The Spitzer 4.5 μm Luminosity-Metallicity Relation for 25 Nearby Dwarf Galaxies

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Why Luminosity-Metallicity (L-Z) ?

★ Motivation :

- L-Z representative of (stellar) mass vs. metallicity
  - Explained by astration? Galactic winds ?
- Clues to physical processes associated with structure assembly
  - Tracers : functions of mass, metallicity, star-formation history, environmental dependence, redshift, …
  - e.g., Kobulnicky et al. 1999; Liang et al. 2004; Savaglio et al. 2004; Tremonti et al. 2004; Gallazzi et al. 2005; Lamareille et al. 2005; Maier et al. 2005
- Theoretical considerations for L-Z, and z-evolution :
  - e.g., Dekel & Silk 1986; Kauffman 1996; Somerville & Primack 1999; Dekel & Woo 2003
  - See also poster #10 by De Rossi et al.

L-Z Relation for Low-Z Systems

- **Connection between L-Z for distant and nearby galaxies ?**
- **Nearby metal-poor dwarf irregulars (< Z_{sun}/2; M_B > -18) :**
  - Optical (B) L-Z relations for nearby dIrrs :
    - e.g., Lequeux et al. 1979; Skillman et al. 1989; Richer & McCall 1995; Garnett 2002; HL et al. 2003; van Zee et al. 2006
  - Worry has been dispersion caused by variations in stellar M/L ratios from recent star formation
  - Sample with D < 5 Mpc; minimize uncertainties by selecting :
    - **Distances from stellar constituents : Cepheids, TRGB**
    - **Nebular oxygen abundances from [O III] λ4363**

IR L-Z Relation of low-Z galaxies at low-z

★ Longer wavelengths :

- Infrared less affected by extinction and by variations in stellar M/L from star-forming events
  - Stellar M/L_K roughly constant with (Optical - NIR) color (e.g., B-K : Bell & de Jong 2001; van den Bosch 2002)
- Direct measures of underlying stellar mass
- Ground-based NIR : e.g., Vaduvescu et al., Saviane et al.

★ Spitzer :

- IRAC channel 2 (4.5 μm) : free of PAH features
- Channel 4 (8.0 μm) images show no to very low emission from PAHs and/or small warm dust grains (Jackson et al. 2005, in prep.)
- Local low-L "complement" to SINGS (i.e., Dale et al. 2005)

Spitzer GTO 128 - PI R. D. Gehrz

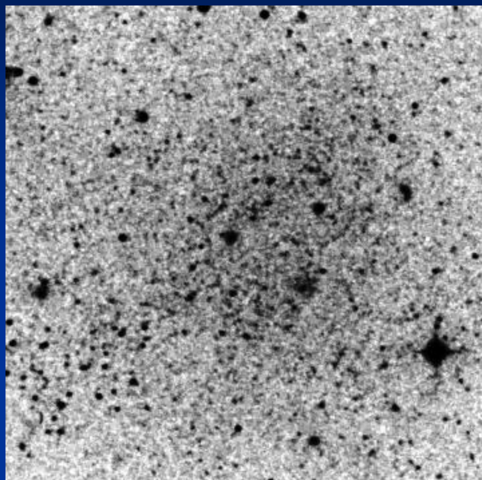
Galaxy	D (Mpc)	Nebular O/H
GR 8	2.1	van Zee, Skillman, & Haynes 2006
IC 1613	0.7	HL, Grebel, & Hodge 2003
IC 5152	2.1	HL, Grebel, & Hodge 2003
Leo A	0.7	van Zee, Skillman, & Haynes 2006
NGC 3109	1.3	Richer & McCall 1995; HL et al. 2003
NGC 55	2.1	Webster & Smith 1983; Tüllmann et al. 2003
Peg DIG	0.8	Skillman, Bomans, & Kobulnicky 1997
Sextans A	1.3	Kniazev et al. 2005; Magrini et al. 2005
Sextans B	1.4	Kniazev et al. 2005; Magrini et al. 2005
WLM	0.9	HL, Skillman, & Venn 2005

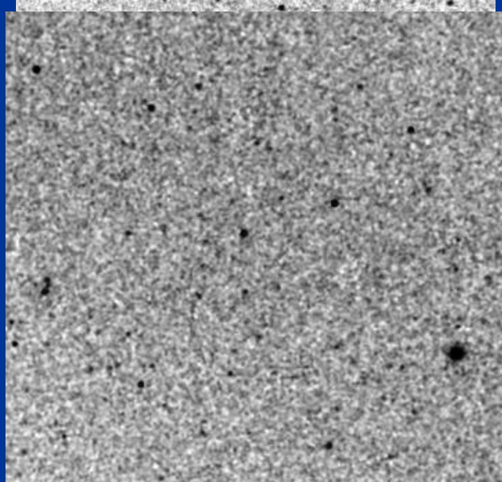
Other nearby dIrrs (Spitzer archive)

Galaxy	D (Mpc)	Nebular O/H
DDO 53	3.6	Skillman, Kennicutt, & Hodge 1989
DDO 154	3.2	van Zee et al. 1997; Kennicutt & Skillman 2001
Ho I	3.8	Miller & Hodge 1996
Ho II	3.4	Masegosa et al. 1991; HL et al. 2003
IC 2574	4.0	Masegosa et al. 1991; Miller & Hodge 1996
M81 dw B	5.3	Miller & Hodge 1996
NGC 1569	2.2	Kobulnicky & Skillman 1997
NGC 1705	5.1	HL & Skillman 2004
NGC 2366	3.2	Gonzalez-Delgado et al. 1994; Izotov et al. 1997
NGC 3738	4.9	Martin 1997
NGC 4214	2.7	Kobulnicky & Skillman 1996
NGC 4449	4.2	Martin 1997; Boeker et al. 2001
NGC 5408	4.8	Terlevich et al. 1991
NGC 6822	0.5	Peimbert et al. 2005; HL, Skillman, & Venn 2006
UGC 6456	4.3	Izotov et al. 1997; Lynds et al. 1998

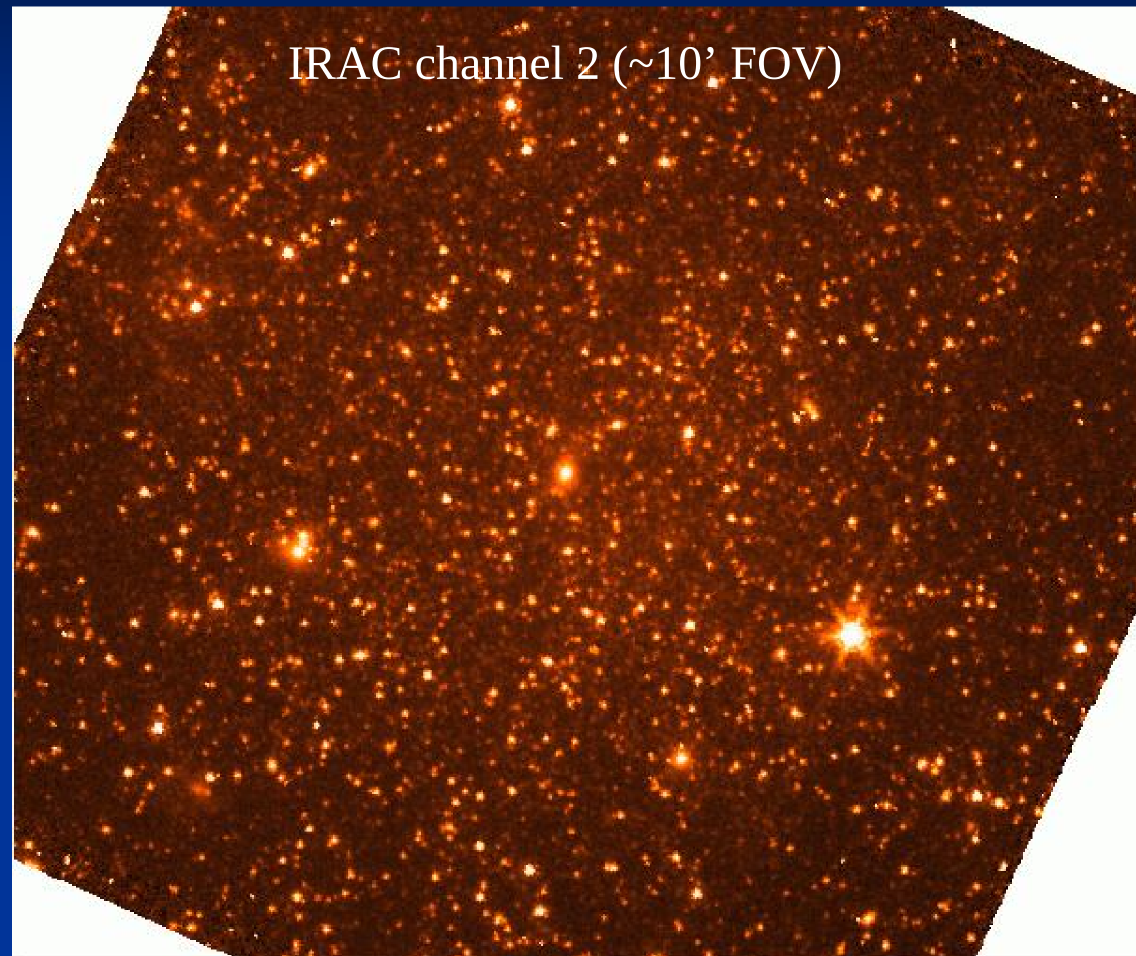
IC 1613

DSS R (6’ FOV)



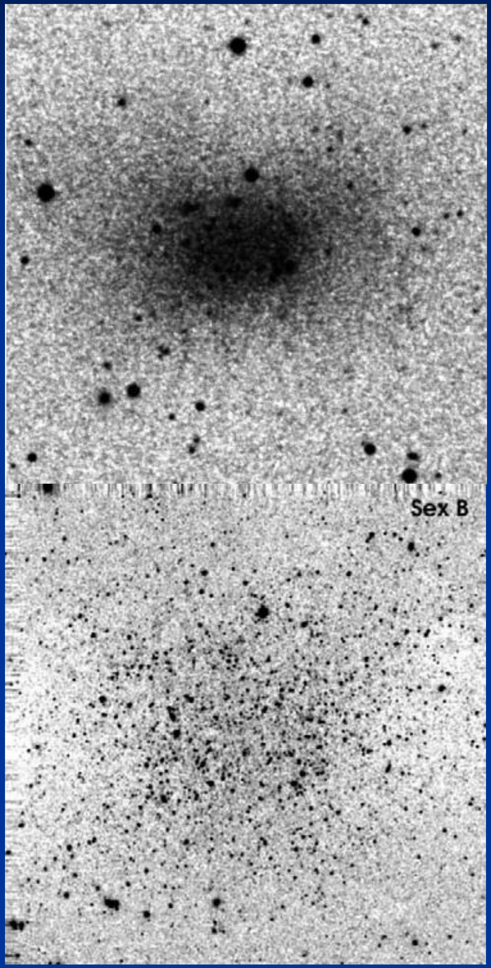


2MASS K (6’ FOV)

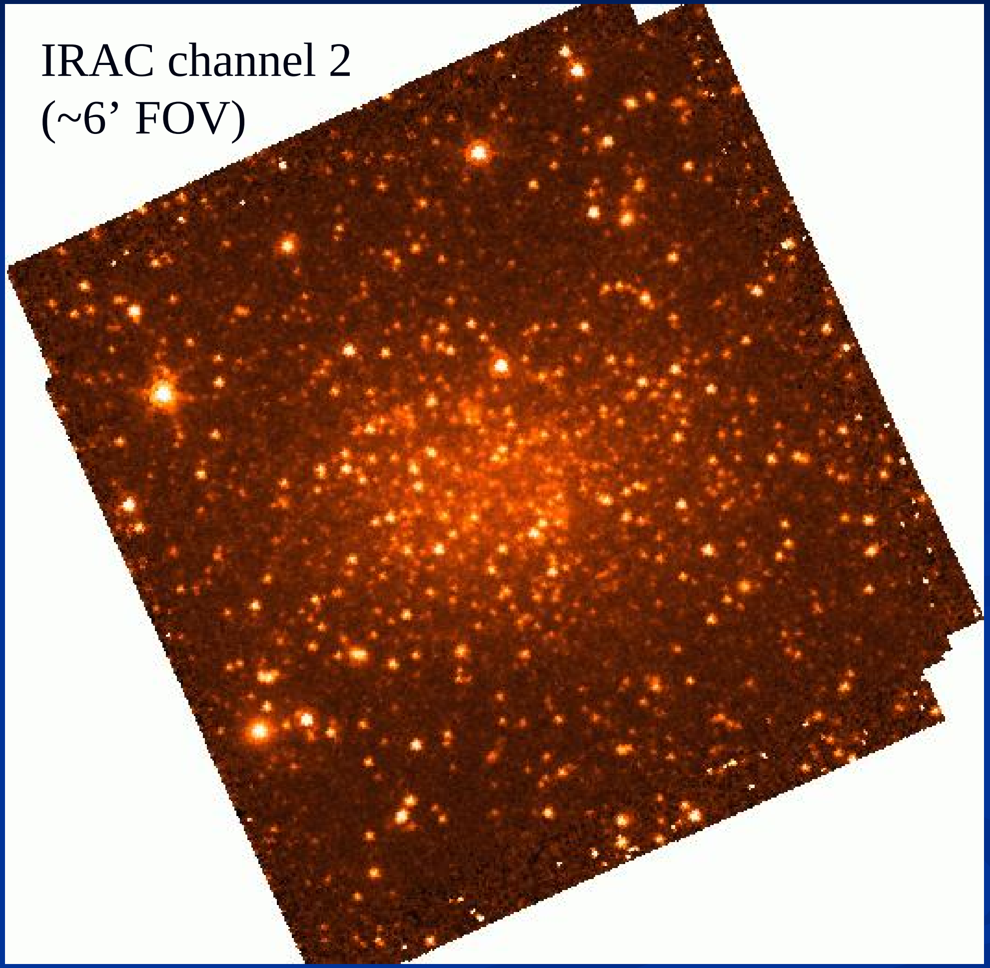


Sextans B

DSS R (6' FOV)

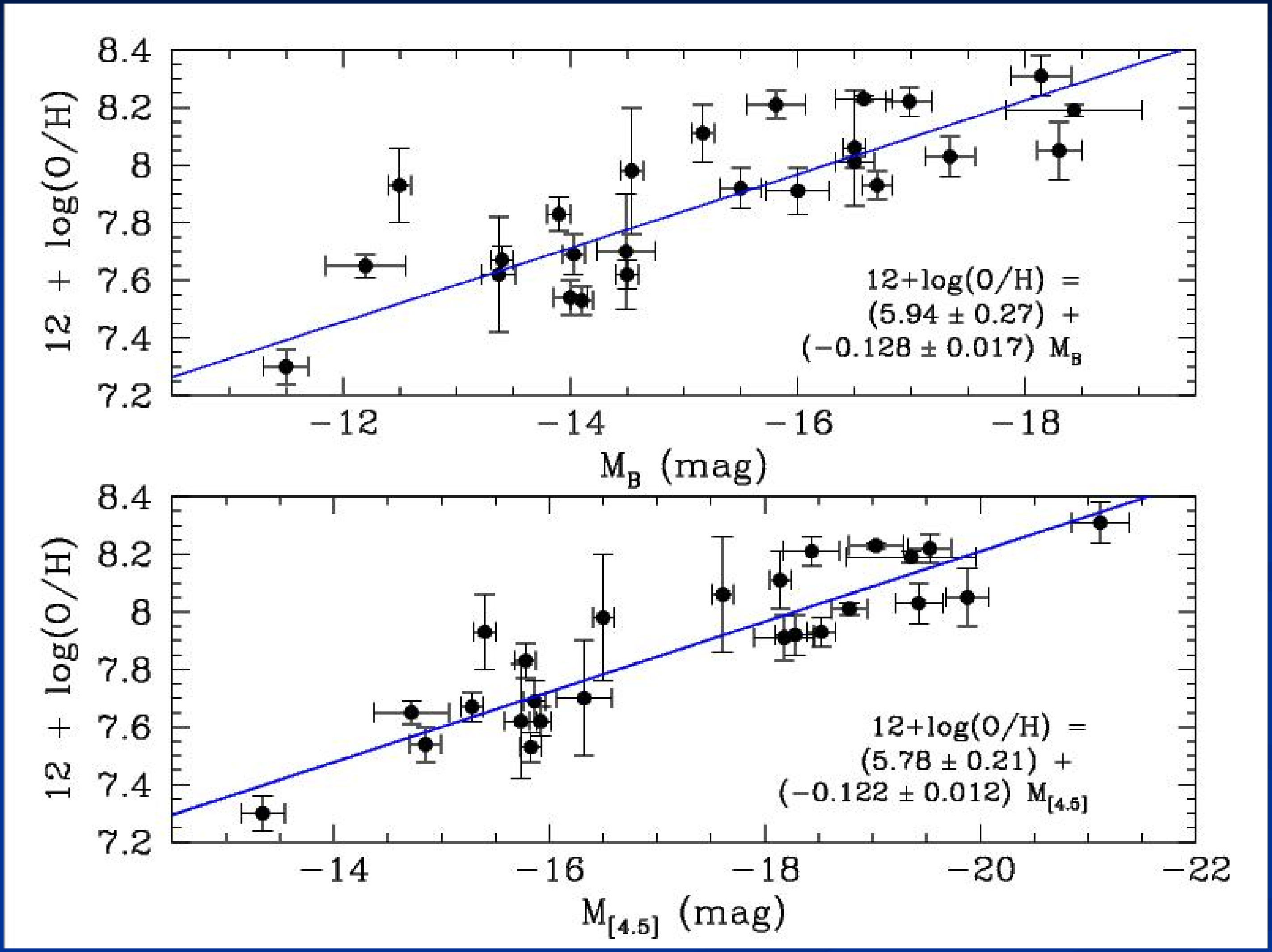


Kshort; 3.5' FOV
(Vaduvescu et al. 2005)



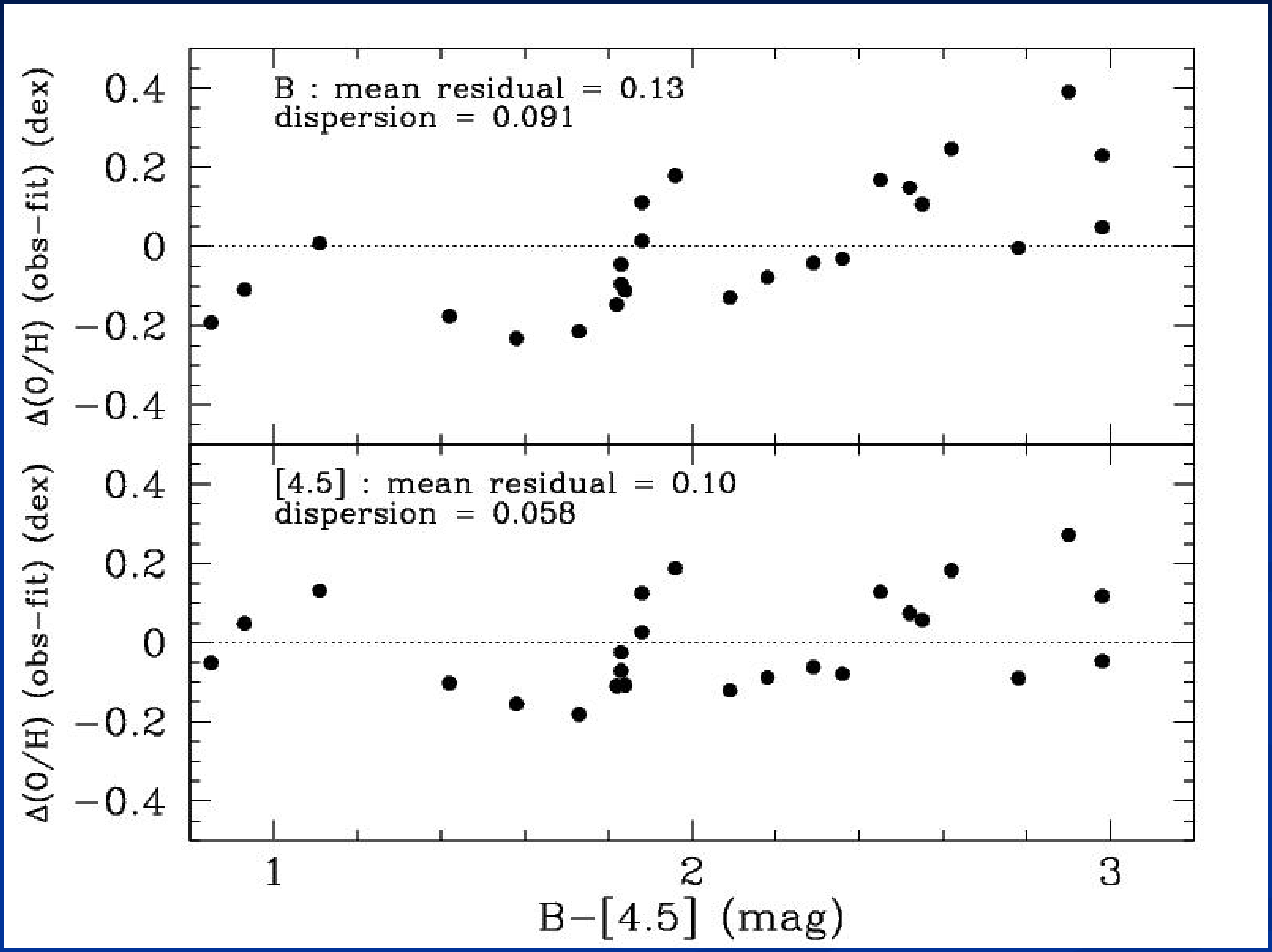
IRAC channel 2
(~6' FOV)

L-Z Relations : B and 4.5 μm



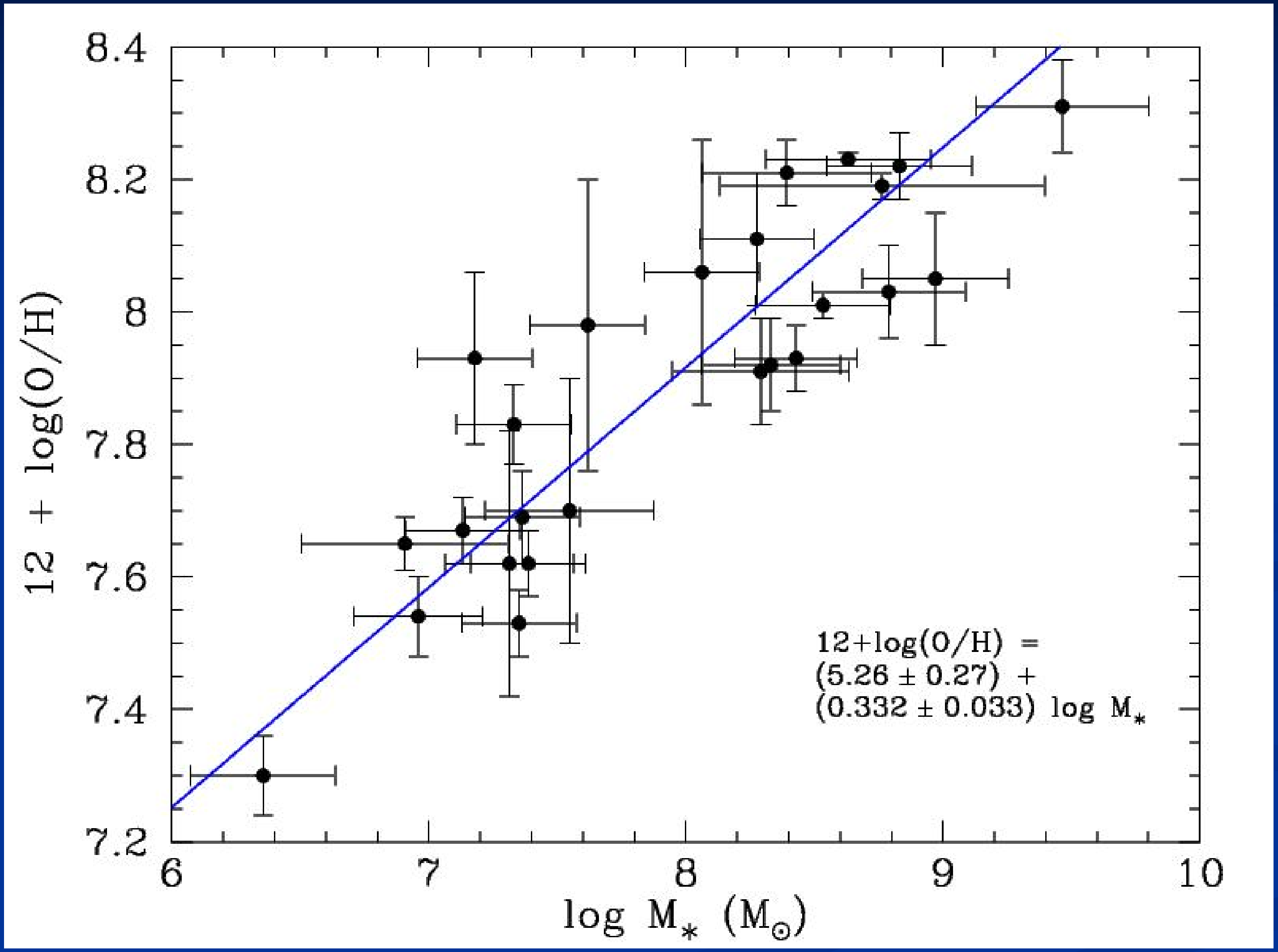
HL, Skillman, et al. 2006, in prep.

Residuals : B and 4.5 μm



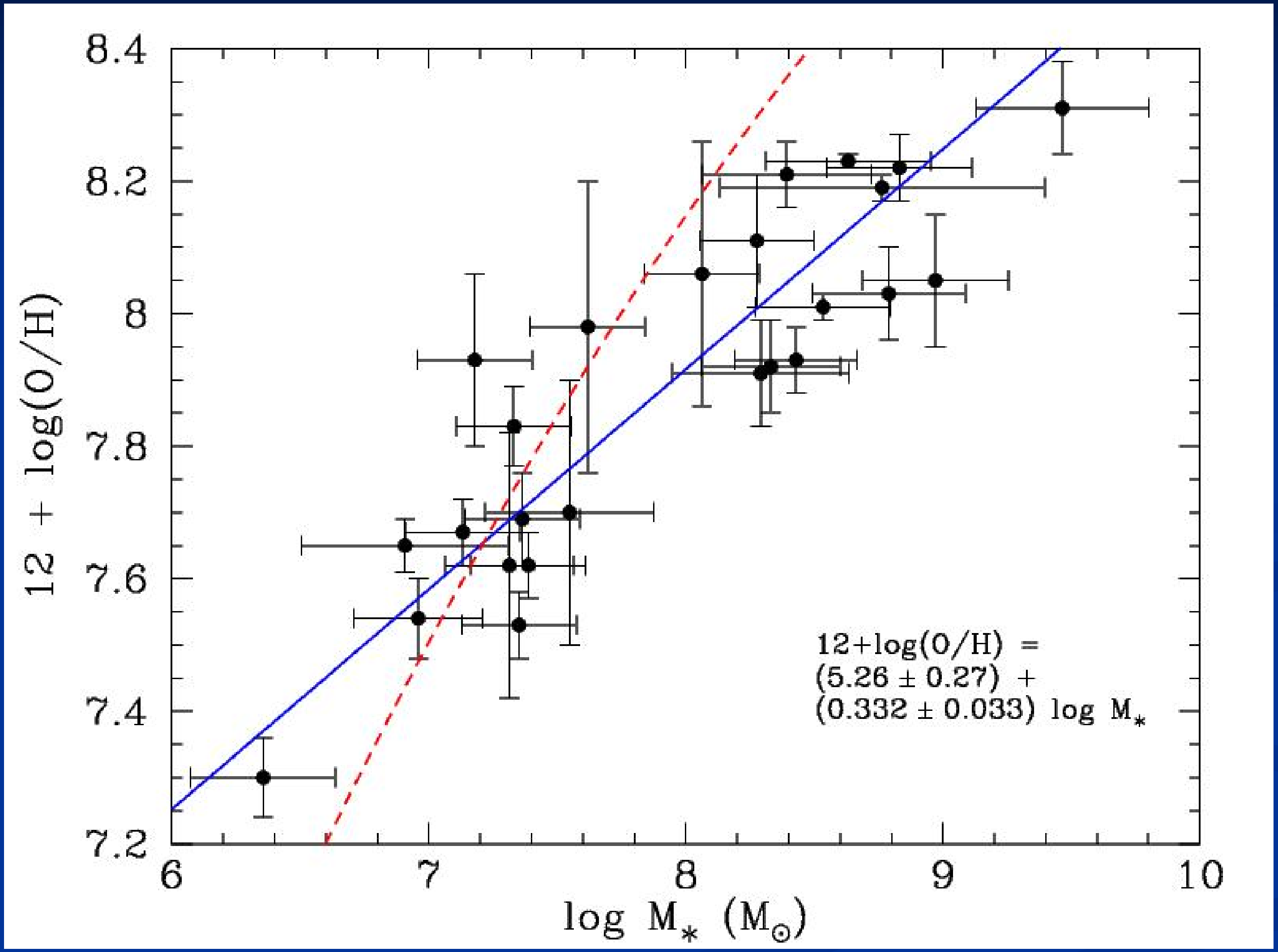
HL, Skillman, et al. 2006, in prep.

(Stellar) Mass-Metallicity Relation



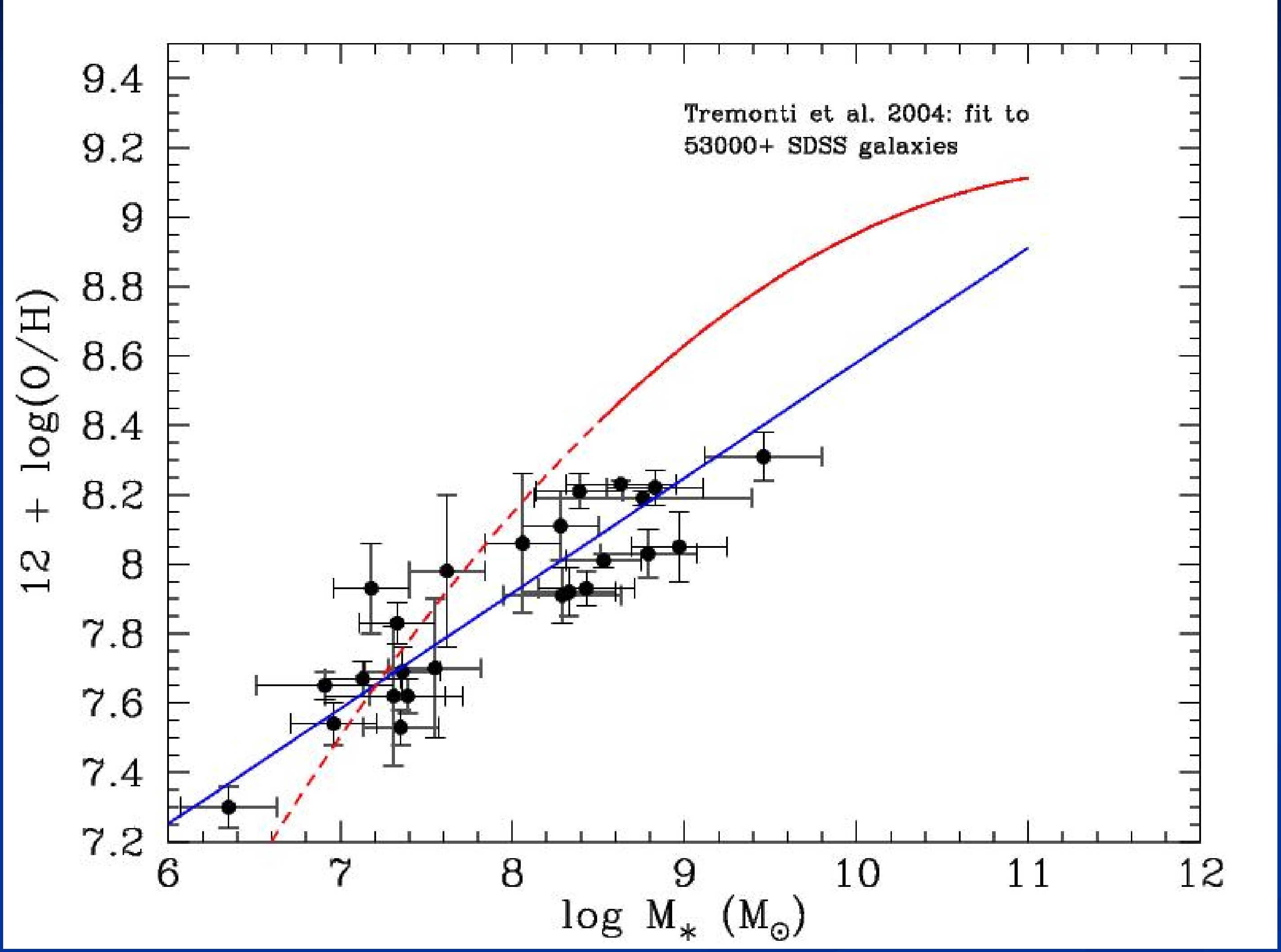
HL, Skillman, et al. 2006, in prep.

(Stellar) Mass-Metallicity Relation



HL, Skillman, et al. 2006, in prep.

Mass-Metallicity Relation vs. SDSS



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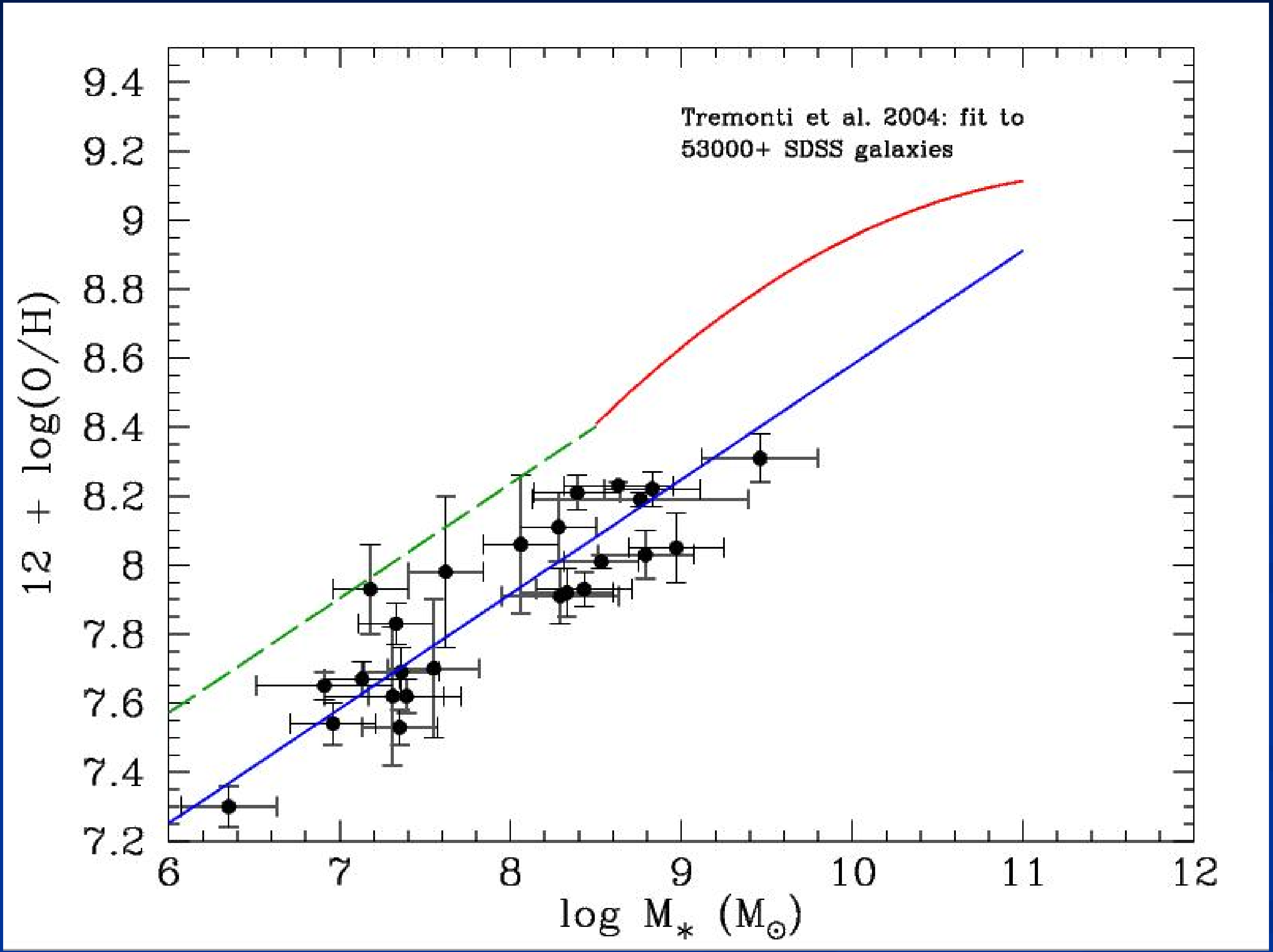
Mass-Metallicity Relation vs. SDSS



HL, Skillman, et al. 2006, in prep.

Conclusions

- ★ **IRAC 4.5 μm L-Z relation for nearby dwarf irregulars**
  - Similar fit parameters comparable to optical
- ★ **Reduced residuals, dispersion in IR L-Z vs. optical L-Z**
- ★ **Could low dispersion in L-Z be telling us that :**
  - Present-day galactic winds playing less of a role,
  - Ability by SNe to eject galactic winds, or
  - Ability by dark matter halo to hold onto hot coronal gas
- ★ **Mass-metallicity relation for low-mass galaxies :**
  - SDSS galaxies higher Z at given M
  - Can be explained by systematic higher O/H for SDSS galaxies