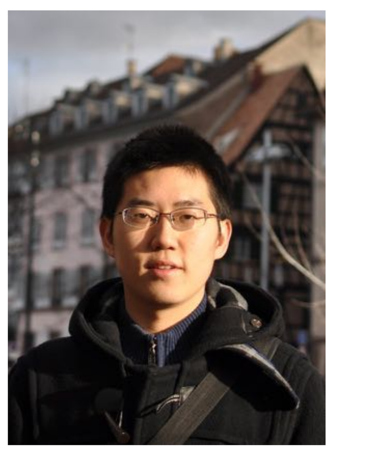
The Massive Stellar Population of W49: the Discovery of a Very Massive Star



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Abstract

As a part of the 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 (LBT) and SOFI at the 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. W49nr1 is discovered as a very massive star and, based on the K-band spectrum, classified as an O2-3.5If* star with a K-band absolute magnitude of -6.27±0.10 mag. The effective temperature and bolometric correction are estimated from stars of similar spectral type. After comparison to the Geneva evolutionary models, we find an the initial mass between 100 $M_\odot$ and 180 $M_\odot$. The age of W49nr1, however, is not well established. The position of W49nr1 in the Hertzsprung Russel diagram suggests an upper age limit of 2 Myrs when compared with non-rotating isochrones, however, considering models with stellar rotation included, the age is estimated to be between 2 and 3 Myrs.

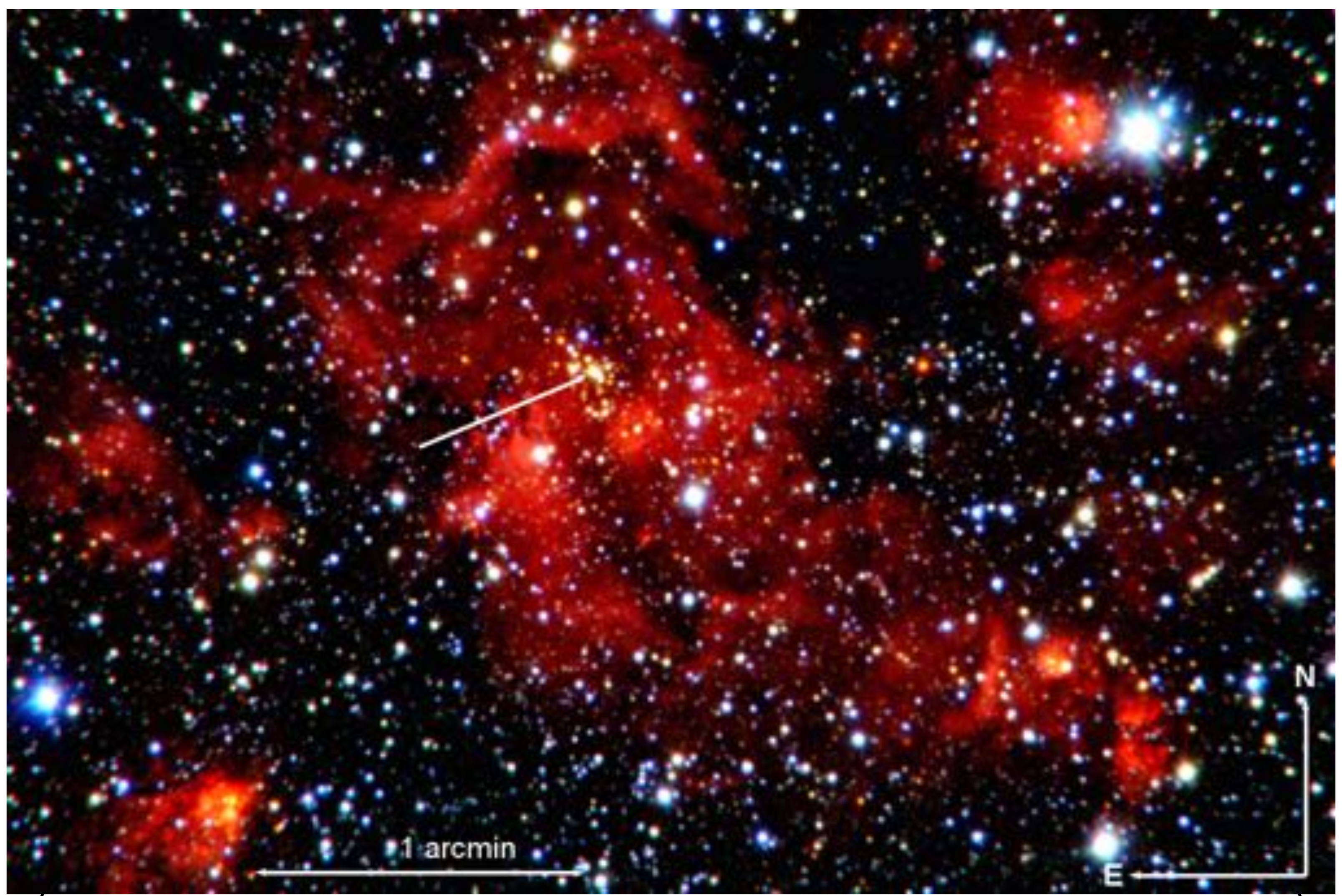


Figure 1. JHK three color image of the central area of W49. The massive star W49nr1 located in the center of the HII region is indicated with a white arrow.

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 discovery of a very massive star in the central cluster of one of the most luminous Galactic HII regions: W49, where 100s of candidate OB stars are found (Alves & Homeier, 2003).The results described here have been published as Wu et al. (2014). Scan the QR code on the left to get free access to the paper and MPIA press release about the paper.

Spectroscopy

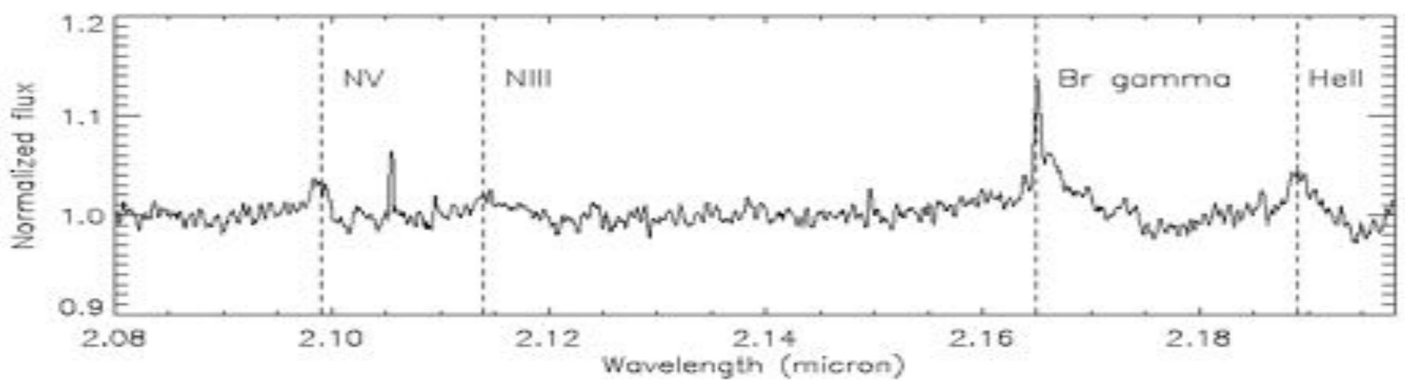


Figure 2. The telluric corrected (and continuum-normalized) K-band ISAAC spectrum of W49nr1.

The K-band spectrum of W49nr1 is dominated by broad emission lines of Brγ (2.16 μm), HeII (2.189 μm), NIII (2.116 μm) and NV (2.10 μm). The narrow emission component of Brγ is a residual of the nebular subtraction. The He II and NV lines are indicatives of an early spectral type (Hanson et al. 2005). The broad emission profiles imply an origin in the stellar wind. These properties suggest similarities with the spectral classes O2-3.5If*, O2-3.5If*/WN5-7 ("slash" stars) and WN5-7 stars (Crowther & Walborn 2011).

Hertzsprung-Russell Diagram

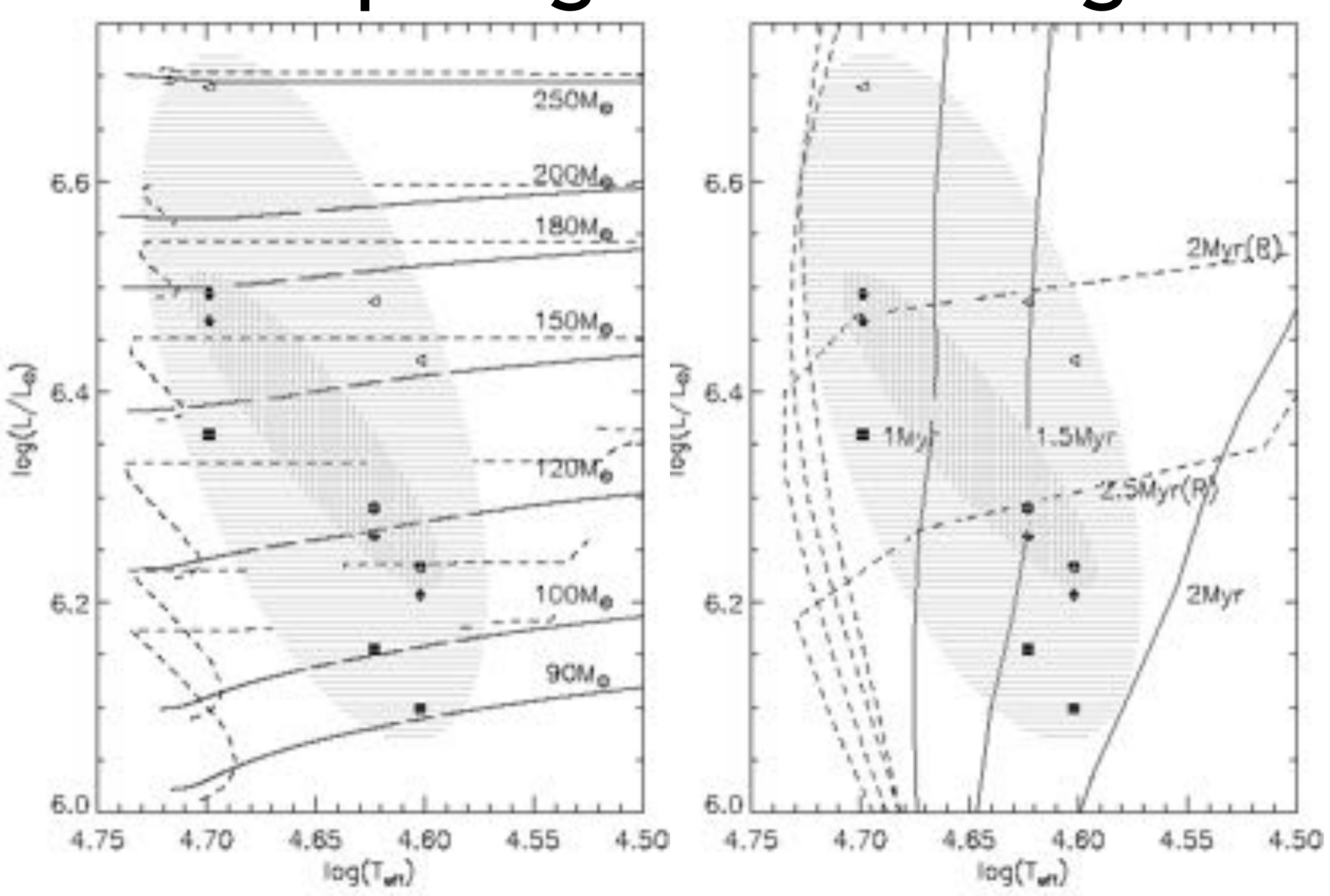
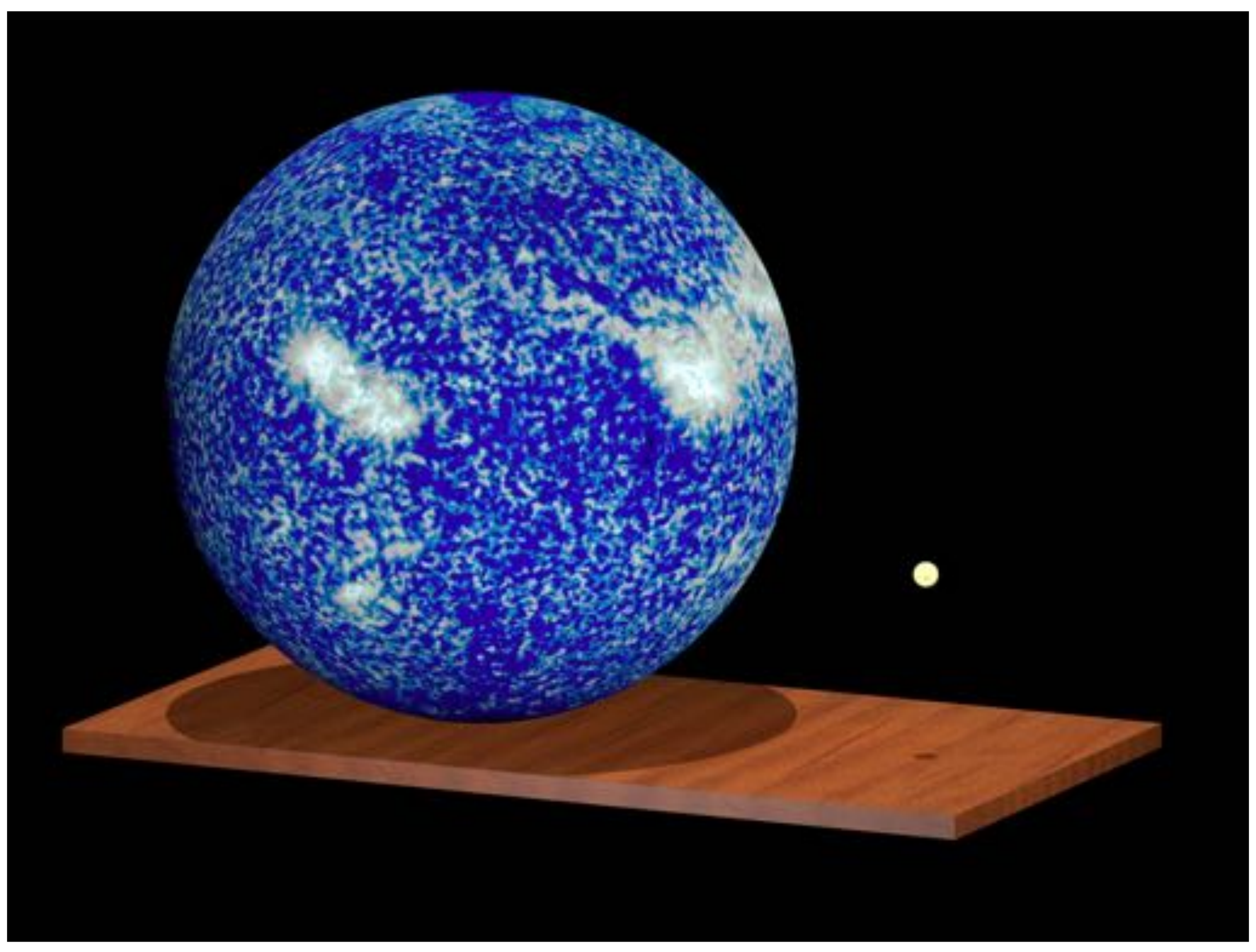


Figure 3. Hertzsprung-Russell Diagram with the possible location of W49nr1 marked as grey areas, as Teff and BCK are correlated, the likely locations of W49nr1 in the HRD is a diagonal ellipse. The smaller ellipse shadow is the likely location when applying the extinction law of Indebetouw et al. (2005). The bigger shadow coming from calculations applying different extinction laws (Rieke & Lebofsky (1985), Fitzpatrick (1999) and Nishiyama et al. (2009)). The likely parameter space in the HRD was compared with the Geneva theoretical stellar evolution models (Ekström eta al. 2012; Yusof et al. 2013), using models with and without stellar rotation.



Artist's impression of W49nr1: with about 25 the diameter of our sun (orange dot on the right) (Credit: MPIA / Axel M. Quetz)

Summary

The basic parameters of this very massive star in the central cluster of W49 are summarized in the right table. As the extinction towards W49nr1 is very high, the choice of the extinction law can have a large effect on its mass and age. The age determination depends severely on the rotational velocity. The next step will be a full spectroscopic modelling of the near-infrared spectrum of W49nr1, allow us to better constrain the rotational velocity and therefore age and mass.

α(J2000) (h m s)	19:10:17.43
δ(J2000) (° ′ ″)	+9:06:20.93
J (mag)	16.57±0.18
H (mag)	13.47±0.12
K (mag)	11.93±0.10
EW(Brγ) (Å)	8.2 ± 1.7
EW(He II) (Å)	2.4 ± 0.7
EW(N III) (Å)	2.3 ± 1.0
EW(N V) (Å)	2.6 ± 0.9
Spectral type	O2-3.5If*
T_{eff} (K)	40,000 – 50,000
BC (mag)	-5.2 – -4.55
A_K (mag)	2.9^a / $2.6 - 3.5^b$
Initial mass ($M_\odot$)	$100 - 180^a$ / $90 - 250^b$
Luminosity ($L/L_\odot$)	$1.7 - 3.1\times10^{6a}$ / $1.2 - 4.9\times10^{6b}$

Notes. (a) With extinction law of Indebetouw et al. (2005) (b) With varying extinction laws (see text).

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