THE VERY MASSIVE STAR CONTENT OF THE NUCLEAR STAR CLUSTERS IN NGC 5253

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arXiv: 1603.06974

From Stars to Massive Stars, Florida, 6-9 April 2016
• Blue compact dwarf
• D = 3.15 Mpc
• Young central starburst
• Z = 35% solar

LEGUS galaxy: Calzetti + (2015) studied clusters using 13 band photometry
• Clusters found around the region where our 11 target clusters are located. We derive separate corrections for each instrument combination.

• For the medium broad-band filters, we perform photometry on both the nebular-emission and stellar-continuum. For the UVIS filters, we perform photometry on both the nebular-emission and stellar-continuum.

• As some of the clusters show a complex structure, we also perform larger-aperture photometry, with a larger value, 2.81, for the F110W filter.

• The larger uncertainty for the F110W filter is comparable to the radius of the default photometric aperture.

• For the WFC3 filters, we perform photometry on both the nebular-emission and stellar-continuum. The region has size 20 pixels and width in the range 1.7 – 2.25 pixels.

• The aperture corrections needed to bring the 5-pixel radius photometry to the corresponding value vary by less than 8%, a much smaller uncertainty than those introduced by other contamination. The resulting photometry varies by less than 0.15.

• The color gradient shown by the emission lines in cluster 11 indicates uncertainties of 5% to 20% for the stellar continuum and 40% to 70% for the emission lines, when comparing to appropriate synthetic photometry from stellar population synthesis models.

• The ages of #11 and #5 are 1 ± 1 Myr. The masses are 2.5 x 10^5, 7.5 x 10^4 M⊙.

• The age for #5 contradicts the age of 3-5 Myr from the presence of WR stars.

• Cluster #11: massive ultracompact H II region (Turner & Beck 2004)

• Cluster #5: peak Hα emission in galaxy

• #5 and #11 are separated by 5 pc
DOES CLUSTER #5 CONTAIN VERY MASSIVE STARS?

• Crowther et al. (2010, 2016): R136 in 30 Dor contains 8 VMS with $M > 100 M_\odot$, age of 1.5± 0.5 Myr

• Examined archival HST/STIS FUV spectroscopy and VLT/UVES optical spectroscopy of #5
STIS spectrum of #5 compared with R136a STIS spectrum

95% of He II 1640 in R136a originates in VMS

#5 is 1-2 Myr old and contains VMS
IONIZING FLUXES

• $Q(H\ I) = 2.2 \times 10^{52} \text{s}^{-1}$ for central 5 pc region (Turner & Beck 2004)
• 50% of this flux is accounted for from SED modelling (Calzetti et al. 2015)
• Four WN5h stars in R136 are responsible for 25% of ionizing flux (Doran et al. 2013)

• For cluster #5, #11, we need just 12 VMS to supply extra ionizing flux
NITROGEN ENRICHMENT

• N is enriched 2-3x in ionized gas around clusters (Walsh & Roy 1987) but no He enrichment
• Rotating massive stellar evolutionary models of Köhler et al. (2015) - early N wind enrichment
  • Dynamical time scale for enrichment = 0.5 Myr
  • Excess N \sim 1 \, M_\odot, need average mass loss rate of $4 \times 10^{-6} \, M_\odot \, yr^{-1}$ for 300 stars > $50 \, M_\odot$ - reasonable

• Lower mass cluster stars will be still be forming
  - may be N-rich cf. GC models (Decressin et al. 2007)
CONCLUSIONS

• NGC 5253 is young, low Z, nuclear starburst

• The nuclear cluster #5 is < 2 Myr old and contains VMS (only other example is NGC 3125-1; Wofford et al. 2014)

• JWST will obtain UV rest frame spectra of high-z galaxies - will their spectra show VMS?

• High ionizing flux in nucleus can be explained by invoking VMS

• Nitrogen enrichment can be explained by massive, rotating stars - environment has been polluted within 1-2 Myr

• Population synthesis models need to be extended to include VMS, which will dominate the mechanical and ionizing feedback in the first 2 Myr