The Evolutionary Status of Blue Compact Dwarf Galaxies

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Introduction

Blue Compact Dwarf galaxies (BCDs) provide a rare window into the early stages of galaxy formation. Today's BCDs may be leftover building blocks that never merged into other galaxies and did not participate in very much hierarchical accretion. These dwarf galaxies are a valuable probe into the raw materials of galaxy formation, but are not simply fossils from the beginning of galaxy formation. Even in isolation, galaxies evolve over time. In order to connect today's dwarf galaxies to the original building blocks in early galaxy formation, we must understand how dwarf galaxies change and evolve. We can study this evolution with an analysis of the structural parameters of the spatial light distribution and by fitting models to the Spectral Energy Distributions (SEDs) of the BCDs.

Sample

While there is debate over definitions, our sample includes "classic" BCDs and possible intermediate or transition objects, to cover the full range of BCD and BCD-like galaxies.

The B filter magnitudes come from this work; recession velocities and oxygen abundances come from our pre-existing spectra; distances are from flow models.

BCD Sample

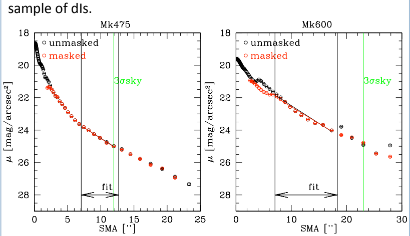
Galaxy name	m_B [mag]	v [km/s]	d [Mpc]	M_B [Mag]	Z logOH+12
IZw18	16.53	751	14.6	-14.43	7.14
IIZw40	15.73	789	11.1	-18.03	8.08
Mk5	16.02	792	15.3	-15.27	8.18
Mk36	15.79	646	8.4	-13.96	7.85
Mk67	16.43	932	18.7	-15.01	8.05
Mk324	15.39	1600	23.2	-16.65	8.50
Mk328	15.49	1379	20.6	-16.48	8.80
Mk475	16.49	583	11.9	-13.94	7.98
Mk600	15.50	1008	13.6	-15.45	7.97
Mk750	15.61	749	5.2	-13.15	8.17
Mk900	14.66	1152	18.9	-16.97	8.74
UM40	15.51		18.8	-15.92	
UM133	16.61		21.8	-15.24	
UM323	16.10	1913	25.6	-16.07	7.70
UM408	17.61	3598	47.5	-15.97	7.74
UM439	15.22	1099	15.9	-15.89	7.95
UM461	16.48	1039	12.7	-14.12	7.74
UM462	14.84	1057	13.5	-15.89	7.87
UM533	14.05	886	6.9	-15.26	8.03
Was5	17.21	1259	23.1	-14.72	7.80
CG10	17.88	1902	30.7	-14.63	7.78
VHC	17.27	1299	27.0	-14.97	7.64

Deep Surface Photometry Fits

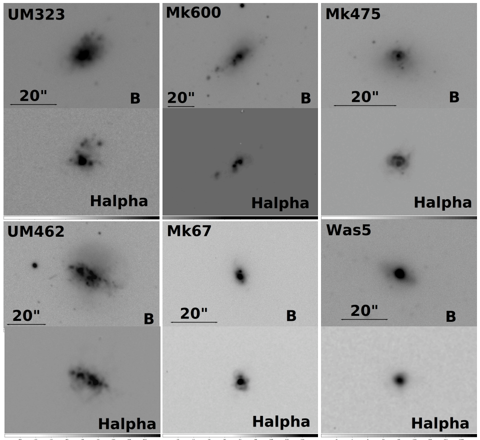
We observed the BCDs with the WIYN (Wisconsin Indiana Yale NOAO) 3.5m telescope at Kitt Peak National Observatory between 2008 and 2010 with the MiniMosaic and OPTIC cameras. Deep, high quality images were taken in B and Hα.

At least two ~900s B images were combined to make our final image, and at least two 720s Hα images were sandwiched around a short R exposure to use for continuum subtraction.

We use the Hα images to mask of the non-diffuse emission brighter than a threshold to leave only light from the underlying galaxy profile. GALPHOT is used to generate surface brightness profiles for the masked and unmasked B images. We fit exponential profiles to the outer regions of the profiles to avoid regions with active star formation. We also fit a comparison sample of dIs.



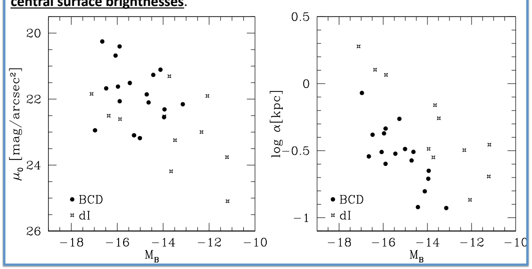
Example Images



Structural Parameters of Underlying Galaxies

These plots show the exponential scale length (α) and the central surface brightness of the underlying light and the total absolute B magnitude.

<u>The underlying galaxy light in BCDs is different from the underlying light in dIs: the underlying light in BCDs is more centrally concentrated and reaches higher central surface brightnesses</u>.



Future Work

- try more SFH scenarios and see if any are preferred/excluded by the SED fits
- use deep H images to make B-H color maps and fit H surface brightness profiles
- expand the comparison dI sample
- use archival VLA observations of BCDs to study structure and motion in HI

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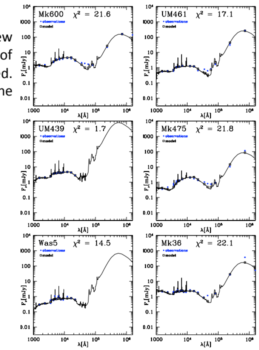
Spectral Energy Distributions

We combine archival photometry with our new GALEX and NIR photometry and measure the flux of the BCDs in many filters from far-UV to far infrared. This broad multi-wavelength data set constrains the BCDs' stars, gas, and dust properties.

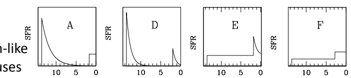
Photometric BCD Observations

Galaxy name	GALEX FUV/NUV	Optical *UBVRI*	SDSS *ugriz*	NIR *JHK*	Spitzer IRAC MIPS
UM40	F/N	B I		JHK	
UM323	F/N	B I	ugriz	JHK	
UM408	F/N	B I		JH	
Mk600	F/N	B I		JHK	1234 123
IIZw40	F/N	UBVRI		JHK	1234 123
Mk5	F/N	UBV I		JHK	1234 123
CG10	F/N		ugriz	JHK	
IZw18	F/N	UBVRI	ugriz	JHK	1234 123
Was5	F/N	UBV	ugriz	JHK	
Mk36	F/N	UBV	ugriz	JHK	1234 123
UM439	F/N	UBV	ugriz	JHK	
Mk750		UBV	ugriz	JHK	
UM461	N	UBV	ugriz	JHK	1234 123
UM462	F/N	UBV	ugriz	JHK	1234 123
VHC	F/N	UBVR	ugriz	JH	1234 12
Mk67	F/N	UBVRI	ugriz	JHK	1234
Mk475	F/N	UBV	ugriz	JHK	1234 123
Mk900	F/N	B I		JHK	1234 123
Mk324	F/N	UBVRI		JHK	
Mk328	F/N	UBVRI		JHK	

Note. — Optical and NIR from old data and recent observations. Some SDSS pipeline photometry shredded the galaxies and is not included.



SED Grids



CIGALE (Noll et al 2009, http://cigale.oamp.fr/) is a Bayesian-like grid-search SED fitting code which uses various physical models to fit a galaxy's SED and return its physical properties. In particular, we use simple stellar population models (of appropriate metallicity) from Maraston 2005 (with improved TP-AGB treatment), a Kroupa IMF, a modified Calzetti extinction law (with its slope modified by δ), FIR emission models of Dale and Helou 2002 (with α heating parameter), and a template-based treatment of emission lines.

Four different star formation history scenarios are used in our four grids, as shown schematically above. In all scenarios the old age is fixed at 13 Gyr and the old population either declines exponentially or remains constant. The young age is a free parameter and the young population also follows a tau or box model. The mass ratio of the two populations is also a free parameter.

SED grids

Parameter	N	range
τ_o [Gyr]	[4]	1, 10
age_o [Gyr]	[1]	13
τ_y [Gyr]	[9]	0.001, 10
age_y [Gyr]	[10]	0.001, 1
f_{burst}	[8]	0.001, 0.999
δ	[7]	-0.5, 0.5
$A_{V,ySP}$	[20]	0.1, 2.95
A_{frac}	[4]	0, 1
α	[9]	0.5, 5

Note. — All grid points are log-spaced between these limits.

SED Fit Results So Far

CIGALE generates posterior probability distributions for all of the input grid parameters and many derived quantities (stellar mass, star formation rate, etc). We use the best-fit parameters to generate mock observations and re-fit them to confirm that the parameters are reliably recovered. We find consistently poor matches to the IR points, systematic over-estimates of IRAC fluxes, consistent but offset estimates of SFR, and little distinction between the four star formation histories. The SED fits provide a wealth of information about the BCDs which we are continuing to explore.