RevMexAA (Serie de Conferencias), **17**, 239–240 (2003)

A COMPARISON OF WFPC2 VS. NICMOS MORPHOLOGY OF GALAXIES IN A CLUSTER AT $Z \sim 1.27$

K. L. Wu,[1] Richard Elston,[1] Peter R. Eisenhardt,[2] Daniel Stern,[2] S. A. Stanford,[3] B. Holden,[3] Luc Simard,[4] Mark Dickinson,[5] and A. J. Connolly[6]

RESUMEN

Presentamos un estudio comparativo de la morfología de galaxias en un cúmulo de Lynx a $z \sim 1.27$ observadas con WFPC2 y NICMOS. Los resultados preliminares indican que, si bien la mayoría de los objetos tienen una distribución espectral de energía parecida a la de galaxias elípticas y de tipos tempranos, sus perfiles de brillo superficial cubren todo el intervalo de valores de la fracción de bulbo. Por tanto, se ha de ser cauto a la hora de suponer que las correlaciones locales entre morfología y color son válidas a alto z.

ABSTRACT

We present a comparison of the observed WFPC2 and NICMOS morphology of galaxies in a cluster in Lynx at a redshift of $z \sim 1.27$. Preliminary results indicate that, though the majority of the cluster galaxies have spectral energy distributions resembling those of local elliptical and early-type galaxies, their surface brightness profiles span the full range of bulge fractions. One must be cautious, therefore, to assume that local correlations between morphology and color persist at high redshift.

Key Words: **GALAXIES: CLUSTERS — GALAXIES: EVOLUTION — GALAXIES: STRUCTURE**

Galaxy Evolution: Theory and Observations (Cozumel, Quintana Roo, México, 8-12 April 2002)
Editors: Vladimir Avila-Reese, Claudio Firmani, Carlos S. Frenk & Christine Allen

1. INTRODUCTION

In local galaxies, morphology and color correlate well with each other. Ellipticals are generally very red, dominated by their old stellar population; spirals are generally forming stars and are, thus, bluer than ellipticals; active, star-forming late-type and interacting galaxies are dominated by bright young blue stars and are, therefore, the bluest galaxies.

Although this relation holds nicely in the local universe, one must be cautious to apply it indiscriminately to higher redshift systems. Not only might such relations be intrinsically different at high redshift, observational biases and selection effects may begin to dominate. For example, objects observed through a given filter at progressively higher redshifts are seen at progressively shorter rest wavelengths, where galaxy morphology has been shown to change dramatically (*e.g.*, O'Connell 1997).

In addition, the resolution and signal-to-noise ratio achievable for high redshift objects are significantly lower than locally. Attempts to offset the poorer image quality with techniques such as subpixel dithering often lead to other problems, such as complicated correlations in the sky noise. Sharp features, such as the cores of early-type galaxies, tend to be smoothed out by tessellation techniques used to recover the desired depth, leading to misclassification of objects and skewed number counts.

It is crucial, therefore, to disentangle the effects of image processing and observational bias from intrinsic evolution in order to attain a realistic understanding of the true nature of high redshift objects.

2. DATA AND ANALYSIS

The data presented here were taken using the Wide Field Planetary Camera 2 (WFPC2) and Camera 3 of the Near Infrared Camera and Multi-Object Spectrometer (NICMOS) on the *Hubble Space Telescope (HST)*. Total WFPC2 exposure time was 4800 seconds through *F814W* in one pointing with two 2.5-pixel dither positions. Total NICMOS exposure time was 33600 seconds through *F160W* in three pointings with eight sub-pixel dithers per pointing.

To avoid the image processing difficulties mentioned above while still taking advantage of the increased signal-to-noise of multiple exposures, we chose to use MGIMFIT2D, a task within the IRAF package Galaxy IMage 2D (GIM2D) written by Luc Simard, which determines a single fit to multiple images of an object (Simard 1998, Simard 2002).

3. RESULTS

Figure 1 shows our analysis of the WFPC2 and NICMOS galaxy morphology. The galaxy bulge frac-

[1]University of Florida, Gainesville, FL, USA.
[2]JPL/CIT, Pasadena, CA, USA.
[3]LLNL, Livermore, CA, USA.
[4]HIA/NRC, Victoria, BC, Canada.
[5]STScI, Baltimore, MD, USA.
[6]University of Pittsburgh, Pittsburgh, PA, USA.

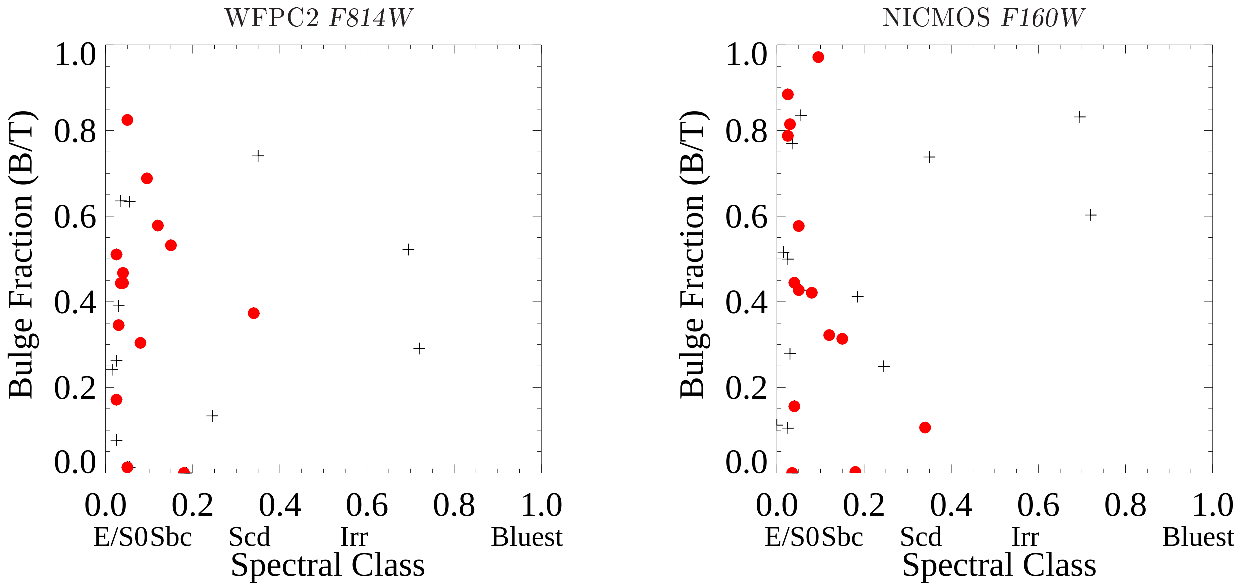

Fig. 1. Galaxy bulge fraction (bulge/total, determined using GIM2D) vs. spectral class (determined using broadband colors) at optical *(left)* and infrared *(right)* wavelengths for galaxies in a cluster in Lynx at $z \sim 1.27$. Dots are likely cluster members (based on z_{phot}), crosses are field galaxies.

tion determined using MGIMFIT2D is plotted relative to the spectral class determined by A. J. Connolly based on the objects' broadband colors. We find that, at both optical and infrared wavelengths, galaxies classified as E/S0s based on their broadband colors span the full range of bulge fractions.

The red objects seen in clusters at high redshifts, therefore, may not be the familiar passively evolving ellipticals found in galaxy clusters today. Though their broadband colors resemble those of nearby early-type galaxies, their surface brightness profiles are disk-like. Indeed, if these objects are the progenitors of today's cluster E/S0s, they must undergo significant morphological evolution between $z \sim 1.27$ and now. Alternatively, they may be dust-enshrouded disks, which will eventually reveal themselves as the familiar (bluer) spirals of today, once the dust has dissipated.

This work serves as a reminder of the significant differences that may exist between the local and distant universe, and the impact that image processing and observational bias may have on our interpretation. It is imperative that we disentangle these effects from intrinsic evolution in order to attain a realistic understanding of the true nature of high redshift objects.

REFERENCES

O'Connell, R. W. 1997, in "The Ultraviolet Universe at Low and High Redshift", eds. W. H. Waller et al., (New York: AIP Press), p.11

Simard, L. 1998, in ADASS VII, 145, eds. Albrecht, R., Hook, R. N., and Bushouse, H. A. (A.S.P. Conference Series), p.108

Simard, L. et al. 2002, ApJS, submitted

A. J. Connolly: Department of Physics and Astronomy, University of Pittsburgh, 3941 O'Hara Street, Pittsburgh, PA 15260, USA (ajc@phyast.pitt.edu).

Mark Dickinson: STScI, 3700 San Martin Drive, Baltimore, MD 21218, USA (med@stsci.edu).

Peter R. Eisenhardt and Daniel Stern: JPL/CIT, MS 169-327, 4800 Oak Grove Drive, Pasadena, CA 91109, USA (prme@kromos.jpl.nasa.gov, stern@zwolfkinder.jpl.nasa.gov).

Richard Elston and K. L. Wu: Department of Astronomy, University of Florida, 211 Bryant Space Science Center, Gainesville, FL 32611-2055, USA (elston, klwu@astro.ufl.edu).

B. Holden and S. A. Stanford: LLNL/IGPP, L-413, PO 808, 7000 East Avenue, Livermore, CA 94550, USA (bholden, adam@igpp.ucllnl.org).

Luc Simard: Herzberg Institute of Astrophysics, National Research Council of Canada, 5071 West Saanich Road, Victoria, BC, V9E 2E7, Canada (Luc.Simard@nrc.ca).

Galaxy Evolution: Theory and Observations (Cozumel, Quintana Roo, México, 8-12 April 2002)
Editors: Vladimir Avila-Reese, Claudio Firmani, Carlos S. Frenk & Christine Allen