RevMexAA (Serie de Conferencias), **33**, 113–115 (2008)

MASSIVE BINARIES IN THE R 136 CLUSTER

N. I. Morrell,[1] P. Massey,[2] K. DeGioia-Eastwood,[3] L. R. Penny,[4] D. R. Gies,[5] Y. Tsitkin,[6,2] and E. Darnell[7]

RESUMEN

En el marco de un extenso estudio destinado a la búsqueda y seguimiento de sistemas eclipsantes masivos en cúmulos y asociaciones estelares jóvenes, hemos obtenido imágenes CCD en la banda V del cúmulo R136 en 30 Doradus, y espectroscopía de alta resolución de algunas de las estrellas variables allí encontradas. Aquí presentamos nuestro análisis preliminar de las variaciones de luz y velocidad radial observadas en 4 sistemas múltiples masivos del cúmulo R136.

ABSTRACT

As part of a large project aimed to the discovery and follow up of massive eclipsing systems in young clusters and stellar associations, we have obtained V-band CCD imaging of the R136 cluster in 30 Doradus, and high resolution spectroscopy of several among the variable stars we found there. Here we summarize our preliminary analysis of light and radial velocity variations for 4 massive multiple systems in the R136 cluster.

Key Words: binaries: eclipsing — binaries: spectroscopic — open clusters and associations: individual (R136) — stars: early-type — stars: fundamental parameters

1. INTRODUCTION

This is part of a large project devoted to the search and subsequent study of massive eclipsing systems in young OB associations and clusters in the Galaxy and the Magellanic Clouds.

The results of this study will hopefully help to a better understanding of

• the "mass discrepancy" first pointed out by Herrero et al. (1992) and recently rediscussed by Massey et al. (2005)

• the upper limit of the Initial Mass Function (IMF), if there is one, as has been claimed for example by Oey & Clarke (2005) and Figer (2005)

• the apparent tendency of OB stars to form in multiple systems (see for example, Mason et al. 1998)

• the way in which unnoticed multiplicity affects the parameters derived for massive stars, as discussed by Walborn et al. (1999), and Nelan et al. (2004) among others

• the physics of individual multiple systems containing massive stars.

2. R136 IN 30 DORADUS

One of our favorite targets in the above mentioned project is the R136 cluster which harbors the largest known concentration of O2-3 stars (those which are expected to be the most massive) as determined by spectral classification works published by Melnick (1985), Parker (1993), Walborn & Blades (1997), and Massey & Hunter (1998, hereafter MH).

The relatively moderate distance of R136 (LMC) allows imaging with 1 m class telescopes, and high resolution spectroscopy with modest exposure times. Moreover, some very massive binaries have successfully been studied there, as for example MH38, which, having an O3 primary of 57 $M_\odot$ (cf. Massey, Penny, & Vukovich 2002) showed the highest mass ever measured for a component of an eclipsing binary system at that time.

3. OBSERVATIONS

Direct imaging in the V band is carried out at the 1 m Swope telescope at Las Campanas Observatory, and at the CTIO/Yale 1.0 m telescope, operated by the SMARTS collaboration in service observing mode.

Spectroscopic observations of selected targets are obtained at Las Campanas Observatory making use

[1]Las Campanas Observatory, Carnegie Observatories, Casilla 601, La Serena, Chile (nmorrell@lco.cl).

[2]Lowell Observatory, 1400 West Mars Hill Road, Flagstaff, AZ 86001 (phil.massey@lowell.edu).

[3]Department of Physics and Astronomy, Northern Arizona University, Flagstaff, AZ 86011-6010 (kathy.eastwood@nau.edu).

[4]Department of Physics and Astronomy, College of Charleston, 101 Science Center, 58 Coming St., Charleston, SC 29424 (pennyl@cofc.edu).

[5]Center for High Resolution Astronomy and Departament of Physics and Astronomy, Georgia State University, Atlanta, GA 30303-3083 (gies@chara.gsu.edu).

[6]Massachusetts Institute of Technology (lianaiad@mit.edu).

[7]Department of Physics and Astronomy, University of Alabama (ekdarnell@bama.ua.edu).

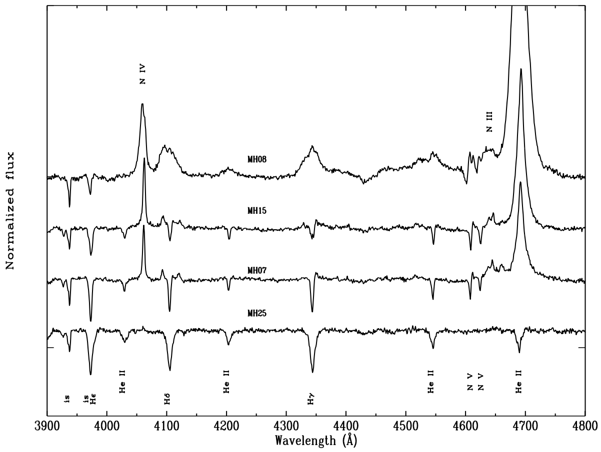

Fig. 1. Low resoltuion spectra of MH08, MH15, MH07 and MH25. Spectral types are taken from MH.

of the Magellan II (Clay) telescope with the Magellan Inamori Kyocera double echelle spectrograph (MIKE) and the du Pont telescope and its echelle spectrograph. Typical resolution is R = 28,000 and 22,000 for the blue and red side of the MIKE spectrograph, respectively; and R = 45,000 for the data obtained with the du Pont echelle.

4. RESULTS

The photometric observations provided information on dozens of new variables among the R136 stars.

We will summarize here preliminary results from 4 of them, namely MH07, MH08, MH15 and MH25. All these targets belong to the earliest spectral types, exhibit photometric variations larger than 0.2 magnitues in our V band observations, and their position in the cluster is not too crowded thus allowing imaging with $\sim 1''$ seeing. They all count among the brightest variables found in this cluster (V $\sim$ 13.0).

In Figure 1 we present low resolution spectra of these four stars obtained with the Boller & Chivens spectrograph at the Clay telescope in Las Campanas Observatory, in Nov. 2003.

MH07: The photometric variations show a probable period of 6.8282 days, while radial velocity variations with an amplitude of 55 km s^{-1} are observed for the N IV 4058 Å narrow emission line, suggesting a somewhat longer period. On the other hand, the radial velocities measured for the He II absorption lines seem to favor shorter periods, of the order of 5 days. If the two different periods are confirmed, we should be dealing with a multiple system consisting of 4 stars at least.

MH08: No obvious periodicity is found from the photometric variations, although the radial velocities obtained to date seem to vary in a period around 8 days, with an observed radial velocity amplitude of 60 km s^{-1} for the N IV 4058 Å emission line. He II lines have complicated profiles that might be multiple.

MH15: The radial velocities for N IV 4058 Å and N V 4604 Å and 4620 Å are in good agreement with the 4.6977 days period derived from the light variations. The observed velocity amplitude is $\sim$200 km s^{-1}. No features from the secondary star have been so far identified in the spectra.

MH25: The He II absorption lines show triple profiles, with a stronger component which exhibits low amplitude radial velocity variations ($\sim$50 km s^{-1}) and two fainter components wich seem to follow very well the period of 1.806 days, found from the photometric observations, with radial velocity amplitudes near $\sim$700 and $\sim$1000 km s^{-1}, respectively. This points to at least 3 stars in the system.

The radial velocity observations of these and other MC stars, are still in progress and the information here provided has to be regarded as very preliminary, pending verification through nextcoming observations, as our present-date database only counts between 7 and 10 high resolution spectra per target.

This research is based on data gathered with the 6.5 m Magellan Telescopes at Las Campanas Observatory, Chile. The authors are indebted to the Carnegie Supernova Project (CSP) team for kindly targeting R136 with the Swope telescope during observing nights allocated to CSP. The authors acknowledge support from NSF through the following grants: AST-0506577 to P. Massey, AST-0506749 to K. DeGioia-Eastwood, and AST-0453611 to E. Darnell.

REFERENCES

Figer, D. 2005, Nature, 434, 192

Herrero, A., Kudritzki, R. P., Vilchez, J. M., Kunze, D., Butler, K., & Haser, S. 1992, A&A, 261, 209

Mason, B. D., Gies, D. R., Hartkpof, W. I., Bagnuolo, W. G., Jr., ten Brummelaar, T., & McAlister, H. A. 1998, AJ, 115, 821

Massey, P., Puls, J., Pauldrach, A. W. A., Bresolin, F., Kudritzki, R. P., & Simon, T. 2005, ApJ, 627, 477

Massey, P., & Hunter, D. 1998, ApJ, 493, 180

Massey, P., Penny, L. R., & Vukovich, J. 2002, ApJ, 565, 982

Melnick, J. 1985, A&A, 153, 235

Nelan, E. P., et al. 2004, AJ, 128, 323
Oey, M. S., & Clarke, C. J. 2005, ApJ, 620, L43
Parker, J. W. 1993, AJ, 106, 560
Walborn, N. R., & Blades, J. C. 1997, ApJS, 112, 457
Walborn, N. R., Drissen, L., Parker, J. W., Saha, A., MacKenty, J. W., & White, R. L. 1999, AJ, 118, 1684

DISCUSSION

N. Walborn - In addition to the important binary results that these systems will provide, they are important reminders of the incidence of multiplicity among the bright MC OB unresolved population, which affects their analysis and interpretation.

N. Morrell - Indeed. Multiplicity has been confusing us for a long time, and still does.

Atsuo entertains Agustín (and father Roberto, too) pulling out some magic threads.