THE MASGOMAS PROJECT

A Spectroscopic Study of G61.48+0.09

A. Herrero[1], A. Lenorzer[1], A. Marín-Franch[1], F. Najarro[2], D. Figer[3], B. Davies[3], A. Font[1]

[1] Instituto de Astrofísica de Canarias, [2] Instituto de Estructura de la Materia (CSIC), [3] Chester F. Carlson Center for Imaging Science ,RIT

ABSTRACT The MAssive Stars in Galactic Obscured Massive clusterS (MASGOMAS) project is a survey of massive clusters candidates and their stellar content. For the time being, MASGOMAS is targeting northern cluster candidates using the IR imaging and spectroscopic capabilities of LIRIS at the WHT. As a first study, we present results for the G61.48+0.09 cluster.

1. MASGOMAS

Motivation

In recent years, the number of massive clusters has remarkably increased, either by discovery of new clusters or by deeper observations of its stellar content. Thus, massive clusters comparable to those oberved in nearby galaxies have been identified and the total stellar mass contained in Galactic massive clusters has been multiplied by a large factor. Figure 1 illustrates this situation.

At the same time, the GTC community is involved in a large effort to build the largest optical-IR telescope and provide it with first-line instruments like EMIR, a NIR mid-resolution MOS, ideally suited to study the stellar content of these clusters.

Inspired by this situation, we have started a survey of massive cluster candidates in the Milky Way, the MASGOMAS project.

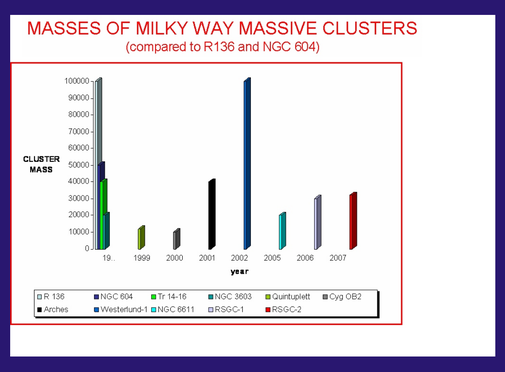


Figure 1
The mass of Galactic clusters versus the year of their identification as a massive cluster. Before last decade, NGC 3603 and Tr 14-16 could be considered the most massive clusters in the Milky Way, however clearly below the masses of R136 in the LMC or NGC 604 in M33. Starting 1999 a number of new massive clusters appear in the literature, even reaching mass estimations comparable to that of R136 and increasing the estimated total mass of Galactic massive clusters by at least a factor of 10. Cluster masses are in solar masses. Note that these may be controversial (see f.e. Brandner et al., 2007, astro-ph 0711.1624). The years are remarkable dates for the clusters, chosen with some degree of arbitrarity. References: R136: Massey & Hunter, 1998; NGC 604: Yang et al., 1996; Tr 14-16: Massey & Johnson, 1993; NGC 3603: Harayama et al., 2007; Quintuplett: Figer et al., 1999 ; Cyg OB2 : Hanson, 2003 ; Arches : Portegies Zwart et al., 2001 ; Wd-1 : Clark et al., 2005 ; RSGC-1 : Figer et al., 2006 ; RSGC-2 : Davies et al., 2007, astro-ph 0708.0821

Aims:

To identify and study massive obscured clusters in the Milky Way, in order to

1. Study the IMF in new massive clusters under different local conditions
2. Find the most massive stars formed in different environments in the Galaxy
3. Estimate the number and location of massive clusters in the MW
4. Estimate the current Star Formation Rate in the Galaxy as function of galactocentric distance and local metallicity

Strategy

1. Select northern cluster candidates from Dutra & Bica + GLIMPSE
   - Use criteria favouring the presence of massive stars
2. Observe them photometrically
   - With better resolution (0.25”/pixel) and deeper photometry than 2MASS
   - Using JHK and (sometimes) narrow band filters
3. Observe the most promising ones with MOS+long slit spectroscopy
   - R= 2500 in K, R= 800 in H (until LIRIS gets an already delivered mid-resolution H grating)
   - Classify stars
   - Derive cluster properties, find peculiar objects
4. If succesful, extende the project
   - Southern hemisphere
   - EMIR@GTC

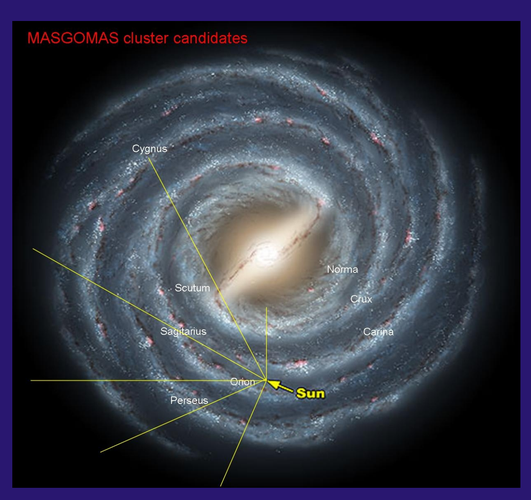


Figure 2
Artistic view of the Milky Way showing the coverage in galactic longitude of MASGOMAS cluster candidates.

MASGOMAS observations up to date

47 cluster candidates selected
37 photometrically observed (J,H,K, sometimes narrow band filters)
Low-res HK + mid-res K MOS and longslit for 2 of them

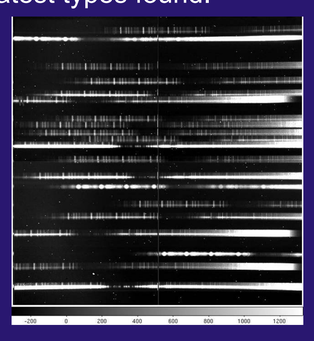
More observations in December 2007

Figure 3
JHK composite figures from MASGOMAS LIRIS observations

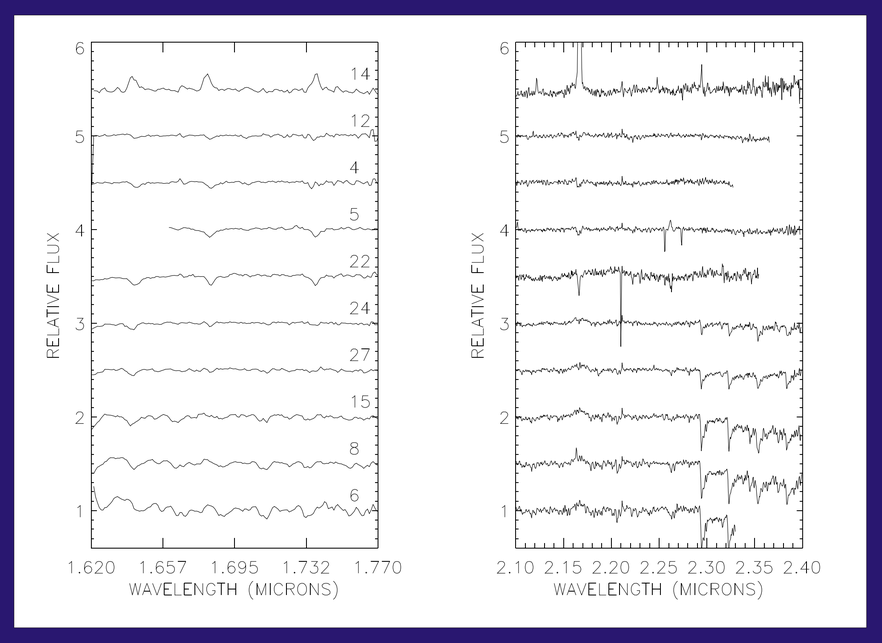
2. Spectroscopic Study of G61.48+0.09

The cluster G61.48+0.09

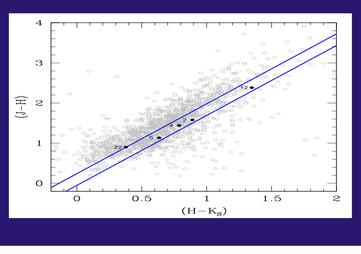
This is a young cluster with a large HII region and strong differential reddening (see Puga et al., 2004). Its distance has been estimated from 2.0 to 6.0 kpc (Deharveng et al., 2000). Figure 4 (below) is an example of a LIRIS MOS H+K observation of this cluster. Figure 5 (right) shows an image from JHK LIRIS observations, with labels for the earliest and latest types found.



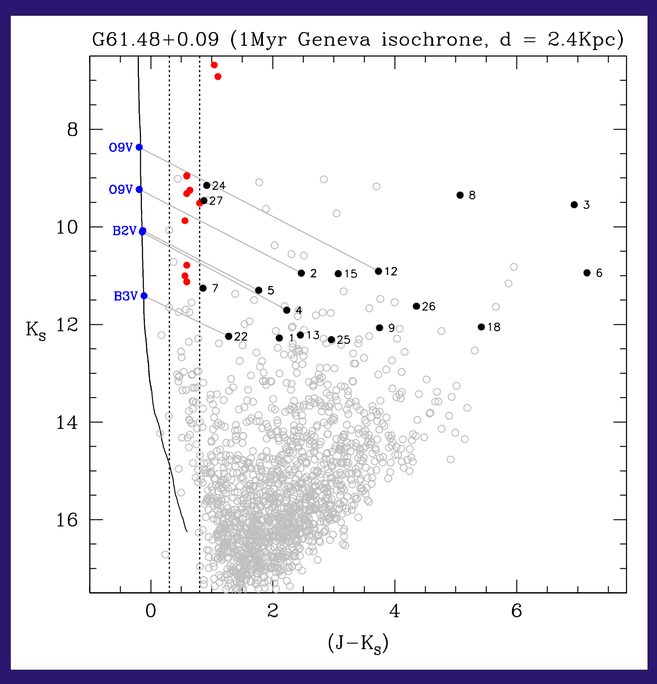
Star	SpT	Ks
#3	ELO	9.1
#14	ELO	10.4
#2	O9V	9.1
#12	O9V	10.0
#4	B1V	9.2
#5	B2V	9.2
#22	B3-B5V	10.9
#17	F	10.6
#9	G3III	9.5
#13	G4III	10.1
#7	G5III	9.3
#24	G6III	11.0
#18	G7III	10.6
#25	G8III	11.1
#27	G9III	11.2
#26	K0III	11.2
#15	K3III	10.4
#8	M2III	9.5
#6	M3III	9.4



Spectra in G61.48+0.09
Table: Spectral types determined for stars observed with LIRIS in G61.48+0.09. ELO means “Emission Line Object”. For the classification the catalogs of Hanson (1996, 1998) and the spectral type-EW(CO) relation in Davies et al. (2007) were used. Figure: the left panel displays the low resolution (R= 800) H-band spectra; the right panel displays the intermediate resolution (R= 2500) K-band spectra. Shown are one ELO, four early types, and five late type giants.



Color-Color Diagram for the stars in the field of G61.48+0.09 showing the position of the early type stars. Their different locations in the color-color diagram and the CMD below indicate the strong differential redenning in the cluster. The two blue lines indicate the locii occupied by the B1V and O8V spectral types when affected by reddening, assuming a Rieke extinction law (Rieke et al., 1989)



Color-Magnitude Diagram and isochrone for G61.48+0.09. The open grey circles are the stars in the cluster field observed photometrically. The solid black circles are the stars that have been observed spectroscopically, either with long slit or MOS. The red circles mark the location of late type stars when corrected for reddening. Most of them suffer large extinction, indicating that they are behind the cluster. The blue circles mark the location of the early type stars when corrected for reddening, assuming that they are luminosity class V stars. Note that they cannot be luminosity class I stars because then the late type stars should be very luminous red supergiants, which is discarded by their K band spectra. The reddening corrected position of the early type stars is fully consistent with isochrones of 1 Myr at the distance of 2.4 kpc (Deharveng et al., 2004).

Conclusions: Parameters for G61.48+0.09

Age (best fit) = 1 Myr
Age (upper limit) < 4.5 Myr
Mass: 10^3 < M(cluster) < 5x10^3 $M_\odot$
D= 2.4 kpc (Deharveng et al. 2004, consistent with our data)
earliest spectral type identified: O9V
earliest possible spectral type O4V

Future work

Complete the photometric survey in the northern hemisphere
Observe spectroscopically with LIRIS the most promising candidates
Extend the survey to the Southern hemisphere
Use EMIR@GTC for high SNR intermediate IR spectroscopy

References
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