Dwarf Galaxies: From the Deep Universe to the Present
Proceedings IAU Symposium No. 344, 2019
K. B. W. McQuinn & S. Stierwalt, eds.

doi:10.1017/S1743921318007780

Origin of Hot Bubble in NGC 6822 Hubble V Star-Forming Region

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Abstract. We observed a bright H II complex, Hubble V in NGC 6822, using the high-resolution near-infrared spectrograph IGRINS (R = 45,000) attached on the 2.7 m telescope at the McDonald Observatory. We carried out a spectral mapping over a $15'' \times 18''$ region in the H and K bands using a slit-scanning technique. The emission lines Brγ and He I from ionized regions as well as molecular hydrogen lines from photo-dissociation regions (PDRs), were detected. We show three-dimensional maps of the emission lines and discuss the possibility of an expanding hot bubble structure within which many ionized components are around the central stellar cluster.

Keywords. galaxies: dwarf, galaxies: irregular, galaxies: kinematics and dynamics, galaxies: Local Group, infrared: galaxies, instrumentation: spectrographs

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1. NGC 6822 Hubble V Observation

NGC 6822 is a member of the Local Group and a metal poor irregular dwarf galaxy whose star-forming environment is free of dynamical driving effects (Lee *et al.* 2005). We can spatially resolve molecular clouds or star-forming regions clearly down to parsec scales at a distance of 474 ± 13 kpc (Rich *et al.* 2014). This galaxy has a bar dominated by an irregular distribution of OB associations and H II regions (Israel 1997). Based on X-ray observation results, some of the bright H II regions of NGC 6822 have bubbles (Kong *et al.* 2004; Tennant 2006).

Hubble V is one of the brightest H II region complexes in this galaxy (RA = 19^h 44^m $52^s.85$, Dec = -14° $43'$ $12''.8$, J2000). The star cluster inside Hubble V has about 80 OB stars massive star candidates brighter than m_{NUV} of 22.5 mag (Hodge 1980; Wilson 1992; Bianchi & Efremova 2006; Schruba *et al.* 2017).

We obtained a spectral map toward Hubble V using Immersion GRating INfrared Spectrometer (IGRINS) attached on the 2.7 m telescope at the McDonald Observatory in 2016 May and July. IGRINS covers the whole infrared H and K bands with resolving

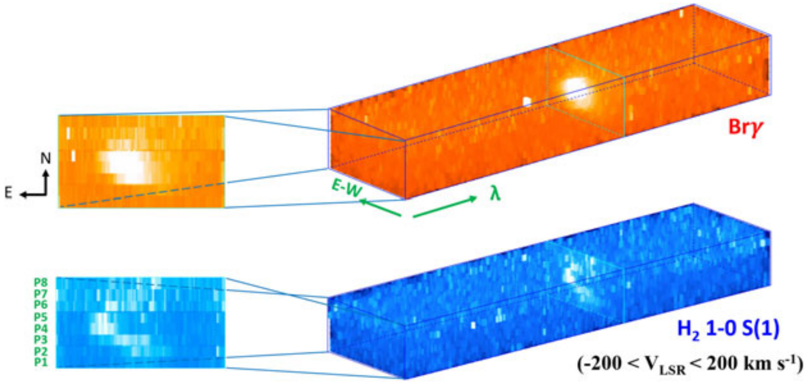

Figure 1. Integrated intensity maps (left) and the 3D cube data (right) of Brγ and H_2 1-0 S(1) emission lines. The molecular clouds surround the ionized region (halo) that extends towards the northwest.

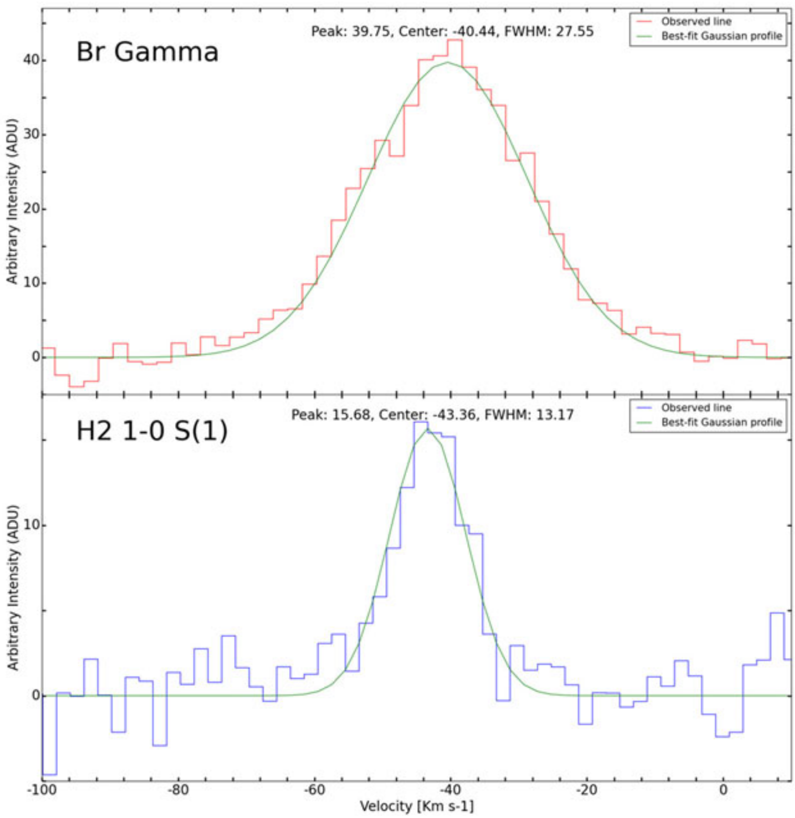

Figure 2. Sample Spectra with Gaussian Fitting. The FWHM difference of mean velocity dispersion between Brγ emission and H_2 1-0 S(1) line is about 14 kms^{-1}.

power of 45,000. Using a slit-scanning technique, we mapped $15'' \times 18''$ (35×17 pc) area over Hubble V. The obtained emission lines are Brγ $\lambda 2.1661$ μm, He I $\lambda 2.0587$ μm from ionized regions, and molecular hydrogen lines of 1-0 S(1) $\lambda 2.1218$ μm, 2-1 S(1) $\lambda 2.2477$ μm, and 1-0 S(0) $\lambda 2.2227$ μm from PDRs.

https://doi.org/10.1017/S1743921318007780 Published online by Cambridge University Press

2. Result and Discussion

We confirmed the structure suggested by Lee *et al.* (2005) through the integrated intensity maps and the 3D cube data of Brγ and H_2 1-0 S(1). The molecular clouds surround the ionized region that extends towards the northwest (Fig. 1).

Bubbles and superbubbles have been detected in the Galaxy and nearby galaxies.(Camps-Fariña *et al.* 2017). Bubbles blown by massive stars contain fast stellar winds (T $> 10^6$ K) which emits diffuse X-rays and a swept-up dense shell (Chu *et al.* 2006).

We suggest that NGC 6822 Hubble V has a hot bubble with surrounding clumpy molecular clouds. The coronal gas and H II regions are also influenced by stellar winds from embedded stars. In spite of the expected hot bubble structure, X-ray emission has not been detected in Hubble V.

The mean velocity dispersion obtained from Full Width at Half Maximum (FWHM) of Brγ emission line in NGC 6822 Hubble V is ≈ 28 kms^{-1}, while that of H_2 1-0 S(1) line is ≈ 13 kms^{-1} (Fig. 2). Considering the line width of 7 kms^{-1} in the IGRINS instrument profile, our result implies that the Brγ emission line profile does show neither double-peaked nor multiple-peaked emission components. From this highly dispersed emission, we argue that embedded H II regions or inside hot gas have a random motion.

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