New Results from the Project MASGOMAS: Near Infrared Study of the Stellar Population of Sh2-152

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Abstract: We present a near-IR characterization of the stellar population of Sh2-152, as part of our project MASGOMAS. Using near-IR *H* and *K* spectra for 6 stars in the field, we have obtained an estimate for the cluster distance, mass and age (upper limit). We also present a new optical spectrum for the central ionizing star of Sh2-152, showing some peculiarities associated to this central object and shed some light over the interesting star embedded into the remarkable bright nebulosity, near to IRAS 22566+5828.

MASGOMAS: The program MASGOMAS (MAssive Stars in Galactic Obscured MAssive clusterS, Marín-Franch et al. 2009) is dedicated to characterize the stellar population of known massive clusters candidates and identify new ones. Based on previous catalogues of galactic cluster candidates (Bica et al., 2003; Dutra et al., 2001), we had completed a near-IR photometric survey (*J*, *H* and K_S) for all our candidates and a spectroscopic follow up for 9 of them. Previous results of the program were published by Marín-Franch et al (2009) and Puga et al. (2010)

Observations of Sh2-152: One of these 9 candidates is the ultracompact H_{II} region Sh2-152. With coordinates $\alpha(J2000)=22^h58^m45^s$ and $\delta(J2000)=+58°46'50''$, this star forming region is situated along l=108.76, close to the Galactic plane (b=-0.95) and has associated H_2O and OH masers (Harju et al. 1998), suggesting massive star forming activity.

Our whole near-IR data set was obtained with LIRIS, an IR camera, equipped with a Hawaii 1024x1024 HgCdTe array detector, with a field of view of 4.2'x4.2'. LIRIS has imaging, polarimetric and spectroscopic (single and multiobject) modes. Images were obtained with seeing around 0.6'', while spectroscopy was acquired with seeing around 1.0''.

With the LIRIS near-IR imaging, we could resolve the central region of the cluster. The central ionizing star, previously classified as an 09V star (Russeil et al. 2007), was spectroscopically observed at optical wavelength with the FIES cross disperser (R=46000) echelle spectrograph at NOT 2.5m (ORM-La Palma).

The images were reduced with FATBOY (Eikenberry et al. 2006) and the photometry was calibrated using 2MASS. The reduction of the infrared spectra was done with LIRISDR, while the telluric correction was completed with xtellcor (Vacca et al. 2003) and the IRAF task, telluric. The optical spectrum was reduced using the FIEStool pipeline.

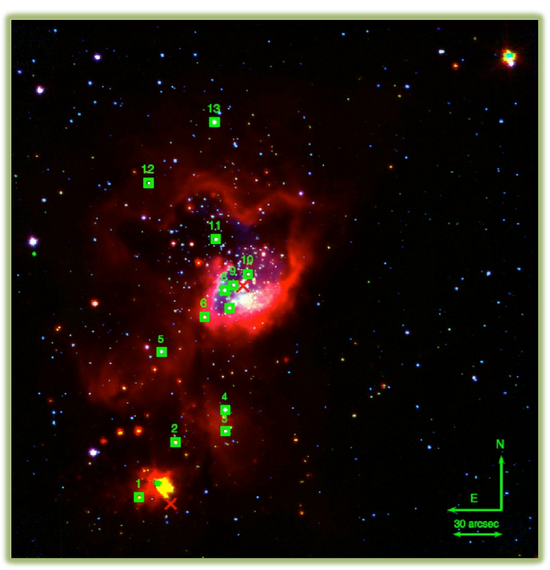

Fig 1: False colour image for Sh152-2, using LIRIS and Spitzer images (blue=J, green=K_S and red=Spitzer 3.6 μm).
In this image, we mark the MOS stars with small green squares (numbered) and with red crosses the central coordinates for the IRAS regions IRAS 22566+5830 (central) and IRAS 22566+5828 (down).

Spectral Classification and Distance: We classified the thirteen spectroscopically observed sources, using Hanson et al. (1996), Wallace & Hinkle (1997), Hanson et al. (1998), Meyer et al. (1998), Ranade et al. (2004 & 2007) near-IR stellar spectral catalogues. Adopting intrinsic colours (Ducati et al. 2001), absolute magnitudes (Cox, 2000) and an extinction law with R=3.09 (Rieke & Lebofsky, 1985), we have determined, using for the first time multiple sources in the field, the cluster distance (3.23 ± 0.17 Kpc).

ID	Spectral Type	A_{Ks}	Distance
01	B1V	2.60	3.35
03	B3V	0.60	3.18
04	B2V	0.50	2.92
05	B2V	0.61	3.98
08	B3V	0.65	3.11
10	B5V	0.86	2.80

ID	Spectral Type
02	YSO
06	--
07	--
09	--
11	G6-7
12	G8
13	G8-9 III

Table 1: Spectral classification and distance derived for stars selected for MOS.

References:
Bica et al. 2003, A&A, 404, 223
Cox, 2000, Allen's Astrophysical Quantities, 4th ed.
Ducati et al. 2001, ApJ, 558, 309
Dutra et al. 2001, A&A, 376,434
Eikenberry et al. 2006, SPIE, 6269, 39
Hanson et al. 1996, ApJS, 107,281
Hanson et al. 1998, AJ, 116, 1915
Harju 1998, A&AS, 132, 211
Helou & Walker 1988, IRAS, vol 7
Marín-Franch et al. 2009, A&A, 502, 559
Meyer et al. 1998, AJ, 508, 397
Puga et al. 2010, A&A in press
Ranade et al. 2004, Bull.Astr.Soc. India, 32, 311
Ranade et al. 2007, Bull.Astr.Soc. India, 35, 87
Rieke & Lebofsky
Russeil et al. 2007, A&A, 470, 161
Vacca et al. 2003, PASP, 115, 389
Wallace & Hinkle 1997, ApJS, 111, 445

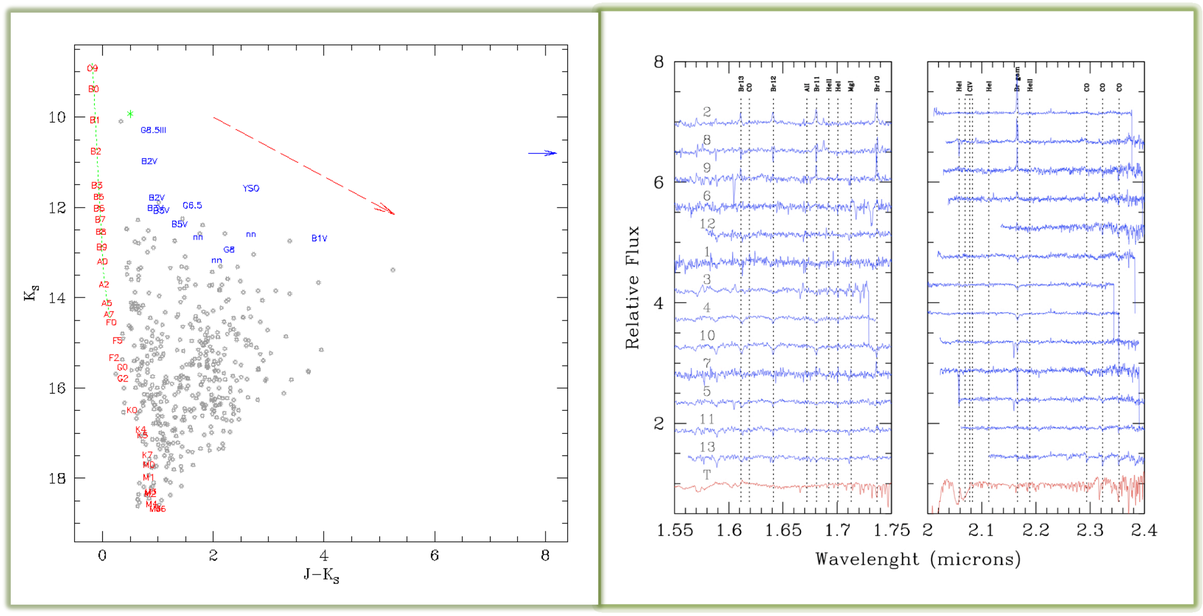

Fig 2: Left: Colour-Magnitude Diagram for Sh2-152. The main sequence is located at 3.23Kpc. Spectral types in blue indicate the MOS stars, the green asterisk gives the position of the central cluster star and the origin of the blue arrow shows the bluest position of the central star embedded into the bright nebulosity, associable with IRAS 22566+5828.
Right: H and K spectra for MOS stars. In red are shown the telluric spectra. The lines used for the classification are labeled.

Cluster Mass: The cluster mass was obtained by subtracting the stellar population from the Galactic disk, using *J-H-*K_S images from a control field. The cluster and control field histograms, previously corrected for completeness, were subtracted leaving the luminosity function for the object. The cluster total mass derived with this method is $(2.63 \pm 1.13)\cdot10^3 M_\odot$

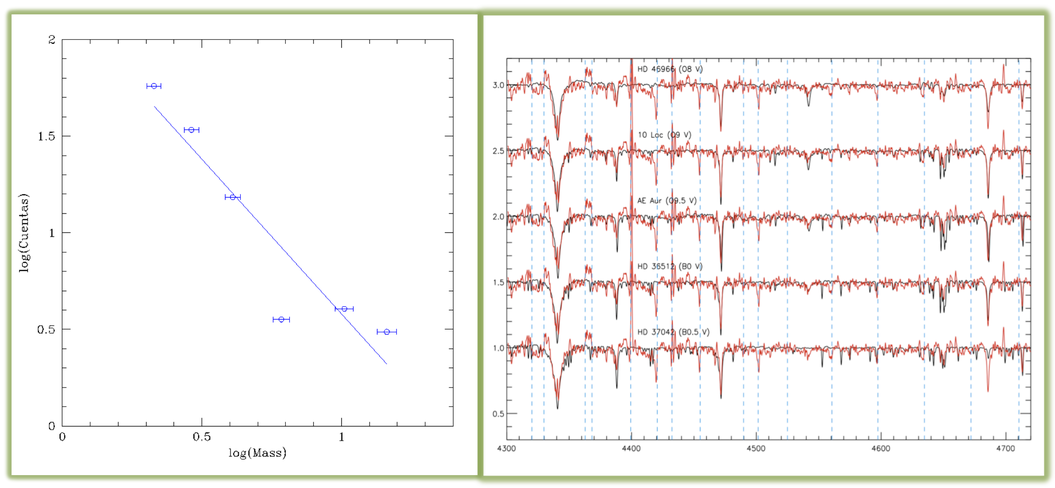

Fig 3: Left: Mass function for Sh2-152; the solid blue line corresponds to the best fit to the data. Right: FIES optical spectra for the central star of the cluster (red) is compared with spectral types templates (O8V-B0.5V, in black).

Possible Ionizing Sources: Within the Sh2-152 field there are also two interesting sources. First, the central star of the cluster, that has been classified as O8.5V (star #4, Russeil et al. 2007) and gives an upper limit for the cluster's age (<10 Myr). From our optical spectra we derive the same spectral type but with two peculiarities:

1) The HeII 4686Å line is similar to HeI 4471Å and deeper than HeI 4388Å. Similar characteristics have been reported in OVz stars (Walborn, 2007).
2) The absence of SiIII (4553 and 4574Å), setting the spectral type to earlier than O9V, which is not consistent with HeII spectrum, and indicate a possible composite character.

Complementary observations are necessary for a better spectral classification.

The second object is a star probably associated with IRAS 22566+5828 (Helou & Walker, 1988). This object was not selected as MOS candidates, due to its large extinction (*J-*K_S > 7), being impossible to measure its J brightness (see Fig 4). With K_S=10.8 and assuming the distance of 3.23 Kpc calculated for the cluster, the central star of IRAS 22566+5828 would have an spectral type earlier than O4V, being the most massive object of the cluster.

Future *K* or mid-IR spectra for this object would clarify its spectral type, diminish the cluster age and increase the upper part of the mass function.

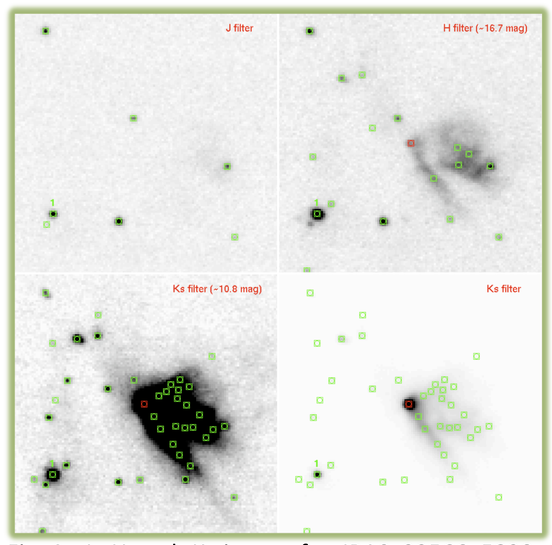

Fig 4: *J*, *H* and K_S image for IRAS 22566+5828. Green squares mark the objects detected in our photometry. The red one, would correspond to the central ionizing star of the nebulosity.

CONCLUSIONS:

We have determined, for first time using near-IR spectra for multiple sources in the field, the distance, mass and age (upper limit) for the cluster Sh2-152.

- Distance = 3.23 ± 0.17 Kpc (in agreement with Russeil et al. 2004)
- Mass = $(2.63 \pm 1.13)\cdot10^3 M_\odot$ (using the cluster's luminosity function)
- Age < 10 Myr

Future works include the near-IR observation and analysis of the possible ionizing stars of IRAS 22566+5830 and IRAS 22566+5828. The spectral classification of the last one, could improve the cluster age and mass determination.