Near-IR View of Massive Binaries in Young Massive Clusters

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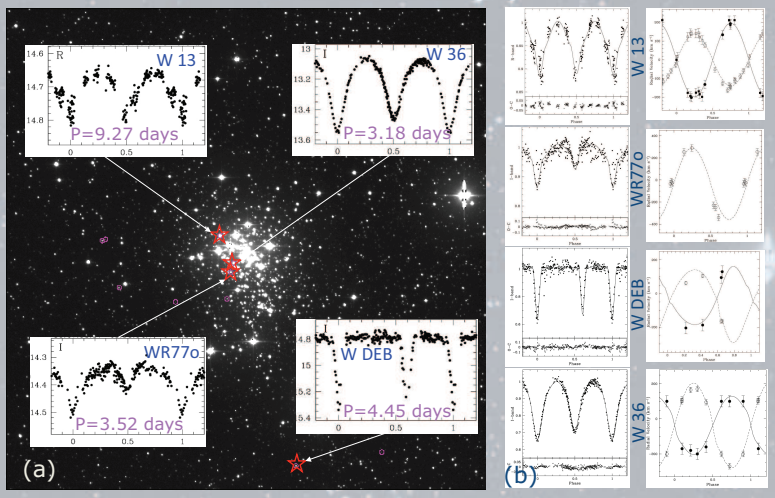
Summary

We present the results of a dedicated search for eclipsing binaries with massive (>30Mo) components in the following young, reddened, massive clusters in our Galaxy: Westerlund 1, Arches and the Danks clusters. The goal is to measure accurate fundamental parameters (radii, masses) and increase the limited sample of available measurements, thereby providing crucial constraints on models of stellar evolution and formation.

Westerlund 1



(c)

Binary	M_1 ($M_\odot$)	M_2 ($M_\odot$)	R_1 ($R_\odot$)	R_2 ($R_\odot$)	$\log g_1$	$\log g_2$
W_{DEB}	14.8 ± 3.5	11.9 ± 1.8	6.9 ± 2.0	5.3 ± 2.0	3.93 ± 0.27	4.07 ± 0.33
W36	16.3 ± 1.5	11.3 ± 1.8	11.0 ± 1.2	9.2 ± 1.2	3.57 ± 0.10	3.56 ± 0.13
W13	23.1 ± 1.1	32.9 ± 1.9	23.0 ± 1.5	21.3 ± 1.5	3.08 ± 0.06	3.30 ± 0.05
WR77o	43.4 ± 6.8	16.1 ± 2.5	12.3 ± 2.0	9.7 ± 2.0	3.89 ± 0.16	3.67 ± 0.19

We have obtained spectroscopic follow up observations of 4 candidate massive eclipsing binaries discovered by Bonanos (2007) in Westerlund 1 and measured their fundamental parameters (Koumpia & Bonanos 2012) confirming their nature.

Figure 1. (a) *I*-band finderchart (9'x9') of Westerlund 1 from the Swope 1-meter telescope at Las Campanas Observatory, Chile with the phased light curves of the 4 candidates overplotted. (b) Model fits to the phased light curves and radial velocity curves of the 4 binaries. (c) Table with fundamental parameters determined for the systems, including two components >40Mo.

Arches Cluster

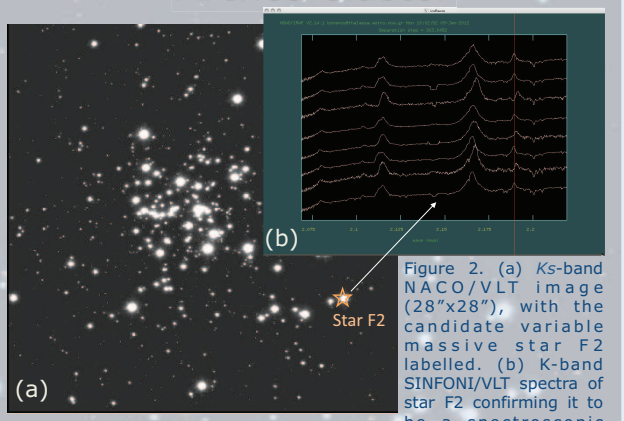


Figure 2. (a) *Ks*-band NACO/VLT image (28"x28"), with the candidate variable massive star F2 labelled. (b) K-band SINFONI/VLT spectra of star F2 confirming it to be a spectroscopic binary.

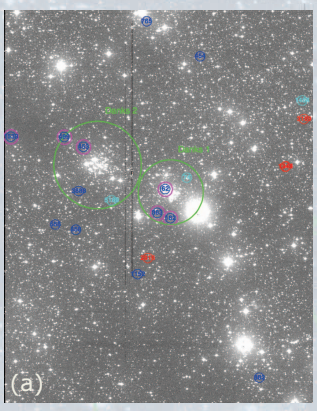
Our search for eclipsing binaries in the Arches cluster in the near-IR with adaptive optics images from NACO/VLT identified star F2 as a candidate variable. We therefore obtained spectroscopic follow up observations in the near-IR with SINFONI/VLT (Program 087.D-0342 (A)) and found that F2 is a spectroscopic binary.

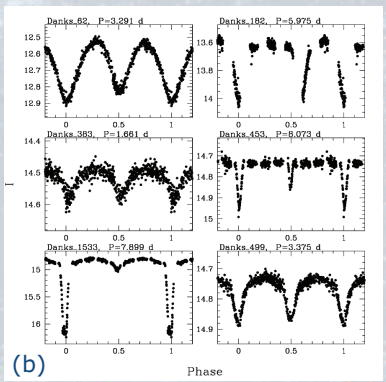
Cluster Properties*

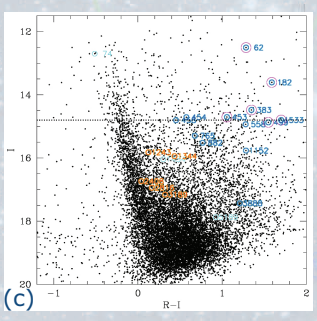
Cluster Name	Log Mass (Mo)	Age (Myr)	Radius (pc)
Westerlund 1	4.75	3.5-5	0.60
Arches	4.30	2-3	0.19
Danks 1	3.90	1-3	0.17
Danks 2	3.48	2-6	0.36

* Values are from Crowther+06, Figer+02, Davies+12.

Danks 1 & 2 Clusters



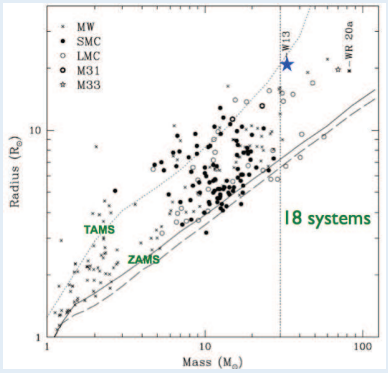




We have conducted a variability survey of the Danks clusters (25 nights in 2011 with the Swope 1-meter at Las Campanas Observatory) and discovered 21 eclipsing binaries (Bonanos, Koumpia & Prieto, in prep.). Spectroscopy of the 6 selected candidate massive targets (out of 13 cluster members) will be obtained in the near-IR with ISAAC/VLT (Program 090.D-0065(A)).

Figure 3. (a) *I*-band finderchart (15'x23') of the Danks clusters from the Swope telescope, with the clusters labelled in green, candidate cluster and foreground eclipsing binaries with blue and red circles, respectively. (b) Phased light curves of 6 systems selected for follow up. (c) I vs. R-I color magnitude diagram, with eclipsing binaries marked as circles. (dark blue: cluster members, cyan: possible members, red: foreground binaries).

Fundamental Parameters



The goal of this work is to populate the above diagram with accurate (<10%) measurements of masses and radii of the most massive stars in eclipsing binaries at a variety of masses, metallicities and evolutionary stages, in order to provide constraints for stellar evolution and formation models. There are currently **18 stars** that fulfill these requirements in the literature (Koumpia & Bonanos 2012). Our targets in the reddened Danks & Arches clusters will significantly increase the available number of accurate measurements.

References: Bonanos 2007, ApJ, AJ, 133, 2696; Bonanos & Koumpia 2012, A&A, in press; Crowther et al. 2006, MNRAS, 372, 1407; Davies et al. 2012, MNRAS 419, 1871; Figer et al. 2002, ApJ, 581, 258.

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