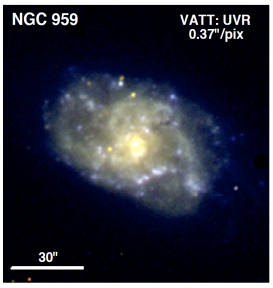
# Revealing the Stellar Populations Underlying the Dust in NGC 0959


*Kazuyuki Tamura*[1,2] (ktamura@asu.edu), *Rolf A. Jansen*[2,1], *Paul B. Eskridge*[2,3], *Seth H. Cohen*[2], *Rogier A. Windhorst*[2,1]

[1] *Department of Physics, Arizona State University*

[2] *School of Earth & Space Exploration, Arizona State University*

[3] *Department of Physics and Astronomy, Minnesota State University*

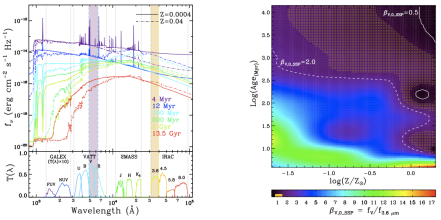

## Introduction

The 2D distribution of visual dust extinction, $A_V$, can be mapped using only observed *V* and 3.6 $\mu$m images (Tamura et al. 2009). Here, we show the effect and importance of a pixel-by-pixel extinction correction of FUV—mid-IR images of NGC 0959 for a study of its stellar populations. We do so by identifying six pixel groups in the extinction-corrected (*B*-3.6 $\mu$m) vs (FUV-*U*) pixel color-color diagram (pCCD), and tracing them in the pCCD *before* correction, as well as on a coordinate map of NGC 0959.

## Method

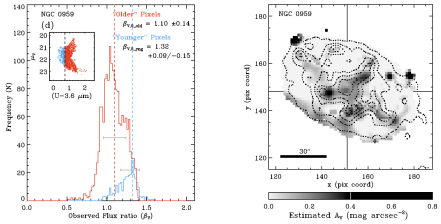
***Tamura et al. 2009, AJ, 138, 1634***

**Model SEDs:** Anders & Fritze-von Alvensleben (2003)

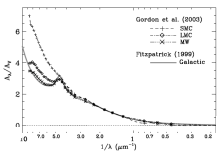



$$A_V = m_V - [\,-2.5\,\log(\beta_{v,0} \times f_{3.6\,\mu m}) - V_{zp}]$$

## Measuring Visual Dust Extinction, $A_V$




- Empirically selecting $\beta_{V,0}$ values for older & younger pixels
  - Due to light-blending (large *GALEX* pixel-scale & PSF)
- Scale to other filters using "LMC2 Supershell" extinction curve of Gordon et al. (2003)




### NGC 0959

- D = 9.9 ± 0.7 Mpc
- FWHM = 5.3" → 250 pc
- 1.5" pixels → 72 pc × 72 pc
- S/N ≥ 3.0 in ALL images

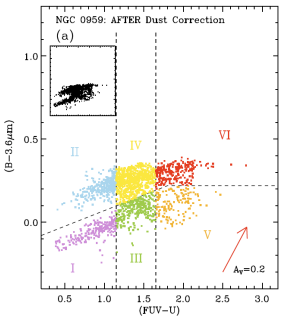
***Tamura et al. 2010a, AJ, submitted***

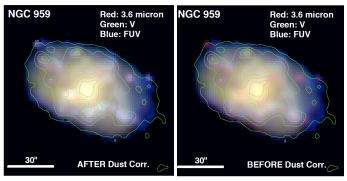
## The (B-3.6 $\mu$m) vs (FUV-U) pCCD

The light in each pixel tends to be dominated by the youngest single stellar population sampled (e.g., Bothun 1986; Eskridge et al, 2003; Lanyon-Foster 2007; Tamura et al. 2009).

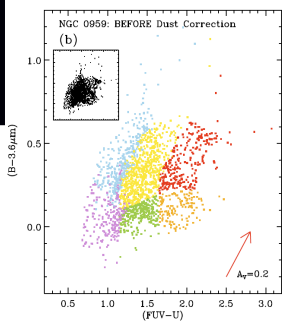
- The (FUV-*U*) color is particularly sensitive to the youngest ages (Kaviraj et al. 2007)
- The *Spitzer*/IRAC 3.6 $\mu$m flux traces stellar mass via redder and older stars (e.g., Willner et al. 2004)
- The (B-3.6 $\mu$m) color was empirically found to be most suited to distinguish mixtures of stellar populations with and without significant recent high-mass star-formation

## *AFTER* Dust Correction




## *BEFORE* Dust Correction



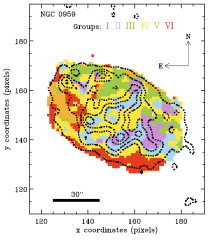

## Description of Pixel-Groups

Pixels are dominated by light from:

- Group I: Young OB-associations
- Group II: OB-associations + Underlying old stellar populations
- Group III & IV: Transition from Group I & II to Group V and VI
- Group V: Old + Intermediate age stars
- Group VI: Old stellar populations

## Pixel-Coordinate Map

- Each square represents a 1.5" ×1.5" (*GALEX*) pixel
- Black contours represents Spitzer/IRAC 8.0 $\mu$m emission (PAHs: Leger & Puget 1984)




## Results

- Group I & II pixels follow 8.0 $\mu$m contours and blue colored regions in color composites:
  - Light is dominated by stellar populations in SF-regions
- A bar-like structure (previously unknown) runs through galaxy center from NW to SE
- Group III pixels mostly on NW side, and Group V & VI pixels on SE side of the galaxy:
  - Large-scale SF episode propagating from SE to NW

## Conclusions

Using a pCCD and pixel-coordinate map, we have presented the importance and potential of a pixel-based extinction correction. After applying our pixel-based extinction correction, six different pixel-groups are selected based on their visual grouping in the (B-3.6 $\mu$m) vs (FUV-*U*) pCCD. Mapping these pixel-groups onto a coordinate-map shows that the distributions of different pixel-groups are not random, but follow the galaxy structures. Our results show that it is *not possible* to meaningfully define these pixel-groups before extinction correction. Also, the pixel-based extinction correction, which is based on only 3.6 $\mu$m and V-band images, allows us to uncover relatively detailed spatial information on the nature of stellar populations and SF history within NGC 0959.

We are currently applying our dust extinction measurement to 40 late-type galaxies (Tamura et al. 2010b, in preparation) to study the relationship between the spatial distribution of extinction and galaxy properties (e.g., morphology, mass, absolute magnitude). Requiring only two filters—one in optical and one in mid-IR wavelengths—our method will also be a powerful tool to correct for the dust extinction in higher redshift galaxies, as observable with *HST*/WFC3 and *JWST*.


***Acknowledgements***

This work is funded by NASA/ADP grant NNX07AH50G, and in part by NASA/JWST grant NAG5-12460.


***References***


Anders, P., & Fritze-von Alvensleben, U. 2003, A&A, 401, 1063

Bothun, G. D. 1986, AJ, 91, 507

Eskridge, P. B., et al. 2003, ApJ, 586, 923

Gordon, K. D., et al. 2003, ApJ, 594, 279

Kaviraj, S., et al. 2007, MNRAS, 381, L74

Lanyon-Foster, M. M., et al. 2007, MNRAS, 396, 462

Leger, A., & Puget, J. 1984, A&A, 137, L5

Tamura, K., et al. 2009, AJ, 138, 1634

Tamura, K., et al. 2010a, AJ, submitted

Willner, S. P., et al 2004, ApJS, 154, 222