IDENTIFICATION OF BROWN DWARFS IN THE YOUNG STAR CLUSTER IC348

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Outline

- Introduction of Young star cluster IC 348.
- Scenarios of Brown Dwarf Formation.
- Observations of Brown dwarfs in the cluster.

Introduction

- IC 348 is a relatively young and small cluster that lies at the eastern edge of the Perseus dark cloud complex at a distance of about 300pc from the sun.
- The cluster is related with dark clouds and its associated with NGC 1333 and Per OB2 association.
- Number of stellar cluster members are estimated to be 400, the earliest type star is BD $+31^{0}$ 643(B5).
- One difficulty in studying the cluster at optical and near-infrared wavelengths is due to high variable extinction A_v ranges from 1~7 mag with a mean value of about 3.5mag

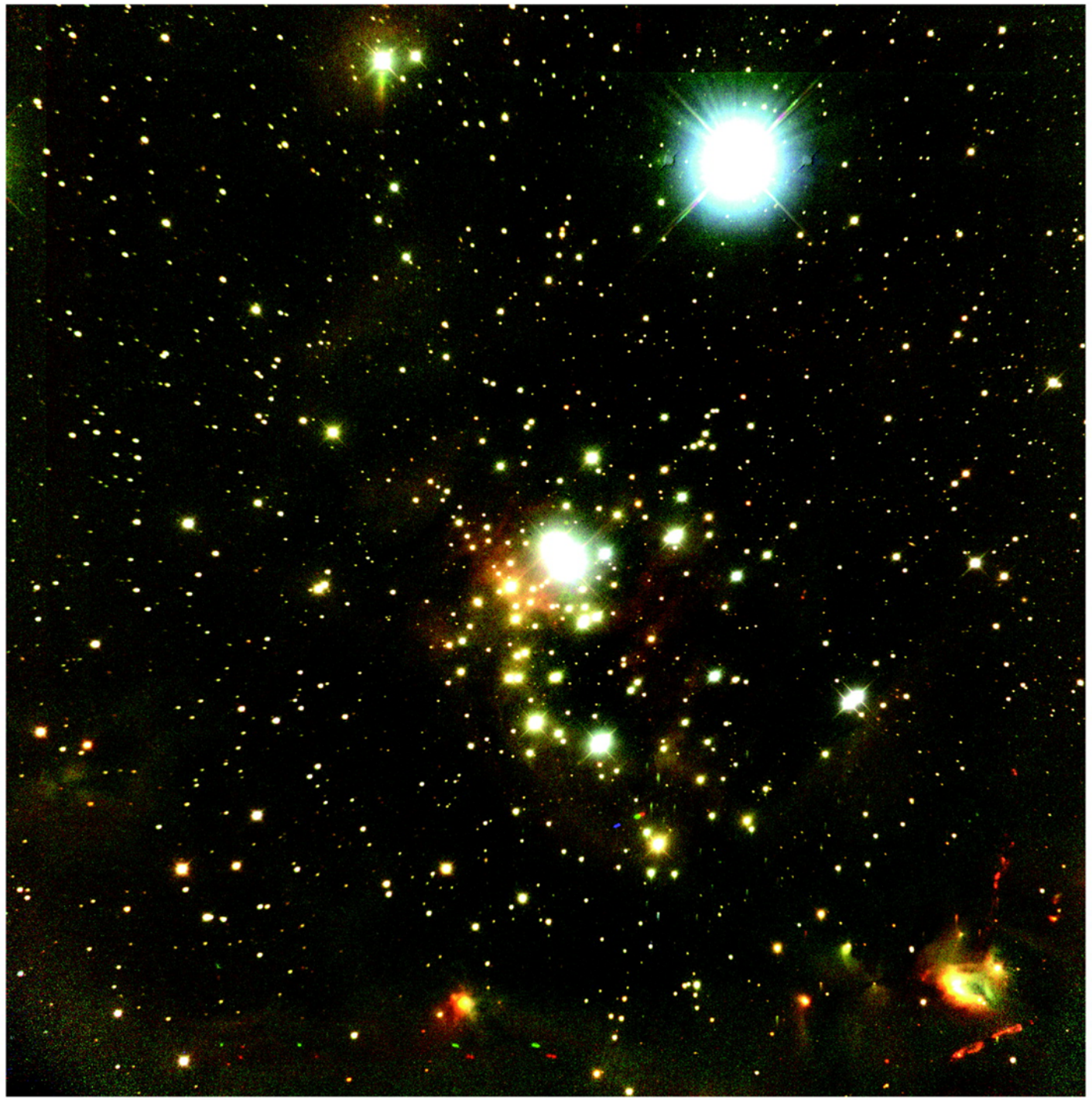


Fig 1: A near-infrared image of IC 348 from Muench et al.(2003). The bright star in the northwest is o Per. IC 348 is at the center and is obviously rather compact.

In the extreme southwestern corner is the molecular hydrogen outflow, HH 211.

Basic Properties

- The low-mass end of the IMF is populated by three types of objects: low-mass hydrogen-burning stars, brown dwarfs and planets.

- Brown dwarfs cannot sustain H-burning but they can burn deuterium($13\ M_J < m < 80\ M_J$).

- Most brown dwarfs known so far are in the field, i.e., already evolved, in the solar neighborhood.

- A thorough census of young stars and brown dwarfs in nearby star-forming regions is important for measuring the properties of young stellar populations and for providing well-defined samples of targets for a variety of studies of star and planet formation.

Scenarios of Brown Dwarf Formation

- There are five mechanism for forming a brown dwarf:

(i) Turbulent fragmentation of molecular clouds, producing very low-mass prestellar cores by shock compression,

(ii) Collapse and fragmentation of more massive prestellar cores,

(iii) Disc fragmentation,

(iv) Premature ejection of protostellar embryos from their natal cores,

(v) Photo-erosion of pre-existing cores overrun by HII regions.

Observations of Brown dwarfs in the cluster

- The candidate cluster members are selected based on X-ray emissions, mid-IR excess emission(disk), optical and near-IR color-magnitude diagrams, accretion (Hα, UV).

- In IC 348, there are late M-type dwarfs to early L dwarfs, Whereas only a few L-type brown dwarfs have been spectroscopically confirmed in nearby young clusters (1–3 Myr).

- One third of the candidate members in IC 348 show evidence of mid-IR excess emission, i.e., they are surrounded by disks or dusty envelopes, remnants from their formation process.

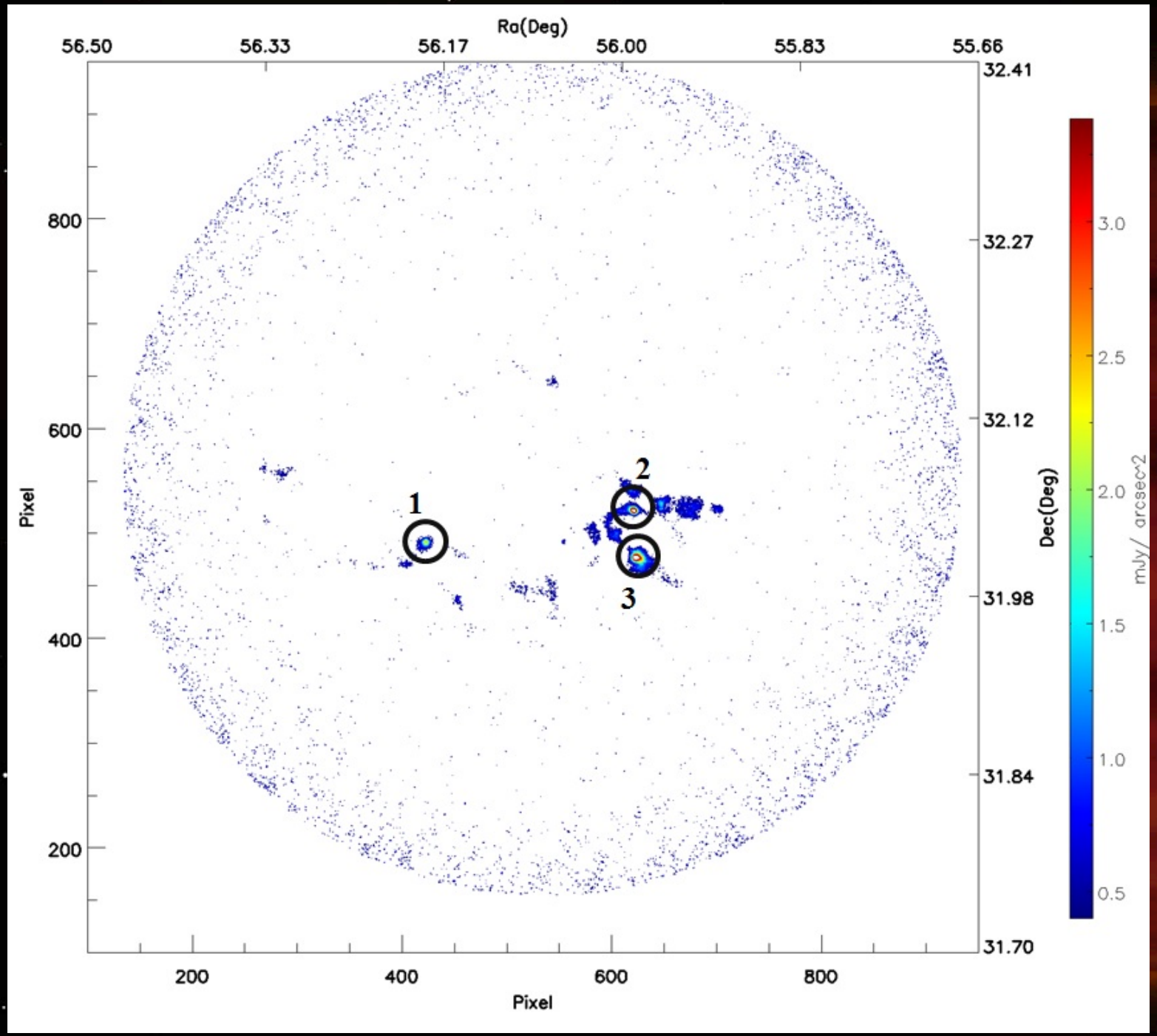
X-ray properties of the Young Stellar Objects

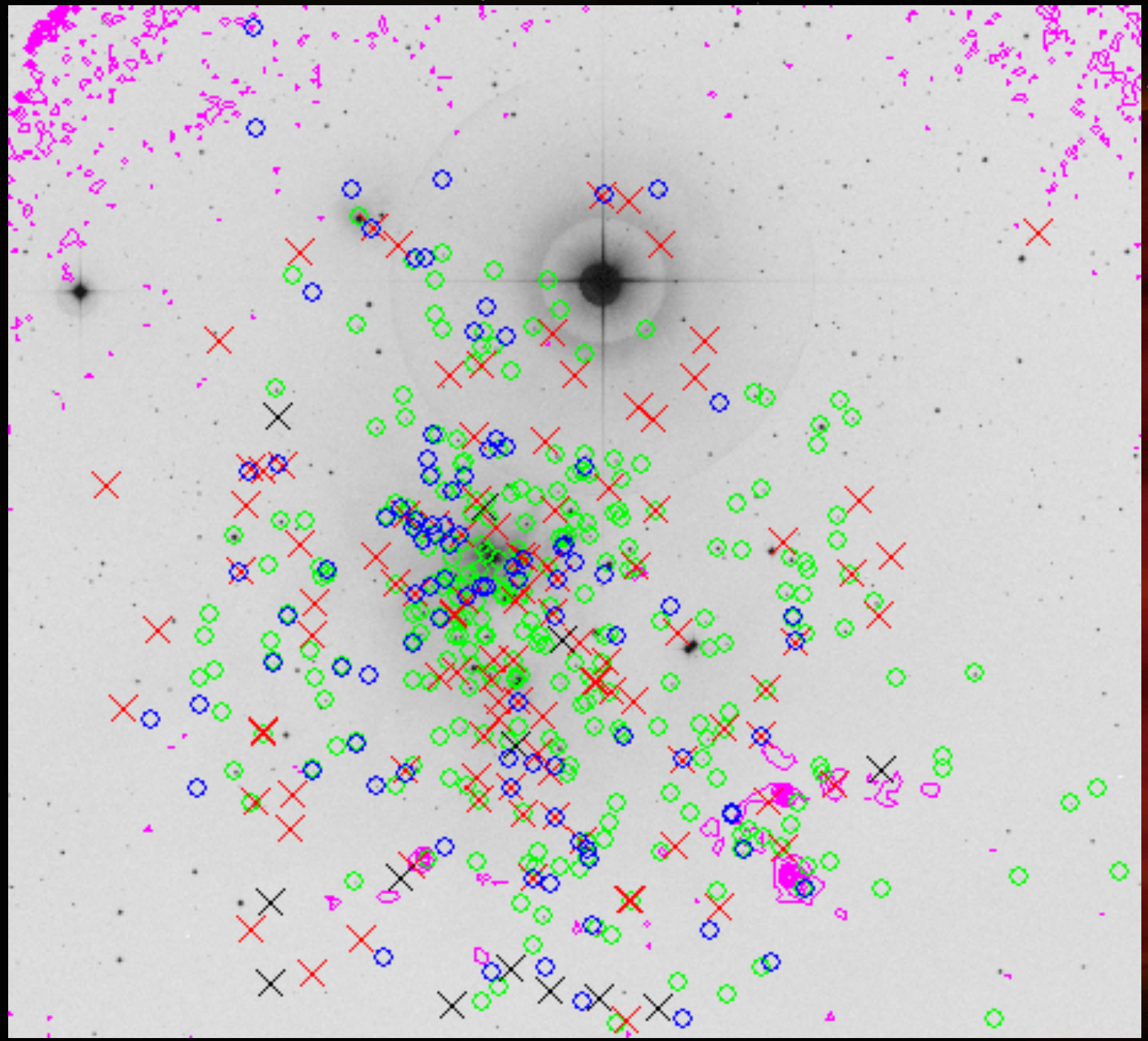
- Even when young, BDs are relatively cool and dim objects, and one would not intuitively expect them to emit high-energy radiation.
- BDs have a fully convective internal structure, The nature of the X-ray emission from BDs (and similarly from fully convective very-low mass stars) and the origin of their activity is still not well understood.
- The observed X-ray properties of the brown dwarfs (and brown dwarf candidates) are very similar to those of late-type stars : very young sub stellar objects are still warm enough to maintain partially ionized atmospheres, which are capable of sustaining electrical currents, while in the cooler neutral atmospheres of L and T dwarfs such currents are shut off (hence no X-ray emission).
- X-ray luminosity functions between classical and weak-line T Tauri stars are: weak-line T Tauri stars that are optically faint and hence X-ray faint, whereas on the other hand, classical T Tauri stars, is essentially completely known because of its very prominent Hα emission.

X-ray brown dwarf associated with sub mm emission

- Young stellar clusters embedded within molecular clouds are valuable laboratories for studying the birth of stars, brown dwarfs and planets (Lada & Lada 2003).
- There are 5 X-ray brown dwarfs that are associated with sub mm emission: 1 confirmed BD, 1 binary pair BD (candidate) and 2 candidates.
- Their properties are tabulated.

JCMT 850 MICRON REGION OF IC 348





My Work

Fig 2: Shows an optical Image of IC 348 with JCMT 850 micron filaments.
(I) X - shows the confirmed Brown Dwarfs.
(II) Blue Circles – shows the candidates.
(III) Green circles – are the X-ray sources.

RA	DEC	CXOUJ	SPECTRAL TYPE	OTYPE	CTnet (ct)	CHnet (ct)	REF
03 44 15.58	32 09 21.9	034415.58 +320921.9	M7.5	T Tau-type Star	9.2	0.0	X-ray view of IC348 (Stelzer+, 2012) Luhman 1999,2003,2005b
03 44 03.633	+32 02 34.77	034403.65 +320235.2	M5	Young Stellar Object	16.7	0.5	X-ray view of IC348 (Stelzer+, 2012) Luhman2003
03 44 03.620	+32 02 33.08	034403.65 +320232.9	M5	Young Stellar Object	34.1	7.2	X-ray view of IC348 (Stelzer+, 2012) Luhman 2003
03 44 02.31	32 01 35.3	034402.61 +320135.0	M4.75	T Tau-type Star	106.0	8.3	X-ray view of IC348 (Stelzer+, 2012) Luhman 1999
03 43 54.38	32 00 31.4	034354.65 +320029.9	M4.25	T Tau-type Star	92.9	17.7	X-ray view of IC348 (Stelzer+, 2012)


Thank You For Your
Attention