Solo Dwarf Galaxy Survey: Exploring dwarfs in the Local Group

Clare Higgs
PhD Supervisor: Alan McConnachie
August 1, 2019

University of Victoria

Solo Collaboration:
M. Irwin, N. Annau, N. Bate, G. Lewis,
M. Walker, P. Côté, K. Venn, G. Battaglia

higgs@uvic.ca
@astrohigglet

Local Group and a little beyond.

➡ Inside 3 Mpc.

Low mass. M_V >-18

NEARBY ISOLATED DWARF GALAXIES

Not within the virial radius of a large galaxy

➡ More than 300 kpc from M31 and the Milky Way

Why … DWARF GALAXIES

- **Sensitive probes of galaxy formation and evolution**

Why … NEARBY

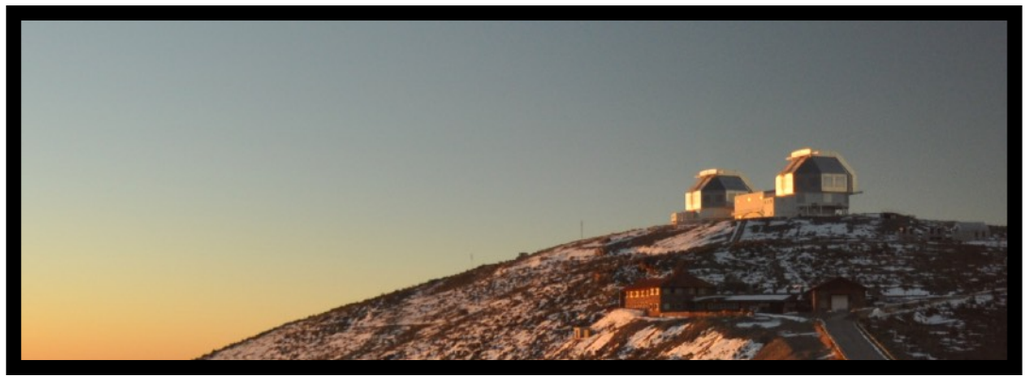
- **Resolved stellar populations**

Why … ISOLATED

- **Intrinsic properties of low mass galaxies**

→ Solitary Local (Solo) Dwarf Galaxy Survey

Solo Observations



- Nearby (<3 Mpc)
- Isolated (>300 kpc from MW/M31)
- Wide field imaging *(u), g & i*
- CFHT MegaCam, Magellan Megacam and Magellan IMACS

Name	Alt. Name	RA	Dec. [kpc]	Distance [Mags.]	$E(B-V)$	Tel.	Filt.
WLM	DDO221	$00^h01^m58.2^s$	$-15^o27'39"$	933 ± 34	0.030	M	*gi*
						C	*gi*
AndXVIII		$00^h02^m14.5^s$	$+45^o05'20"$	1355 ± 81	0.102	C	*gi*
ESO410-G005	KK98	$00^h15^m31.6^s$	$-32^o10'48"$	1923 ± 35	0.013	M	*ugi*
Cetus		$00^h26^m11.0^s$	$-11^o02'40"$	755 ± 24	0.038	M	*gi*
						C	*g*
ESO294-G010		$00^h26^m33.4^s$	$-41^o51'19"$	2032 ± 37	0.013	M	g i
IC1613	DDO8	$01^h04^m47.8^s$	$+02^o07'04"$	755 ± 42	0.030	M	*ugi*
						C	*gi*
KKs3		$02^h24^m44.4^s$	$-73^o30'51"$	2120 ± 70	0.045	M	*gi*
Perseus		$03^h01^m22.8^s$	$+40^o59'17"$	785 ± 65	0.062		C
Eridanus II		$03^h44^m21.1^s$	$-43^o32'00"$	785 ± 65			M
UGCA86		$03^h59^m48.3^s$	$+67^o08'19"$	2960 ± 232	0.918	C	*gi*
HIZSS3A(B)		$07^h00^m29.3^s$	$-04^o12'30"$	1675 ± 108	0.046	M	*ugi*
						C	*g*
UGC4879		$09^h16^m02.2^s$	$+52^o50'24"$	1361 ± 25	0.215	C	*gi*
LeoT		$09^h34^m53.4^s$	$+17^o03'05"$	417 ± 19	0.037	C	*gi*
Antlia B		$09^h48^m56.1^s$	$-25^o59'24"$	1294 ± 99		C	g
LeoA		$09^h59^m26.5^s$	$+30^o44'47"$	798 ± 44	0.055	C	*gi*
SextansB		$10^h00^m00.1^s$	$+05^o19'56"$	1426 ± 20	0.034	C	gi
NGC3109	DDO236	$10^h03^m06.9^s$	$-26^o09'35"$	1300 ± 48	0.013	M	*ugi*
Antlia		$10^h04^m04.1^s$	$-27^o19'52"$	1349 ± 62	0.011	M	*gi*
SextansA	DDO75	$10^h11^m00.8^s$	$-04^o41'34"$	1432 ± 53	0.046	M	*ugi*
LeoP		$10^h21^m45.1^s$	$+18^o05'17"$	1620 ± 150	0.090	C	*gi*
DDO99		$11^h50^m53.0^s$	$+38^o52'49"$	2590 ± 167	0.053	C	*ig*
NGC4163		$12^h12^m09.1^s$	$+36^o10'09"$	2860 ± 39	0.050	C	gi
IC3104		$12^h18^m46.0^s$	$-79^o43'34"$	2270 ± 188	0.065	M	*ugi*
DDO113		$12^h14^m57.9^s$	$+36^o13'08"$	2950 ± 82	0.049	C	*gi*
DDO125		$12^h27^m40.9^s$	$+43^o29'44"$	2580 ± 59	0.091	C	gi
GR8	DDO155	$12^h58^m40.4^s$	$+14^o13'03"$	2178 ± 120	0.066	M	*gi*
UGC8508		$13^h30^m44.4^s$	$+54^o54'36"$	2580 ± 36	0.227	C	*gi*
KKH86		$13^h54^m33.5^s$	$+04^o14'35"$	2590 ± 190	0.053	M	*ugi*
KKR3		$14^h07^m10.5^s$	$+35^o03'37"$	2188 ± 121	0.047	C	*gi*
UGC9128		$14^h15^m56.5^s$	$+23^o03'19"$	2291 ± 42	0.038	C	*g*
DDO190		$14^h24^m43.4^s$	$+44^o31'33"$	2790 ± 93	0.100	C	*gi*
KKR25		$16^h13^m48.0^s$	$+54^o22'16"$	1905 ± 61	0.345	C	*gi*
IC4662		$17^h47^m08.8^s$	$-64^o38'30"$	2440 ± 191	0.020	M	*gi*
SagDIG		$19^h29^m59.0^s$	$-17^o40'51"$	1067 ± 88	0.019	C	*ugi*
NGC6822	DDO209	$19^h44^m56.6^s$	$-14^o47'21"$	459 ± 17	0.018	C	*ugi*
Phoenix		$19^h44^m56.6^s$	$-14^o47'21"$	415 ± 19	0.010	M	*ugi*
DDO210	Aquarius	$20^h46^m51.8^s$	$-12^o50'53"$	1072 ± 39	0.026	M	*ugi*
						C	*ugi*
IC5152		$22^h02^m41.5^s$	$-51^o17'47"$	1950 ± 45	0.016	M	*ugi*
AndXXVIII		$22^h32^m41.2^s$	$+31^o12'58"$	661^{+152}_{-61}	0.051	C	*ugi*
KK258		$22^h40^m43.9^s$	$-30^o47'59"$	2230 ± 50	0.011	M	*gi*
Tucana		$22^h41^m49.6^s$	$-64^o25'10"$	887 ± 49	0.024	M	*ugi*
UKS2323-326	UGCA438	$23^h26^m27.5^s$	$-32^o23'20"$	2208 ± 92	0.021	M	*ugi*
PegDIG	DDO216	$23^h28^m36.3^s$	$+14^o44'35"$	920 ± 30	0.061	C	*ugi*
KKH98		$23^h45^m34.0^s$	$+38^o43'04"$	2523 ± 105	0.053	C	*ugi*

Why … DWARF GALAXIES

- **Sensitive probes of galaxy formation and evolution**

Why … NEARBY

- **Resolved stellar populations**

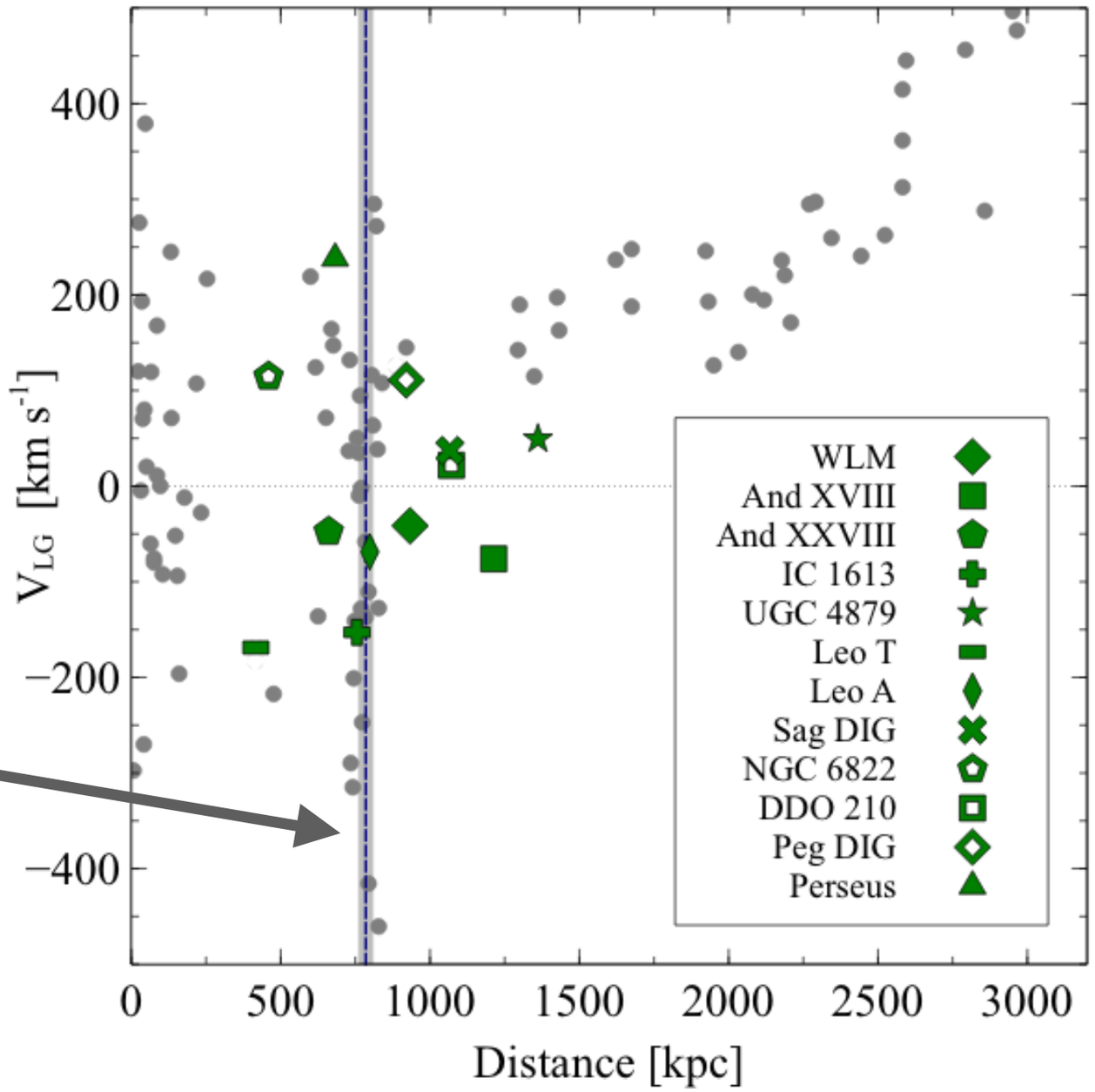
Why … ISOLATED

- **Intrinsic properties of low mass galaxies**

Why … HOMOGENEOUS

- **Need to minimize systematics**

Local Group Subsample



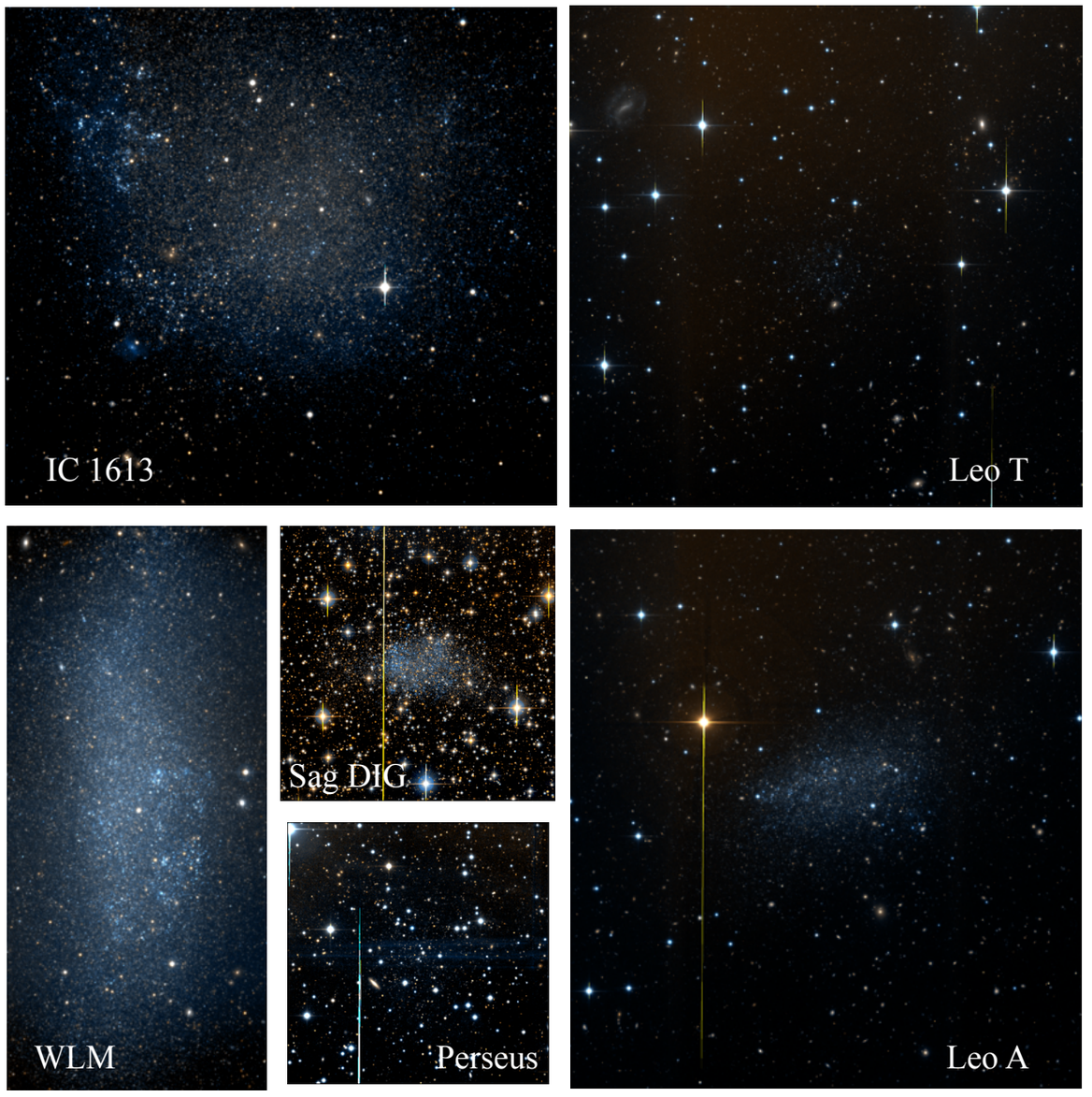
distance to M31

Alt. Names:

WLM = DDO 221
UGC 4879 = VV 124
IC 1613 = DDO 8
DDO 210 = Aquarius
NGC 6822 = DDO 209
Peg DIG =DDO 216

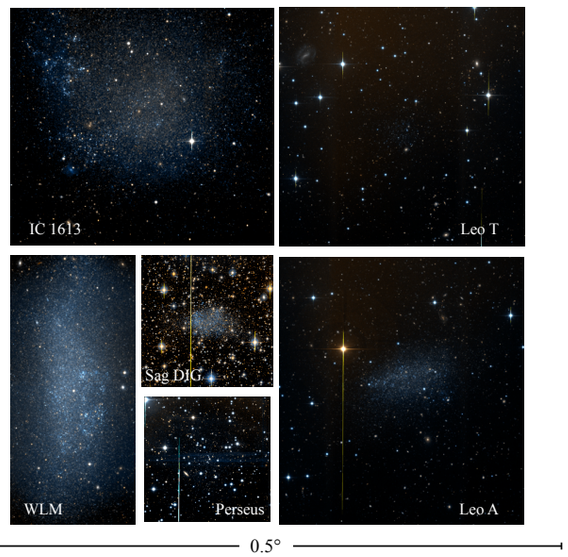
McConnachie 2012

Solo Dwarfs



Solo Dwarfs

Full field of view



Analysis Techniques

Resolved Stars

Pros:

- Reveals faint and extended stellar populations.
- Mass weighted rather than luminosity weighted.
- Can study the fainter old RGB population.
- Kinematic tracers often RGB stars.

Cons:

- Incompleteness due to Crowding in the central part
- Radial profiles are not in “conventional” units.

Integrated Light

Pros:

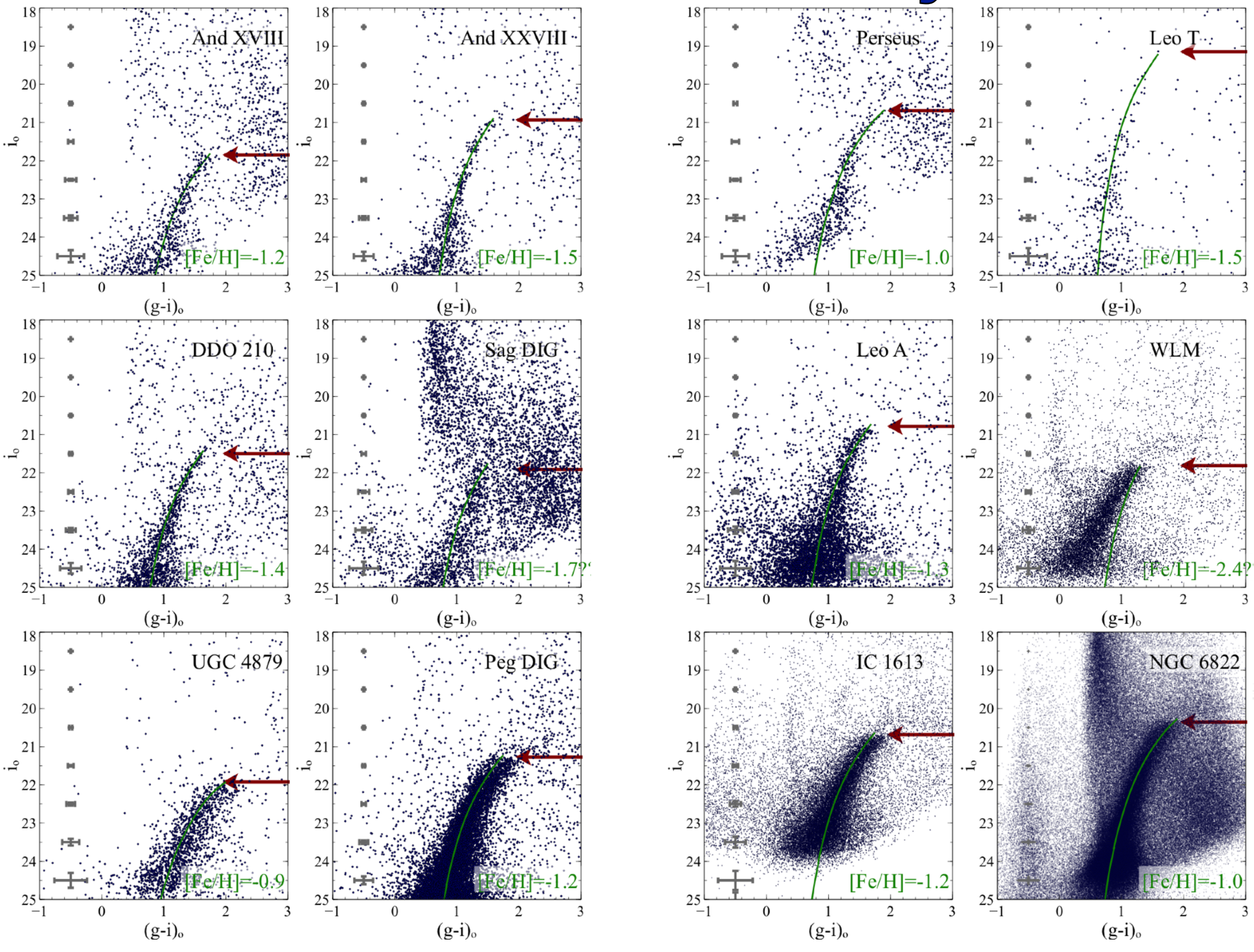
- Describe the central regions well.
- Colour profiles

Cons:

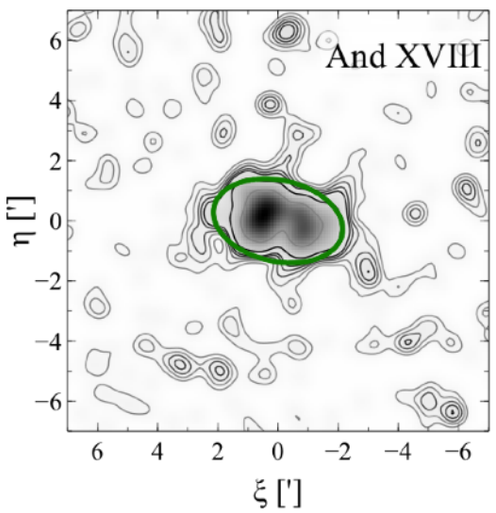
- Dominated by younger stellar populations.
- Heavily contaminated by foreground and background sources.

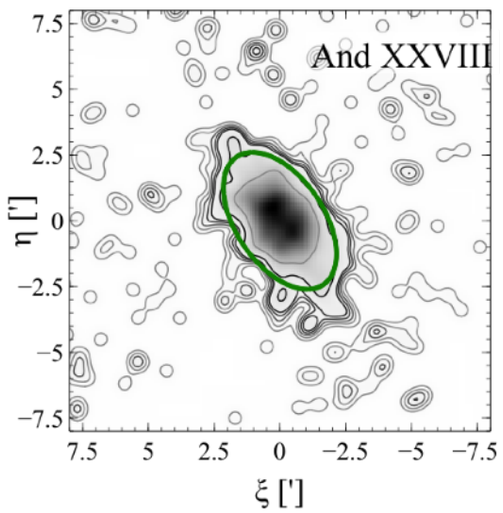
Combine both!

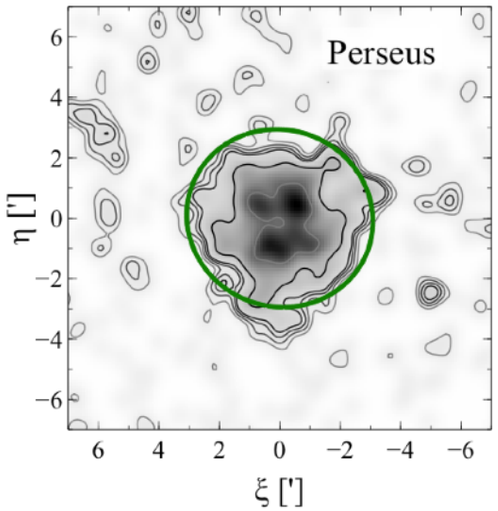
Resolved Stars in Nearby Dwarfs

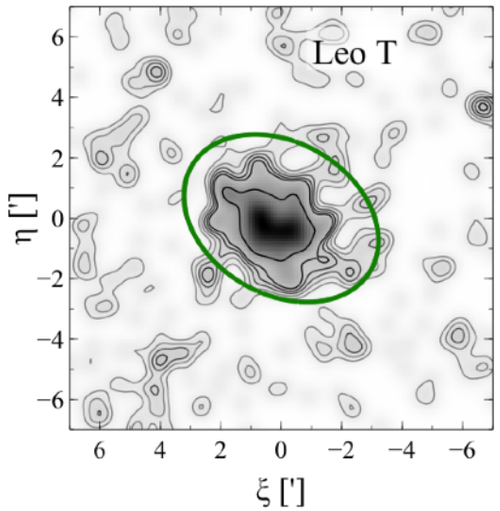


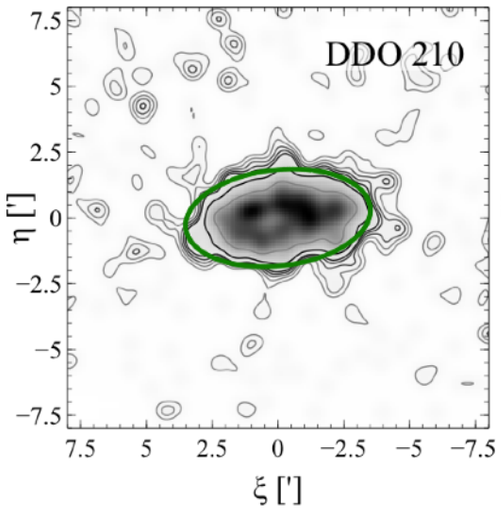
Resolved Stars in Nearby Dwarfs

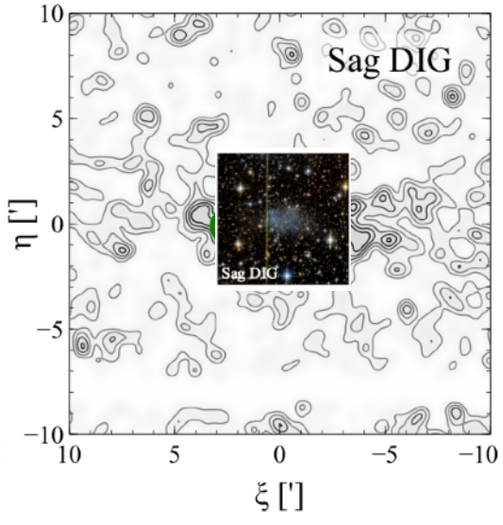


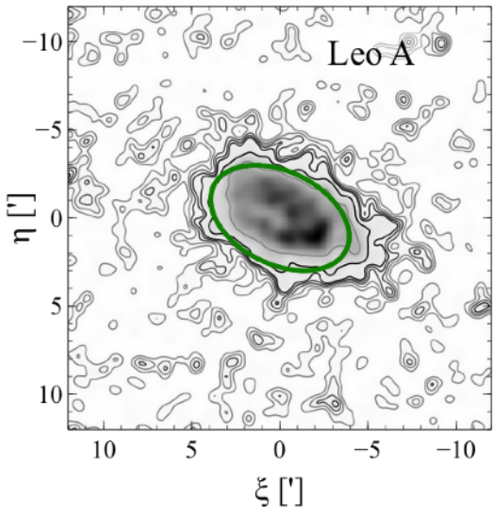


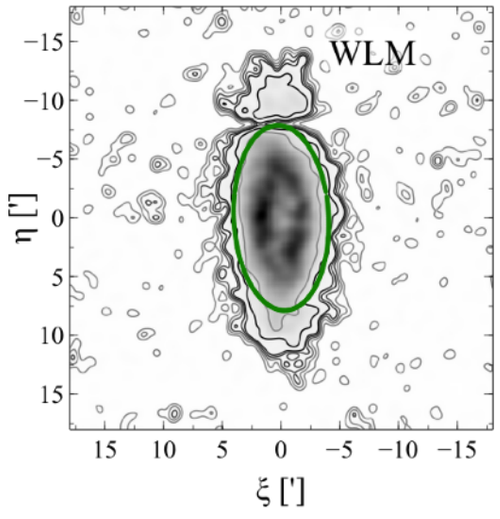


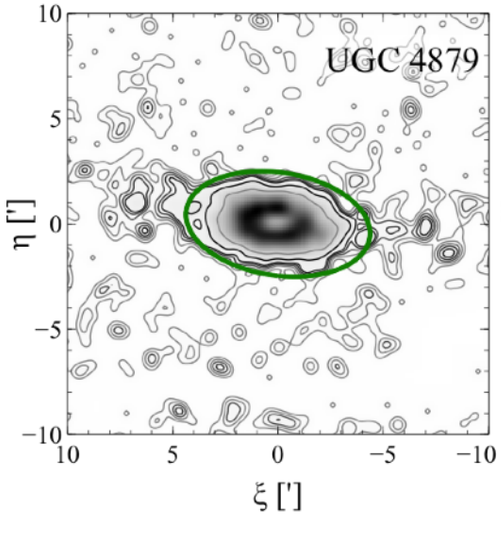


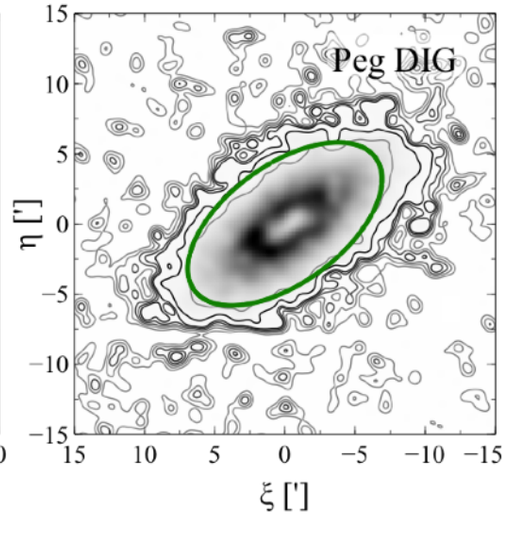


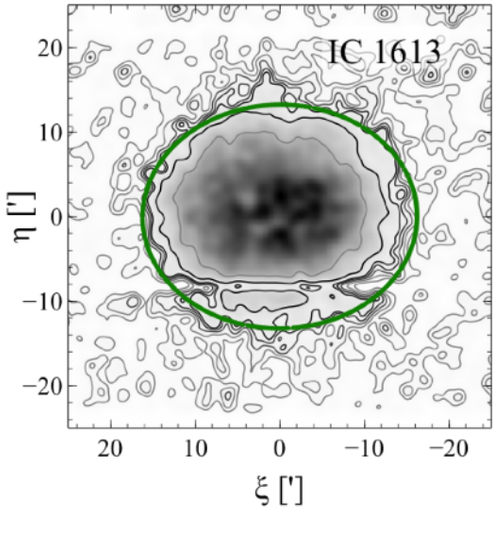


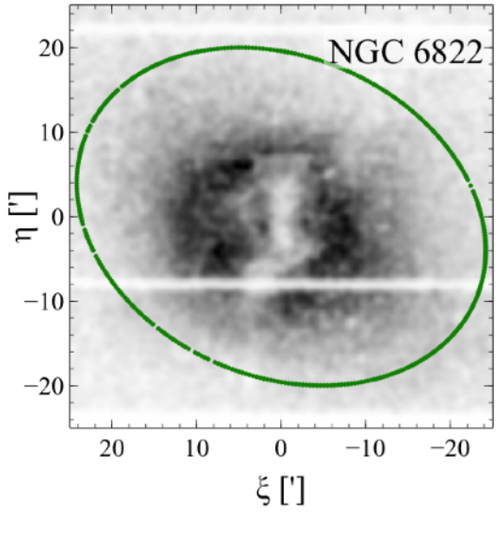




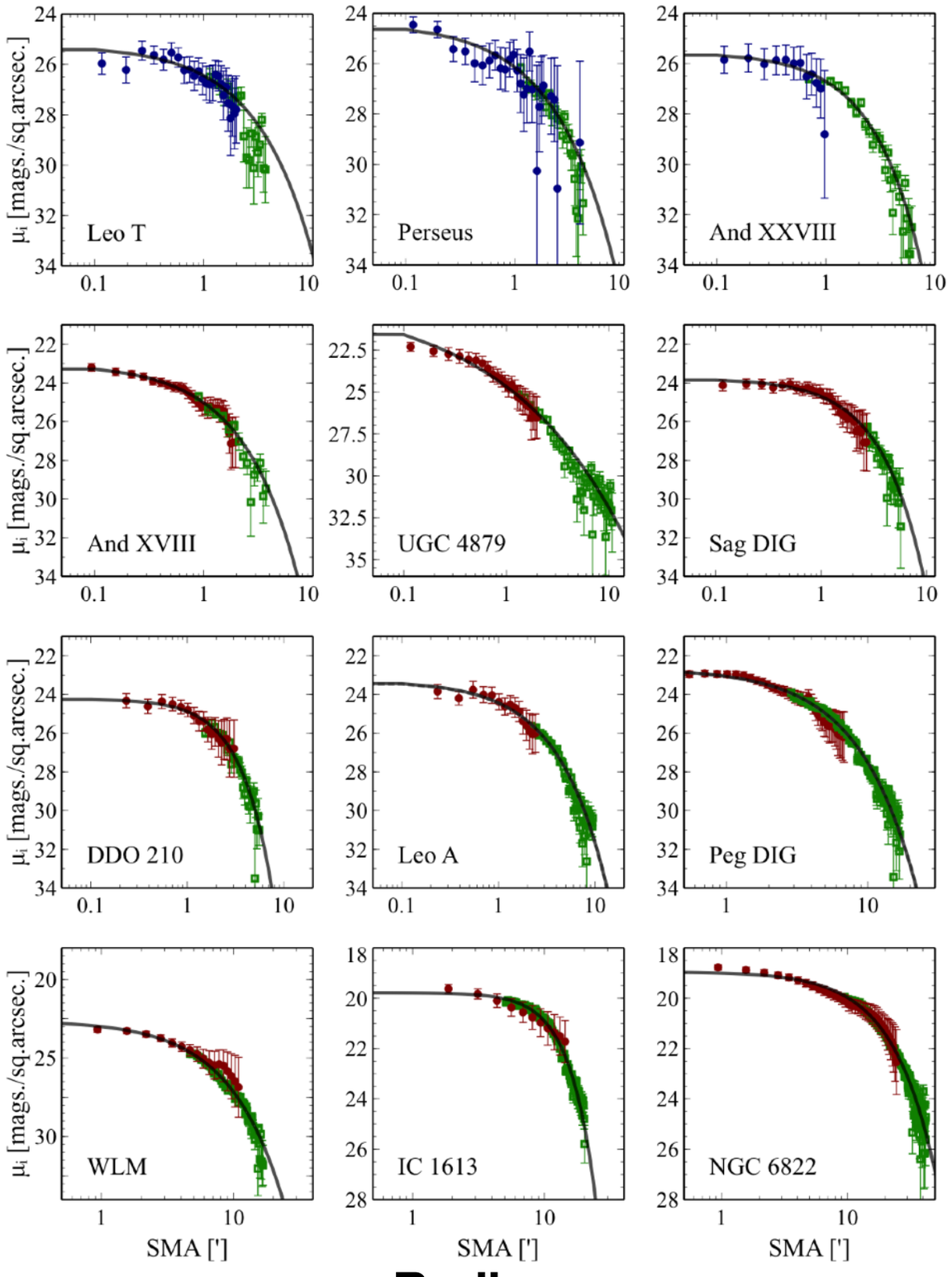






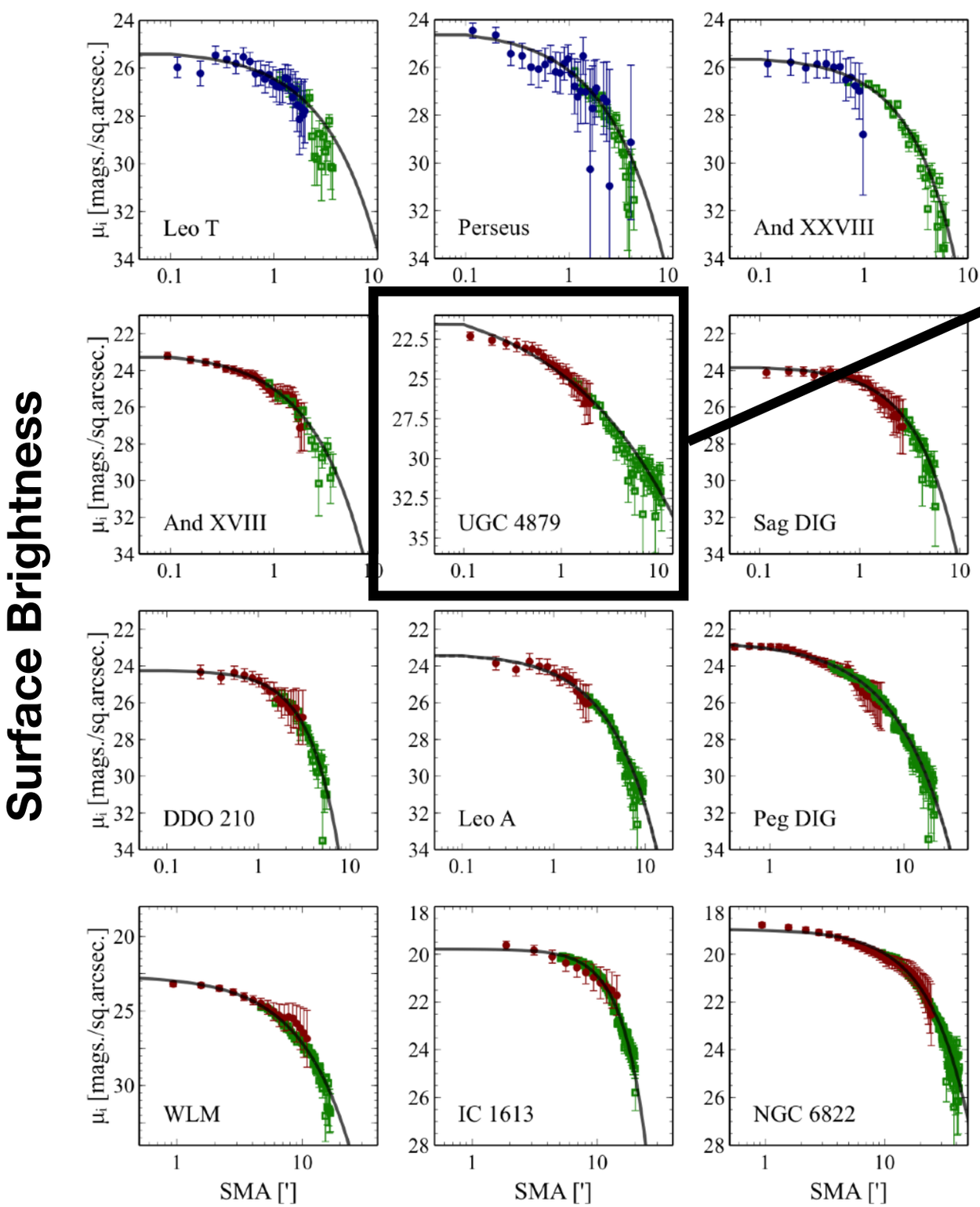


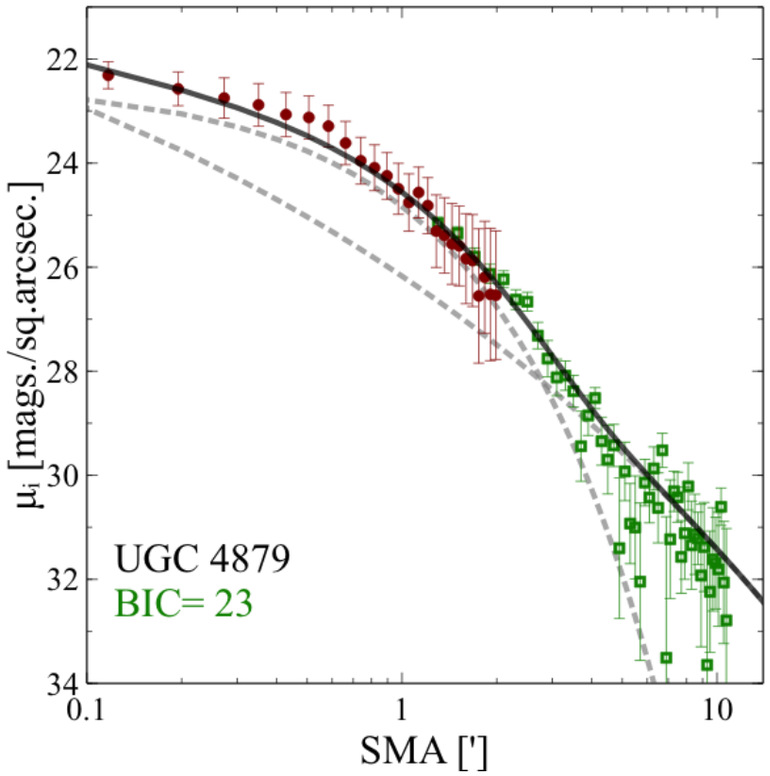
Extended Radial Profiles

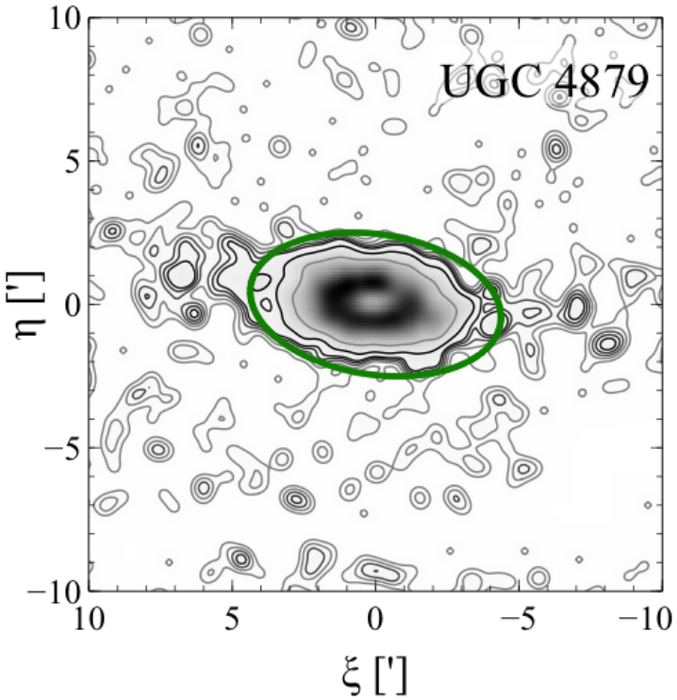


- Combine **resolved stellar profiles** with integrated light profiles in the **i band**.
- The **g band** is used in dwarfs with no visible integrated i band.
- Combine with parameter γ_{RGB}.

Extended Radial Profiles



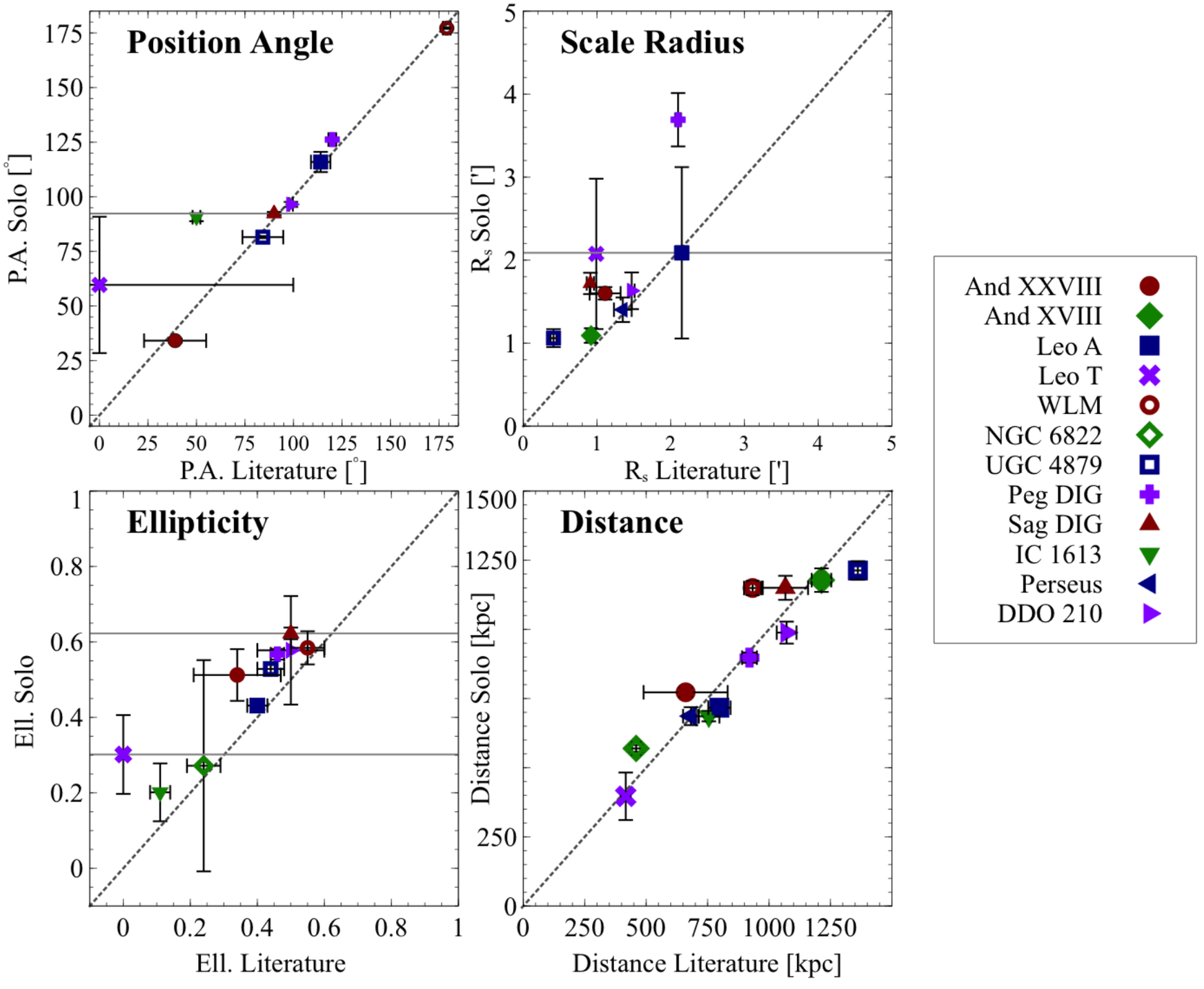




Similar “wings” observed by Bellazzini et al. 2018.

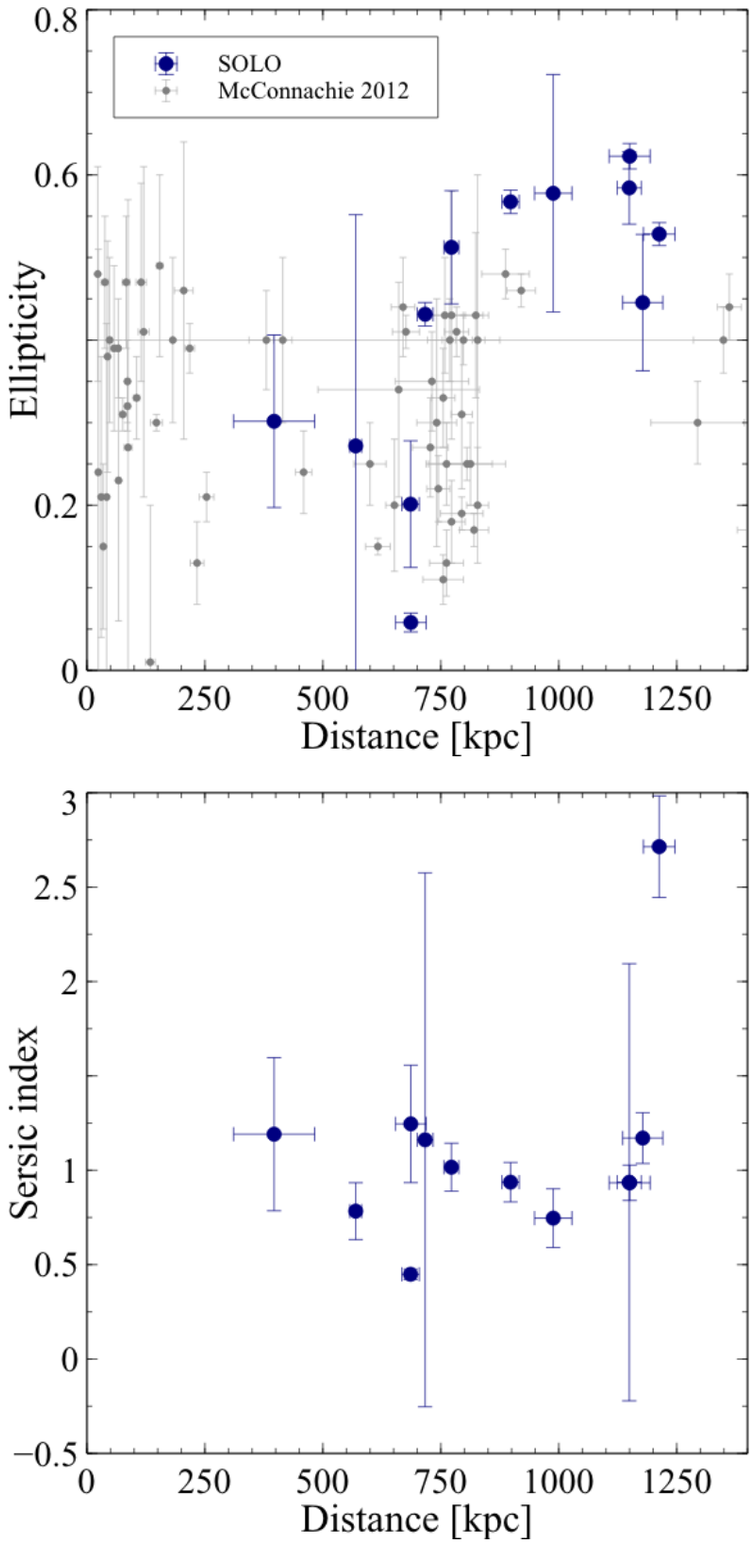
Comparisons with Literature Values

Comparisons to values compiled by McConnachie 2012



Preliminary!

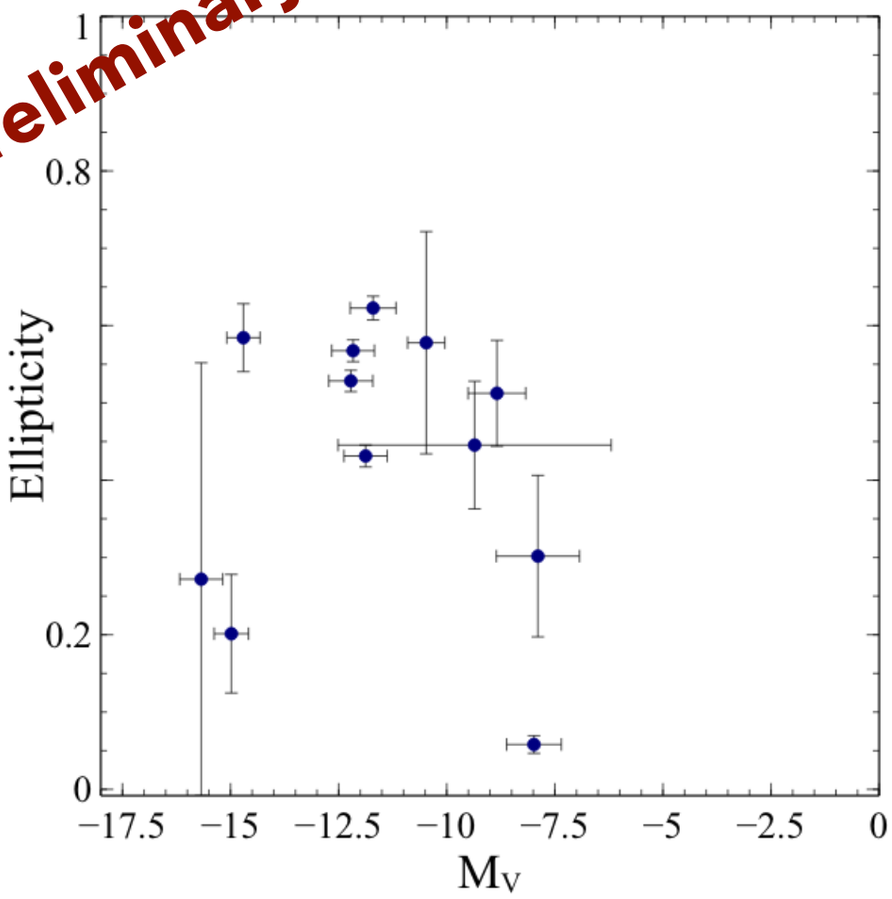
Trends/Future Work

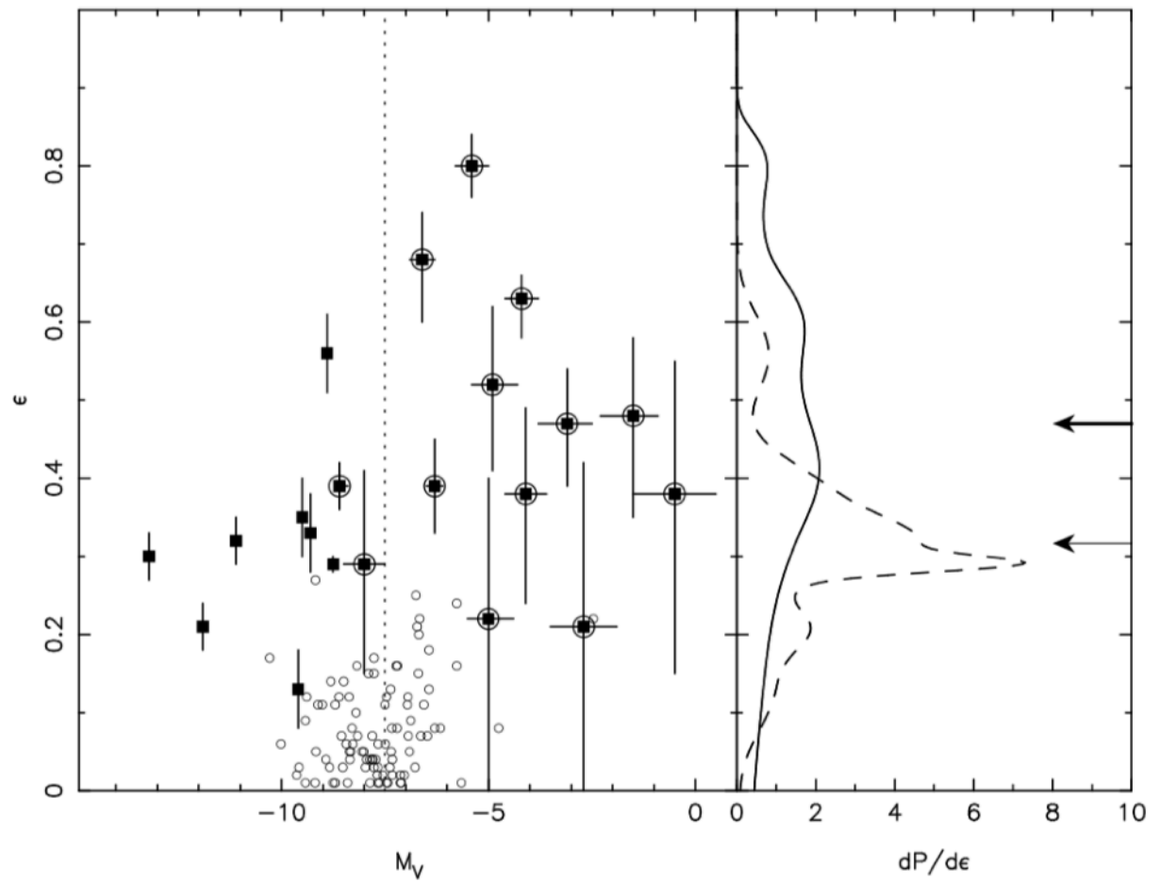


- How does shape or size vary with distance?
  - Indicative of tidal effects
- Trends with star formation histories?
  - Reshaping due to internal processes
- Comparison to MW or M31 satellites, dwarfs in Fornax, M101 etc.
  - External environmental effects

Trends/Future Work

Preliminary!



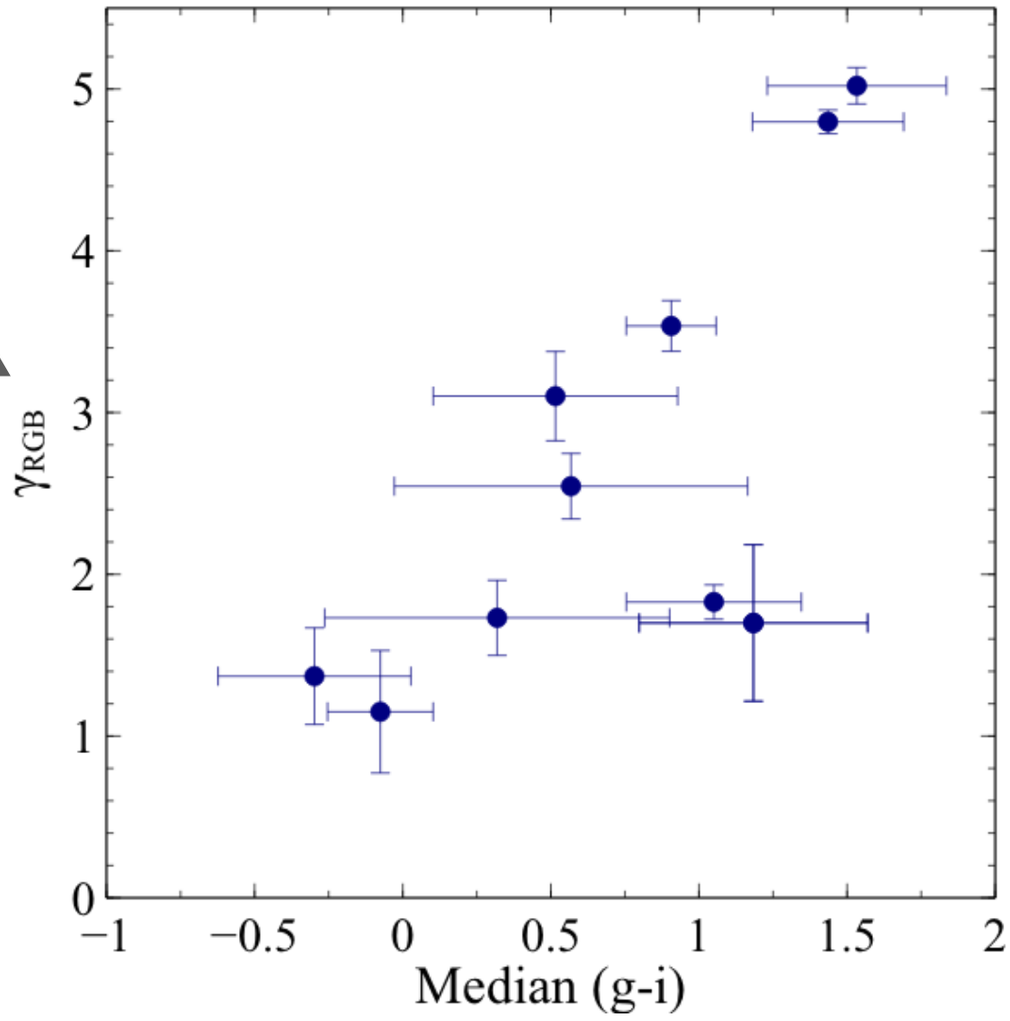


Martin et al. 2018

- Martin et al. 2018 find ultra faint MW satellites are increasingly flatter with decreasing luminosity.
  - We find the brighter Solo dwarfs are more elliptical in general

Exploring γ_{RGB}

Larger fraction from RGB stars



Redder

- γ_{RGB} describes the fraction of i band light resulting from the RGB stars.
- Dependent on spatially resolved star formation history, metallicity, age - metallicity relation, dust reddening…

Summary

- **Uniform and homogenous** analysis of nearby isolated dwarf galaxies near the Local Group.
- Generate **extended radial profiles** to faint surface brightness limits.
- Study dwarfs **collectively** and **individually.**

University of Victoria

Clare Higgs
higgs@uvic.ca
@astrohigglet