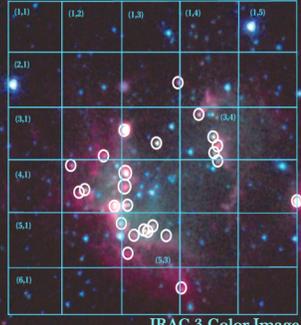


Star Formation in SMC Young Cluster NGC 602: Spatial and Temporal Distribution

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IRAC 3-Color Image

NGC 602 is a young stellar cluster in the wing of SMC. Here, we present an examination of the spatially and temporally resolved stellar and proto-stellar populations as viewed in the optical with HST's Advanced Camera for Surveys and in the near IR with Spitzer's IRAC. Color-Magnitude Diagrams over a range of wavelengths in comparison with theoretical models and isochrones reveal a distinct spatial distribution of bright Main Sequence and newly-discovered pre-Main Sequence stars, as well as IR-bright Young Stellar Objects (YSOs) still embedded in nebular material. We infer that star formation began near the center of this region about 4 Myrs ago and has continued propagating outward, with the youngest observed sources a mere 1 Myr in age.

Grid of CMDs

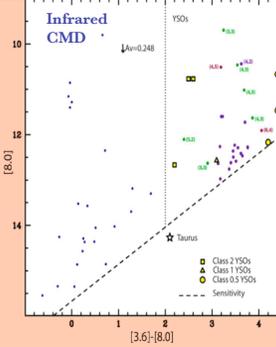
Below, we show the spatial distribution of the different stellar populations in a quantitative way. Using the same photometry list employed in making the full optical CMD, we construct a CMD for each of the individual grid-sections. We use the same isochrones as above: Red = 6 Gyr, Blue = 4Myr (Main Sequence), and Aqua = 4Myr (pre-Main Sequence). In each grid-section CMD, we only apply those isochrones corresponding to the populations observed in that region. We also note the number of YSO candidates in each section.

The high concentration of pre-MS stars is quite noticeable near cluster center. Section (4,3) is the most notable, containing a huge population of pre-Main Sequence and Zero Age Main Sequence stars. In fact 38% of all of the clusters candidate pre-MS stars lie within grid-section (4,3), and more than 61% lie within regions (4,3), (3,5), and (4,2). The concentration of YSO candidates lies a little farther out. Grid-section (5,3) contains 6 of the 25 YSO candidates along its dusty ridge but contains less than 7% of the cluster's pre-MS stars. Sections (4,2) and (3,4) each contain 4 YSO candidates and contain 12% and 3% of the pre-MS candidates respectively. Sections (2,3), (4,5), (6,4), and (5,2) each contain one YSO, accompanied by little or no pre-MS population.

Many of the edge regions contain only Main Sequence and old Turn-Off stars, consistent with SMC wing field star populations. This is notably true of sections (2,2), (2,5), (5,1), (5,4), (5,5), (6,1), (6,2), (6,5), and the entire top row, including section (1,3), which contains a cluster that appears to be bright blue in the optical. Region (2,1) contains only Turn-Off stars.

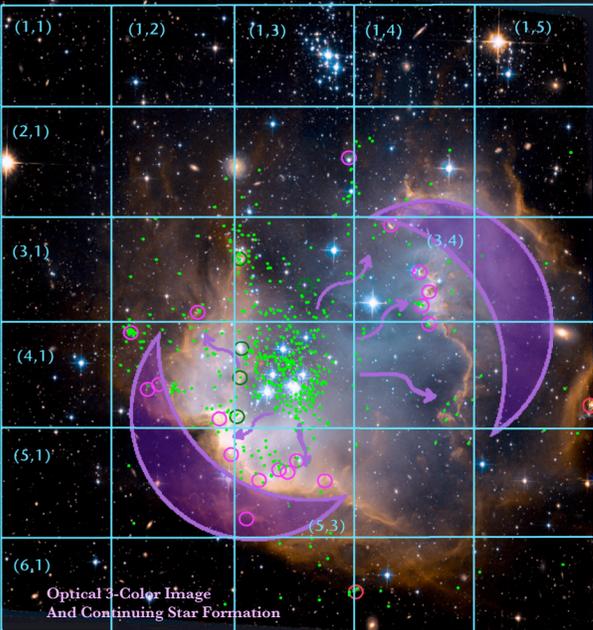
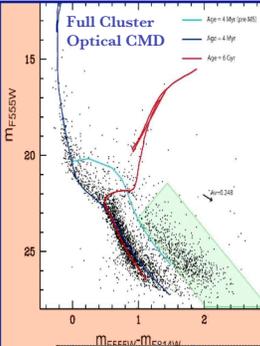
IRAC Infrared 3-Color Image
The 3-color Spitzer/IRAC image shown above is composed of Blue=[3.6], Green=[4.5], and Red=[8.0]. Its Field of View is approximately 5' x 5' (58pc x 58pc). North is up, and East is to the left.

Candidate Young Stellar Objects, as selected via analysis of various Color-Magnitude diagrams in the IRAC bands, are indicated with white circles. They appear primarily along IR-bright dust ridges and so-called elephant trunk formations. The overlaid grid corresponds to that shown below on a 3-color HST/ACS optical image. Note that the bright red YSO candidate in grid-section (4,5) extends far beyond the bounds of the grid marking the edge of the ACS observation. Also, while the central grid-section (4,3) contains several blue point sources, they are markedly separated from the YSO candidates.

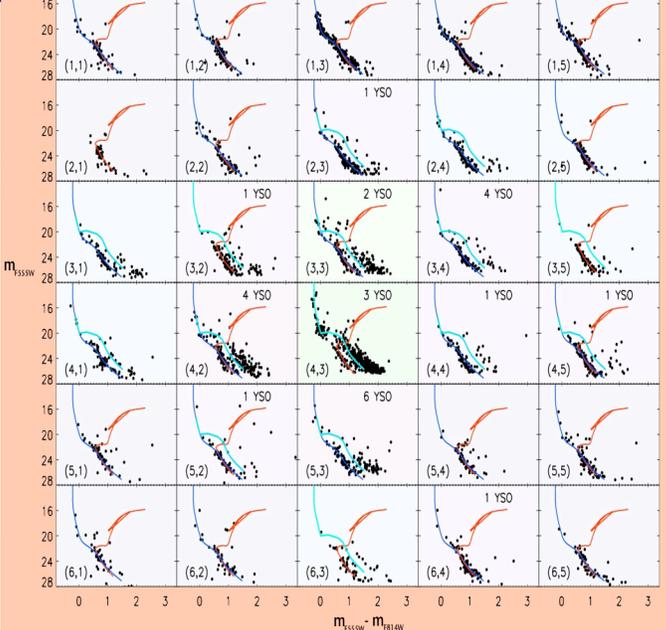


Infrared CMD
We choose candidate Young Stellar Objects based on the Color-Magnitude (CMD) and Color-Color positions of model YSOs in IRAC band comparisons. Here, we show the representative [3.6]-[8.0] v. [8.0] CMD. We designate all sources that lie red-ward of $[3.6] - [8.0] = 2$ as candidate YSOs with ages up to about 1 Myr. Points indicating YSO candidates are color-coded according to position in the cluster. Purple points correspond to sources in the dustiest regions, grid-sections (1,3), (3,4), (4,4), (5,3), (5,2), and (4,2) on the optical 3-color image. Green points represent the most centrally located sources in sections (3,3) and (4,3). Burgundy points correspond to the YSO candidates in grid-sections (4,5) and (6,4). Blue points are other IRAC sources, probably Main Sequence stars. The Taurus cluster position is adapted from Meixner et al. (2006).

Optical ACS CMD
This optical CMD at right is constructed from HST/ACS Wide Field Channel data in apparent magnitudes for filters F555W and F814W (roughly Johnson V and I). The red isochrone shows the presence of an old, field population with a low metallicity ($Z \sim 0.001$), while the blue isochrone delineates a young Main Sequence population with $Z \sim 0.004$. The sizable pre-Main Sequence population is concentrated in the color space $1 < [m(F555W) - m(F814W)] < 2$ and indicated by the aqua isochrone with $Z \sim 0.004$ and by the green box. A reddening value of $E(B-V) = 0.08$ ($A_V = 0.248$), determined from ground-based photometry has been applied to all isochrones, bringing them into alignment with the observed data. Main Sequence and Turn-Off isochrones are from Bertelli et al. (1994), while the pre-Main Sequence isochrone is from Siess, Dufour, & Forestini (2000).



Optical 3-Color Image And Continuing Star Formation



Optical ACS 3-Color Image

The background 3-color optical image above comes courtesy the Hubble Heritage team, and is composed of HST/ACS images from the Wide Field Channel: Blue = F555W, Green = F555W + F814W, Red = F658N(Ha+[NII]) + F814W. The Field of View is about 200'' x 200'' with North up and East to the left. Marked on the beautiful Heritage image are candidate pre-Main Sequence stars (green dots), as identified via the Optical Color-Magnitude Diagram shown above. Young Stellar Object candidates from infrared data are marked as circles. Note that the spatial distributions are distinct. The pre-Main Sequence stars are highly concentrated at the cluster center (especially in grid-section (4,3)), near the brightest blue stars in the cluster. The Young Stellar Objects are systematically farther from cluster center. On average, they occupy more obviously dusty regions.

Continuing Star Formation

With all of this evidence, we conclude that the bright cluster center stars and pre-MS stars formed coevally about 4 Myr ago. Their radiation and possible winds then swept out a cavity in their dusty nebular birthplace, triggering further star formation. The crossing time from cluster center to the dusty ridges is about 1-2 Myr.