

Mid-IR Metallicity Diagnostics for Star-Forming Galaxies

[Tohru Nagao \(Ehime U.\)](#)

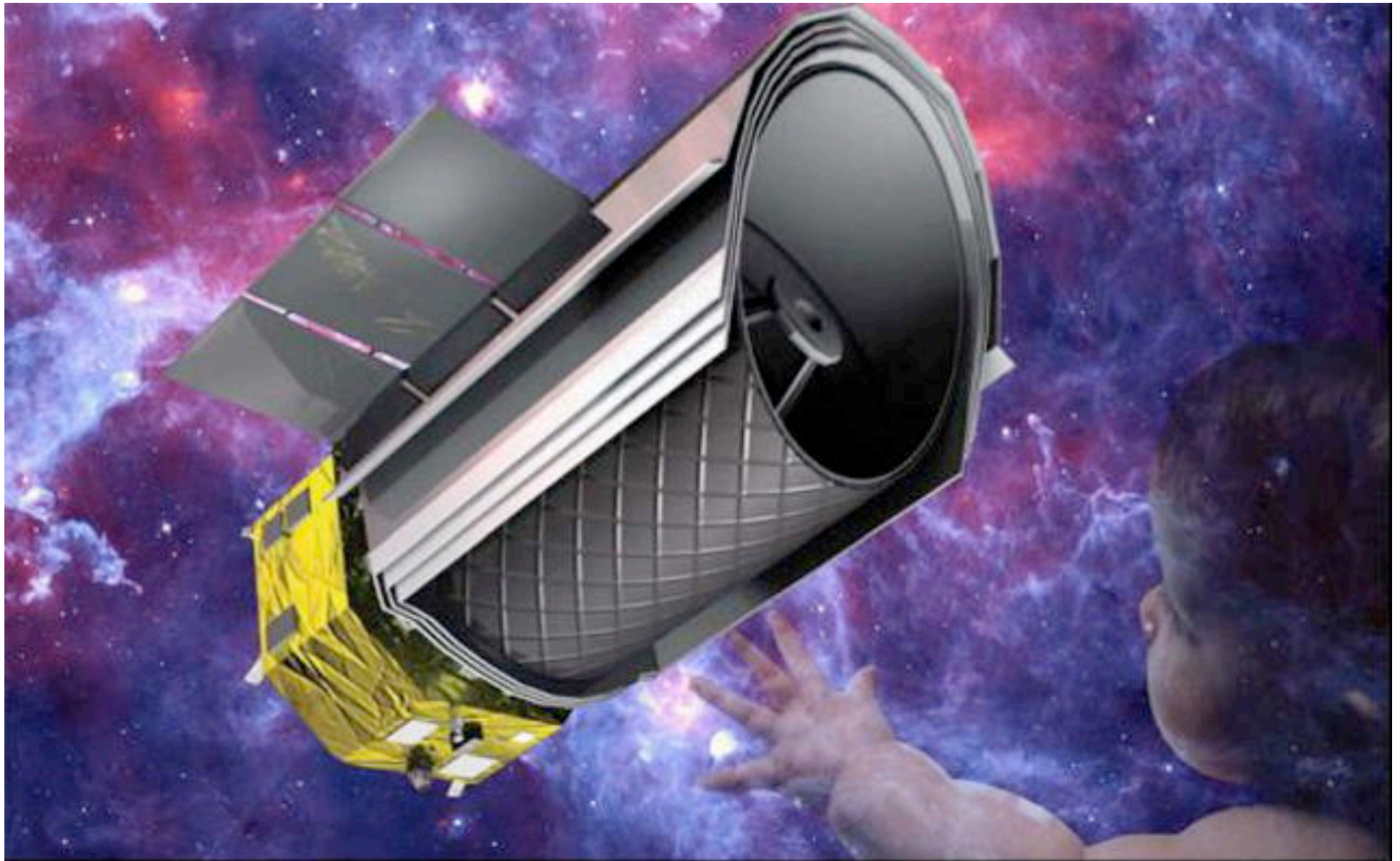
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Alessandro Marconi (Florence U.)

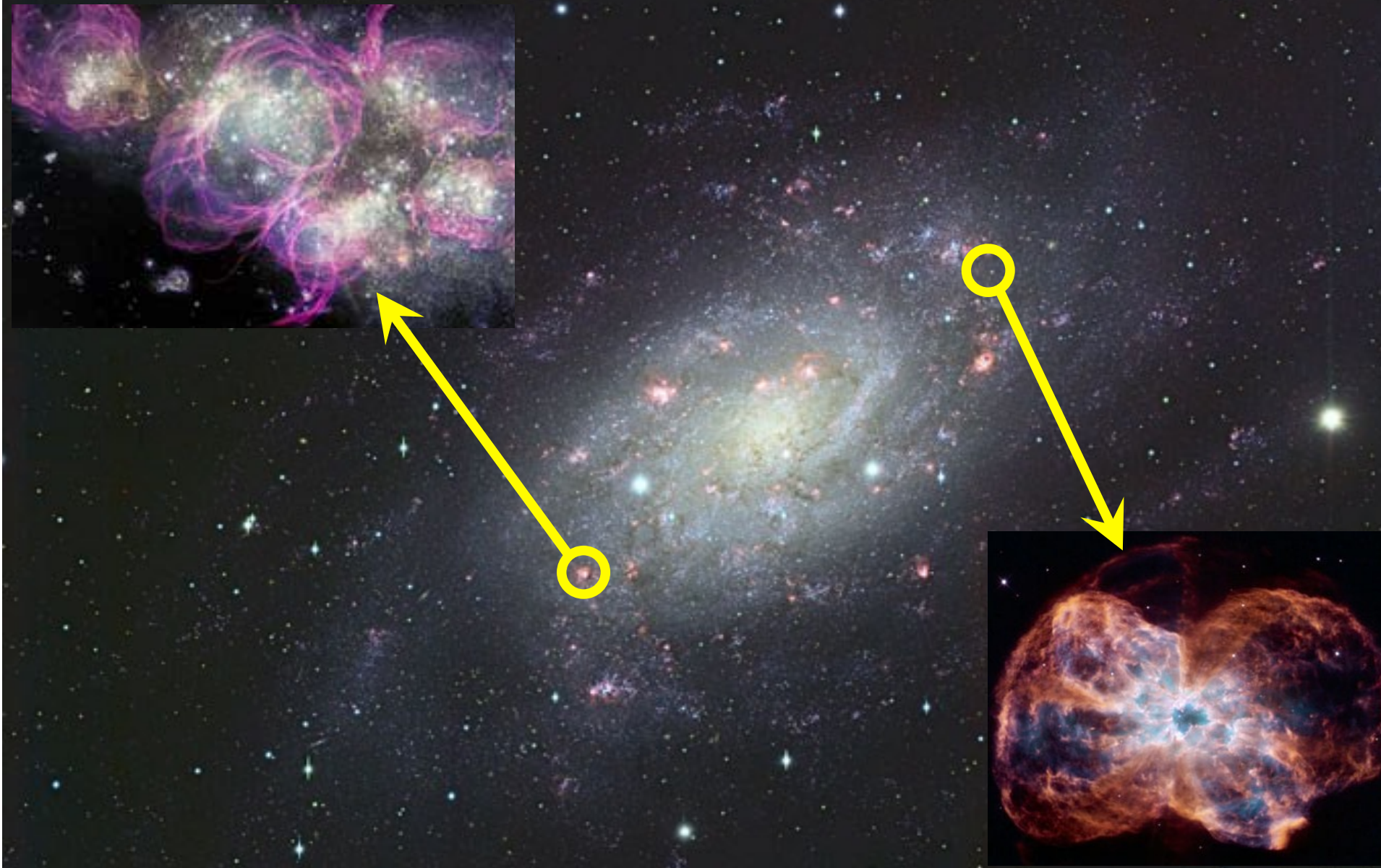
Hideo Matsuhara (ISAS/JAXA)

- Metallicity Measurements for Galaxies
- Why Mid-Infrared?
- New Mid-IR Metallicity Diagnostics
- Observational Feasibility with SPICA

NAOJ Mitaka, 16 Dec. 2010
SPICA Science Workshop

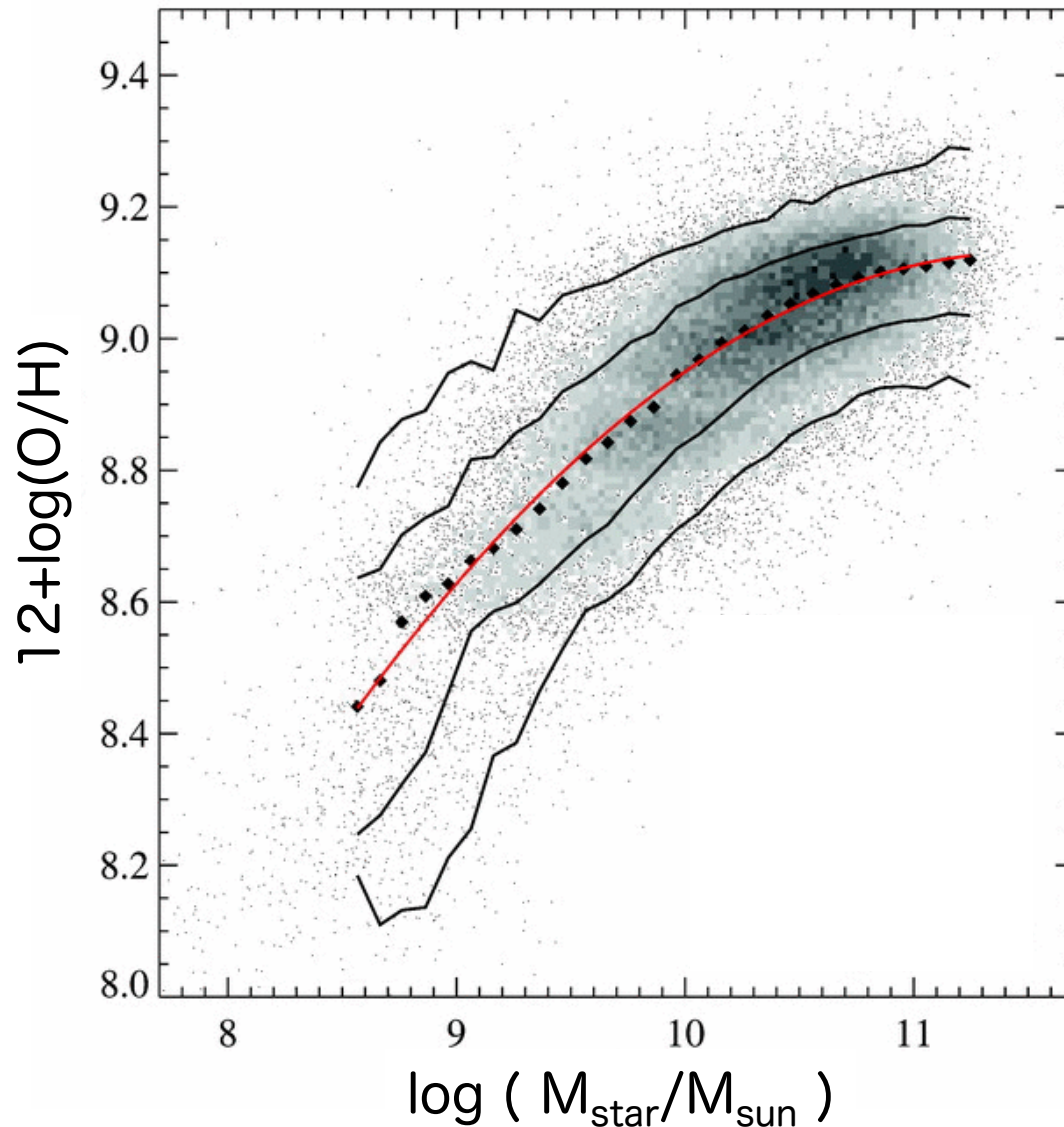


Keyword: “銀河進化/物質循環”



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The Mass-Metallicity Relation in Galaxies

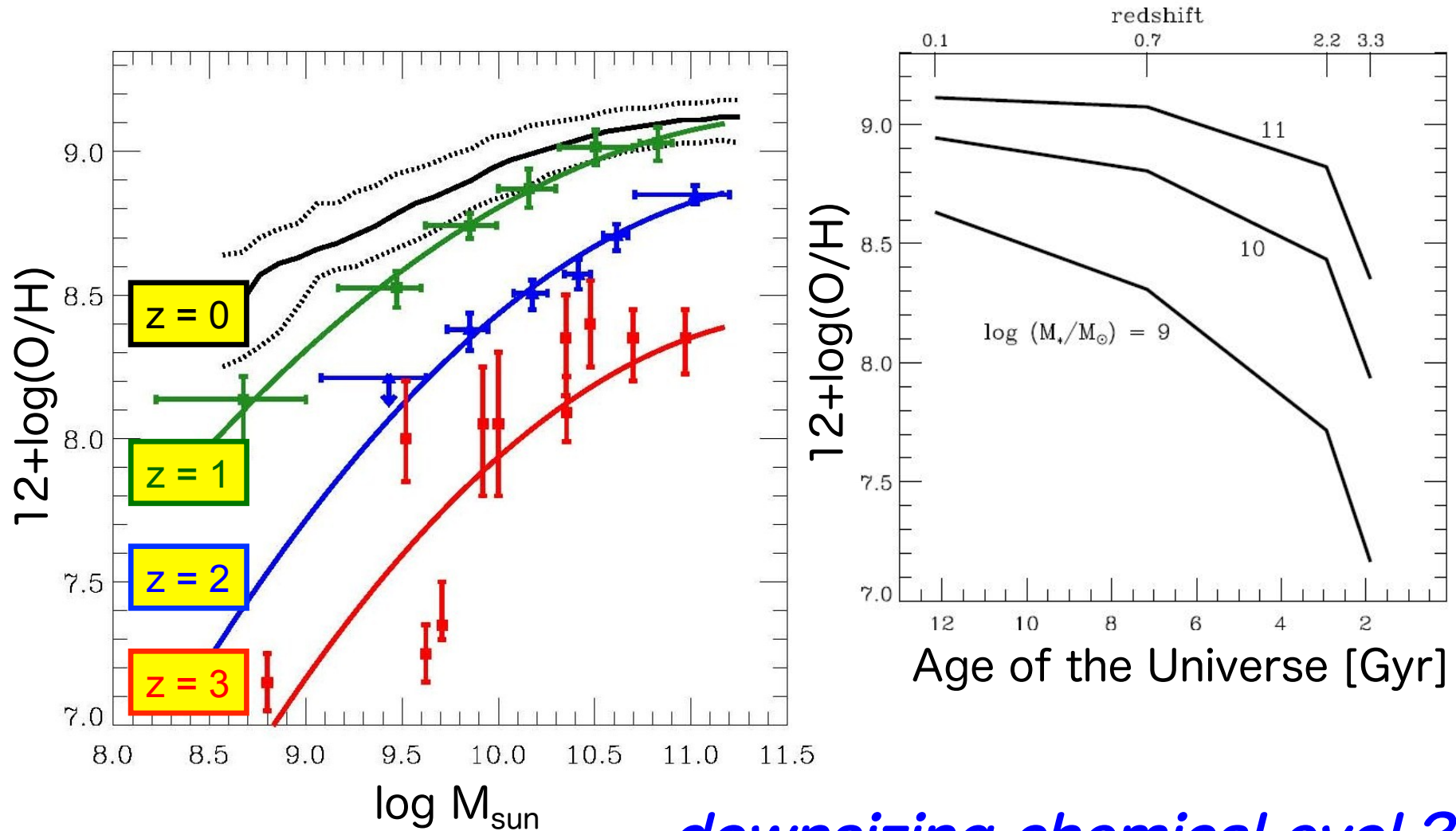


...suggesting the importance of galactic outflows (superwinds)

SDSS 53000 galaxies
at $z \sim 0.1$

Tremonti et al. (2004)

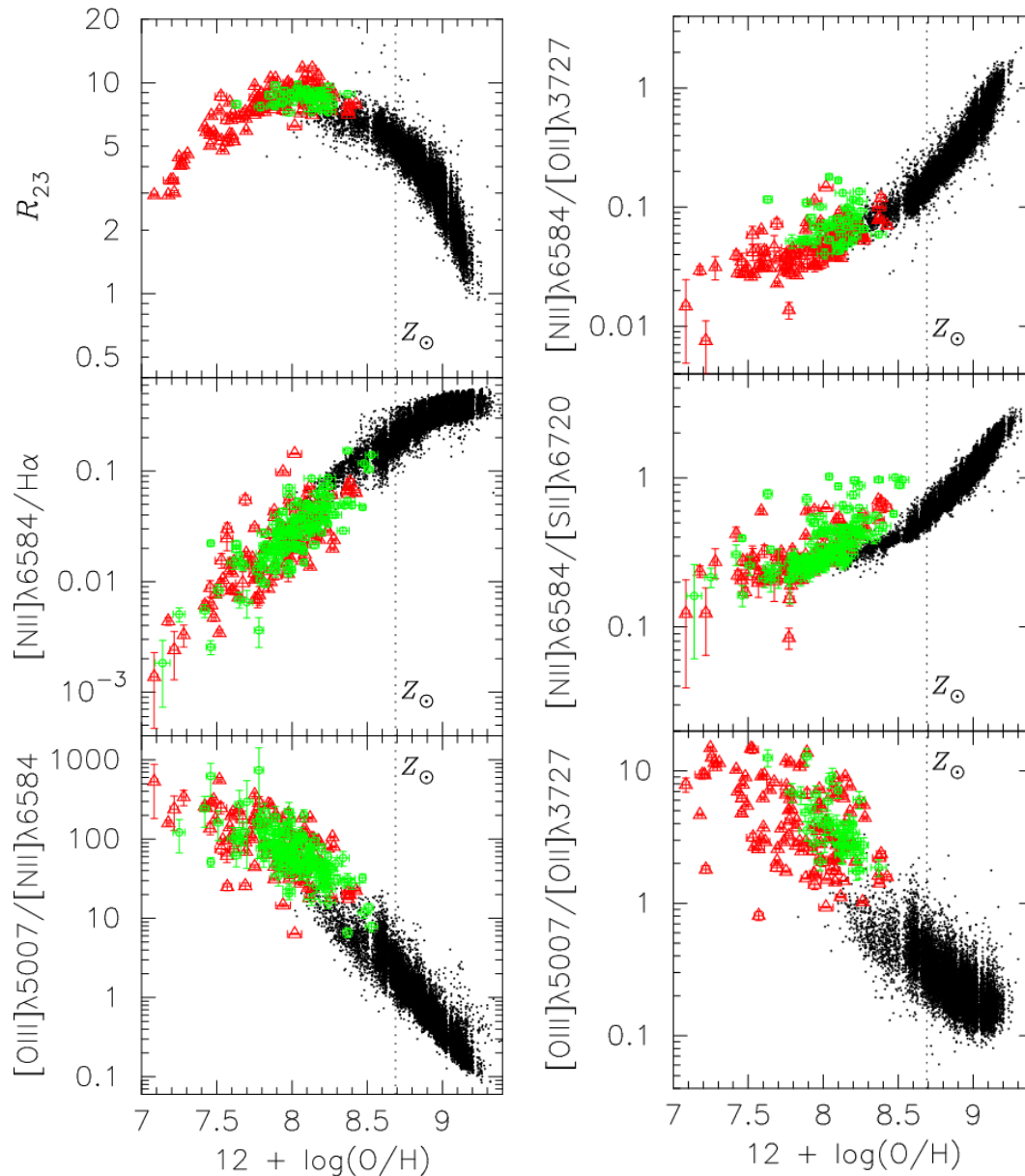
The Mass-Metallicity Relation: Redshift Evol.



downsizing chemical evol.?

Maiolino, Nagao, et al. (2008)
with calibrations of Nagao+06

Metallicity Diagnostics



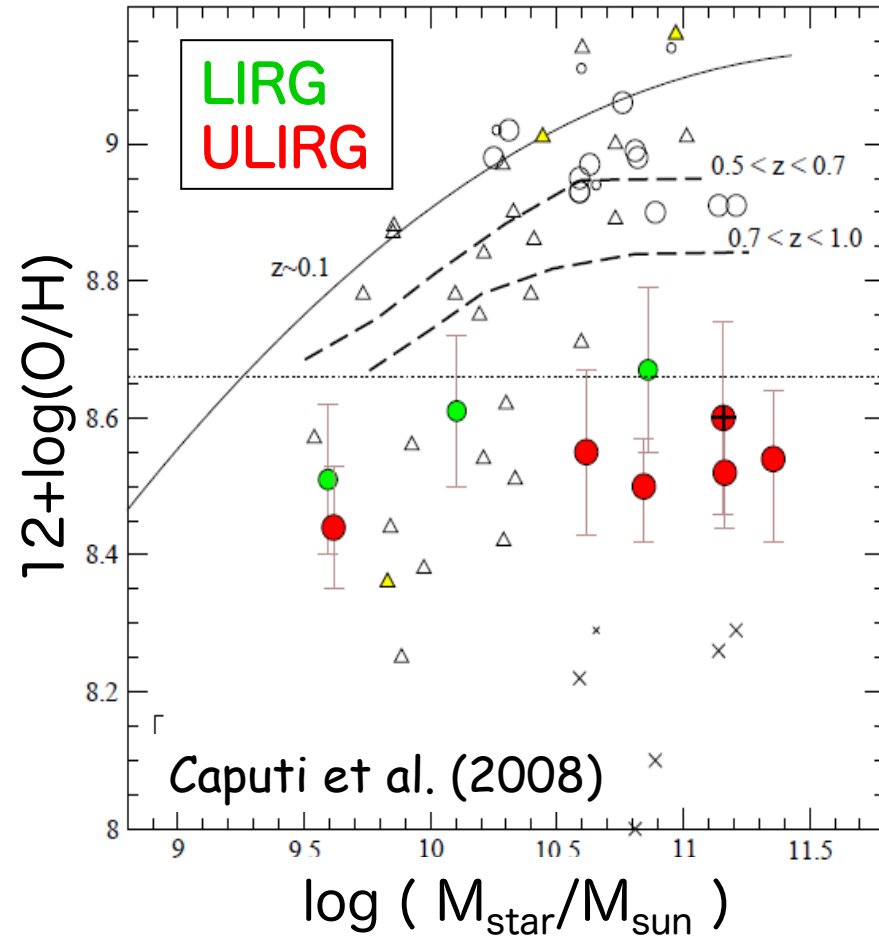
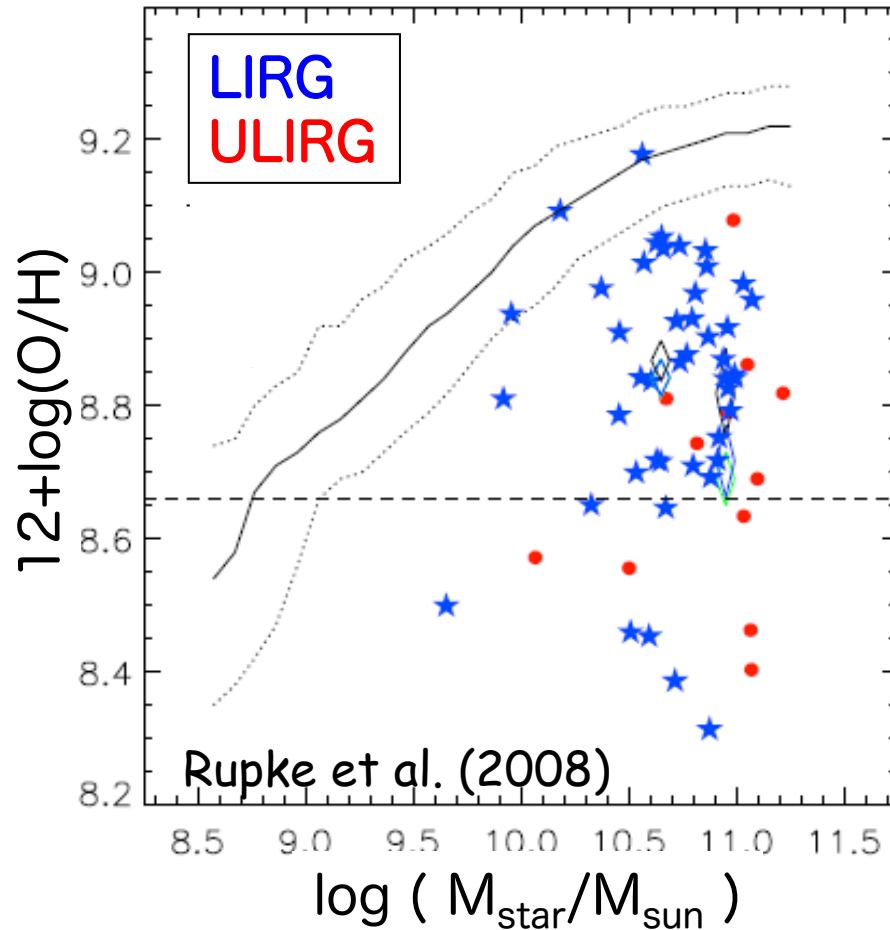
Using various **optical** emission lines such as:

[OII] 3727
[NeIII] 3869
H beta 4861
[OIII] 5007
H alpha 6563
[NII] 6584
[SII] 6717,31

(and [OIII] 4363)

Nagao et al. (2006)

Metallicity in Dusty Galaxies

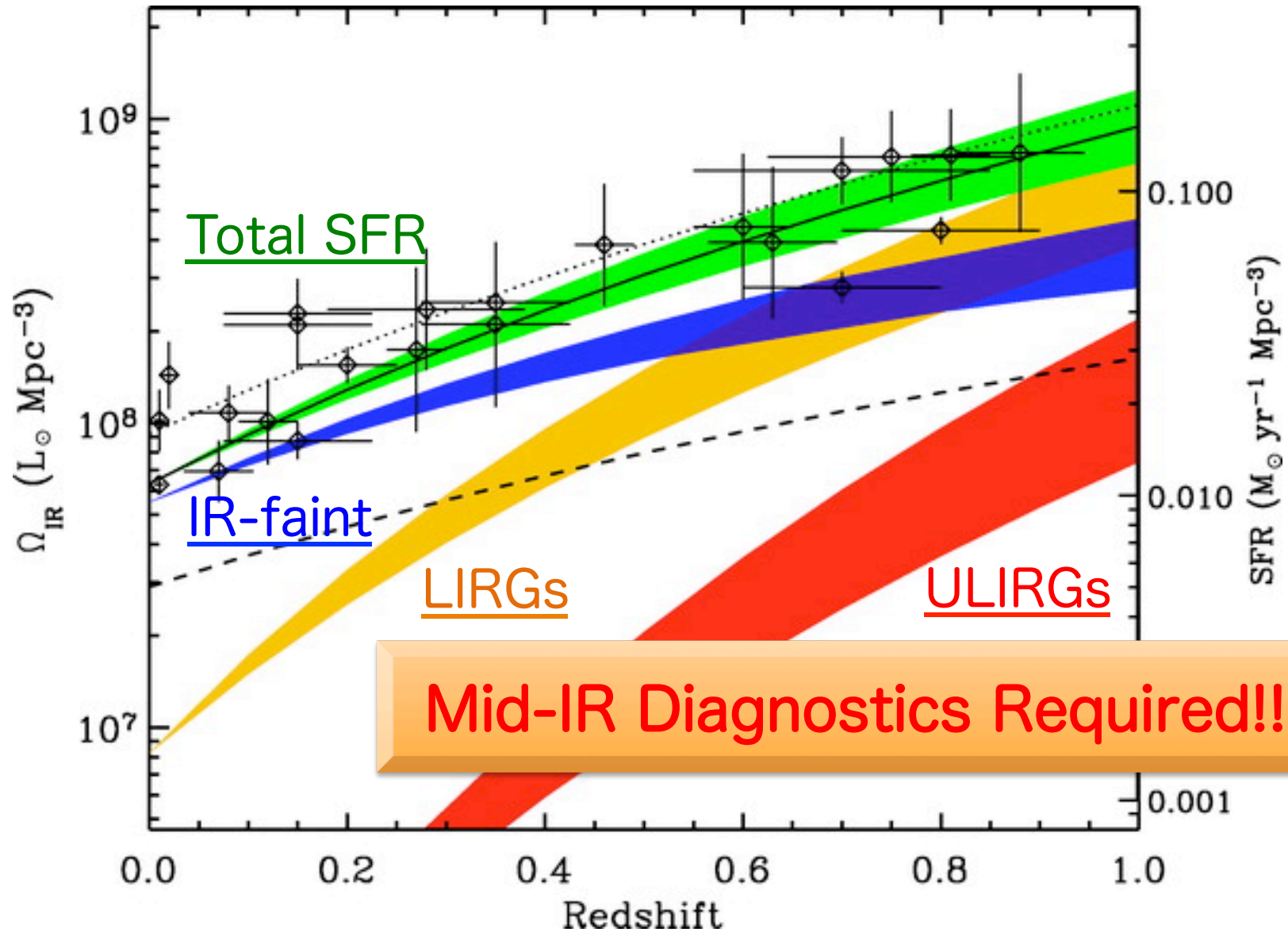


Are IR galaxies “chemically un-evolved” systems !?

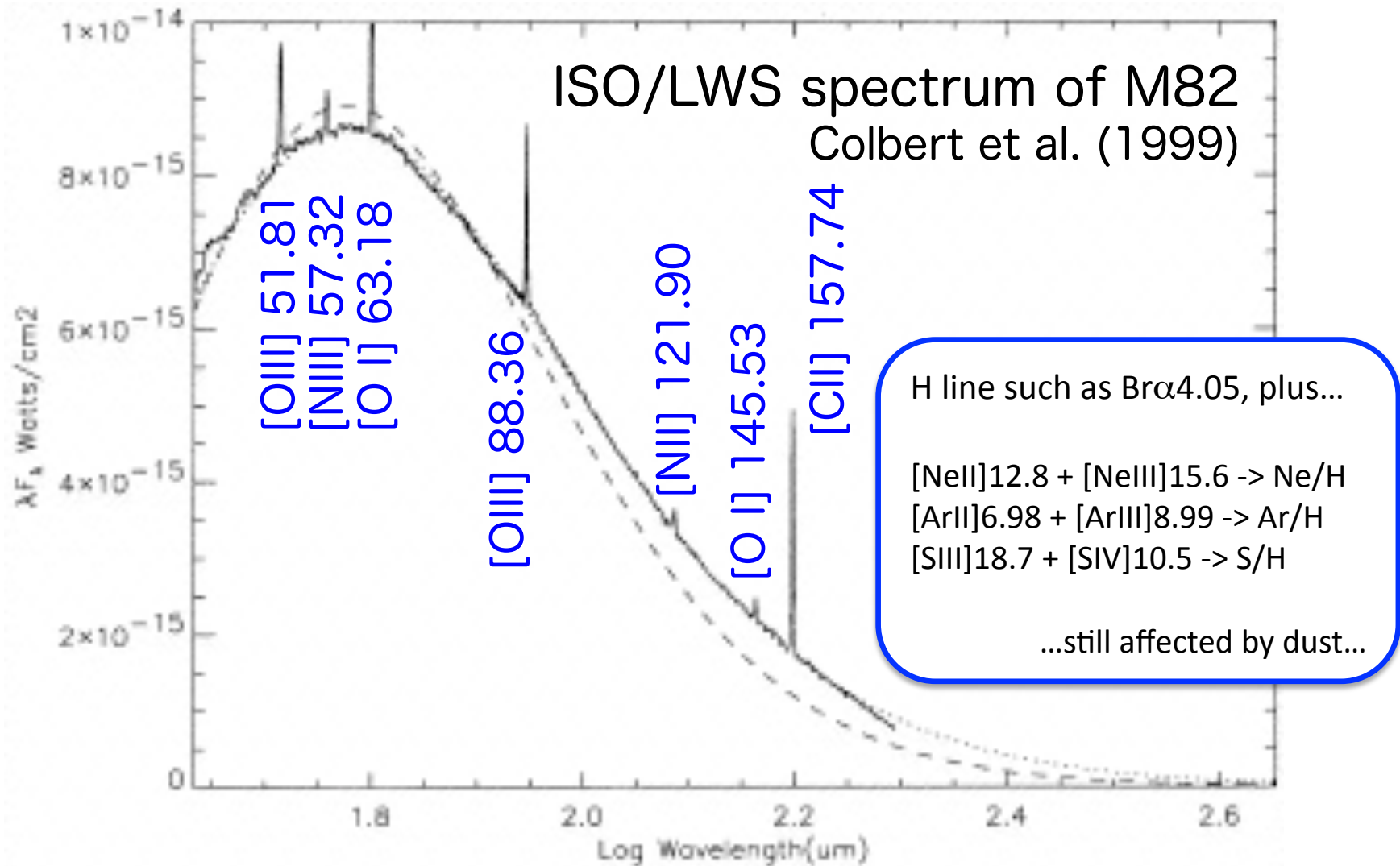
...optical lines are from “un-obscured” parts

Importance of IR Galaxies

Le Floc'h et al. (2005)

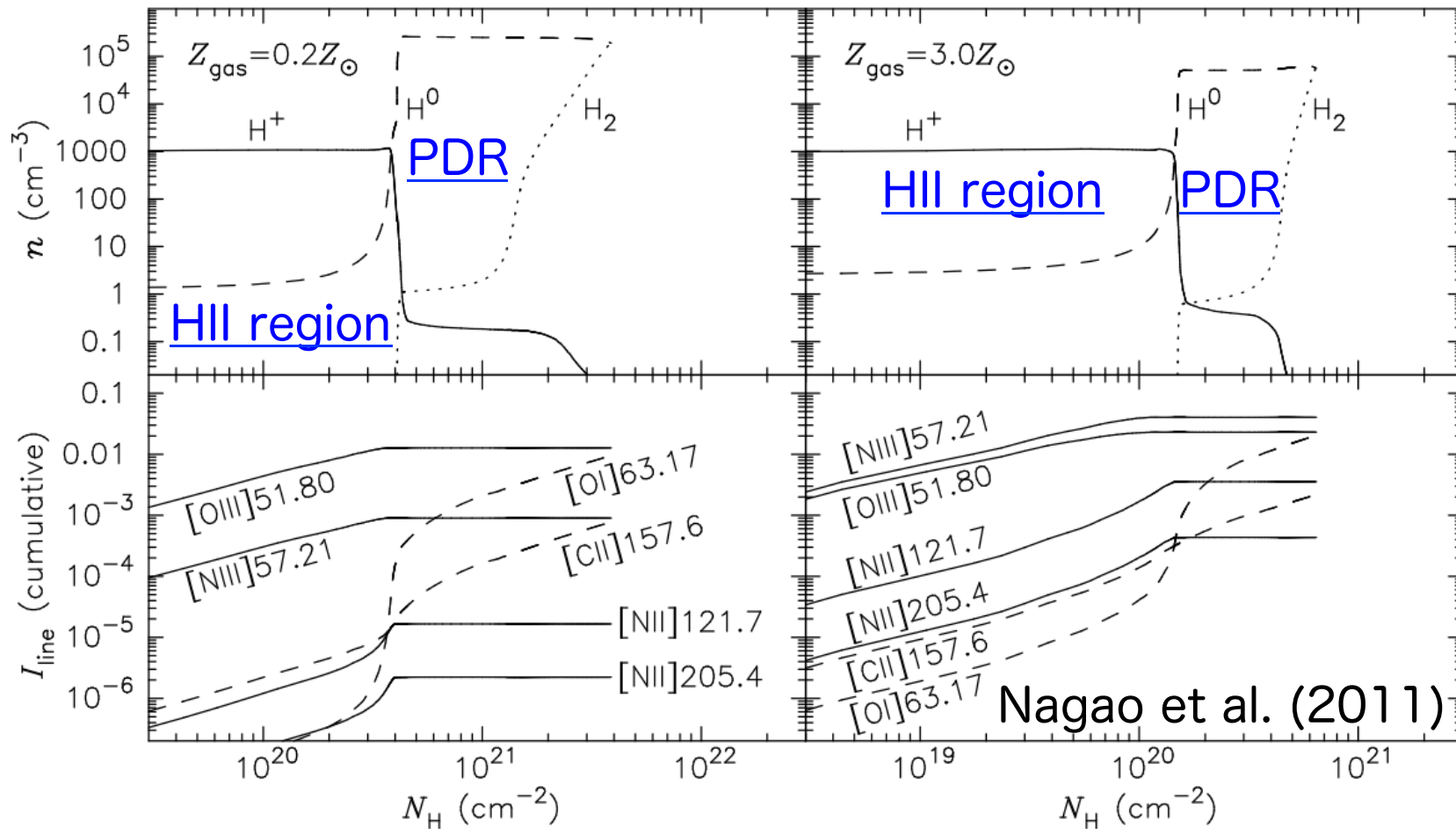


MidIR-FarIR Spectra of Galaxies



Various fine-structure lines: from **WHERE??**

Emissivity Distribution of Fine-Structure Lines



Cloudy simulations

ver.08.00

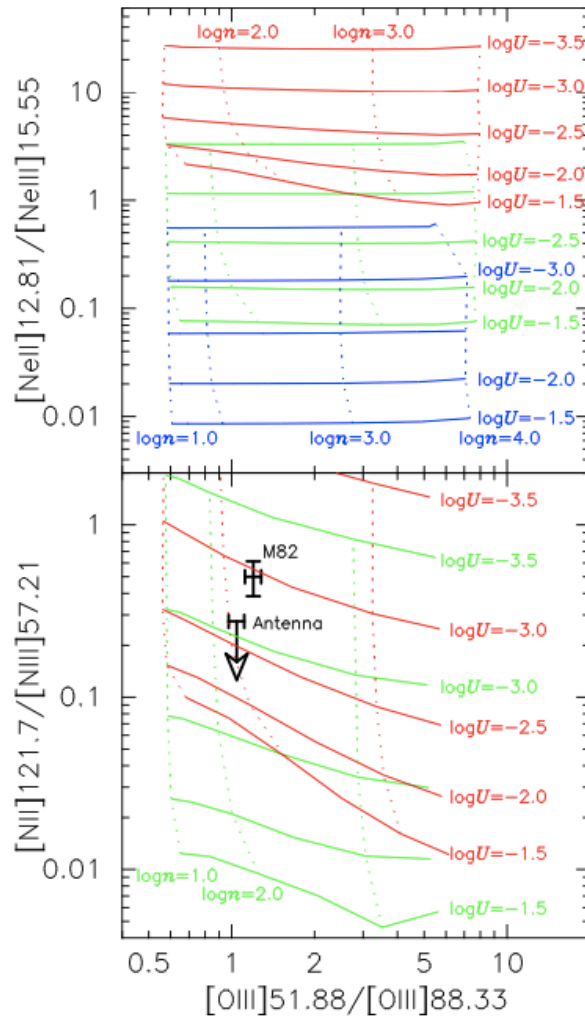
constant pressure

SED: starburst99 (const.SFR)

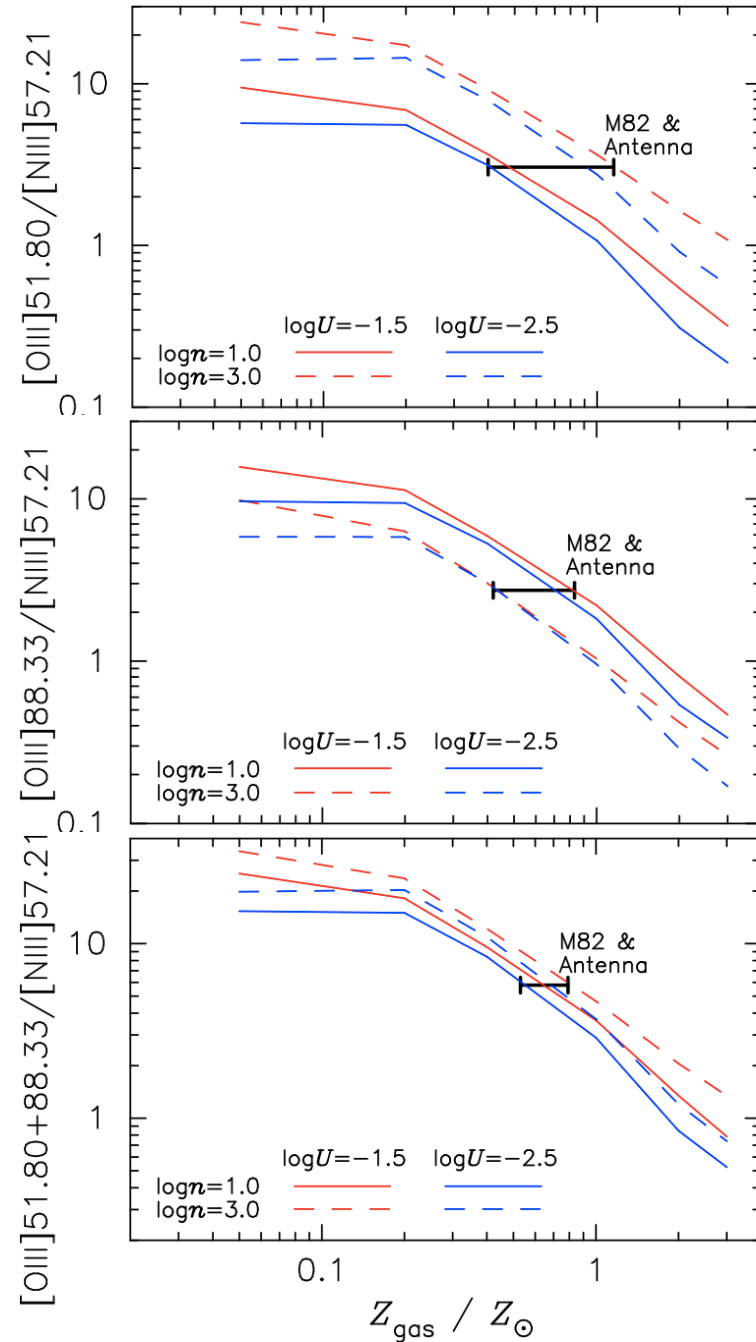
**Focusing only on IR lines
from H II regions !!**

MidIR-FarIR Diagnostics

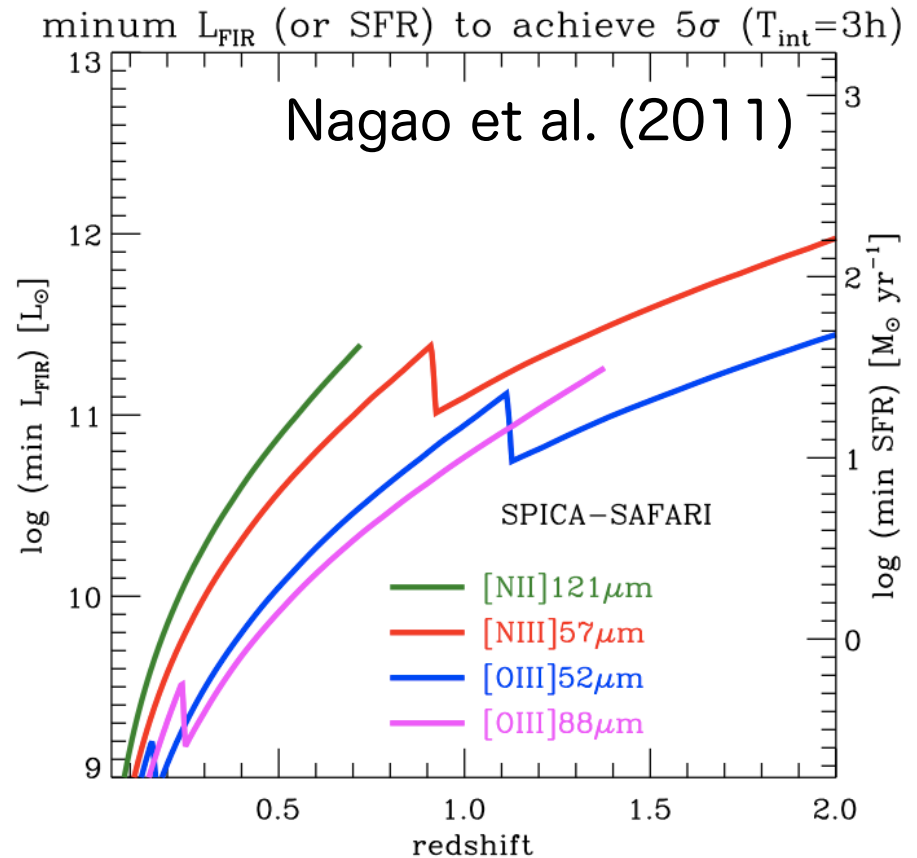
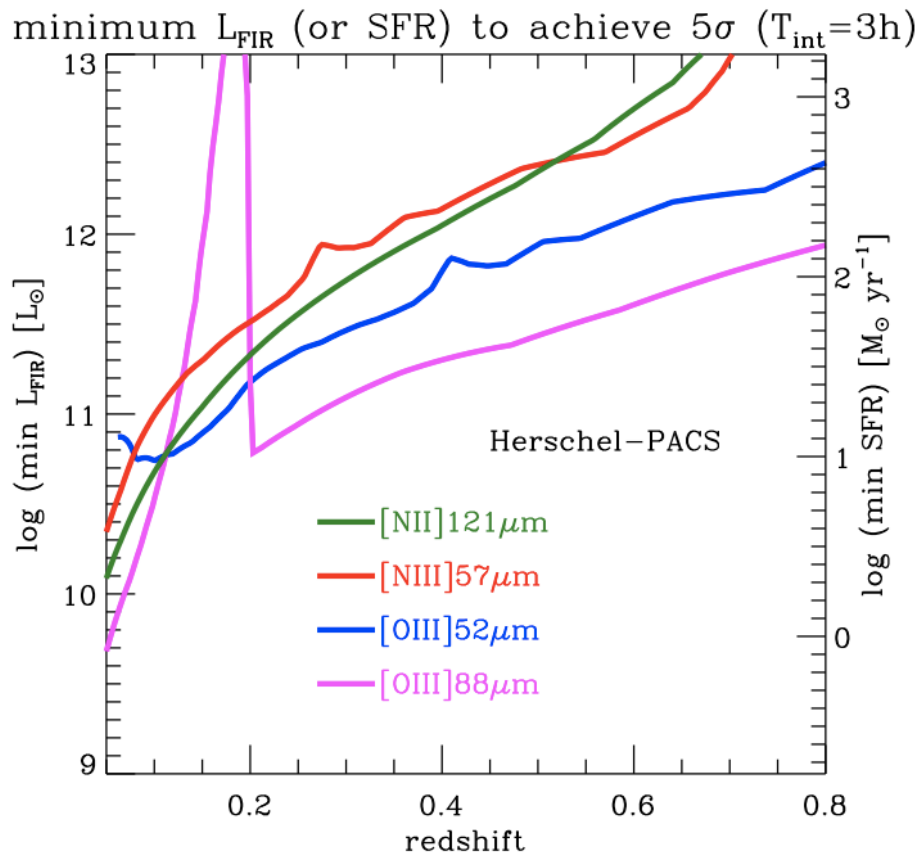
Use only strong lines from HII regions
 ...[OIII]51.80, [NIII]57.21, [OIII]88.33



Nagao et al.
 (2011)



Observational Feasibility with SPICA



Herschel/PACS: ULIRGs up to $z \sim 0.5$
 SPICA/SAFARI: LIRGs up to $z \sim 1.5$
 SPICA/BLISS: LIRGs up to $z \sim 4$

Summary

MIR-FIR diagnostics needed for “evolving” galaxies:
are dusty galaxies really “chemically young” !?

Key features: [OIII]51.80, [NIII]57.21, [OIII]88.33
for density and metallicity measurements

LIRGs up to $z \sim 1.5$ can be studied with SAFARI

Requirement: wavelength coverage up to $\sim 210 \mu\text{m}$
& wavelength resolution $R \sim 2000$ ($\Delta v \sim 150 \text{ km/s}$)

Synergy with ALMA: [NII]205, PDR lines, CO, ...

See Nagao+ (arXiv:1012.2471) for more details!