Session Classification: Interstellar Medium

Track Classification: Interstellar Medium