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N131: A dust bubble was born from the disruption of a gas filament?

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Abstract. N131 is an infrared dust bubble residing in a molecular filament. We aim to study the formation and fragmentation of this bubble with multi-wavelength dust and gas observations. Towards the bubble N131, we analyzed archival multi-wavelength observations including 3.6, 4.5, 5.8, 8.0, 24, 70, 160, 250, 350, 500 μm, 1.1 mm, and 21 cm. In addition, we performed new observations of CO (2-1), CO (1-0), and ^{13}CO (1-0) with the IRAM 30-m telescope. Multi-wavelength dust and gas observations reveal a ringlike shell with compact fragments, two filamentary structures, and a secondary bubble N131-A. The bubble N131 is a rare object with a large hole at 24 μm and 21 cm in the direction of its center. The dust and gas clumps are compact and might have been compressed at the inner edge of the ringlike shell, while they are extended and might be pre-existing at the outer edge. The column density, excitation temperature, and velocity show a potentially hierarchical distribution from the inner to outer edge of the ringlike shell. We also detected the front and back sides of the secondary bubble N131-A in the direction of its center. The derived Lyman-continuum ionizing photon flux within N131-A is equivalent to an O9.5 star. Based on the above, we suggest that the bubble N131 might be triggered by the strong stellar winds from a group of massive stars inside the bubble. We propose a scenario in which the bubble N131 forms from the disruption of a gas filament by expansion of H II region, strong stellar winds, and fragments under self-gravity.

Keywords. infrared, formation, bubbles, H II regions, clouds.

Based on the intriguing morphological structure (in Fig. 1) and velocity distribution of the N131 studied in Zhang *et al.* (2013) and Zhang *et al.* (2015), we propose that the progenitor of the bubble N131 was a filamentary nebula elongated along the direction of the clumps AD and BC (see the sketch in Fig. 2). It is likely that within the middle of the filamentary nebula, a cluster of massive stars ionized, heated, and blew away the surrounding interstellar medium and compressed the pre-existing clumps. With the expansion of H II region at relatively high temperature, pressure, and a strong stellar winds lasting more than 10^6 yr, the feedback from the massive stars broke up the pre-existing filamentary nebula and separated it into the two unconnected clumps AD and BC. With the expansion of evolving H II region, a ringlike structure is formed. Bodenheimer *et al.* (1979) have simulated a similar scenario. We provide further evidence to back up this argument.

The clumps AD and BC are two unconnected filamentary nebula on the opposite sides of the bubble. Along the direction of the clumps C, B, A, and D in Fig. 1, there is a velocity gradient from -14.5 to -6.5 km s^{-1} (Zhang *et al.* 2013). This velocity coherence indicates that in the past the clumps AD and BC were likely connected together. The velocity gradient may be partly produced by the bubble expansion.

These broken filamentary morphologies, caused by bubble expansion, are rather common in large scale surveys, i.e. the 500 pc filamentary gas wisp from Li *et al.* (2013), and the bubble N39 from Deharveng *et al.* (2010). In addition, the secondary bubble N131-A (Zhang *et al.* 2015) close to the N131 is also embedded in the filamentary nebula (or the clumps AD). The N131-A is expanding outwardly, and compressing the surrounded

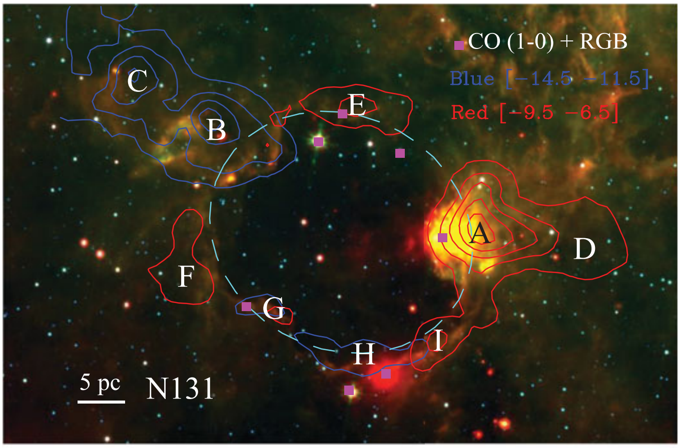

Figure 1. Integrated intensity contours of the CO (1-0) line of the blueshifted and redshifted clouds superimposed on the RGB image with 24 μm (red), 8.0 μm (green), and 4.5 μm (blue). The CO (1-0) data is from Zhang *et al.* (2013). The integration range is from -14.5 to -11.5 km s^{-1} for the blueshifted cloud, and from -9.5 to -6.5 km s^{-1} for the redshifted cloud. The symbols "■", letters (A, B, ..., and I), and ellipse indicate the positions of eight IRAS point sources, nine molecular clumps, and ringlike shell of the bubble, respectively.

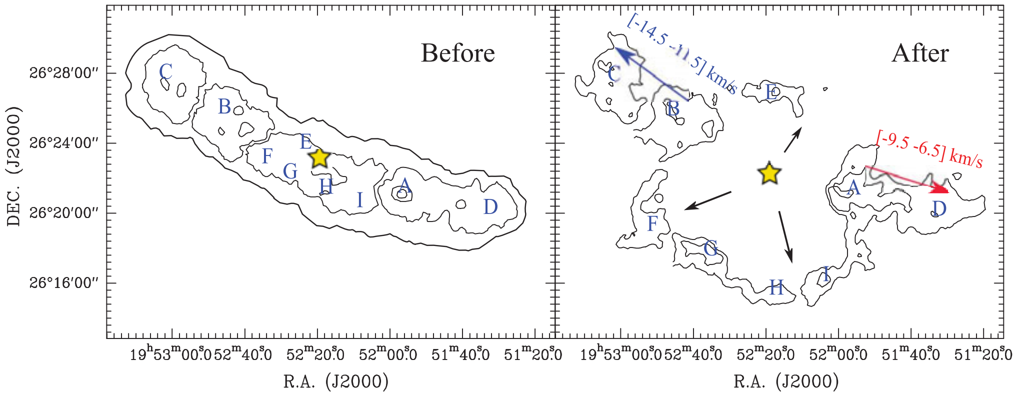

Figure 2. A schematic illustration depicting our target region before and after the formation of the bubble N131. The yellow star indicates a group of ionizing stars, which caused expansion of the shell. In the upper panel, we indicate the proposed pre-existing clumps A, B, ..., and I. In the lower panel, we indicate the observed clumps A, B, ..., and I, and the velocity structure.

material. The N131 in its early stage might have had a similar evolutionary process as the N131-A. With the expansion of the bubble, finally the strong stellar winds helps to form the bubble N131.

To probe the scenario, we also compared the relative masses of these clumps surrounding the bubble N131 with the proposed pre-existing clumps in (Zhang *et al.* 2015). The similar masses between the clump AD, clump BC, and ringlike shell suggests that the bubble might originate from a filamentary nebula in view of mass conservation.

References

Bodenheimer, P., Tenorio-Tagle, G., & Yorke, H. W. 1979, ApJ, 233, 85
Deharveng, L., Schuller, F., Anderson, L. D., *et al.* 2010, A&A, 523, A6
Li, G.-X., Wyrowski, F., Menten, K., & Belloche, A. 2013, A&A, 559, A34
Zhang, C.-P., Li, G.-X., Wyrowski, F., *et al.* 2015, A&A, submitted
Zhang, C.-P., Wang, J.-J., & Xu, J.-L. 2013, A&A, 550, A117