The Stellar Content of Nearby Star-Forming Galaxies. III. Unravelling the Nature of the Diffuse Ultraviolet Light

Rupali Chandar (1), Claus Leitherer (1), Christy A. Tremonti (2), Daniela Calzetti (1), Alessandra Aloisi (1,3), Gerhardt R. Meurer (4), and Duilia de Mello (5,6)

1 - Space Telescope Science Institute
2 - Steward Observatory
3 - On assignment from the Space Telescope Division of ESA
4 - Johns Hopkins University
5 - Goddard Space Flight Center
6 - Catholic University of America

We investigate the nature of the diffuse intra-cluster ultraviolet light seen in twelve local starburst galaxies, using long-slit ultraviolet spectroscopy obtained with the Space Telescope Imaging
Spectrograph (STIS) aboard the Hubble Space Telescope (HST). We take this faint intra-cluster light to be the field in each galaxy, and compare its spectroscopic signature with STARBURST99 evolutionary synthesis models and with neighboring star clusters. Our main result is that the diffuse ultraviolet light in eleven of the twelve starbursts lacks the strong O-star wind features that are clearly visible in spectra of luminous clusters in the same galaxies. The difference in stellar features dominating cluster and field spectra indicate that the field light originates primarily from a different stellar population, and not from scattering of UV photons leaking out of the massive clusters. A cut along the spatial direction of the UV spectra establishes that the field light is not smooth, but rather shows numerous ``bumps and wiggles''. Roughly 30-60% of these faint peaks seen in field regions of the closest (<4 Mpc) starbursts appear to be resolved, suggesting a contribution from superpositions of stars and/or faint star clusters. Complementary WFPC2 U,V,I imaging for the three nearest target galaxies, NGC 4214, NGC 4449, and NGC 5253 are used to obtain a broader picture, and establish that all three galaxies have a dispersed population of unresolved, luminous blue sources. Because the field spectra are dominated by B-stars, we suggest that the individual sources observed in the WFPC2 images are individual B stars (rather than O stars), or small star clusters. We consider several scenarios to understand the lack of observed massive stars in the field, and their implications for the origin of the field stellar population. If the field stellar populations formed in situ, the field must either have an IMF slope which is steeper than Salpeter (3.0-3.5), or a Salpeter slope with an upper mass cutoff of 30-50 solar masses. If star formation occurs primarily in star clusters, the field could be composed of older, faded clusters, and/or a population which is coeval with the luminous clusters but lower in mass. We use these benchmark populations to place constraints on the field stellar population origin. Although the field probably includes stars of different ages, the UV light is dominated by the youngest stellar populations in the field. If the field is composed of older, dissolving clusters, we estimate that star clusters (regardless of mass) need to dissolve on timescales 7-10 Myr to create the field. If the field is composed of young clusters which fall below the detection limit of individual sources in our spectroscopy, they would have to be several hundred solar masses or less, in order to be deficient in O stars, despite their extreme youth.

Reference: 2005, ApJ, 628 (in press)
Status: Manuscript has been accepted

Weblink: http://www.stsci.edu/science/starburst/

Comments:

Email: rupali@stsci.edu