Detailed CO (J=1–0, 2–1 and 3–2) observations toward an HII region RCW 32 in the Vela Molecular Ridge

(submitted to PASJ)

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RCW 32

The brightest HII region in the **Vela D** region (southern sky) with two bright rimmed clouds (SFO57, 58) and dake lanes (see Fig.1).

Exciting star : HD 74804 (B0V; Pettersson & Reipurth 1994)
Distance : ~ 1.0 kpc (e.g., Vogt & Moffat 1973)
Age : ~ 1 Myr (e.g., Pettersson & Reipurth 1994)

We carried out CO observations toward RCW 32 to reveal gas dynamics around the high mass star.

Tab. 1 Summary of our observationl parameters.

	NANTEN2	ASTE
Line	^{12,13}CO (J=2–1)	^{12}CO (J=3–2)
Resolution	~ 90″ (0.4 pc)	~ 21″ (0.1 pc)
Sensitivity	~ 0.4 K ch^{-1}	~ 0.4 K ch^{-1}

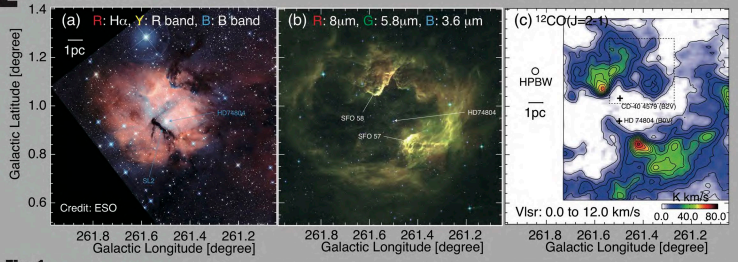


Fig. 1 RCW 32 in various wavelengths. (a) Optical three-color composite image of RCW 32. Blue, yellow, and red correspond to B band, R band, and Hα taken by the MPG/ESO 2.2-metre telescope (credit: ESO). (b) Infrared three-color composite image of RCW 32. Blue, green, and red correspond to 3.6, 5.8, and 8.0 μm obtained by GLIMPSE (Benjamin et al. 2003, Churchwell et al. 2009). (c) Integrated intensity distribution of the 12CO (J=2-1) obtained by the NANTEN2 telescope. The dashed square shows the region which we observed in 12CO (J=3-2) with the ASTE telescope. Crosses indicate positions of early B stars of CD−40 4579 and HD 74804 in this region.

1. NANTEN2 OBSERVATIONS

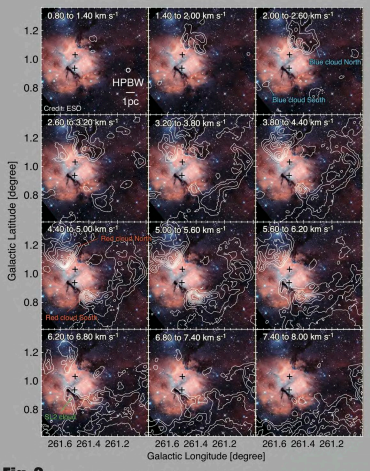


Fig. 2 Velocity channel distribution of 12CO (J=2-1) superposed on the optical image of Figure 1a. Contours are from 2.1 Kkm s−1 with the step of 3.37 Kkm s−1. Velocity integration ranges are shown at the top of each panel.

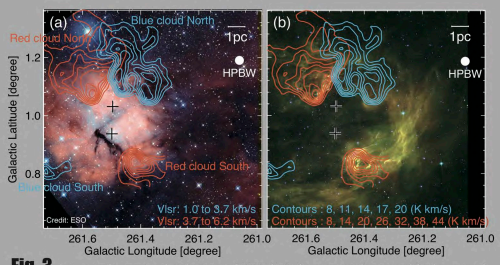


Fig. 3 Integrated intensity distributions of 12CO (J=2-1) corresponding to red (red contours) and blue (blue contours) superposed on (a) the optical and (b) infrared images.

Tab. 2 Physical parameters of the molecular clouds.

	Velocity range [km s^{-1}]	Peak Vlsr [km s^{-1}]	Mass [M$_\odot$]	Column density [cm^{-2}]
Blue cloud North	1.4 – 3.8	2.8	400	2×10^{21}
Blue cloud South	1.4 – 3.8	3.2	110	1×10^{21}
Red cloud North	2.6 – 6.8	5.2	900	6×10^{21}
Red cloud South	2.6 – 6.8	5.4	300	6×10^{21}

We found that the two red clouds in North and South have similar ranges of radial velocities, peak velocities, and column densities. Both of them are ionized by the same source (HD74804) and form bright rims toward the side close to the ionization source.

This suggests that **the two red clouds had been an unified large cloud** which is distributed from direction of the red cloud North to South until B stars were formed.

The two blue clouds also show simillar trend.

It is possible to consider both the red and blue clouds as natal clouds of RCW 32.

2. ASTE OBSERVATIONS

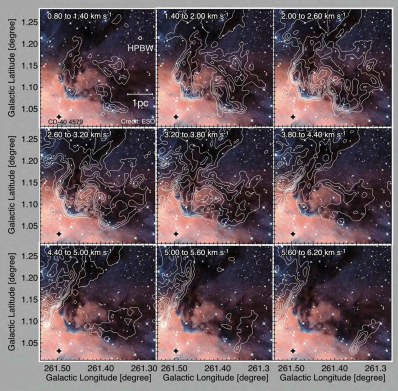


Fig. 4 Velocity channel distribution of 12CO (J=3-2) obtained by the ASTE telescope superposed on the optical image of Figure 1a.

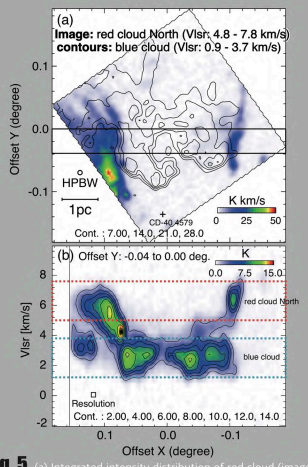


Fig. 5 (a) Integrated intensity distribution of red cloud (image) and blue cloud (contours) in 12CO (J=3-2) in Offset X and Y coordinate. The integration ranges for red and the blue clouds are shown in the figure. The cross indicates the position of CD−40 4579.
(b) Position-Velocity diagram of 12CO (J=3-2) in Offset X and Y coordinate. The integration range is shown as the black box in Figure a.

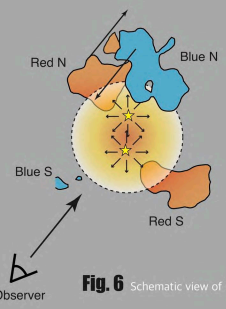


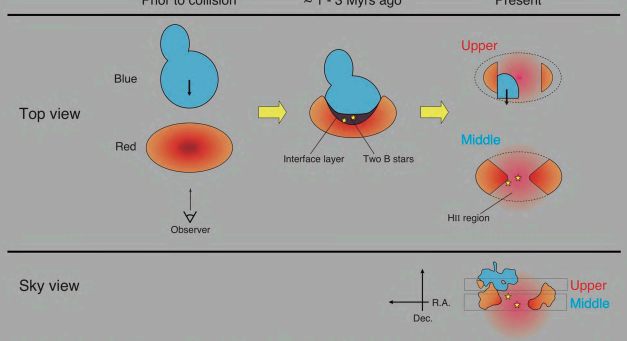
Fig. 6 Schematic view of RCW 32.

Red cloud North and Blue cloud North show a complementary spatial distribution. These two clouds are located the top edge of the HII region with relative velocity of ~2 km/s.
The cloud distribution and kinematics are hard to explain by a simple expanding wind model.

We propose the possibility of a cloud-cloud collision as an alternative model.

This is the 4th observational evidence of cloud-cloud collision in the Vela region.
(RCW34; Hayashi et al. 2017, RCW36; Sano et al. 2017, RCW 38; Fukui et al. 2016)

3. Cloud-Cloud Collision model



* The collision time scale are estimated from the cloud size and the velocity separation to be ~2 Myrs and terminated ~1 Myr ago, which is consistent with an age of the B star(s) and the associated cluster.

4. SUMMARY

- We found two natal clouds of RCW 32 through NANTEN2 observations
- We revealed physical parameters and detailed molecular distribution for the clouds (See also Enokiya et al. 2017 submitted to PASJ)
- We argued that the cloud distribution and kinematics are hard to explain by a simple expanding model. We present a hypothesis that a collision between the red and blue clouds took place from ~3 Myrs ago in a duration of ~2 Myrs and formed the B star(s) and the cluster whose age is ~1 Myr.

- REFERENCES -

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[8] Vogt & Moffat 1973, A&AS, 9, 97