Triggered Star Formation in a Turbulent ISM
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Synthetic observations of turbulent flows in diffuse multiphase interstellar medium

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Abstract. We examined observational characteristics of multi-phase turbulent flows in the diffuse interstellar medium (ISM) by calculating atomic and molecular carbon lines. Radiation field maps of C^+, C^0, and CO line emissions were generated by calculating the non-local thermodynamic equilibrium (nonLTE) level populations and high resolution hydrodynamic simulations of diffuse ISM. By analyzing synthetic line emission, we found a high ratio between the lines of high- and low-excitation energies in the diffuse multi-phase interstellar medium. Our results shows that simultaneous observations of the lines of warm- and cold-gas tracers will be useful in examining the thermal structure, and hence the origin of diffuse interstellar clouds.

Keywords. turbulence, ISM: lines and bands, radio lines: ISM, line: formation, instabilities

1. Observational characteristics in multi-phase turbulence

Recent studies of the multi-phase interstellar medium (ISM) have demonstrated that the origin of small scale interstellar turbulence might be attributed to the thermally unstable nature of the ISM itself. However, most of their studies focus on dynamics. We, on the other hand, tried to bring these theoretical scenarios into the observational realm by calculating the line emission field.

2. Results: line ratio as a probe of ISM models

We calculate the line ratio of high- and low- excitation energy lines in two- and one-phase model (isothermal with $T_{\rm kin}$=10K). Our results show the significantly different line ratio between two- and one- phase model irrespective of the species of emitting particles. CO line ratio $R_{(J,J-1)/1,0}$ is higher than unity up to $J \lesssim 4$ in two-phase medium, though in one-phase model $R_{(J,J-1)/1,0} \ll 1$. This trend applies to the ratio of [CI] fine structure lines as well. Our results are easily understood by level population: if kinetic temperature is higher than the transition energy ($\Delta E/k_B T_{\rm kin}$) a large number of particles that can excite the high J level enables high line ratio – this is the case of two-phase medium. On the other hand, in the cold one-phase gas $\Delta E/k_B T_{\rm kin} \gg 1$ and then line ratio is small. These results demonstrate that simultaneous observations of high- and low- excitation energy lines will reveal the existence of two-phase medium formed by thermal instability.

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References

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