Formation of very low mass stars and brown dwarfs: the case of dark cloud Barnard 35

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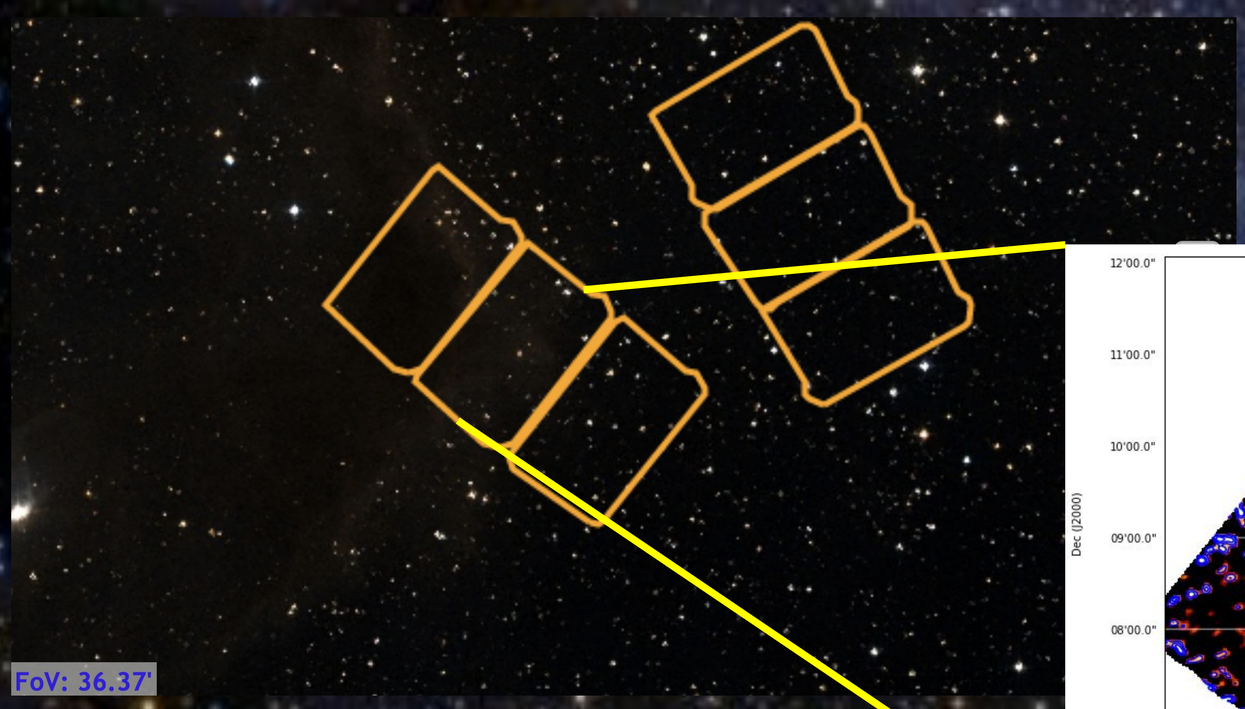
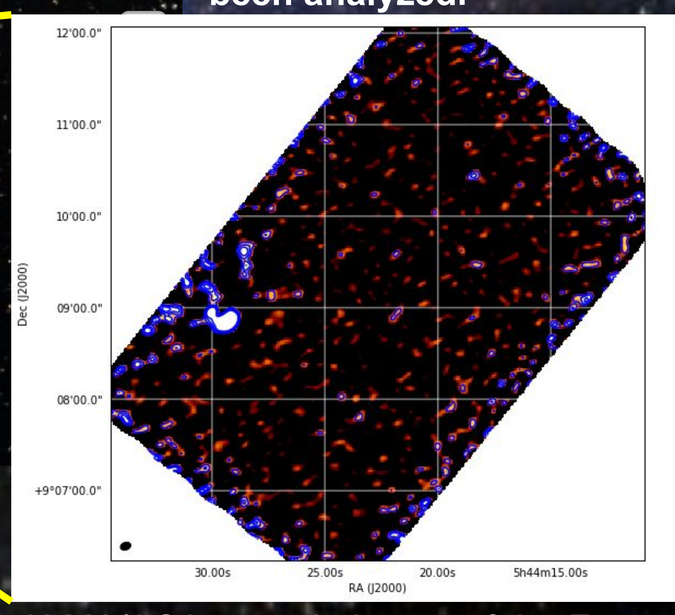
Identifying and confirming pre and proto brown dwarfs require significant observational effort, given they intrinsic low luminosities, and distances towards star forming region.
Our group has focused to search for new candidates in different star forming regions, particularly in the Orion complex. Here we present preliminary results of the search for very low mass objects in the Barnard 35 dark cloud located near the lambda Orionis star forming region.

Context and motivation

How do brown dwarfs form is still one open question. In order to understand this we need to study brown dwarfs while they are still forming, which means they will be still deeply embedded in their clouds, which limits our capabilities to directly observe them. Now with ALMA the sensitivity, at the mm and sub-mm range, is high enough that we can start to discover and characterize the proto low mass stars and proto brown dwarfs.
If brown dwarfs undergo the same phases of formation as low-mass stars, one would expect to find brown dwarfs in the Class 0/I phases of young stellar objects, where powerful outflows, dense infalling envelopes, and accretion rotating disks are typically seen. One would also expect to find pre-substellar cores, i.e., starless cores which will form brown dwarfs in the future.
Only a handful of these extremely low mass object are known to date



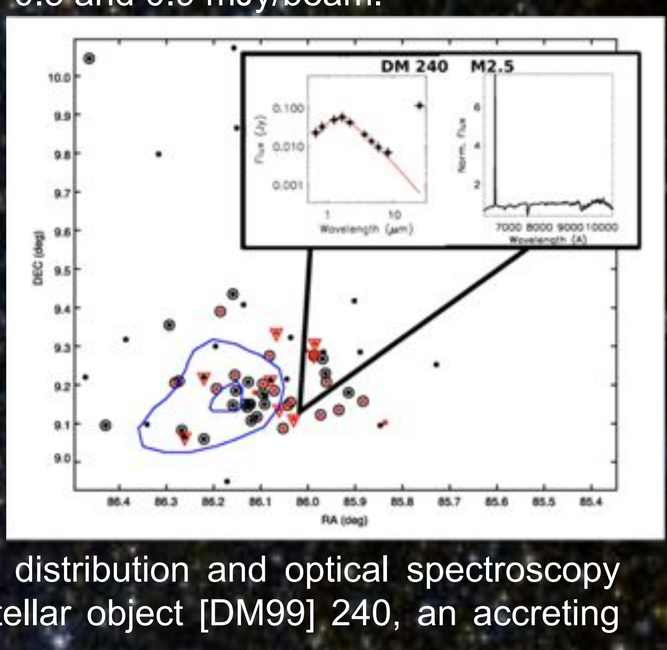
B35 region and the six ALMA/ACA pointings to search for new pre and proto brown dwarfs.
So far three fields have been analyzed.



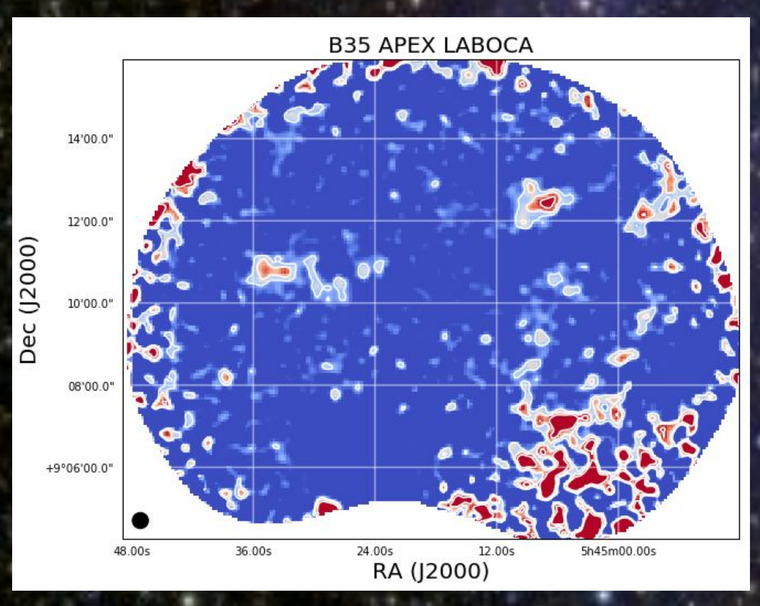
ALMA/ACA zoom in in one of the East pointings. The blue contours show the 3σ, 5σ, 7σ and 10σ levels. The typical RMS in the continuum are between 0.5 and 0.9 mJy/beam.

Why B35?

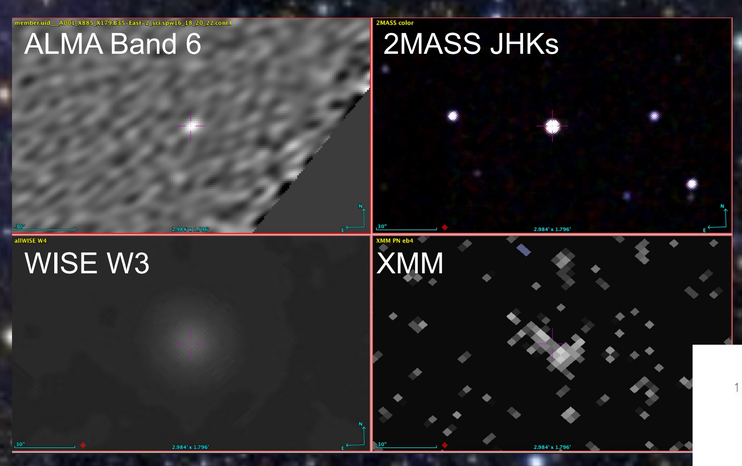
At a distance of 400pc. The λ Orionis Star Forming Region (LOSFR) is part of the Orion molecular cloud complex. Three main substructures stand out in the LOSFR, namely Collinder 69 (almost extinction-free cluster), Barnard 30 (heavily embedded) and Barnard 35(less extinct than B30).
B35 appear to be almost entirely composed of low-mass stars. Moreover, the fraction of accreting low-mass stars in B30 and B35 seems to be much higher than that of C69 (Bayo 2009), suggesting that B30 and B35 are significantly younger than C69.



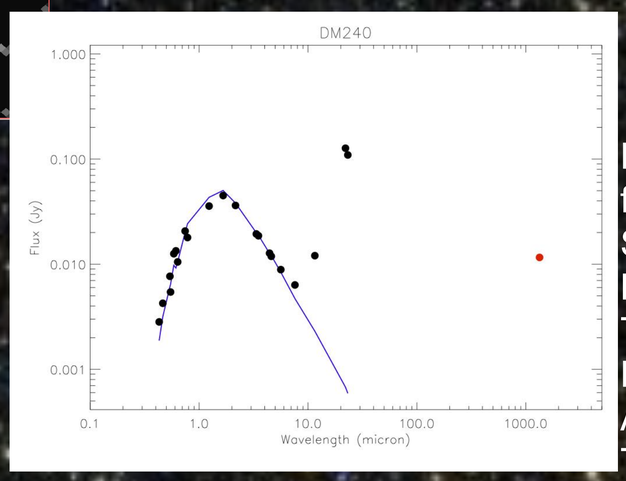
Spectral energy distribution and optical spectroscopy for the young stellar object [DM99] 240, an accreting low mass star.



APEX/LABOCA observations towards the East of B35 dark cloud. Several sources appear in the map We identify some regions to follow up with ALMA/ACA



Multiwavelength view of DM240 from X-rays to sub-mm



Physical parameters for DM240
SpT = M 2.5
Log Macc = -10.95
Transition
D = 400 pc
Av = 0.11+-0.9
Teff = 3700 +- 51
Lbol = 0.7
Flux Band 6 = 11.6 mJy

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