Evidence For Cloud-Cloud Collision and Parsec-Scale Stellar Feedback Within the L1641-N Region

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Most stars form in GMCs. In GMCs, various environmental effects such as large-scale flows, supernovae, and stellar feedback from young stars (winds, radiation, and outflows) often shape the cloud structure and dynamics, triggering and suppressing the formation of the next-generation stars. Fingerprints of these environmental effects have been found in some star-forming regions, However, the roles of the environmental effects in star formation remain poorly understood observationally. This is partly because wide-field, high spatial and/or spectral resolution observations, which are needed to resolve the cloud structure and kinematics in detail, are still limited. In particular, stellar feedbacks such as winds or outflows are often extended to parsec-scale. Wide-field observations of the cloud structure and kinematics are needed to unveil such environmental effects. At the same time, it is necessary to resolve the cloud structure at a scale of "dense cores", which are the basic units of individual star formation (≈ 0.1 pc ~ one arcmin at a distance of 400 pc), in order to uncover a link between individual star formation and the environmental effects.

In this study, to understand how the environmental effects influence the internal structure and kinematics in star-forming molecular clouds, we present the results of wide-field ^{12}CO ($J = 1$–0) mapping observations toward the L1641-N region, a nearby active star-forming region in the Orion A giant molecular cloud complex, using the Nobeyama 45 m radio telescope. Our data have high angular (≈ 21″) resolution, allowing us to resolve spatial structures at a scale of 0.04 pc at a distance of 400 pc.

The main results are summarized as follows.

The ^{12}CO ($J = 1$–0) velocity channel maps suggest that the blueshifted ($V_{LSR} < 6\ \mathrm{km\ s^{-1}}$) and redshifted ($V_{LSR} > 7\ \mathrm{km\ s^{-1}}$) components are interacting with each other. Since the two components appear to overlap toward the dust filaments identified by the AzTEC/ASTE observations (Shimajri et al. 2010) on the plane of the sky, the collision between the two components may have occurred almost along the line of sight.

We found several parsec-scale shells in the ^{12}CO ($J = 1$–0) data cube. Some of the shells appear to be spatially well-ordered and homocentric. The centers of the shells are close to either the L 1641-N or V 380 Ori cluster centers, implying that the star formation activity in the clusters may be responsible for the formation and evolution of the shells.

The molecular gas distribution and kinematical structure of this region led us to the following scenario. On the large scale of at least about 1–10 pc, a cloud-cloud collision may have occurred almost along the line of sight in this region, contributing to the formation of several dense filaments. The cloud-cloud collision have triggered the formation of the L1641-N cluster. Multiple protostellar winds and outflows from the cluster member YSOs created large expanding bubbles that can be recognized in the ^{12}CO and ^{13}CO maps. Here, we call these YSO winds as "protocluster winds". The shell surrounding V 380 Ori also has two different velocity components both in the ^{12}CO and ^{13}CO maps. Both the cloud-cloud collision and the protocluster winds are likely to have created the complicated cloud morphology and kinematics.

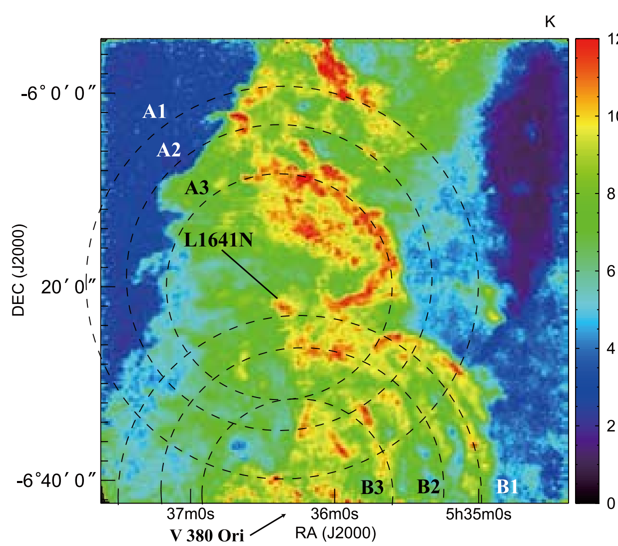

Figure 1: CO (1–0) peak intensity map twoard the L1641-N region in Orion A. The image indicates that several prominent shells shape the cloud structure in this region. We propose that these shells were created by protostellar winds, stellar feedback from forming star clusters. See [1] for more detail.

Reference

[1] Nakamura, F., Miura, T., Shimajiri, Y., et al.: 2012, *ApJ*, **746**, 25.