

WB89 520: A Small Isolated High Mass Star Forming Region Associated with an Extremely Metal-Poor Nebula

Jun-Jie Wang, Jing-Yao Hu, Jian-Yan Wei

National Astronomical Observatory, Beijing, 100012, P.R. China

Leonardo Testi

Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, I-50125 Firenze, Italy

Abstract. In this paper, by discussing and analyzing the observational results of near infrared imaging, optical spectroscopy and ^{12}CO molecular line, together with IRAS and NVSS data, we conclude that WB89 520 is an UC HII region with a very young compact stellar cluster. The spectrum of the UC HII region shows that it is an extremely metal-poor nebula, which has the lowest line ratio of $[\text{NII}]/\text{H}\alpha$ ($\sim 1/56$) discovered in the nebulae of our Galaxy until now. We give two possible explanations for the low metallicity.

1. Introduction

It is well-known that high mass OB stars form in Giant Molecular Clouds (GMCs) which lie in the spiral arms. And generally the mean diameter of a GMC is 45 pc with a mass of $10^{5-6}M_{\odot}$ (Blitz,1987).

WB89 520 (IRAS 04000+5052) has not been studied extensively before. In 1993, based on the analysis of near infrared photometry and optical CCD imaging, Wang et al. (1993) found the source of IRAS 04000+5052 is an interesting near infrared variable object associated with an HII region (1993).

2. Observations and Discussions

The near infrared imaging observations were carried out on Nov.7 1995 , using the 1.5m TIRGO telescope with the Arcetri near-infrared camera (ARNICA) at Gornergrat Observatory. The ARNICA detector is a NICMOS3 256×256 pixel HgCdTe array. The scale on the detector is roughly $0.95''/\text{pixel}$. WB89 520 was observed in the J, H and K broad-bands and H_2 S(1) 1 - 0, Br_{γ} narrow bands. Spectroscopic observations of this source were taken with the Beijing Astronomical Observatory 2.16 m telescope and the OMR spectrograph with a Tektronix 1024×1024 CCD as detector. The $200 \text{ \AA} \text{mm}^{-1}$ grating was used, blazed at 6500 \AA .

A very strong $\text{H}\alpha$ emission line appears in the optical spectrum. And the continuum of the spectrum shows that WB89 520 is an extremely red source.

The spectral type of the embedded exciting star of the UCHII region can be obtained using the Lyman-continuum photon method. The radio continuum flux at 1.4 GHz is used to calculate the number of Lyman-continuum photons heating the gas. i.e.

$$N(\text{rad}) = 7.54 \times 10^{46} (\nu/\text{GHz})^{0.1} \times (T_e/10^4 \text{K})^{-0.45} (S_\nu/\text{Jy})(D/\text{kpc})^2$$

Here we used an electron temperature 10^4K like many others used ([6],[8] etc.), and assume the kinematic distance 3.88 kpc obtained from CO observation [9]; thus $\log N(\text{rad})$ can be calculated to be 46.27, corresponding to the spectral type B0.5 in Panagia's table (1973).

WB89 520 appears to be a single somewhat extended red source on optical CCD images. But from our infrared imaging observations, an infrared cluster, including 15 infrared detectable objects, is discovered. It is a very small ($0.83 \text{ pc(NS)} \times 1.55 \text{ pc(EW)}$) and isolated high mass star forming region in which there is a B0.5 type star exciting the UC HII region. Possibly it is not an on-arm high mass star forming region and is located far beyond the Perseus arm. Its heliodistance ($\sim 4.29 \text{ kpc}$) is twice as far as that of the Perseus arm , which means the OB stars are forming not only in GMCs of the spiral arms.

The spectrum of the UC HII region shows that it is an extremely metal-poor nebula, which has the lowest line ratio of $[\text{NII}]/\text{H}\alpha$ ($\sim 1/56$) discovered in the nebulae of our Galaxy until now. We suppose that there are two possibilities to explain this point. One is that the material constituting this nebula does not belong to our Galaxy, and comes from some extragalactic objects due to some physical mechanisms, for instance merging or accretion of galaxies. Another explanation is that in the outer disk without spiral arm in our Galaxy some primeval material or some primeval material without over-contamination by objects of inner Galaxy still exists. For both the two explanations we need more examples like WB89 520 and need to have further observational evidences and theoretical results.

References

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