A SEARCH FOR NEW VERY LOW-MASS MEMBERS WITH DISKS IN THE *CORONET* CLUSTER

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Abstract

We report on the results of an infrared study of the *Coronet* cluster in the core of the Corona Australis star forming region. *Spitzer* IRAC and MIPS 24 μm data are combined with 2MASS near-infrared photometry to identify nine new candidate members of the cluster using different colour criteria documented in the literature. For three of them, optical photometry is available, enabling us to derive their effective temperatures and gravities from the fitting of their SEDs. According to our results, if they indeed belonged to the Coronet cluster, these three objects would be substellar, thus being among the lowest mass objects with disks identified so far in this region ($M<0.030\ M_{Sun}$). One of these sources could be the lowest-mass object identified so far to possess a disk with an inner hole.

Object selection

To look for new candidate members of the *Coronet* cluster harbouring disks, we made use of the IRAC ([3.6]-[4.5], [5.8]-[8.0]) colour-colour diagram. In this diagram, class I and class II sources tend to have positive colours, while class III sources and field objects are located around the origin (e.g. Allen et al. 2004; Hartmann et al. 2005; Barrado y Navascués et al. 2007). We used other colour criteria from the literature (Harvey et al. 2006; Gutermuth et al. 2008) to purge our selection from likely contaminants.

We retrieved 24 objects (4 class I and 20 class II sources); nine of them (one class I and 8 class II sources) had not been reported in previous works. Three of these new candidate members are detected in the optical survey by López Martí et al. (2005).

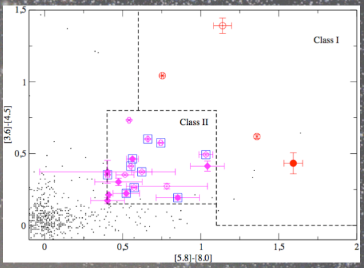


Figure 1
IRAC ([3.6]-[4.5], [5.8]-[8.0]) colour-colour diagram for the RCrA sources. The dashed lines indicate the boundaries for the selection loci for class I and II sources. Open and solid symbols indicate objects known from previous studies and new candidates from this work, respectively. The red circles are class I sources and the magenta diamonds, class II sources. Objects with optical counterparts are encircled with blue squares.

Spectral energy distributions (SEDs)

With the available photometry, we constructed the SEDs of our new candidates, confirming the mid-infrared excess with the VOSA tool (Bayo et al. 2008). One source, IRAC-CrA 5, displays a small excess only at 24 μm, suggestive of a transitional disk with an inner hole, or a debris disk. This object has no optical photometry because it is located outside the boundaries of the optical survey.

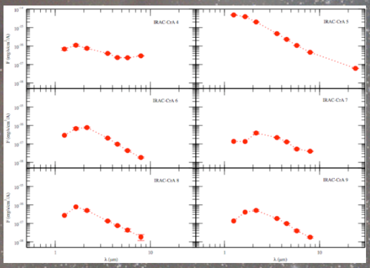
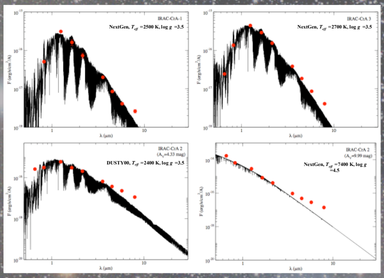


Figure 2
Observed SEDs for our new candidate members without optical counterparts.

For the sources with optical counterparts (IRAC-CrA 1, 2 and 3), we tried to fit the observed SEDs to model photospheres. The distance was set to 170 pc for all objects (Knude & Høg 1998). For the extinction, two values were explored for each object: One derived from a 2MASS star count map, and another one derived from the J–K colour of the sources. This second value is expected to be more accurate if the object is indeed a cloud member, while the star-count value represents the most pesimistic case in which the source is located behind the cloud.

Figure 4
SED of our new candidate members IRAC-CrA 1, 3 and 2 (red dots), compared to their best-fitting photospheres (solid black lines). For IRAC-CrA 2, we show the results using the extinction derived from the near-infrared colour (left) and the star counts (right).



According to the SED fitting results, IRAC-CrA 1 and 2 would be two relatively evolved low-mass brown dwarfs ($M<0.040 M_{Sun}$, ages 3-7 Myr), with little mid-infrared excess. In particular, the SED of IRAC-CrA 1, with no significant excess above the photosphere below 8 μm, is suggestive of an object that has undergone significant inner disk clearing (a so-called "transitional disk"). If confirmed as a cloud member, this could be the lowest-mass object known to harbour such a disk ($M \sim 0.020\ M_{Sun}$).

For IRAC-CrA 2, the fits yield two very different results depending on the extinction used: If it belonged to the cloud, this object would be a very young brown dwarf with clear mid-infrared excess, but its SED is also consistent with that of a reddened background star. The blue R–I colour of this source (1.84), compared to the cloud members in our survey (>2), also hints towards this second possibility.

Hertzprung-Russell Diagram

We made use of VOSA to derive effective temperatures and luminosities for all the *Coronet* members and candidate members with optical counterparts selected with our method, and to plot them in the HR diagram. The locations of our new candidate members in this diagram are fully compatible with those of the previous members.

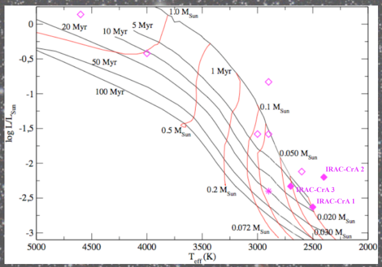


Figure 5
Hertzprung-Russell diagram of the *Coronet* sources with optical counterparts. Open diamonds and asterisks indicate objects known from previous studies, while our new candidates are shown with solid diamonds. Isochrones and mass tracks from the Lyon evolutionary models (Baraffe et al. 1998; Chabrier et al. 2000) are also shown. For IRAC-CrA 2, we only show the location it would have, should it be a cluster member.

Disk fraction

The very low number of new candidate members identified in this work suggests that the census of *Coronet* members harbouring primordial disks is basically **complete down to 0.030M_{Sun}**. Thus, the results from this study do not substantially alter the reported disk fraction in this cluster, which is found to be **around 45-50%** (Sicilia-Aguilar et al. 2008; López Martí et al. 2010).

References

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