Absolute Proper Motion of IRAS 00259+5625 with VERA: Indication of Superbubble Expansion Motion

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Since their first discovery by Heiles (1979) [1], shell or arc-like HI objects with sizes ranging from a few pc to more than 1 kpc have been discovered in the Milky Way Galaxy. The large HI objects (up to a few kiloparsecs in scale) are called the superbubbles or supershells, and they are believed to play a role in mass and energy transportation from the disk to the halo. However, studies about superbubbles were mainly conducted using 2D positions on the sky and 1D line-of-sight velocities of the objects, meaning that there are uncertainties in terms of precise physical parameters (e.g., size and expansion velocity) of the objects. To understand 3D structure and kinematics of the superbubbles with VLBI astrometry, we conducted VERA observations toward an H_2O maser emission of IRAS 00259+5625, an star-forming region associated with the "NGC 281 superbubble" in the Galaxy.

13 epoch VERA observations were conducted between 2008 January and 2009 September to measure trigonometric parallax and proper motions of the source. The derived parallax, marginal, is 0.412 ± 0.123 mas, corresponding to a distance of $2.43^{+1.03}_{-0.56}$ kpc. Also, the (systematic) proper motions are $(\mu_\alpha \cos\delta, \mu_\delta) = (-2.48 \pm 0.32, -2.85 \pm 0.65)$ mas yr^{-1} in the equatorial coordinates. Combining the both results and the systemic velocity obtained from a molecular emission provides an absolute vertical motion (v_b) of -17.9 ± 12.2 km s^{-1} with $\sim 1.5\sigma$ significance. The non-circular motion is shown in fig. 1 with previous VLBI results. Clearly, both NGC 281 and IRAS 00259+5625 show the vertical motions away from the Galactic plane, indicating that the superbubble expansion motions might be related to sequential supernova explosions originated in the Galactic plane.

As for future expectations, more VERA observations would give us an accurate understanding of the superbubble regions related to the Galaxy evolution in the near future.

References

[1] Heiles, C.: 1979, *ApJ*, **229**, 533.
[2] Sakai, N., et al.: 2014, *PASJ*, **66**, 3.

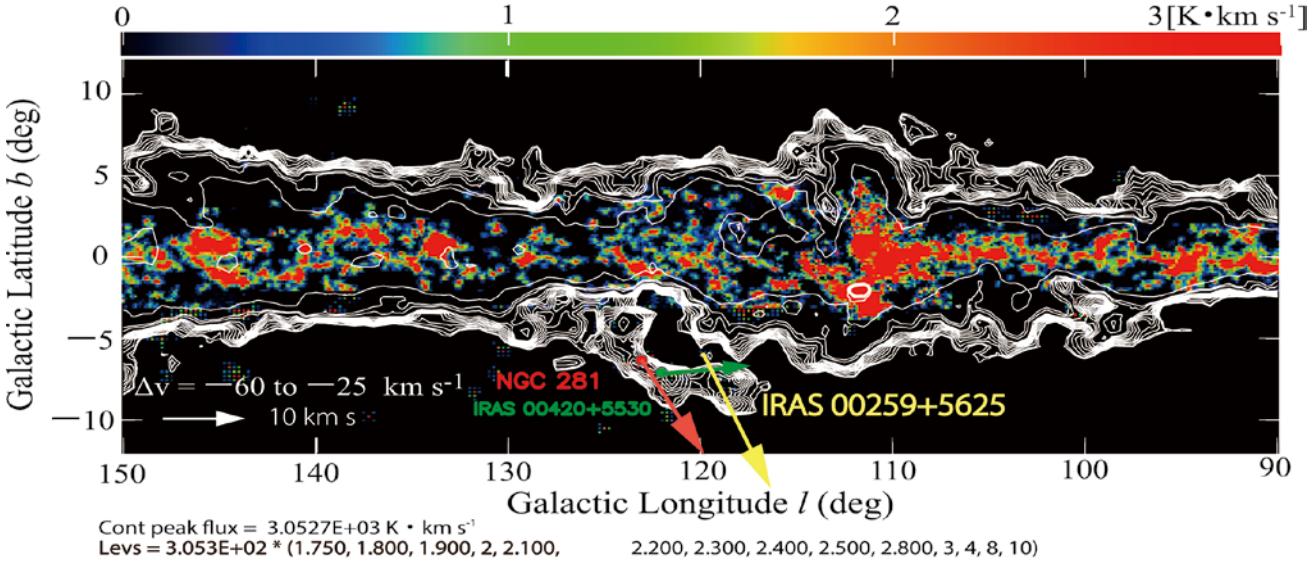

Figure 1: l vs. b map of NGC 281 superbubble is shown with white contours HI data and color ^{12}CO (J=1–0) data. The positions of NGC 281 (red), IRAS 00420+5530 (green), and IRAS 00259+5625 (yellow) are indicated. The map is velocity-integrated for the Perseus-arm line-of-sight velocity range of $V_{LSR} = -60$ to -25 km s^{-1}. The observed non-circular motions of the three sources are plotted as red (NGC 281), green (IRAS 00420+5530), and yellow arrows (IRAS 00259+5625). Note that we assumed a flat rotation model to derive the non-circular motions.