A multi-wavelength study of circumstellar disk evolution in Cygnus OB2

Indo-French CEFIPRA Astronomy Meeting

By

Saumya Gupta

With Jessy Jose, Swagat R.Das, Surhud More, Manash R Samal, Gregory Herczeg, Hiro Takami,

Satoko Takahashi, Guo Zhen, Katsuo Ogura, Tsuyoshi Terai, Tae-Soo Pyo

Date: 22nd-26th Mar'2021

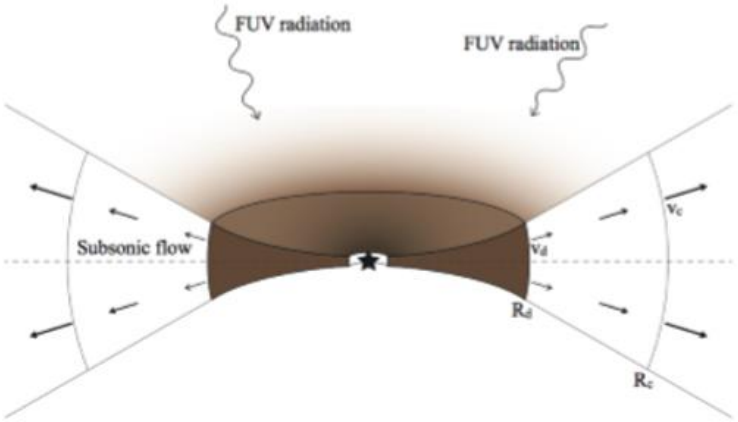
Why low mass star formation?

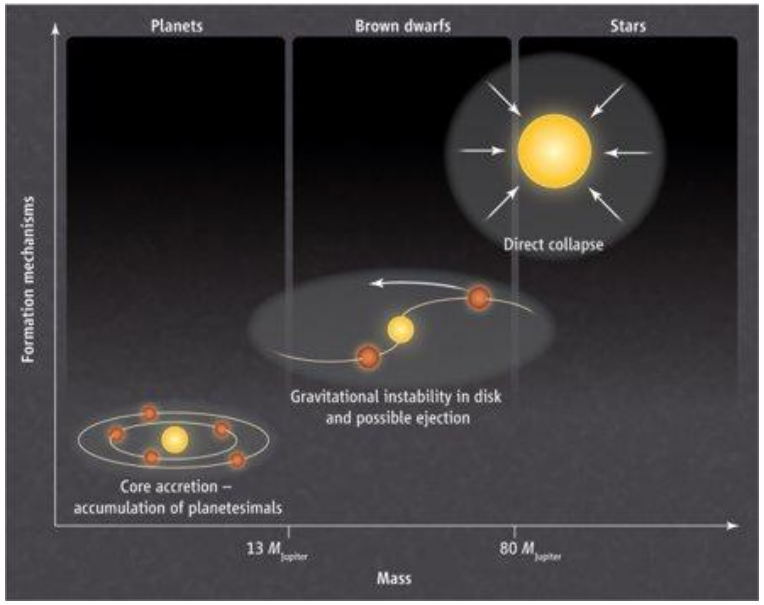
Low mass star formation in massive clusters : Global star formation models

Role of stellar feedback on low mass and sub-stellar realm

TRAPPIST–South first light image of the Tarantula Nebula[1]

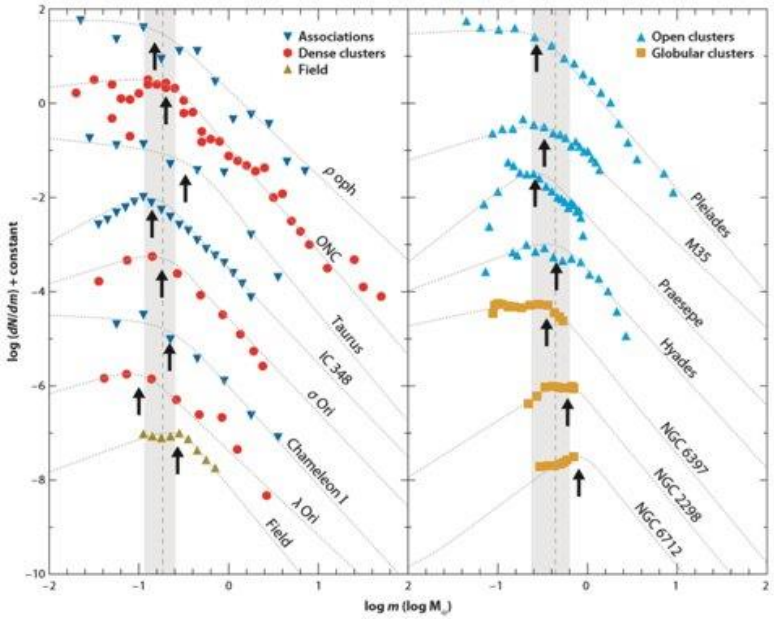
Protoplanetary disk evolution[2]





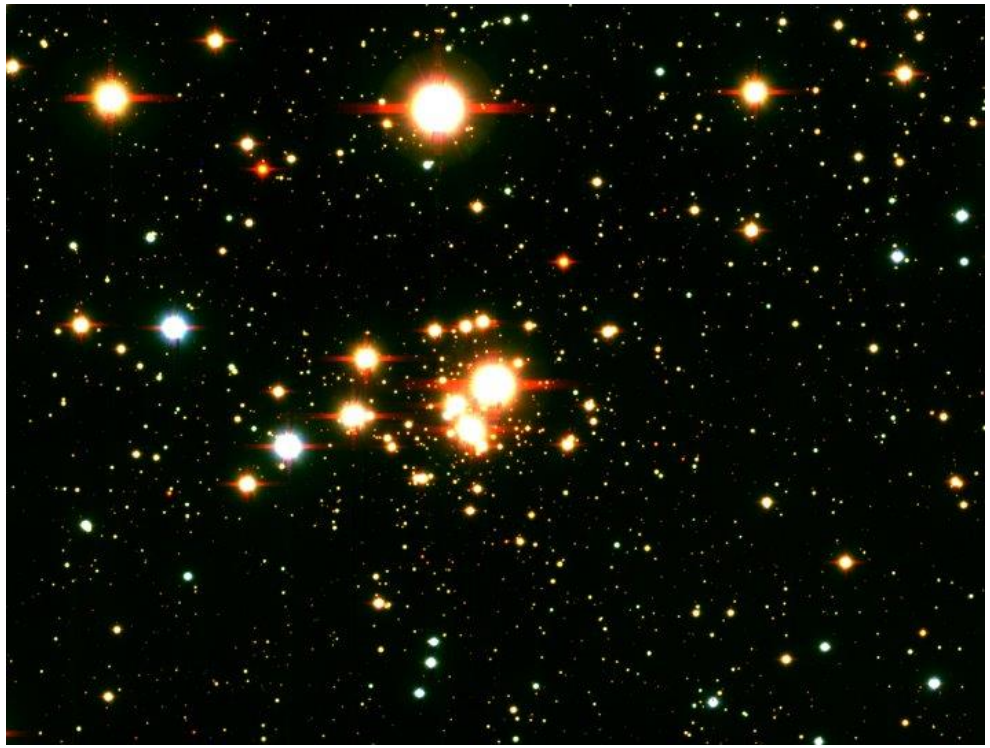
Brown dwarf formation[3]

IMF in sub-stellar regime[4]



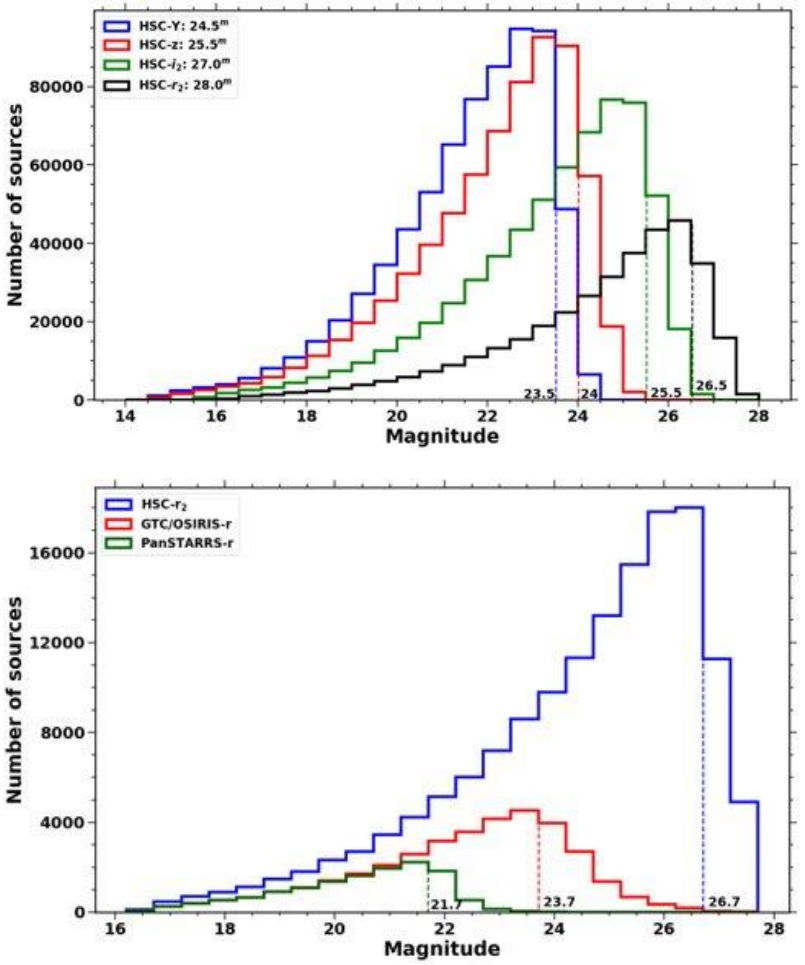
1. https://www.eso.org/public/images/eso1023a; 2. Fachini et al. 2016;
3. Basu et al. 2012; 4. Bastian et al. 2014

HSC observations of a feedback driven protoglobular cluster '*Cygnus OB2*'



An RGB image with r_2, i_2 and Y-band of a central 15'x10' region of Cygnus OB2

- A young massive Galactic proto-globular cluster at 1.6 kpc, age: 3-5 Myrs.
- Rich in OB-stars ($\sim$ 150 O-type stars) implying PMS population affected by extreme UV environment.

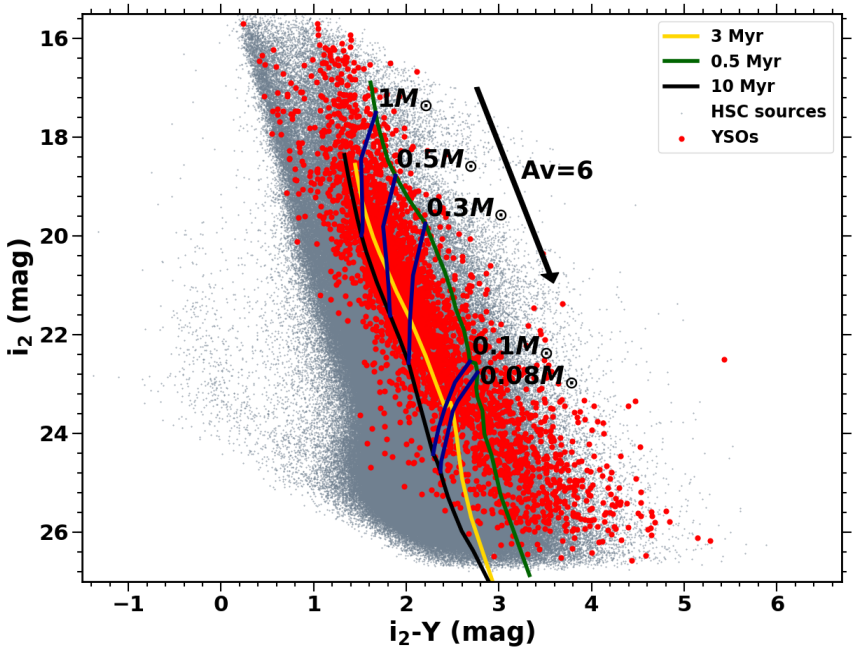


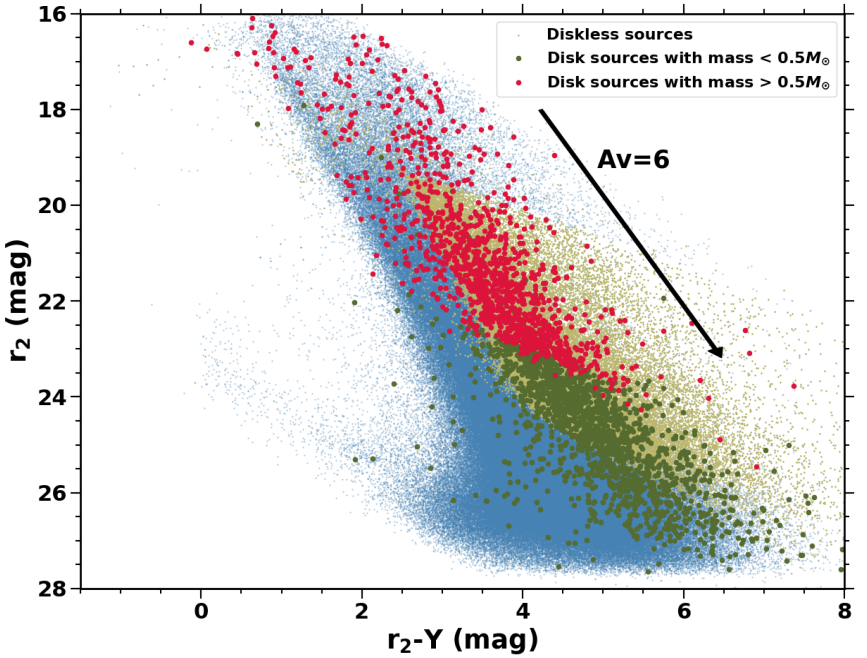
Top: Histogram shows the detection limit in individual HSC filters. *Bottom:* Histogram shows comparison between HSC (26.7^m) and existing GTC/OSIRIS (23.7^m) and Pan-STARRS (21.7^m) photometry.

- The deepest and the widest optical (r_2, i_2, z and Y-band) observations of any Galactic star forming region.
- $\sim$ 713,529 sources observed in 1.5^o diameter region centred at Cygnus OB2 with atleast 2-band detection with 27^m (≤ 0.06 $M_\odot$ at Av=6^m, d=1.6 kpc)
- HSC photometry $\sim 3^m$–5^m deeper than existing PanSTARRS and GTC/OSIRIS photometry.

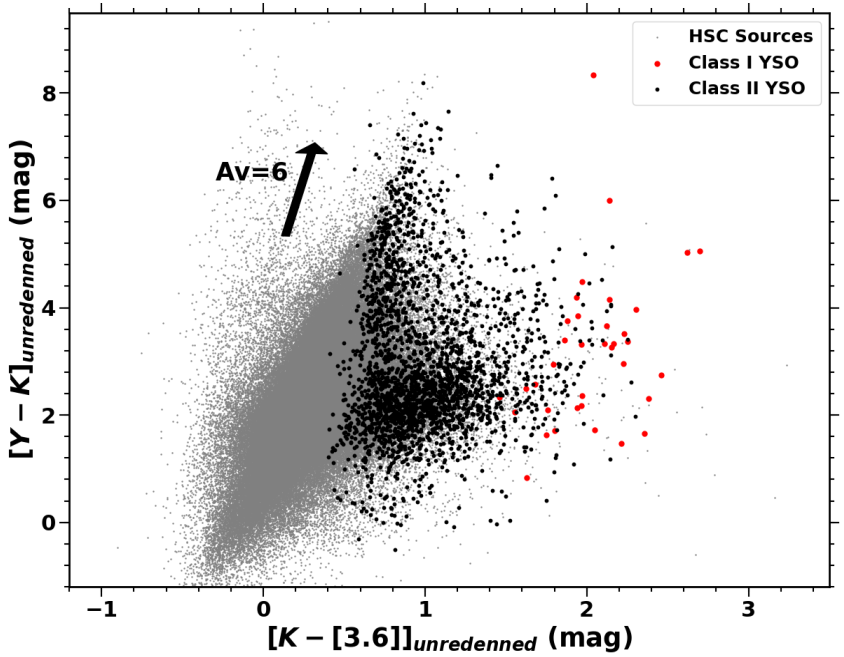
We acknowledge the HSC helpdesk and IUCAA cluster computing facility for the HSC data reduction.

Disk population in Cygnus OB2





Top Left: Bottom: i2-Y vs i2 CMD for entire 1.5^{o} diameter region overplotted with YSOs and Baraffe isochrones and evolutionary tracks. *Top Right:* r_2 -Y vs r_2 CMD overplotted with disk-bearing sources of age > 0.5 $M_{\odot}$ (red) and < 0.5 $M_{\odot}$ (green)

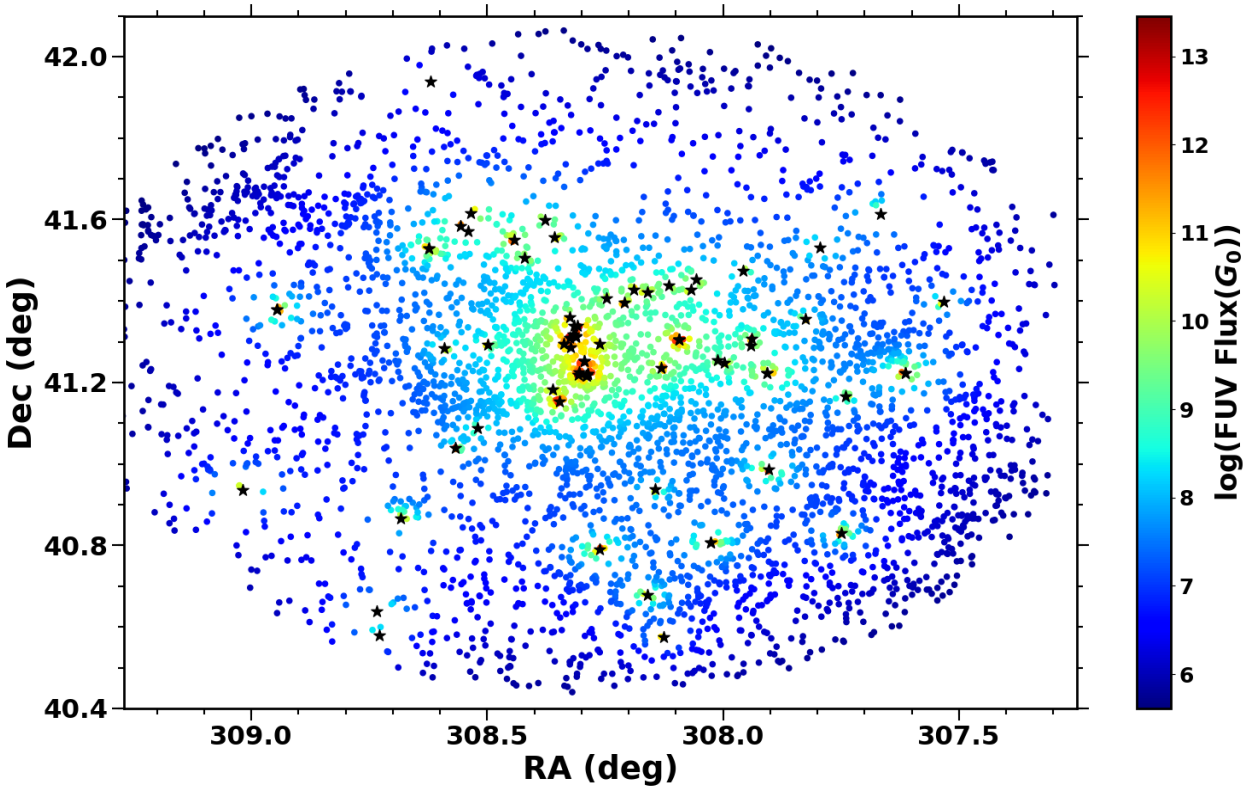


- ~ 4200 disk-bearing sources identified in the entire region.
- Approximately, 65% of disk bearing sources have age < 3 Myrs and mass < 0.5 $M_{\odot}$.

Bottom: ((K-[3.6])--(Y-K)) two-color plot overplotted with identified with Class I and II YSOs.

We acknowledge the HSC helpdesk and IUCAA cluster computing facility for the HSC data reduction.

Spatial distribution of disk population



- A clustering of disk sources is observed towards the centre of Cygnus OB2.

References

1) Baraffe et al. 2015 (2) Gutermuth et al. 2009 (3) Guarcello et al. 2013 (4) Guarcello et al. 2016 (5) Saumya et al. 2021, MNRAS, to be submitted soon

Summary and Future Works

- We perform a deep multi-wavelength study with deep HSC optical, UKIDSS NIR and Spitzer MIR data to identify disk-bearing sources in the feedback affected environment of Cygnus OB2.
- Sources reaching down to brown dwarf limit (<= 0.07 $M_{\odot}$) have been detected with our Subaru HSC optical data.
- We identify ~ 4200 disk bearing sources with 65% of them with age < 3 Myrs and mass < 0.5 $M_{\odot}$.
- We attempt to segregate cluster members from contaminants using machine learning techniques.
- Further, we aim to analyse the variation of circumstellar disk fraction as a function of age and mass.
- We also aim to identify sub-stellar sources, star to brown dwarf ratio and obtain the IMF Cygnus OB2.