Exploring molecular-cloud formation in the Pipe Nebula with the OH 18 cm transition

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The Pipe nebula is a nearby (~145 pc) massive molecular cloud with a low star-forming activity. It shows a characteristic filamentary structure from west (B59 region) to east (Bowl region) according to the ^{13}CO (1-0) and C^{18}O (1-0) observations ([1] Onishi et al. 1999) (cyan contours in Fig. 1). Another filament from north to south is seen in the integrated intensity map of the ^{12}CO (1-0) in the red-shifted velocities (6-10 km/s) ([1] Onishi et al. 1999) (red contours in Fig. 1). These filaments are overlapped in the bowl region, and collisions between them are considered to be important to understand the formation of the cloud ([2] Frau et al. 2015). In addition, the heating effect from the nearby B2 IV star, θ-Ophiuchi, is also studied to understand the origin of the cloud ([3] Gritschneder & Lin 2012)

In order to examine these scenarios, we study the temperature structure of the Pipe nebula from observations of the four hyperfine structure components of the OH 18 cm transition (1.612, 1.665, 1.667 and 1.720 GHz) with the Green Bank Telescope (yellow circles in Fig. 1). This transition can be used as a good thermometer for molecular clouds, according to our recent study ([4] Ebisawa et al. 2015). As a result, we find no heating effect from the θ-Ophiuchi. On the other hand, the temperature is found to be higher in the interface of the two filaments (~110 K), which might result from a heating effect by the filament collisions. This result demonstrates a unique power of the OH 18 cm transition in studies of molecular cloud formation.

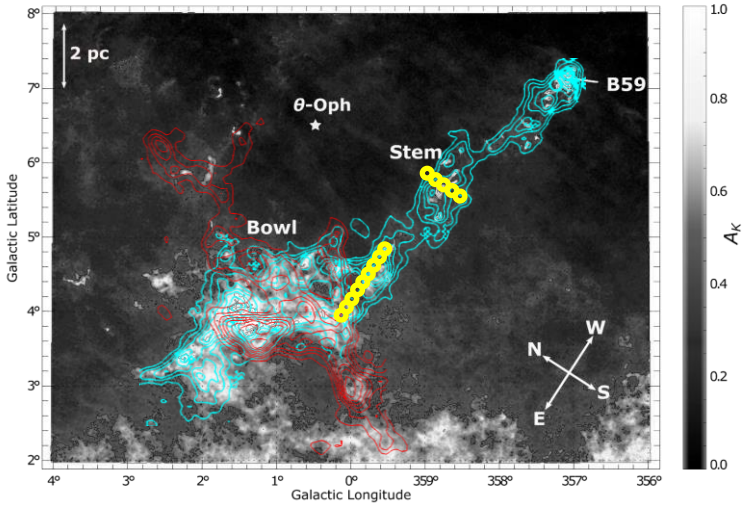

Figure 1: The visual extinction (A_k) map (gray, [5] Lombardi et al. 2006) overlaid with the integrated intensity maps of ^{13}CO (cyan contours) and ^{12}CO (red contours) ([1] Onishi et al. 1999).

References

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