Cl1813-178: A new young massive stellar cluster in the Milky Way & Identification of new massive stars

Maria Messineo
MPIfR (Bonn)
A new massive cluster: Cl 1813-178

MASSIVE STARS IN THE CI 1813-178 CLUSTER: AN EPISODE OF MASSIVE STAR FORMATION IN THE W33 COMPLEX

MARIA MESSINEO1,2, BEN DAVIES3,4,5, DONALD F. FIGER3, R. P. KUDRITZKI6,7, ELENA VALENTI8, CHRISTINE TROMBLEY3, F. NAJARRO9, AND R. MICHAEL RICH10

1 European Space Agency (ESA), The Astrophysics and Fundamental Physics Missions Division, Research and Scientific Support Department, Directorate of Science and Robotic Exploration, ESTEC, Postbus 299, 2200 AG Noordwijk, The Netherlands; messineo@mpifr-bonn.mpg.de
2 Max-Planck-Institut f"ur Radioastronomie, Auf dem Hugel 69, D-53121 Bonn, Germany
3 Center for Detectors, Rochester Institute of Technology, 74 Lomb Memorial Drive, Rochester, NY 14623, USA
4 School of Physics & Astronomy, University of Leeds, Woodhouse Lane, Leeds LS2 9JT, UK
5 Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UK
6 Institute for Astronomy, University of Hawaii, 2680 Woodlawn Drive, Honolulu, HI 96822, USA
7 Max-Planck-Institute for Astrophysics, Karl-Schwarzschild-Str. 1, 85748 Garching, Germany
8 European Southern Observatory, Karl Schwarzschild-Strasse 2, D-85748 Garching bei Munchen, Germany
9 Centro de Astrobiologíca (CSIC-INTA), Ctra. de Torrelodones km4, 28850, Torrelodones, Madrid, Spain
10 Physics and Astronomy Building, 430 Portola Plaza, Box 951547, Department of Physics and Astronomy, University of California, Los Angeles, CA 90095-1547, USA

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ABSTRACT

Young massive ($M > 10^4 M_\odot$) stellar clusters are a good laboratory to study the evolution of massive stars. Only a dozen of such clusters are known in the Galaxy. Here, we report about a new young massive stellar cluster in the Milky Way. Near-infrared medium-resolution spectroscopy with UIST on the UKIRT telescope and NIRSPEC on the Keck telescope, and X-ray observations with the Chandra and XMM satellites, of the CI 1813-178 cluster confirm a large number of massive stars. We detected 1 red supergiant, 2 Wolf-Rayet stars, 1 candidate luminous blue variable, 2 O, and 19 OB stars. Among the latter, twelve are likely supergiants, four giants, and the faintest three dwarf stars. We detected post-main-sequence stars with masses between 25 and 100 $M_\odot$. A population with age of 4–4.5 Myr and a mass of $\sim 10,000 M_\odot$ can reproduce such a mixture of massive evolved stars. This massive stellar cluster is the first detection of a cluster in the W33 complex. Six supernova remnants and several other candidate clusters are found in the direction of the same complex.

Key words: infrared; stars – stars: evolution

Online-only material: color figures

1. INTRODUCTION

An understanding of the mechanisms of formation, evolution, and end state of massive stars is fundamental for the study of clusters and massive stars with the TeV γ-ray source HESS J1813–178. Interestingly, the W33 complex appears to contain several other candidate stellar clusters and several SNRs. Clusters do form in large complexes (e.g., Beuther et al. 2007), and their spatial distribution varies...
CI 1813-178

SNR G12.82-0.02
HESS J1813-178
SNR G12.72-0.0
W33

2MASS

3.6 um
8 um
90 cm
Cl 1813-175

74 Chandra point sources from Helfand et al. (2007)
All but one new detections.

WN7

cLBV

O6-O7f+

WN7

O8-O9If
Cl 1813-178

- $\text{Ak} = 0.8 \text{ mag}$
- $D = 4.8 \text{ kpc}$
- Age = 4-4.5 Myr
- Mass $\sim 10,000 \text{ Msun}$

Meynet & Maeder (2000)
W33 complex

24 um MIPSIGAL
20 cm MAGPIS
Stellar Clusters
SNRs

[BDS2003]115
[BDs2003]7
CI1813–178
CI1
CI2
Mercer1
SNR1
SNR2
SNR3
SNR4
SNR5
SNR6
W33A

Right Ascension
Center: R.A. 18 13 14.93 Dec -17 47 57.6

Declination
SINFONI program ongoing
Co-I Messineo M., Figer D., Davies B., Menten K., Ivanov V., Clark S

3-Colors 2MASS images
Cl1813-178

Scutum-Crux

Sagittarius Carina

Perseus

Cordes & Lazio (2003)
15 MASSIVE CLUSTERS IN THE MILKY WAY.
Revised version of Table 4 in Messineo et al. (2009, ApJ 697, 701)

Table 1. Galactic massive clusters (> 10^4 Msun).

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>RSGC2</td>
<td>26.2</td>
<td>0.0</td>
<td>5.8±1.9</td>
<td>17 ± 3</td>
<td>40 ± 10</td>
<td>Davies et al. (2007)</td>
</tr>
<tr>
<td>Westerlund1</td>
<td>339.5</td>
<td>-0.4</td>
<td>3.6 ± 0.2</td>
<td>3.6 ± 0.7</td>
<td>36 ± 22</td>
<td>Brandner et al. (2008)</td>
</tr>
<tr>
<td>RSGC1</td>
<td>25.3</td>
<td>-0.2</td>
<td>6.6 ± 0.9</td>
<td>12.0 ± 2.0</td>
<td>30 ± 10</td>
<td>Davies et al. (2008)</td>
</tr>
<tr>
<td>RSGC3</td>
<td>29.2</td>
<td>-0.2</td>
<td>6 ± 1</td>
<td>18.0 ± 2.0</td>
<td>30 ± 10</td>
<td>Clark et al. (2009)</td>
</tr>
<tr>
<td>Arches</td>
<td>0.1</td>
<td>0.0</td>
<td>7.62 ± 0.32^a</td>
<td>2.5 ± 0.5</td>
<td>~ 20</td>
<td>Figer (2008); Figer et al. (1999a)</td>
</tr>
<tr>
<td>Quintuplet</td>
<td>0.2</td>
<td>-0.1</td>
<td>7.62 ± 0.32^a</td>
<td>4 ± 1</td>
<td>~ 20</td>
<td>Figer (2008); Figer et al. (1999a)</td>
</tr>
<tr>
<td>GC central</td>
<td>0.0</td>
<td>0.0</td>
<td>7.6 ± 0.3^a</td>
<td>6.0 ± 2.0</td>
<td>20</td>
<td>Martins et al. (2007)</td>
</tr>
<tr>
<td>NGC3603</td>
<td>291.6</td>
<td>-0.5</td>
<td>6.0 ± 0.8</td>
<td>&lt; 2.5</td>
<td>13 ± 3</td>
<td>Harayama et al. (2008)</td>
</tr>
<tr>
<td>Trumpler14</td>
<td>287.4</td>
<td>-0.6</td>
<td>~ 2.8</td>
<td>3.25 ± 2.75</td>
<td>10 ± 1</td>
<td>Ascenso et al. (2007b)</td>
</tr>
<tr>
<td>Cyg OB2</td>
<td>80.2</td>
<td>0.8</td>
<td>~ 1.5</td>
<td>~ 2.5</td>
<td>~ 10^b</td>
<td>Negueruela et al. (2008)</td>
</tr>
<tr>
<td>W49A</td>
<td>43.2</td>
<td>0.0</td>
<td>11.4 ± 1.2</td>
<td>1.2 ± 1.2</td>
<td>~ 10</td>
<td>Homeier &amp; Alves (2005)</td>
</tr>
<tr>
<td>CI1813-178</td>
<td>12.7</td>
<td>0.0</td>
<td>3.6 ± 0.7</td>
<td>4.5 ± 0.5</td>
<td>&gt; 10</td>
<td>Messineo et al. (2008, 2011)</td>
</tr>
<tr>
<td>Alicante 7-RSGC5</td>
<td>29.2</td>
<td>-0.2</td>
<td>6 ± 1</td>
<td>18.0 ± 2.0</td>
<td>&gt; 10</td>
<td>Negueruela et al. (2011)</td>
</tr>
<tr>
<td>Alicante 8-RSGC4</td>
<td>24.6</td>
<td>0.4</td>
<td>6.6 ± 0.9</td>
<td>20</td>
<td>~ 10</td>
<td>Negueruela et al. (2010)</td>
</tr>
<tr>
<td>Westerlund2</td>
<td>284.3</td>
<td>-0.3</td>
<td>~ 2.8</td>
<td>2.0 ± 0.3</td>
<td>&gt; 7^c</td>
<td>Ascenso et al. (2007a)</td>
</tr>
</tbody>
</table>

Note. — For each cluster, names and Galactic coordinates are followed by distances, ages, masses, and references.

^aDistance to the Galactic center as given by Eisenhauer et al. (2005).

^bA mass of 10000 M_☉ is estimated using a number of 50 stars more massive than 20 M_☉ (Negueruela et al. 2008), and a Salpiter
Cluster identification is not an easy task.

Spectroscopy is expansive and only possible for a limited number of targets.

New efficient searches based on photometric classification of bright targets are mandatory.
## Near and mid-IR Galactic Survey

<table>
<thead>
<tr>
<th>Survey</th>
<th>Reference</th>
</tr>
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<tbody>
<tr>
<td>Two Micron All Sky Survey (2MASS)</td>
<td>470.992.970 P.S.</td>
</tr>
<tr>
<td>The Deep Near-Infrared Survey (DENIS)</td>
<td>355.220.325</td>
</tr>
<tr>
<td>The UKIRT Infrared Deep Sky Survey (UKIRT)</td>
<td>$2 \times 10^9$</td>
</tr>
<tr>
<td>The VISTA survey</td>
<td>similar to UKIRT</td>
</tr>
<tr>
<td>The ISO infrared survey of the Galactic Plane (ISOGAL)</td>
<td>106.150</td>
</tr>
<tr>
<td>The Midcourse Space Experiment (MSX)</td>
<td>177.860</td>
</tr>
<tr>
<td>The Galactic Legacy Infrared Mid-Plane Survey Extraordinaire (GLIMPSE)</td>
<td>104.240.613</td>
</tr>
</tbody>
</table>
In the Milky Way, we know about:

500 (1000) RSGs (119 in clusters)  5000 M-type RSGs
226 WR stars (van der Hucht 2001)  3000 WR  + ...

A dozen confirmed LBVs (Clark et al. 2005)

Several thousands of AGBs have been detected via their maser emission, or photometric pulsation properties (e.g. Alard et al. 2001; Glass et al. 2001; Habing et al. 2006; Messineo et al. 2002; Sevenster 2002; Deguchi et al. 2004, and references therein).
(9 millions Miras).

Predictions by Gehrz 1989

AKs = 3 mag

Q2

Free-free

46% RSGs

Q2

Q1
Detectability depends on Cluster mass

14 RSGs make a cluster.

RSGC1, Figer et al. (2006)
Candidate stellar clusters

AIUK 59

VIUK 10

VIUK 14

Ivanov, V. et al. IAUS, 266, 203
Messineo, M., Zhu, Q., Ivanov, V., et al. in preparation
Parallactic distances of all known maser sources using VLBI observations will be soon available: **BESSEL survey**

European side is financed by GLOSTAR: *A Global View of Star Formation in the Milky Way* (EU grant - Menten K.)

Brunthaler et al. 2011

Artistic view of the MW by NASA/JPL -- credit to Hurt (IPAC)
An homogeneous re-calibration (distance, extinction)

Parallax measurements for 28 regions have already been published.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>HII region</th>
<th>Spectro-phot</th>
<th>Parallactic</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLIMPSE9</td>
<td>G23.01-0.41</td>
<td>4.24$^{+0.40}_{-0.40}$</td>
<td>4.59$^{+0.38}_{-0.38}$</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Brunthaler al. (2009)</td>
</tr>
<tr>
<td>Cl 1813-178</td>
<td></td>
<td>3.6$^{+0.7}_{-0.7}$</td>
<td>To come</td>
</tr>
<tr>
<td>Cyg OB2</td>
<td>Cygnus/ W75N</td>
<td>1.5</td>
<td>1.32$^{+0.11}_{-0.11}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rygl et al. (2010)</td>
</tr>
</tbody>
</table>

Soon a *recalibration* the intrinsic properties of OB stars will be possible.
THANK YOU