SFRs: UV versus H$\alpha$

Salim et al. 2007 ApJS..173..267S

Outline

- **GALEX photometry by GALPHOT**

- SFR derived from UV (Salim et al. 2007)

- UV versus Hα SFR (Lee et al. 2009)
GALEX photometry by GALPHOT

Process
- Retrieve data, add keywords
- Cut big images
- Mark skyboxes, subtract skybg
- Record seeing disk
- Clean images
- Run SCPHOT to fit ellipse (ELPHOT)
- Fix jumps in position angle
- Mark disk
- Rescale the table
- Compute magnitudes with SCMAG
- Record the best match from catalog
- Archive data
GALEX photometry by GALPHOT

- Comparison to GALEX pipeline result

![Graphs showing comparison between GALEX and GALPHOT magnitudes in NUV and FUV bands.](image)

- More details
  - ALFALFA GALEX Team Website
SFR derived from UV (Salim+ 2007)

- SED fitting (u, g, r, i, z, NUV, FUV) to obtain SFR
- UV extinction (different from star-burst, not valid in extreme)

Empirical conversion factor for Salpeter IMF

\[
\text{SFR}(M_\odot\text{yr}^{-1}) = 1.08 \times 10^{-28} L_{FUV}^0 (\text{erg}^{-1}\text{s}^{-1}\text{Hz}^{-1})
\]

- 1σ scatter of 0.17 dex in -1<\log\text{SFR}<1 range
UV versus Hα SFR (Lee+ 2009)

Data

- 436 local volume objects from 11HUGS, dominated by dwarfs
- Complete to $m_B < 15.5$, corresponding to $M_B < -15$, $M_{HI} > 2 \times 10^8 M_\odot$ for $|b| > 20^\circ$, 11Mpc
- Hα+[NII] and R-band imaging (Kennicutt et al. 2008)

<table>
<thead>
<tr>
<th>Telescope</th>
<th>Detector</th>
<th>CCD Scale (arcsec)</th>
<th>FOV (arcmin)</th>
<th>Continuum Filter (Å)</th>
<th>Line Filter(s) (Å)</th>
<th>Exp Times (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bok 2.3 m</td>
<td>Loral 2k x 2k</td>
<td>0.43</td>
<td>4.9</td>
<td>6451/1473</td>
<td>6585/66</td>
<td>1000/200</td>
</tr>
<tr>
<td>VATT 1.8 m</td>
<td>Loral 2k x 2k</td>
<td>0.40</td>
<td>6.4</td>
<td>6338/1186</td>
<td>6585/66</td>
<td>1800/360</td>
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<tr>
<td>CTIO 0.9 m</td>
<td>Tek 2k x 2k</td>
<td>0.79</td>
<td>13.5</td>
<td>6425/1500</td>
<td>6600/75</td>
<td>2700/360</td>
</tr>
</tbody>
</table>

- UV images from GALEX
- NGS (~1500s) and archival data
- Photometry following Gil de Paz et al. 2007
Comparison of Hα and FUV SFRs

- Corrections for Galactic extinction
  - Maps of Schlegel et al. 2008 and Cardelli 1989 extinction law
  - Remove [NII] component from [NII] \( \lambda \ 6583/H\alpha \) ratio

\[
\begin{align*}
\text{SFR}[M_\odot\text{yr}^{-1}] &= 7.9 \times 10^{-42} \ L(H\alpha) \ [\text{ergs s}^{-1}] \\
\text{SFR}[M_\odot\text{yr}^{-1}] &= 1.4 \times 10^{-28} \ L_\nu(\text{UV}) \ [\text{ergs s}^{-1}\text{Hz}^{-1}] 
\end{align*}
\]

- Reasonable agreement
- Hα begins to underpredict the SFR relative to the FUV luminosity at low SFRs (logSFR < -1.5)
Internal dust attenuation

- $\text{H} \alpha$
  - Balmer decrement (spectra)
  - Without spec

$$A_{\text{H} \alpha} = \begin{cases} 
0.10 & \text{if } M_B > -14.5 \\
1.971 + 0.323M_B + 0.0134M_B^2 & \text{if } M_B \leq -14.5 
\end{cases}$$

UV

- TIR/FUV ratio (MIPS)

$$A(\text{FUV}) = -0.0333x^3 + 0.3522x^2 + 1.1960x^3 + 0.4967$$

$$TIR = 1.559\nu f_\nu(24) + 0.7686\nu f_\nu(70) + 1.347\nu f_\nu(24)$$

- Without FUV: Calzetti's law
  - $A(\text{FUV})/A(\text{H} \alpha) = 1.8$
Stellar model uncertainties
- 20% uncertainties in the Hα/UV ratio (no sys trend)

Metallicity
- Low SFR increasingly dominated by metal-poor dwarfs
- Larger Hα/UV ratio at low Z

Ionizing photon loss
- Dwarf galaxies embedded in large envelopes of HI

Starbursts in dwarf galaxies
- Require uncommonly high amplitude

Stochasticity in high mass star formation at low SFRs
- Deviation from logSFR<-3
IMF
- IMF deficient in high mass stars in dwarf and LSB galaxies
- Integrated galaxial IMF
  - The maximum mass of a cluster formed in a given galaxy depends on its SFR
  - The maximum mass of a star formed in a given cluster depends on the total cluster mass, and is lower than the strict limit
- Declining trend of Hα - UV ratio

FUV is more robust SFR indicator in individual galaxies with low total SFRs and low dust attenuations.