"MASSIVE STAR FORMATION: OBSERVATIONS CONFRONT THEORY"
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Star formation in young star cluster NGC 1893

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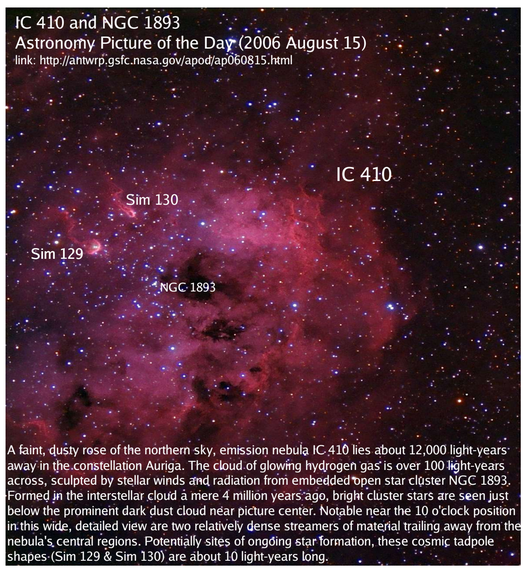
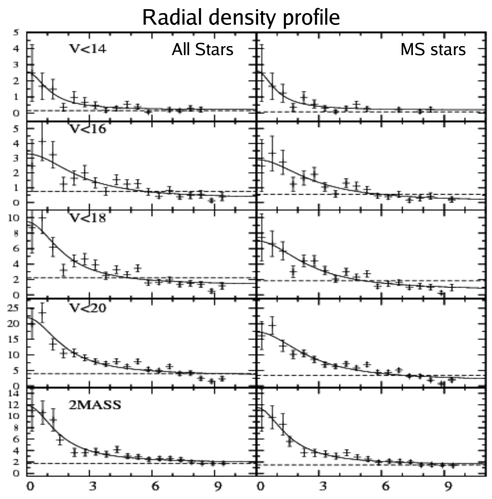


NGC 1893 is one of the youngest known open clusters and is considered to be the center of Aur OB2 association. It can be recognized as an extended region of loosely grouped early-type stars, associated with the H II region IC 410 with two pennant nebulae Sim 129 and Sim 130 and obscured by several conspicuous dust clouds. NGC 1893 has a moderately large population of O-type stars, represents thus a good laboratory for the study of massive star formation and the impact of massive stars on the formation of low mass stars. Therefore, in this poster, we present a multiwavelength study of the star forming region NGC 1893 to make a comprehensive exploration of the effects of massive stars on low mass star formation. Deep optical UBVRI and narrow band Hα photometric data from ARIES, Nainital, slitless spectroscopic data from HCT, Hanle along with archival data from the surveys such as 2MASS, MSX, IRAS and NVSS are used to understand the global scenario of star formation in NGC 1893 region.

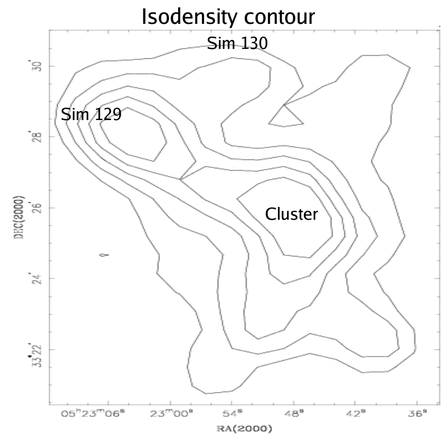
Radial density profile



The radial density profiles (RDP) of the cluster NGC 1893 for different optical magnitude levels and 2MASS data for all (left panels) and MS (right panels) stars. The solid curve shows a least-square fit of the King (1962) profile to the observed data points. The error bars represent ±√N errors. The dashed line indicate the density of field stars. The cluster extent (whole region) and core radius (inner region) for this cluster is comes out to be 6 and 2 arcmin respectively.

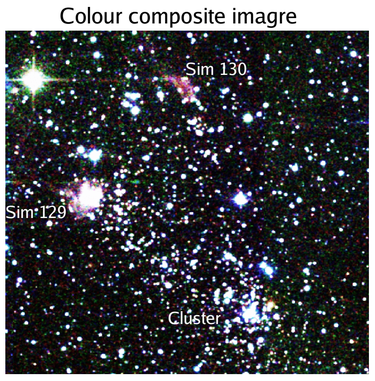
Morphology

Isodensity contour



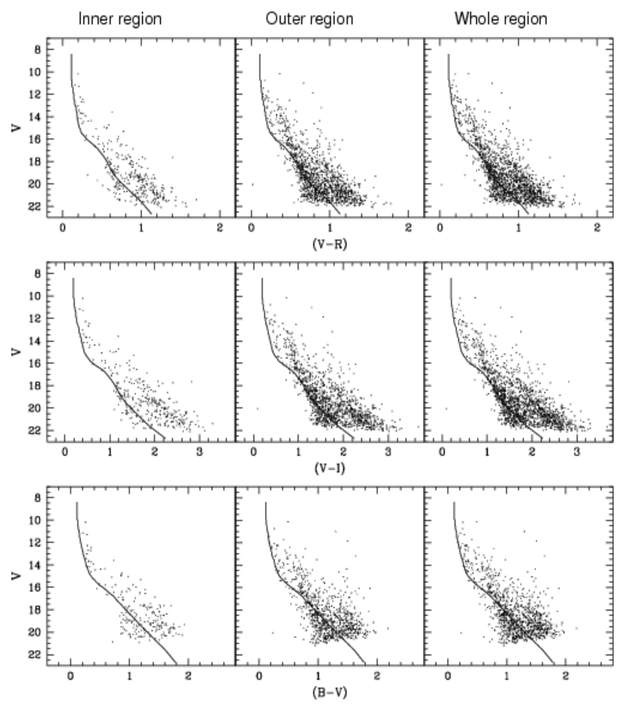
Isodensity contours for the 2MASS stars in the cluster region. The contours are plotted above 3 sigma levels having lowest value of 6 stars/pc^2 and step size of 2 stars/pc^2. The maximum stellar density is ~18 stars/pc^2. It can be seen that the stars are elongated from cluster to one of the nearby nabula Sim 129.

Colour composite imagre



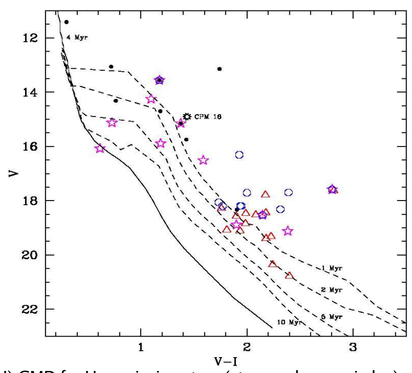
JHKs colour composite image of the cluster (J: blue; H: green; Ks: red) obtained from 2MASS.

Distance and age of the cluster

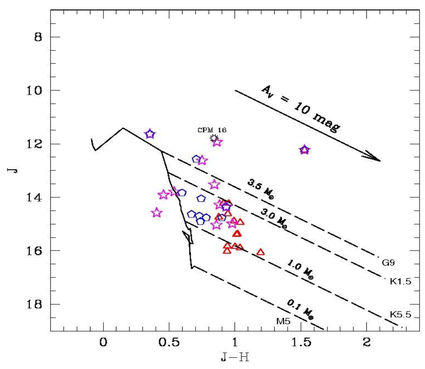


The CMDs for stars lying in the two subregions and whole cluster region. The isochrone by Bertteli et al. (1994) for solar metallicity and age = 4 Myr are also plotted for $E(B-V)_{min}$=0.4 and distance modulus of 13.8 mag.

Position of Young stellar sources in Colour Magnitude Diagrams

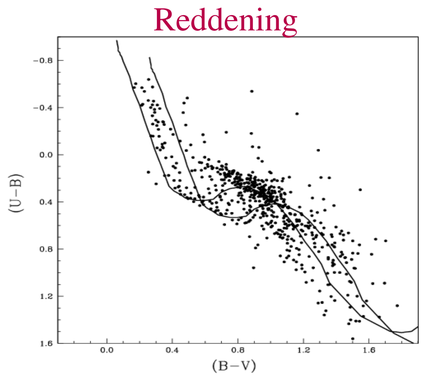


V,(V-I) CMD for Hα emission stars (stars and open circles) and NIR excess stars (triangles). Isochrone for 4 Myr by Bertelli et al. (1994) (continuous line) and PMS isochrones for 1,2,5,10 Myr by Siess et al. (2000) (dashed line) are also shown. All the isochrones are corrected for distance of 3.25 kpc and reddening E(B-V)=0.4. Maximum of the stars are located between 1-5 Myr isochrones.



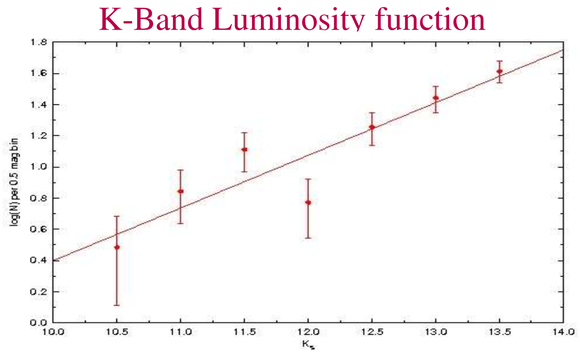
J/(J-H) CMD for the YSO candidates in cluster region. The solid curve denotes PMS of 1 Myr derived from Siess et al. (2000). Masses range from 3.5 to 0.1 M_O from top to bottom. The dashed oblique reddening lines denote the positions of PMS stars of 0.1, 1, 3.0 and 3.5 M_O. Majority of stars have masses in the range 3.0-1.0 M_O indicating these may be T-Tauri stars.

Reddening



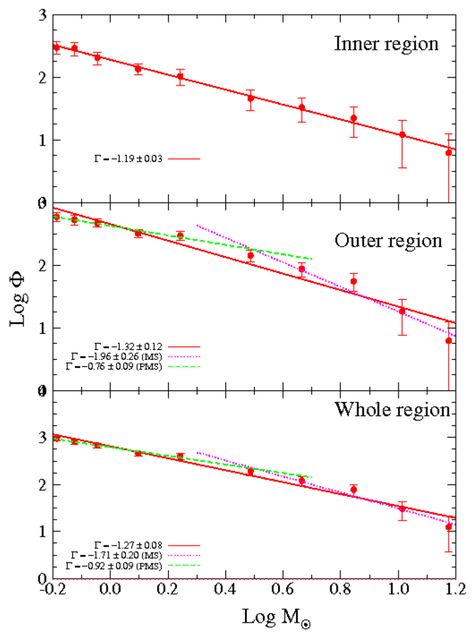
The (U-B)/(B-V) colour-colour diagram for the stars lying within the cluster region. The continuous curve represents intrinsic MS for Z=0.02 by Schmidt Kaler (1982) shifted along the reddening vector of 0.72 for $E(B-V)_{min}$ = 0.4 and $E(B-V)_{max}$ = 0.6.

K-Band Luminosity function



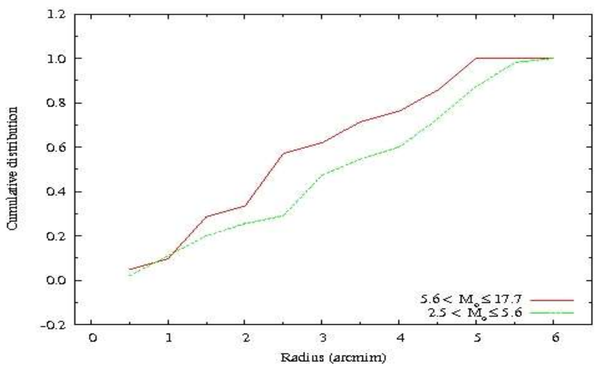
The corrected KLF for the probable members in the cluster. The straight line is the least-square fit to the data points in the mag range 10.5-13.5. The error bars represent ±√N errors. The KLF slope is 0.34±0.07.

Initial Mass Function



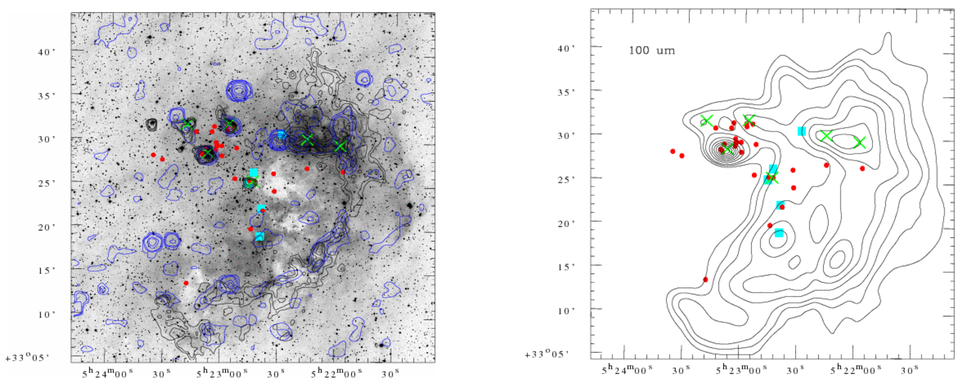
A plot of the mass function in the cluster. The error bars represent ±√N errors. The solid line shows a least square fit to the entire mass range 0.6 < M_O < 17.7 where as thin and thick dashed line are fitted for 0.6 < M_O < 2.0 and 2.5 < M_O < 17.7 mass range respectively.

Mass Segregation



Cumulative radial distribution of MS stars in two mass intervals

Spatial Distribution: Global overview of star formation around the cluster



Right: Spatial distribution of all the YSOs overlaid on DSS-2 R band image in cluster region. The colour-excess stars (probable T-Tauri type stars) are represented by red circles, five O-type stars are represented by blue squares and IRAS point sources are represented by green cross. NVSS (1.4 GHz) radio contours (blue contours) and MSX A-Band intensity contours (black contours) have also been shown. The abscissa and the ordinates are in the J2000 epoch. Left: The IRAS-HIRES intensity map for the cluster region at 100 μm. From the orientation of the two emission nebulae and the arc shaped ring around the cluster, it is suggested that the O-type stars are most likely responsible for the cometary morphology and the trigger of star formation.

Results:

1. Reddening 'E(B-V)' in the direction of cluster is found to be varying between 0.40±0.02 to 0.60±0.03 mag. Post-main-sequence age and distance for this cluster are found to be 4 Myr and 3.25 kpc respectively.
2. Using near infrared two colour diagrams, we have identified candidate YSOs which are localized in a pattern from the cluster to one of the nearby nebulae Sim 129. The position of the Hα emission stars and IR excess stars in CMDs indicate that majority of these stars have age 1 Myr to 5 Myr indicating an age spread in the star formation in the cluster.
3. The slope of K-band luminosity function for the cluster is 0.34±0.07 which is in accordance with the average value (~0.4) reported for young clusters.
4. The slope of the initial mass function ' Γ ' for PMS phase stars (mass range 0.6 < M_O< 2.0) is found to be -0.88±0.09 which is shallower than the value (-1.71±0.20) obtained for MS stars having mass range 2.5<M_O<17.7 indicating a break in the slope of the mass function at ~ 2 M_O. Estimated 'Γ' values indicate an effect of mass segregation for main-sequence stars, in the sense that massive stars are preferentially located towards the cluster center. However for the entire observed mass range 0.6 < M_O ≤ 17.7 the value of Γ comes out to be -1.27±0.08, which is in agreement with the Salpeter value (-1.35).
5. The estimated dynamical evolution time (T_E = 29 Myr) is found to be greater than the age of the cluster, therefore the observed mass segregation in the cluster may be the imprint of the star formation process.
6. Present study of young cluster NGC 1893 indicates that there are evidence for triggered star formation in the region. Initial morphology of the cluster seems to be governed by the star formation in the region.