Testing the role of external UV radiation on the disk evolution in twin clusters of W5 complex

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Abstract

The circumstellar disks (or protoplanetary disks) are a natural by-product of the star formation process and it is important to understand the dependence of disk properties on environmental factors. In this regard, we test the disk properties in the twin clusters of W5 complex, which share similar physical parameters such as age, stellar density, extinction, and distance with a single variable i.e., the external UV radiation making these clusters make an ideal pair of targets. Using deep multi-band photometry we compare the disk fraction as a function of mass, age and UV flux between the two clusters. The average disk fraction is estimated to be $\sim$ 20%, which is relatively less for an average age of 2Myr and we see no signs of variation of disc fraction as a function of mass or UV flux and age between the two clusters. We conclude that even if there is any role of external UV radiation in the disk evolution, the amount of UV flux required should be much higher than the radiation present in the clusters under this study.

Twin clusters of W5 complex

Fig. 1: Herschel image of W5 cloud complex also known as the Soul nebula. Image credit: ESA.

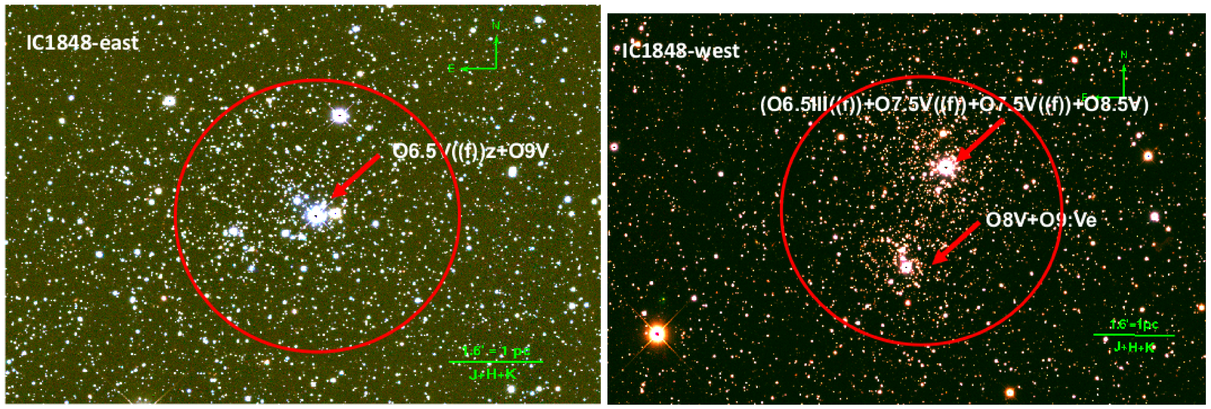

Fig. 2: J,H and K color composite image of the IC1848-East (*left*) and IC1848-West (*right*). The red circle marks the radius of the cluster. The massive OB stars in the cluster are shown with an arrow mark.

Analysis

Parameters	IC1848-East	IC1848-West
Peak $L_{FUV}/L_{\odot}$	1.23x10^5	4.19x10^5
Peak stellar density (stars/pc^2)	200	420
Distance (pc)	2380±510	2220±420
A_v (mag)	2.3±0.7	1.5±0.5
Age (Myr)	2±1	2±1

Data: Deep multiwavelength photometry in optical (CFHT-Megaprime and PanSTARRS - g, r, i, z, y bands), NIR (Mayal telescope-Newfirm - J, H, K bands), MIR (Spitzer-IRAC, MIPS).

Completeness: 90% completeness in J, H, K, IRAC1, IRAC2 bands upto J=18 mag (0.1$M_{\odot}$) and 80% completeness in the other seven bands upto J=18 mag.

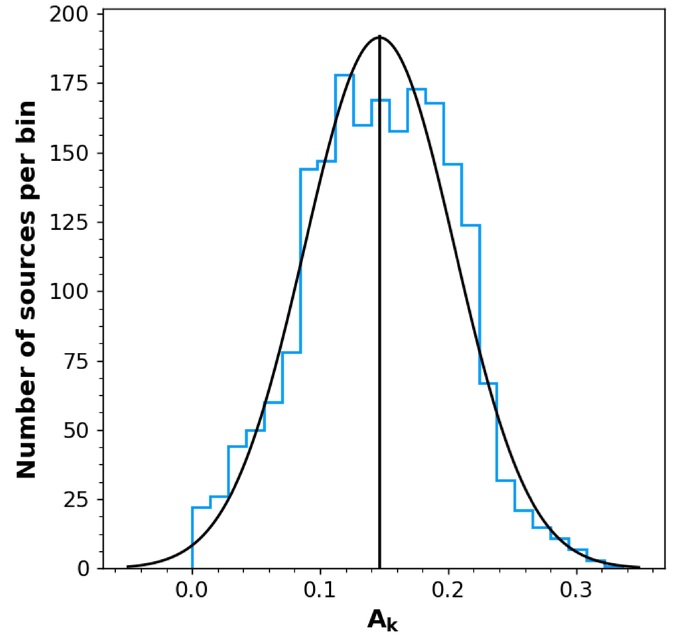

Fig. 3: Histogram showing the extinction distribution of the candidate members in IC1848-West.

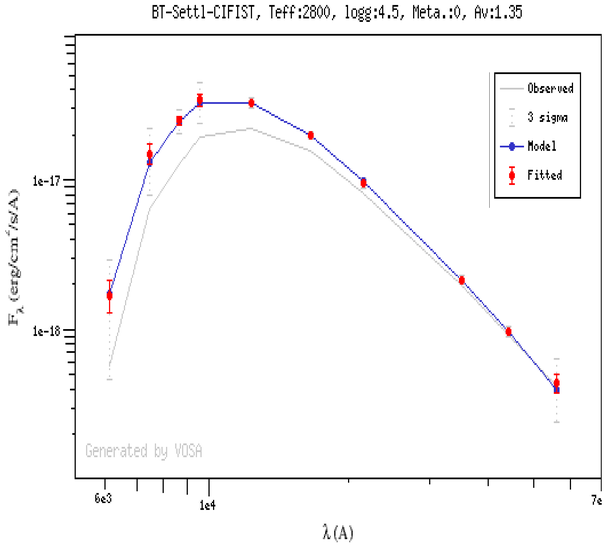

Fig. 4: Sample SED of a low-mass object in the cluster IC1848-West, generated using the multiwavelength photometry in VOSA (http://svo2.cab.inta-csic.es/theory/vosa/).

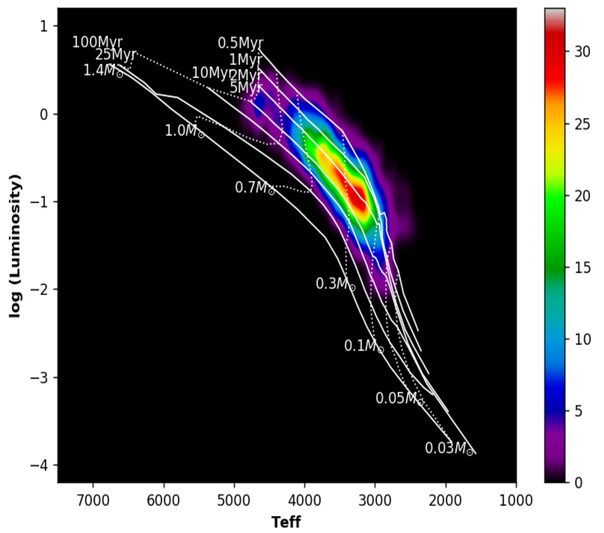

Fig. 5: HR-diagram of IC1848-West. The luminosities and effective temperatures were obtained from the VOSA SED analysis. Baraffe et al. 2015 evolutionary tracks and isochrones are shown as white dotted and continuous lines respectively.

Results

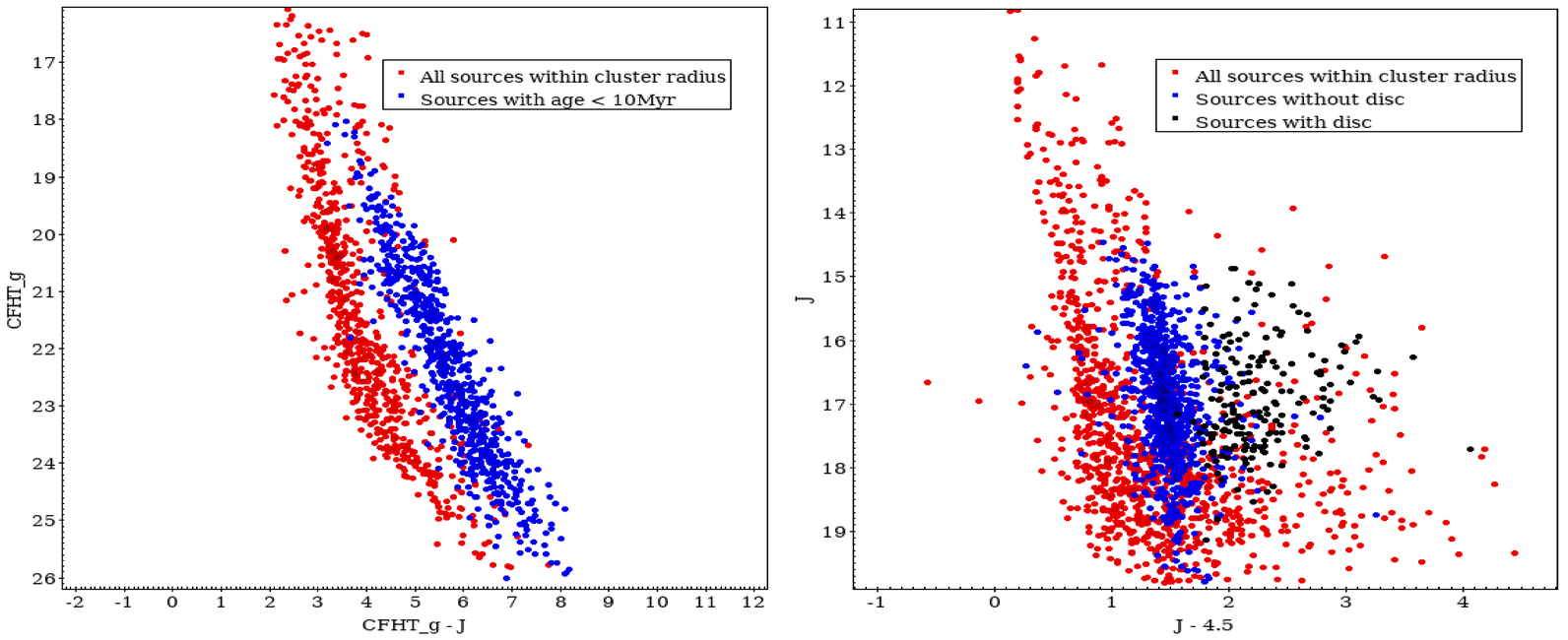

Fig. 6: (*left*) g-J vs g CMD of IC1848-West. Red dots - sources within the cluster area; blue dots - sources with age <10Myr as shown in Fig.5. (*right*) J-4.5μm vs J CMD. Red dots - sources within the cluster area; blue dots - sources without disc; black dots - sources with excess which is indicative of the presence of disc.

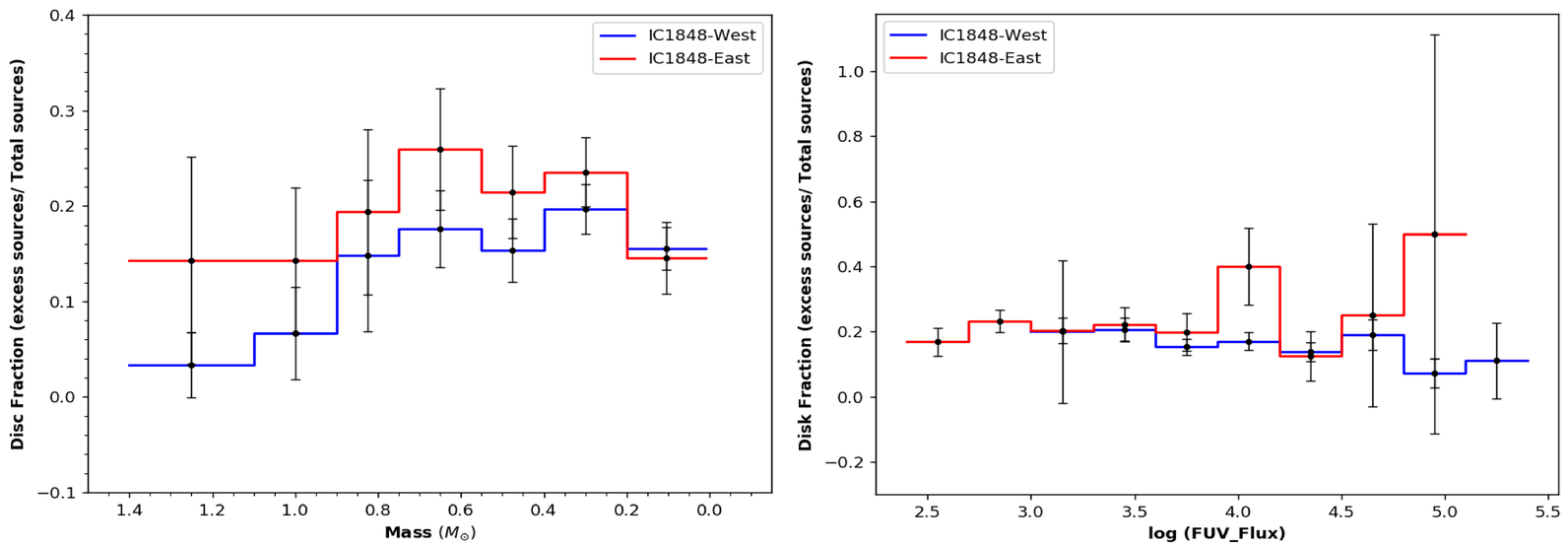

Fig. 7: Disc fraction as a function of mass (*left*) and FUV flux (*right*) of the low-mass objects in IC1848-East and IC1848-West. Both the clusters are found to have relatively low disk fraction $\sim$ 20% at $\sim$2 Myr for the mass range of 1.0 - 0.1 $M_\odot$ and do not show any significant variation as a function of flux.

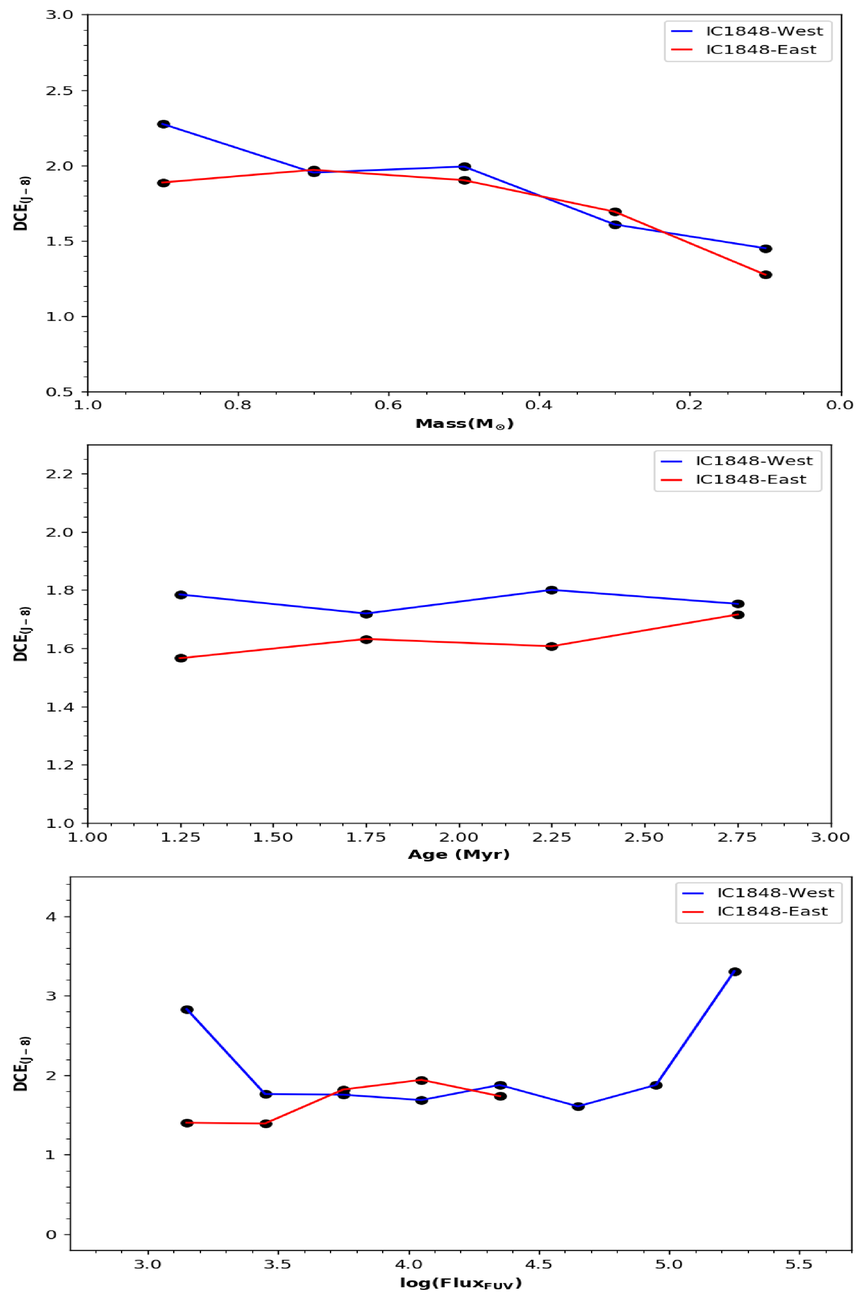

Fig. 8: Disc color excess (J-8μm) as a function of mass (*top*), age (*middle*) and FUV flux (*bottom*) of the low-mass objects with disc in IC1848-East and IC1848-West. Both the clusters have similar disc color excess as function of mass, age and flux.

Conclusion

1. The young clusters IC1848-east and IC1848-west are unique targets with similar physical properties (distance,age,extinction) except for varying external UV radiation.
2. The average disk fraction of both the clusters was estimated to be $\sim$ 20%, which is relatively low for young regions of age of $\sim$2 Myr.
3. We do not find any significant variation of disk fraction as a function of mass or UV flux and the inner disk color excess is almost uniform with respect to age, mass and UV flux. (Preliminary results in Damian et al.2021, accepted for publication in MNRAS)

References

Baraffe, Isabelle et al. (May 2015). "New evolutionary models for pre-main sequence and main sequence low-mass stars down to the hydrogen-burning limit". In: 577, A42, A42. doi:10.1051/0004-6361/201425481. arXiv: 1503.04107 [astro-ph.SR].