The Universal Initial Mass Function (IMF)

Deep Subaru Hα Observations of M83 XUV Disk

J. Koda¹, M. Yagi², S. Boissier³, A. Gil de Paz⁴, M. Imanishi⁵, J. Donovan Meyer¹, B. Madore⁶, D. Thilker⁷


ABSTRACT & CONCLUSIONS: We report Subaru deep Hα observations of the extended ultraviolet (XUV) disk of M83. Combining Subaru and GALEX data with a stellar population synthesis model, we find that (1) the stochastic stellar initial mass function (IMF) is preferred rather than the truncated IMF, because some low mass stellar clusters (10^2-3 M☉) have massive O type stars; and that (2) the standard Salpeter IMF and a simple aging effect explain the counts of FUV-bright and Hα-bright clusters. The new data, model, and previous spectroscopic studies provide overall consistent results with respect to the internal dust extinction (Aᵥ~0.1 mag) and low metallicity (~0.22 Z☉). After the extinction correction and background subtraction, virtually all clusters in the XUV disk are blue FUV-NUV <0.0 mag (Koda et al. 2012, ApJ, 749, 20).

**OBSERVATIONS & DATA**

- Subaru 8.2m Observations
- Suprime-Cam: Prime Focus Camera
- Large Field-of-View (34' x 27')
- Entire M83 XUV disk with TWO pointings
- NA659 (Ha) & Rc bands
- Archival GALEX Data (Bagiel et al. 2010)
- FUV & NUV bands
- Sensitivities (AB mag, 1sigma)

<table>
<thead>
<tr>
<th>NA659</th>
<th>Rc</th>
<th>FUV</th>
<th>NUV</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.90</td>
<td>25.56</td>
<td>26.34</td>
<td>26.20</td>
</tr>
</tbody>
</table>

**CONSTRAINING THE IMF**

- Basic Idea
  - UV and Hα trace stellar clusters with different stellar populations
  - GALEX UV to with B (possibly O) stars
  - Subaru Ha to with O stars
  - Counts of clusters bright in UV and Hα should constrain the IMF at high-mass end.
  - N_UV = # of UV-bright clusters
  - N_Hα = # of Ha-bright clusters
  - Practically, we can use color criteria to count them (FUV-NUV<0mag & NA659-Rc<1mag)

- Taking into account the cluster aging effect, we would expect:
  - t_Hα: timescale that cluster is UV-bright
  - t_UV: timescale that cluster is Ha-bright

**SAMPLE SELECTION**

- Inside HI disk (IN objects)
  - O Stars exist
  - O or B stars exist

- Outside HI disk (OUT objects)
  - FUV-based detection
  - SExtractor (5' aperture)
  - Separate IN and OUT objects

**NUMBER COUNTS**

- Low-mass clusters (10^2-3 M☉)
  - N(10<3 M☉) = 9 ± 3 (Poisson noise)

**STOCHASTIC IMF**

- Higher-mass clusters (>10^3 M☉)
  - N(10^3 M☉) = 88 ± 9

**MODEL**

- Photometric Evolution Model
- STARBURST99 (Leitherer et al 1999)
- Single Stellar Population (SSP)
- Salpeter IMF with THREE upper stellar masses

Note: assume0.2Z☉ from previous spectroscopy (Gil de Paz et al. 2007)

Clusters with O stars (surrounded by HI regions; blue in NA659-Rc) are only inside the HI disk.

HII regions around clusters are clearly detected.

Number ratios – MODEL and OBS are CONSISTENT

→ The standard IMF in the M83 XUV disk.