# Q13a Molecular-cloud-scale chemistry: constraints of physical conditions from chemical models

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With the development of high-capability (sub-)millimeter telescopes, it has become possible to conduct astrochemical observations in external galaxies to study their physical conditions. To understand how extreme activities in external galaxies affect the chemical composition, the chemical composition in nearby, relatively quiescent sources needs to be understood in the same spatial scale as observations in external galaxies. Such multi-species observations of Galactic molecular clouds are recently conducted in the 10-pc scale. In this work, we simulate molecular spectra with a grid of physical parameters to assess which physical parameters agree best with observed spectra of Galactic molecular clouds averaged in the 10-pc scale. Time-dependent chemical abundance model and radiative transfer model are used to simulate modeled spectra with varying density, temperature, cosmic-ray ionization rate, and visual extinction. Modeled spectra include species that are commonly observed in external galaxies such as HCN, $HCO^+$, CCH, HNC, HNCO, c-$C_3H_2$, CS, SO, $N_2H^+$, and CN. Our results show that physical parameters having good agreement with observations have the density of $n = (1-3) \times 10^3\,\mathrm{cm}^{-3}$, much less than the commonly-quoted critical densities of those species. The chemistry time with the best agreement is $t = 10^5\,\mathrm{yr}$, much shorter than the lifetime of giant molecular clouds. This result may imply frequent turbulence resetting the chemistry time in molecular clouds.