Characterising the physical properties of comets

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Two long-period comets C/2012 F6 (Lemmon) and C/2012 S1 (ISON) were observed with the Atacama Large Millimetre/Submillimetre Array (ALMA) band 7 receiver at heliocentric distances of 1.5AU and 0.54 AU, respectively. Cordiner et al. (2014) have identified 3 molecular lines (HCN, HNC, and H_2CO) and mapped their spatial distribution. They found that both comets have spherically symmetric HCN distribution, while HNC is consistent with collimated outflows. The distribution of H_2CO exhibits very different patterns in both comets, that is, extended on Lemmon and spherically symmetric on ISON.

I will use the data presented in this paper to derive some physical properties of these two comets. The goal of this project is twofold:

1. Place constraints on physical parameters. Continuum flux can be a powerful tool to serve this purpose if assumptions such as opacity and grain size distribution are carefully chosen. Following the methods described in Jewitt & Luu (1992), I will estimate the dust mass of the coma and the nucleus size of the two comets.

2. Derive coma temperature. Coma temperature is usually calculated using rotation diagram. However, at least 3 transitions of a molecule is required to give a plausible estimation with this method. Therefore, I will instead simulate the population of HCN transitions using the radiative transfer model described in Crovisier (1987) to constrain the coma temperature. The model takes collisional excitation as well as infrared excitation of the fundamental bands into account.

Reference

Cordiner, M. A., Remijan, A. J., Boissier, J. et al. 2014, ApJ, 792, L2