The Massive Stellar Population of W49: a Spectroscopic Survey

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Abstract

As a part of LOBSTAR project (Luci OBservations of STARburst regions) which aims at understanding the stellar content of young star-forming regions, we present our first result on the high-mass stellar content of W49. Near-infrared imaging observations are obtained with LUCI at the Large Binocular Telescope and SOFI of New Technology Telescope (NTT). The K-band spectra (ISAAC/VLT) of the candidate massive stars provide us with more reliable spectral types than photometry alone. Four massive stars are identified as O3V-O5V stars while indications for an O2If*/WN6 star are found for a possible very massive star. After spectroscopic classification (and applying the proper extinction law), the objects can be placed in a Hertzsprung–Russell diagram. With comparison to stellar evolution models, the age of the cluster is estimated as lower than 2Myrs and the mass of the massive stars are calculated.

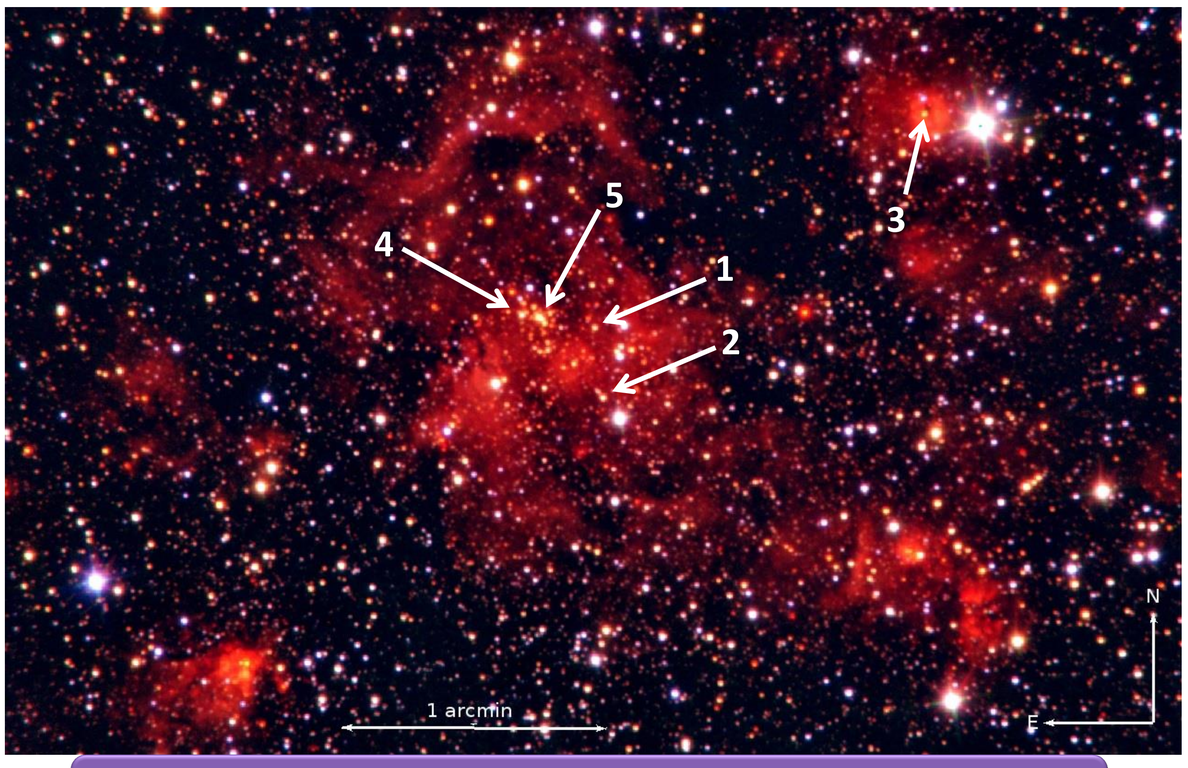


Figure 1. JHK_s color image of W49.

Introduction

Stars form in regions ranging from large-scale associations to gravitationally bound clusters. In order to study their formation history we are carrying out a spectral survey of the stellar content of some of the most massive star formation complexes in our galaxy (e.g. Bik et al, 2012). In this poster we present the first results on starburst cluster W49 where 100s of candidate OB stars are found (Alves & Homeier, 2003). W49 is one of the most luminous and youngest HII regions in our galaxy located at a distance of 11.4 kpc. The region consists of over 40 ultra-compact HII regions as well as a more extended Giant HII region.

Photometry

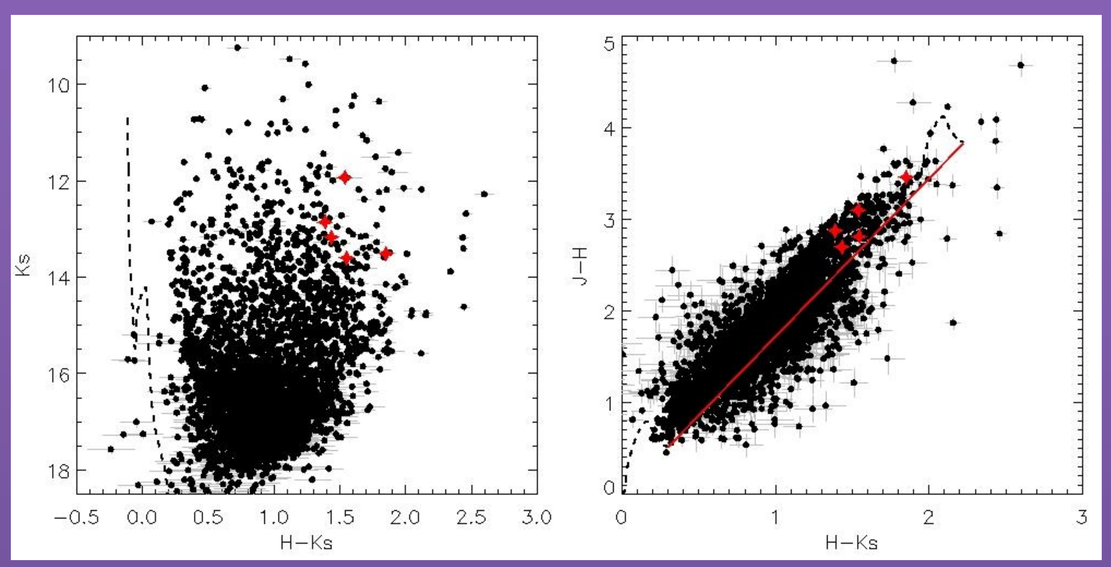


Figure 2. Left: H-K_s vs. K_s color-magnitude diagram of W49. Plotted as red dots are the candidate massive stars identified in our work. Overplotted as a dashed line is the main sequence isochrone of 1 Myrs form Brott et al (2011). Right: J-H, H-K_s color-color diagram of W49.

Point Spread Function photometry on the JHKs images (SOFI/NTT) was performed using DAOPHOT package within the IRAF environment. 5822 stars were identified in all the three bands. We calibrated the photometry with 2MASS to ensure reliable photometry. The color-magnitude diagram (CMD) and color-color diagram (CCD) are shown in Fig. 2. The location of massive stars is in the upper-right region of CCD, indicates the cluster is deeply embedded ($A_k \sim 2.5$ mag) and most of the stars detected are foreground stars.

Spectroscopy

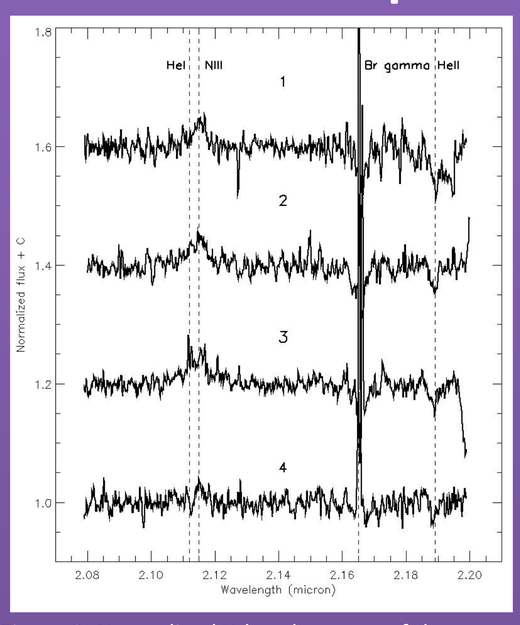
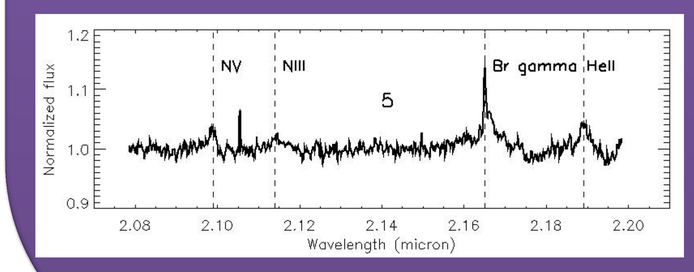


Figure 3. Normalized K-band spectra of the massive stars in W49 from ISAAC. Annotated with the dashed line are the spectral features which are important for classification of the stellar spectra.

The K-band spectra of the massive stars are shown in Fig. 3. The majority of spectra shows Brγ absorption with a narrow emission component. The absorption has a photospheric origin, while the narrow emission is emitted by the surrounding HII region. The spectra are compared with high-resolution reference spectra of optical classified O and early B stars from Hanson et al. (2005) to determine the best matching spectral type. Four of them are identified as O3V-O5V stars. The fifth star with unique features is hard to be classified in the method mentioned above.



This star shows evidence for strong stellar wind (broad Brγ and HeII) and a feature associated with WN stars (NV). Based on that we found strong similarities with the O2If*/WN6 star from Roman-Lopes (2013). This star is extremely massive (might be around 100 $M_\odot$). More detailed analysis is required to make a proper classification to this star.

HR Diagram

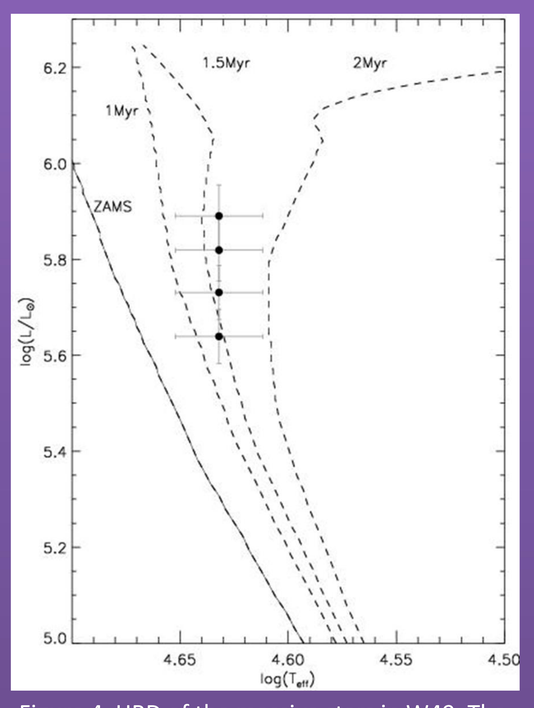


Figure 4. HRD of the massive stars in W49. The dashed lines represent the main-sequence isochrones from Lejeune & Schaerer (2001) for ZAMS, 1, 1.5 and 2 Myrs. The stars are de-reddened using the extinction law of Rieke & Lebofsky (1985).

After spectroscopic classification, the objects are placed in Hertzsprung–Russell diagram (HRD). Based on the position of the massive stars in the HRD, we derive an upper limit on the age of 2 Myrs. With the derived luminosity, we compare them to the 1.5 Myrs isochrone and obtained the following masses:

1: 49±3 $M_\odot$
2: 54±4 $M_\odot$
3: 64±5 $M_\odot$
4: 59±5 $M_\odot$

Our multi-object LUCI spectra will provide stronger constraints on the derived cluster properties and evolutionary stage by adding many more stars to the HRD.

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