Far-IR Line Spectra of AGN from *Herschel*/PACS

The Complete Database

Juan Antonio Fernández-Ontiveros

Istituto di Astrofisica e Planetologia Spaziali (**INAF–IAPS**), Roma, Italy

L. Spinoglio || M. Pereira-Santaella || M. Malkan || P. Andreani || K. Dasyra

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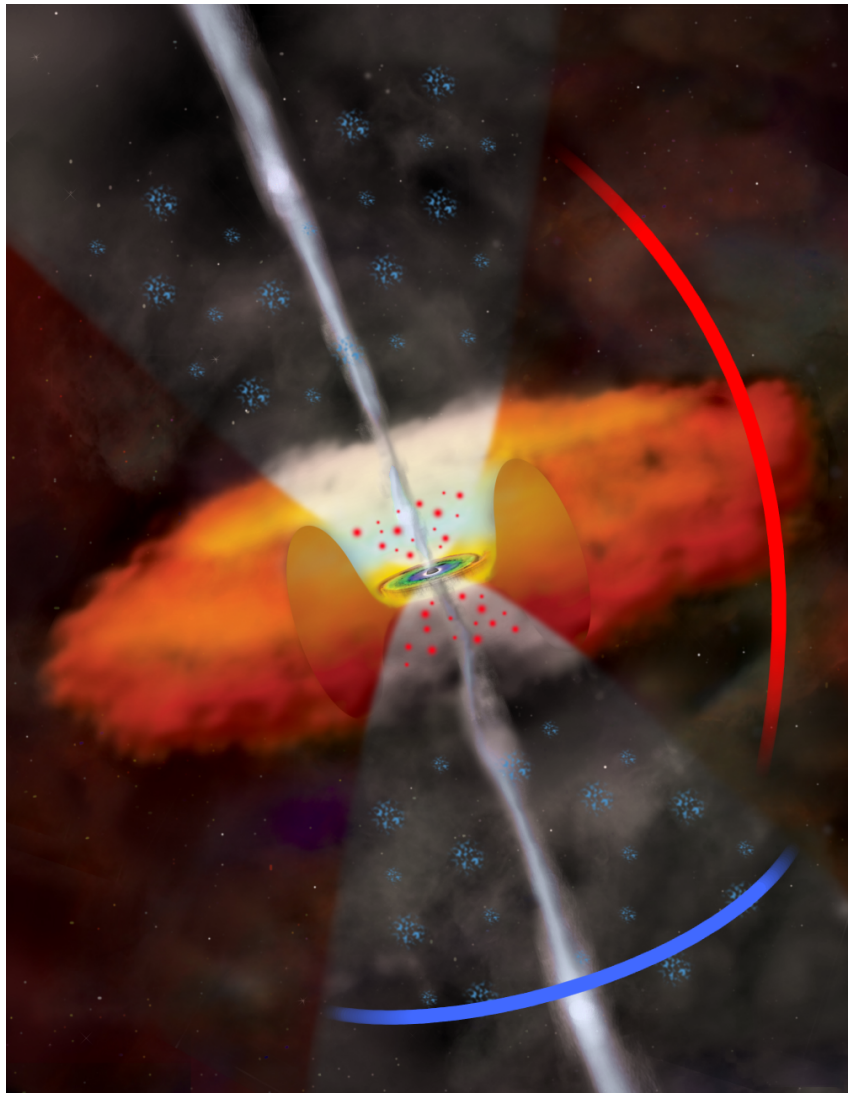
Outline

Why IR spectroscopy?

- **Avoid** most of **extinction**



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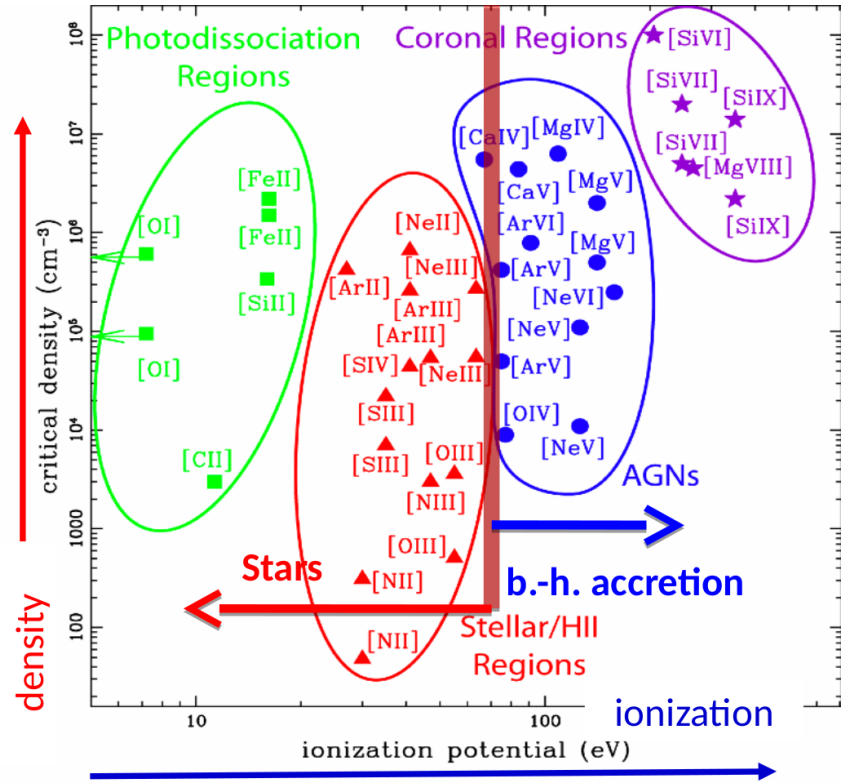

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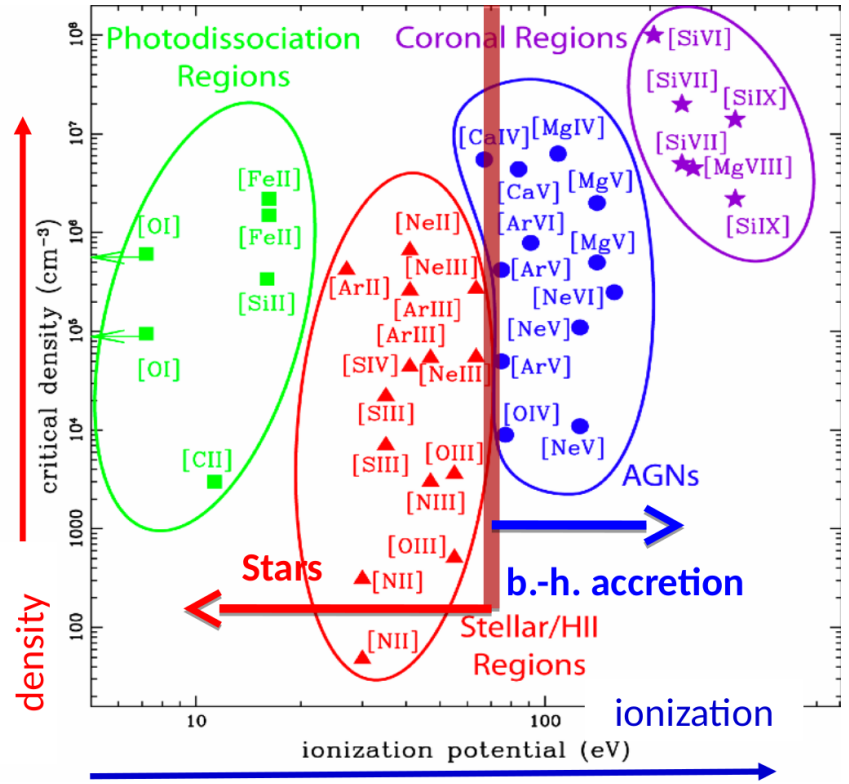

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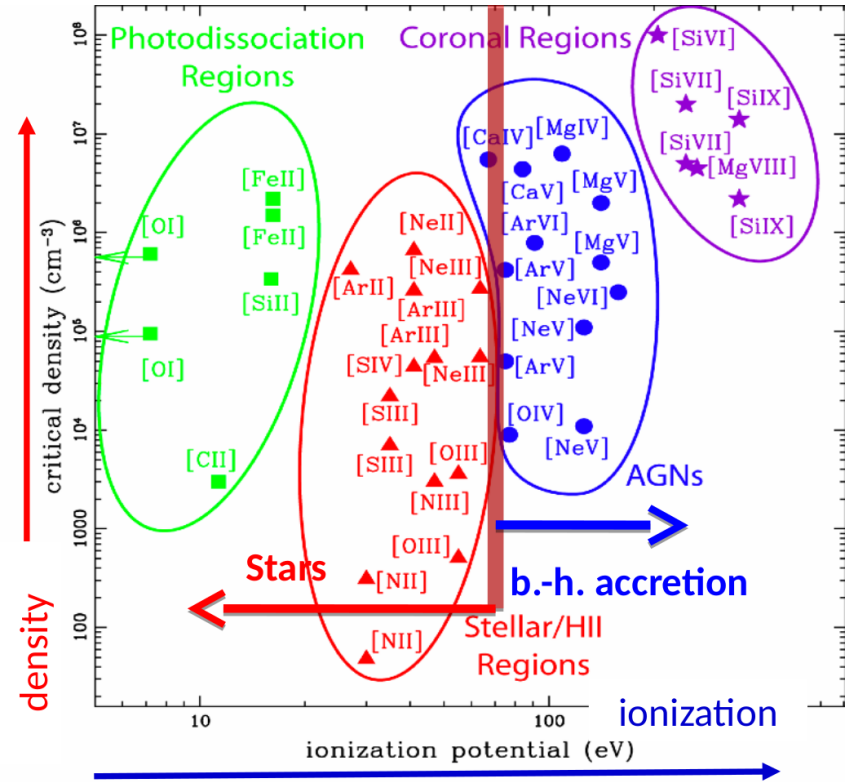
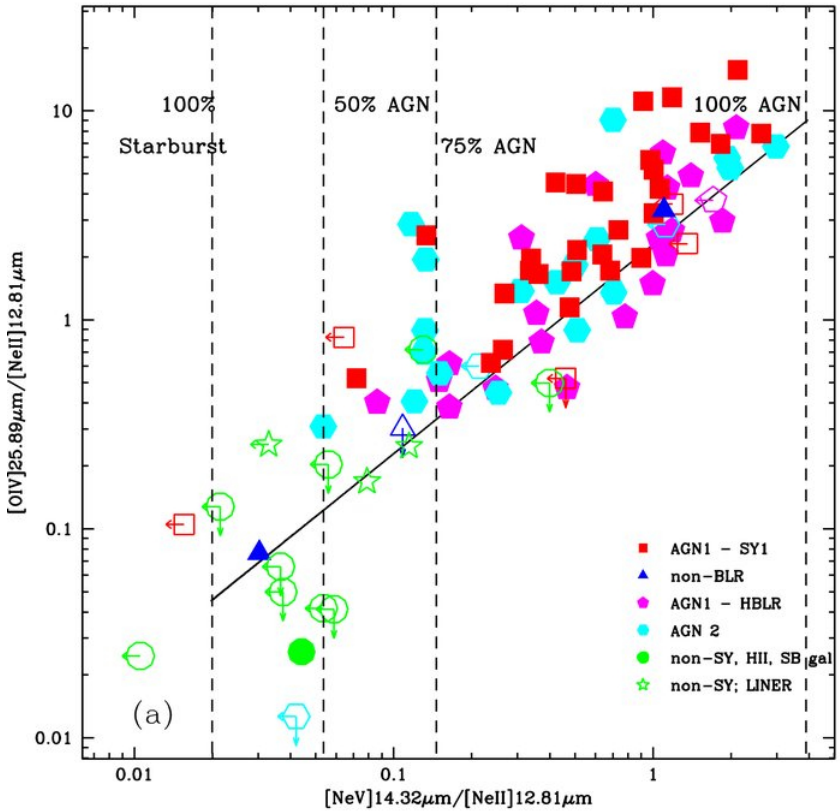
- Trace **AGN** and **SF** activity
- Cover **ionisation–density** parameter space
- Outflows: OH (Sturm+2011; Spoon+2013; Veilleux+2013)
- High CO lines: >CO(13-12)



Previous Work

- **Mid-IR** diagnostics with fine-structure lines *Spitzer*/IRS (Tommasin+2008,2010)



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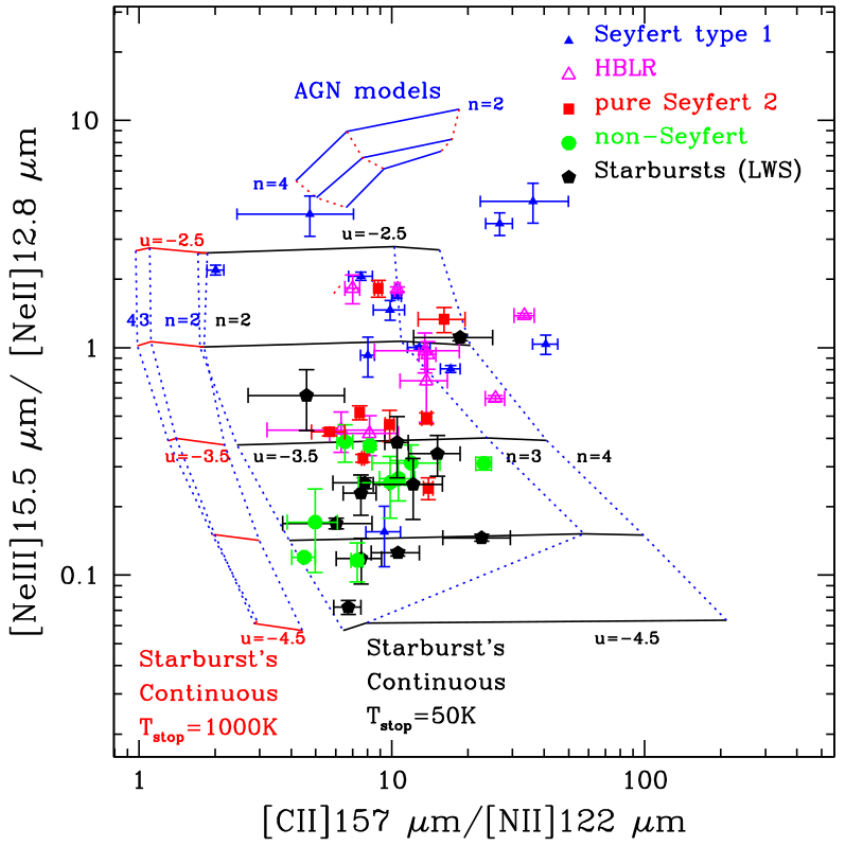

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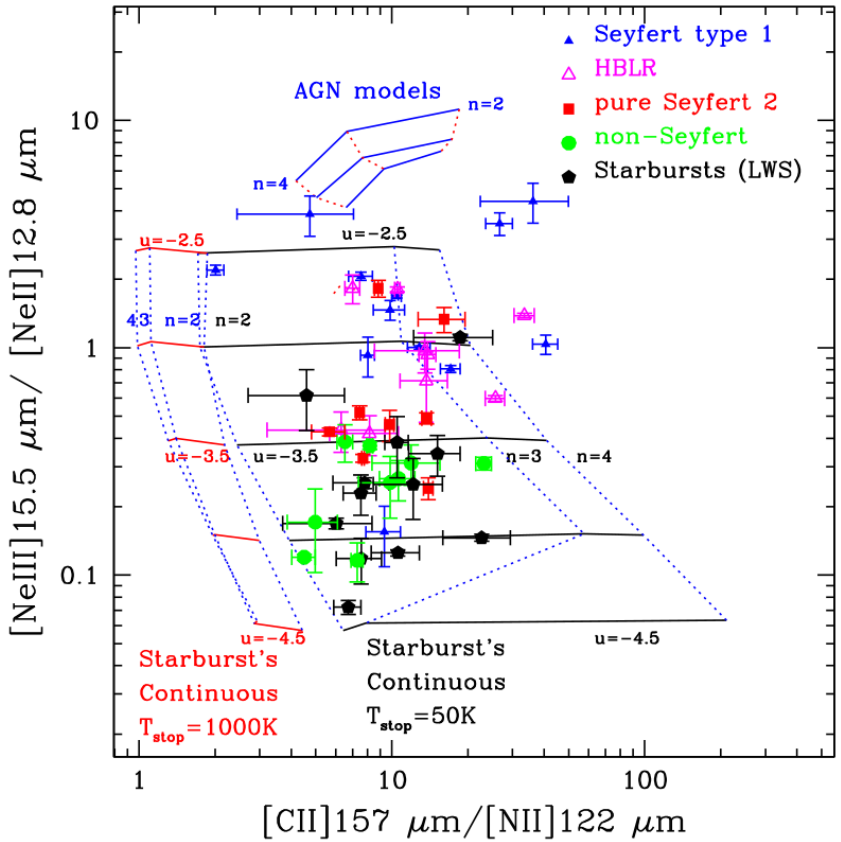

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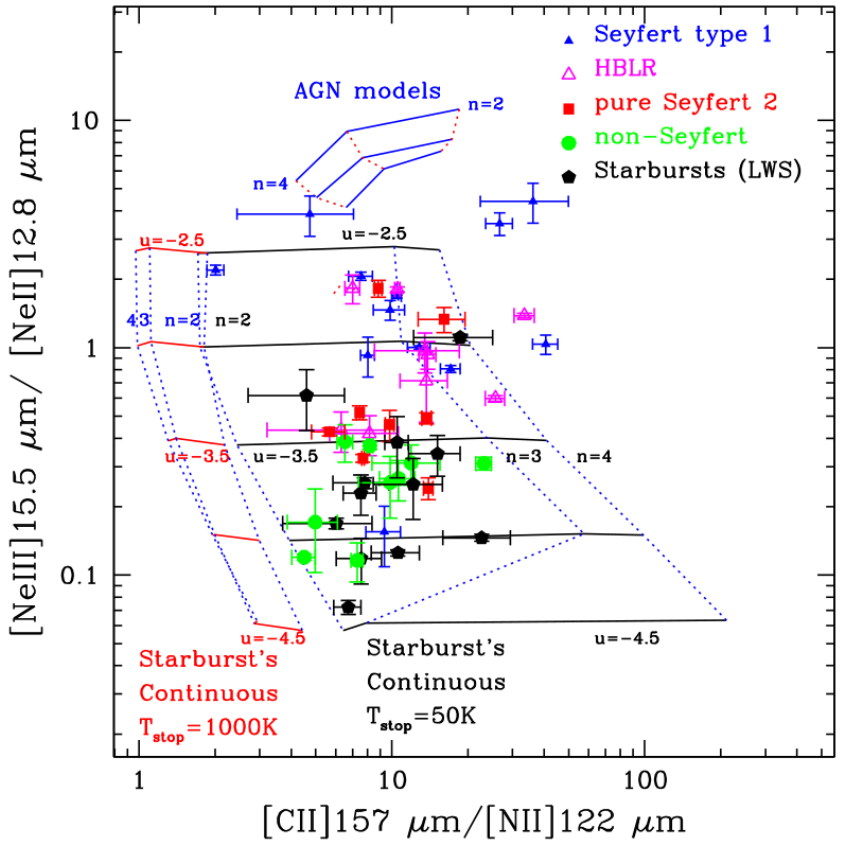
Extension to **all AGN** in ***Spitzer* + *Herschel***



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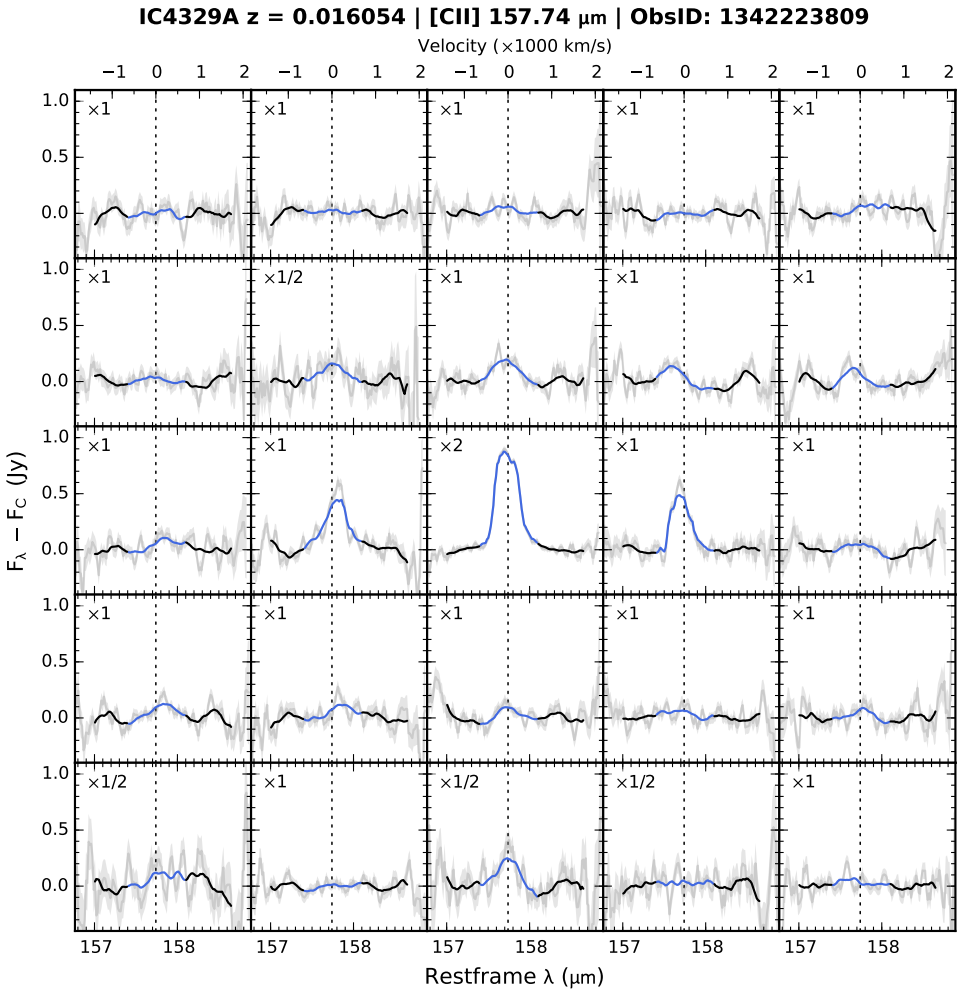
\+ **43 Dwarf** galaxies (Madden+2013, Cormier+2015)

\+ **20 Starburst** galaxies

(Bernard-Salas+2009; Goulding & Alexander 2009)

Dataset

- **Background subtraction** using HIPE v13.0.0
- 5×5 spaxels
  FOV: $47'' \times 47''$



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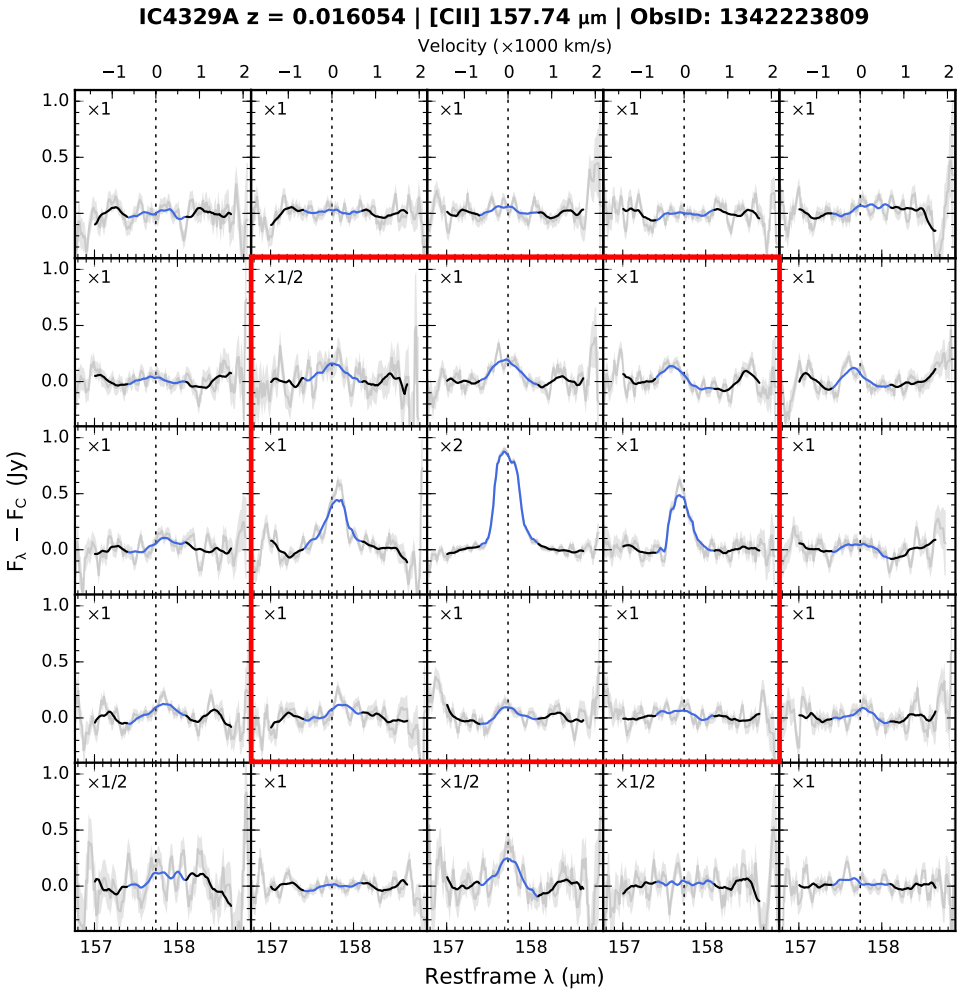

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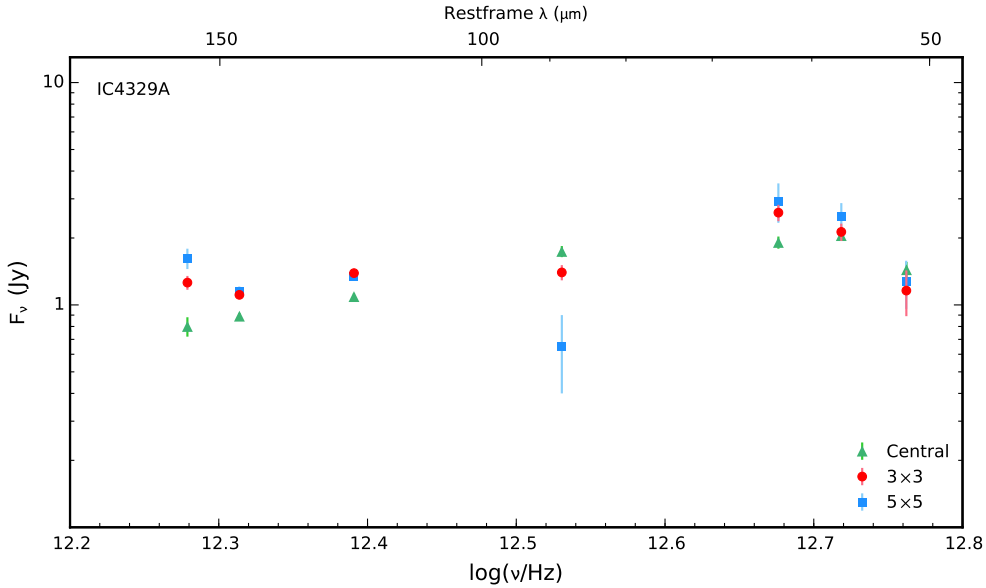

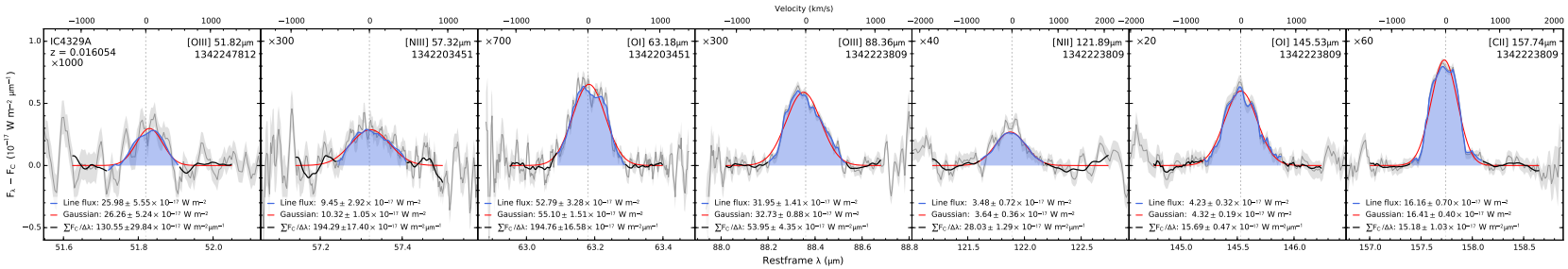

CLOUDY Models

CLOUDY photoionisation models

- Constant **SF**, Starburst99, 20 Myr, $Z_\odot$: **Starburst model**
- Instant **SF**, Starburst99, 1 Myr, $\frac{1}{5}\,Z_\odot$: **Dwarf model**

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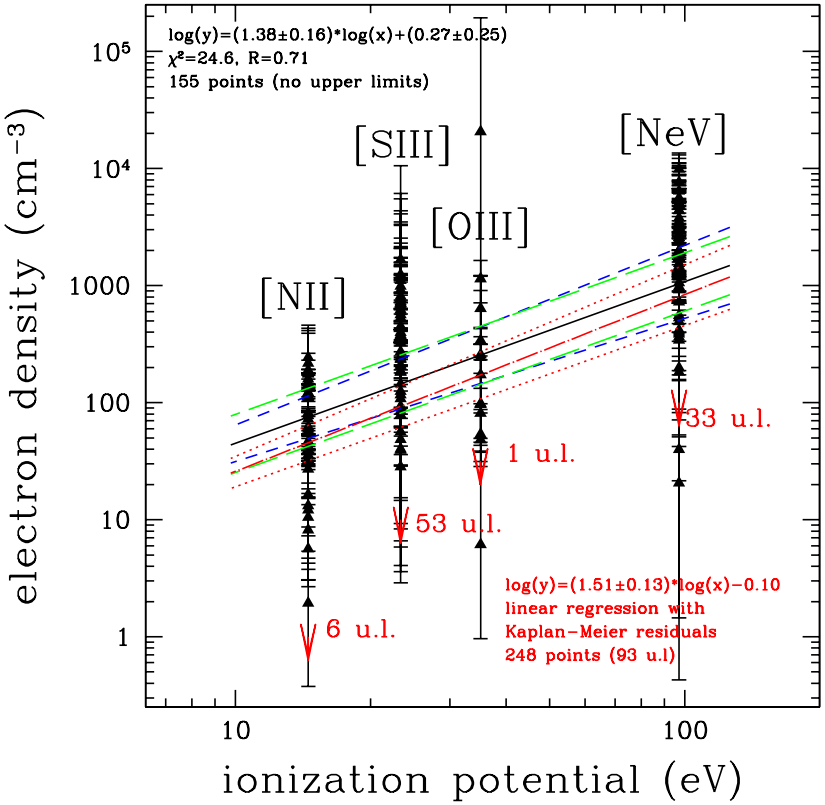
- $\log U = -(1.5\text{–}4.5)$, $\log(n_\mathrm{H}/\mathrm{cm}^{-3}) = 1\text{–}6$
- Metallicity study: $Z = \frac{1}{20}\text{–}2\,Z_\odot$ for **AGN** and **Dwarf** models

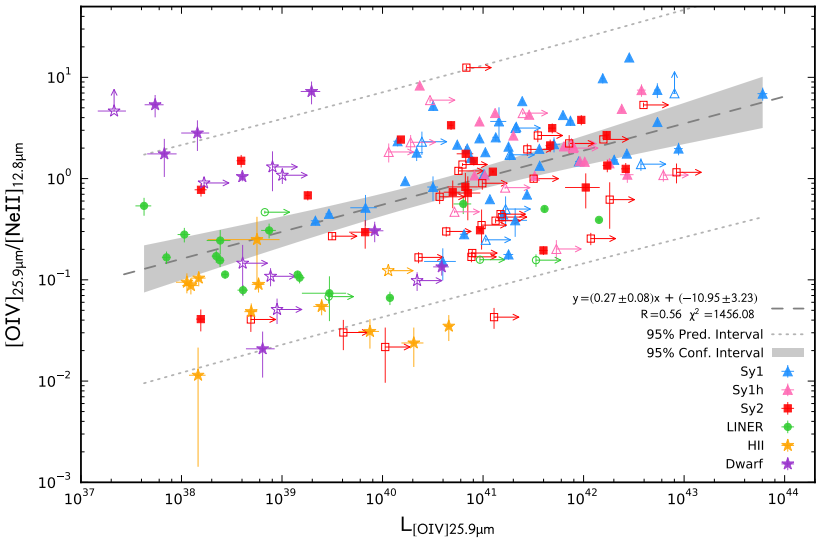
Density stratification



- Found in Spinoglio+(2015) confirmed using **155** (**+93** upper limits) line **pairs**
- Increasing gas density with ionisation potential

Fernández-Ontiveros, Spinoglio et al. (2016, ApJS submitted)

AGN/star-formation



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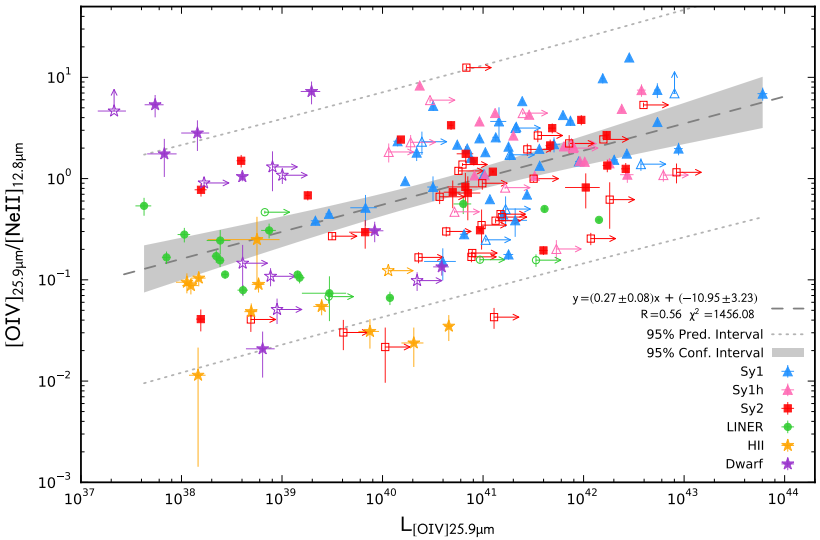

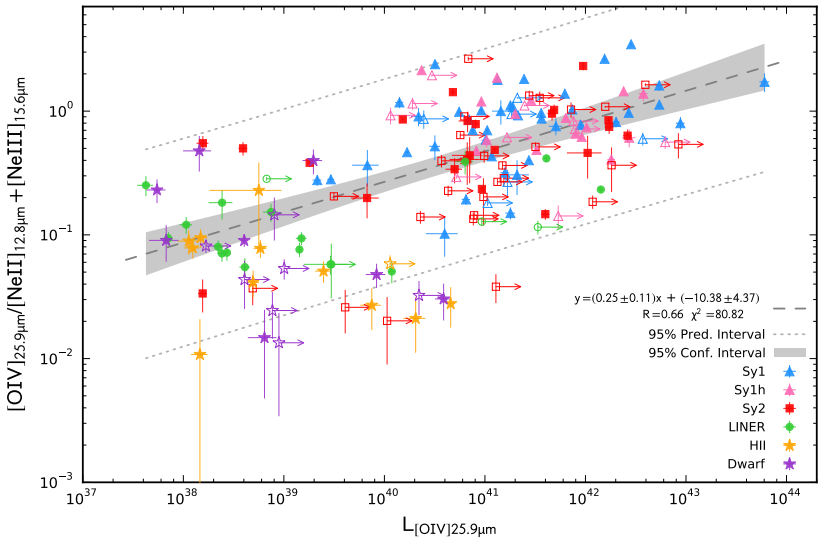

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- $\frac{[\mathrm{OIV}]_{25.9}}{[\mathrm{NeII}]_{12.8}+[\mathrm{NeIII}]_{15.6}}$, a better approach ($R = 0.66$)

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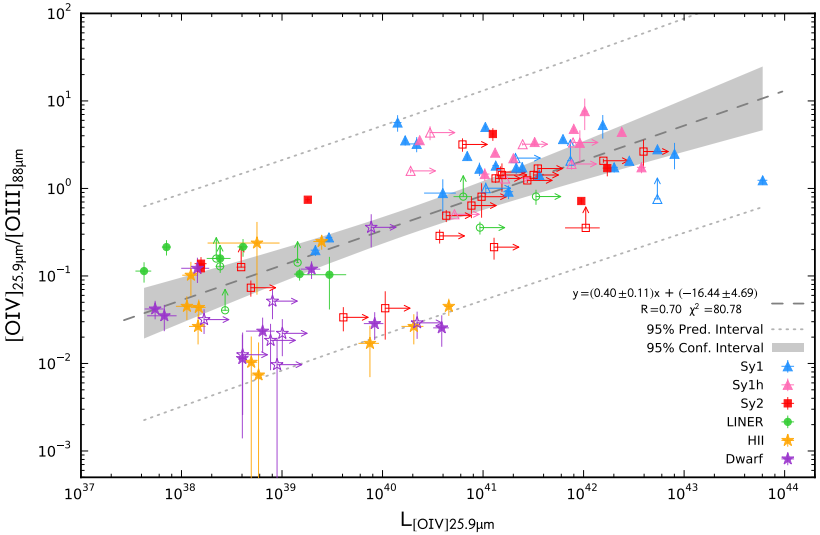

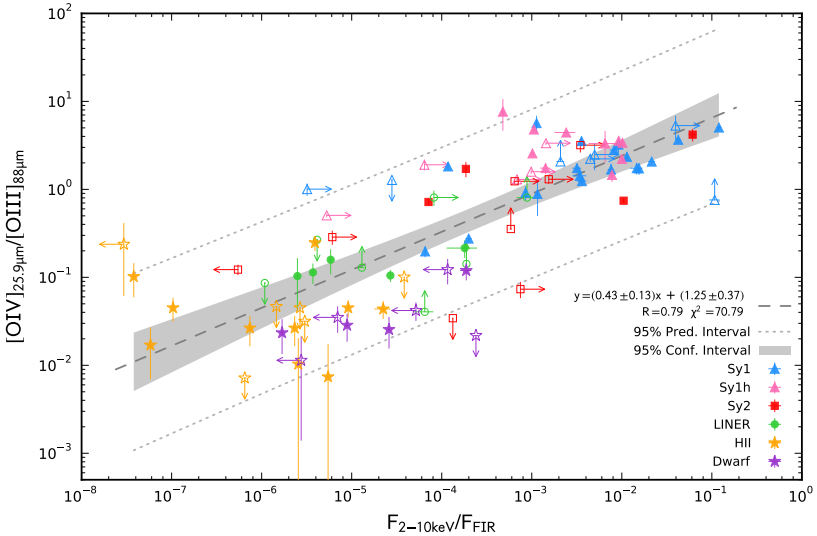

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- $\frac{[\mathrm{OIV}]_{25.9}}{[\mathrm{OIII}]_{88}}$, the **best AGN/SF** tracer ($R = 0.70$)

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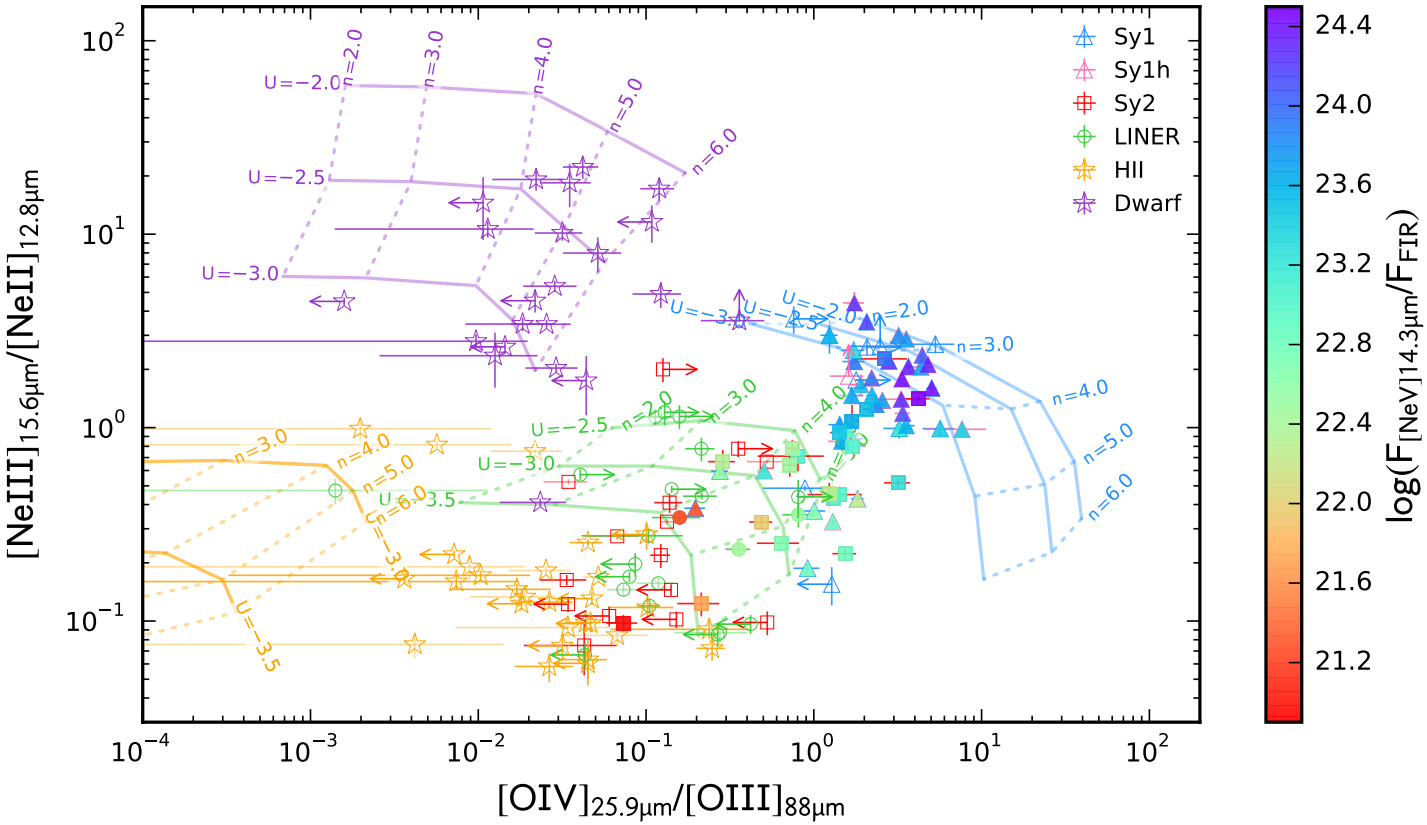

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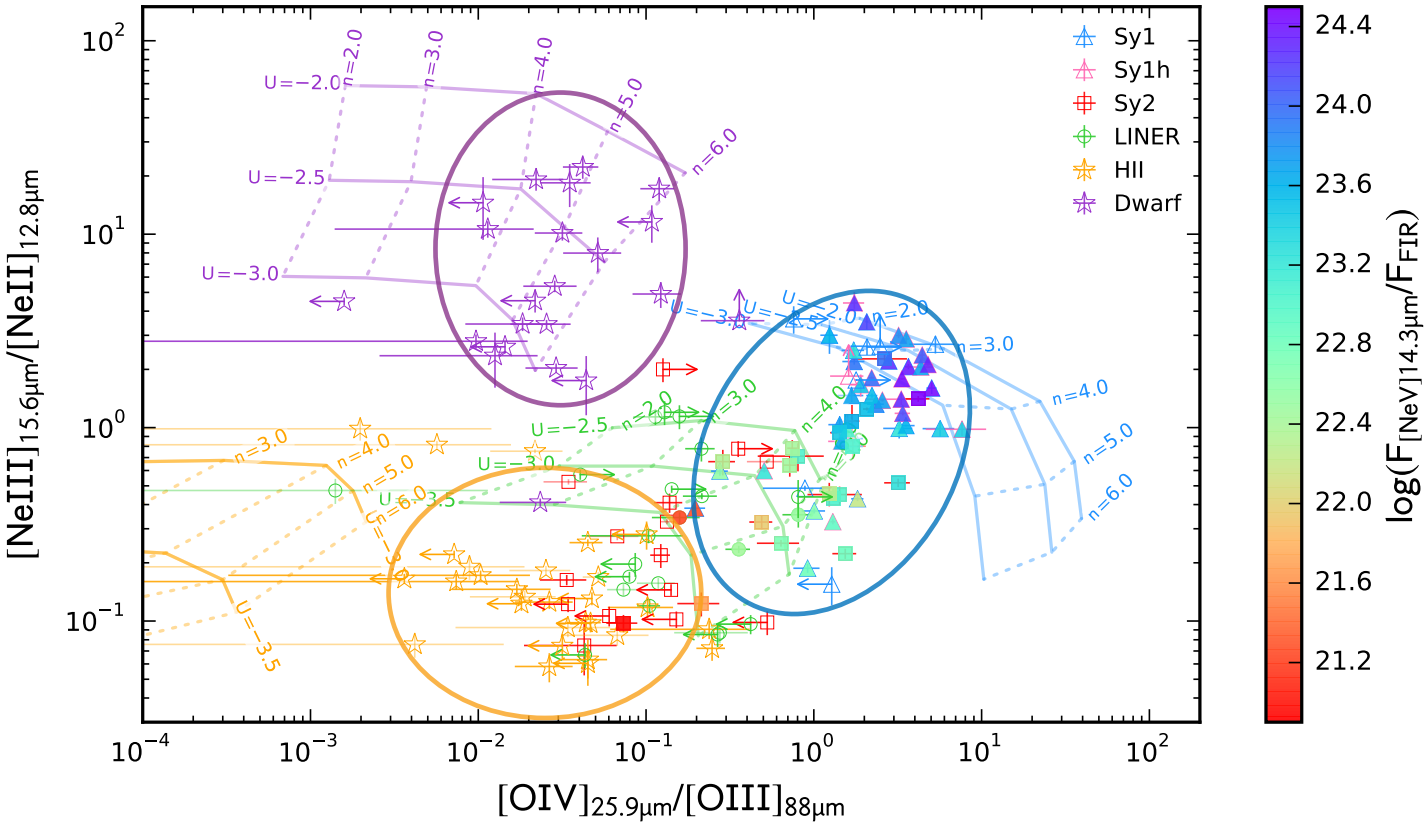

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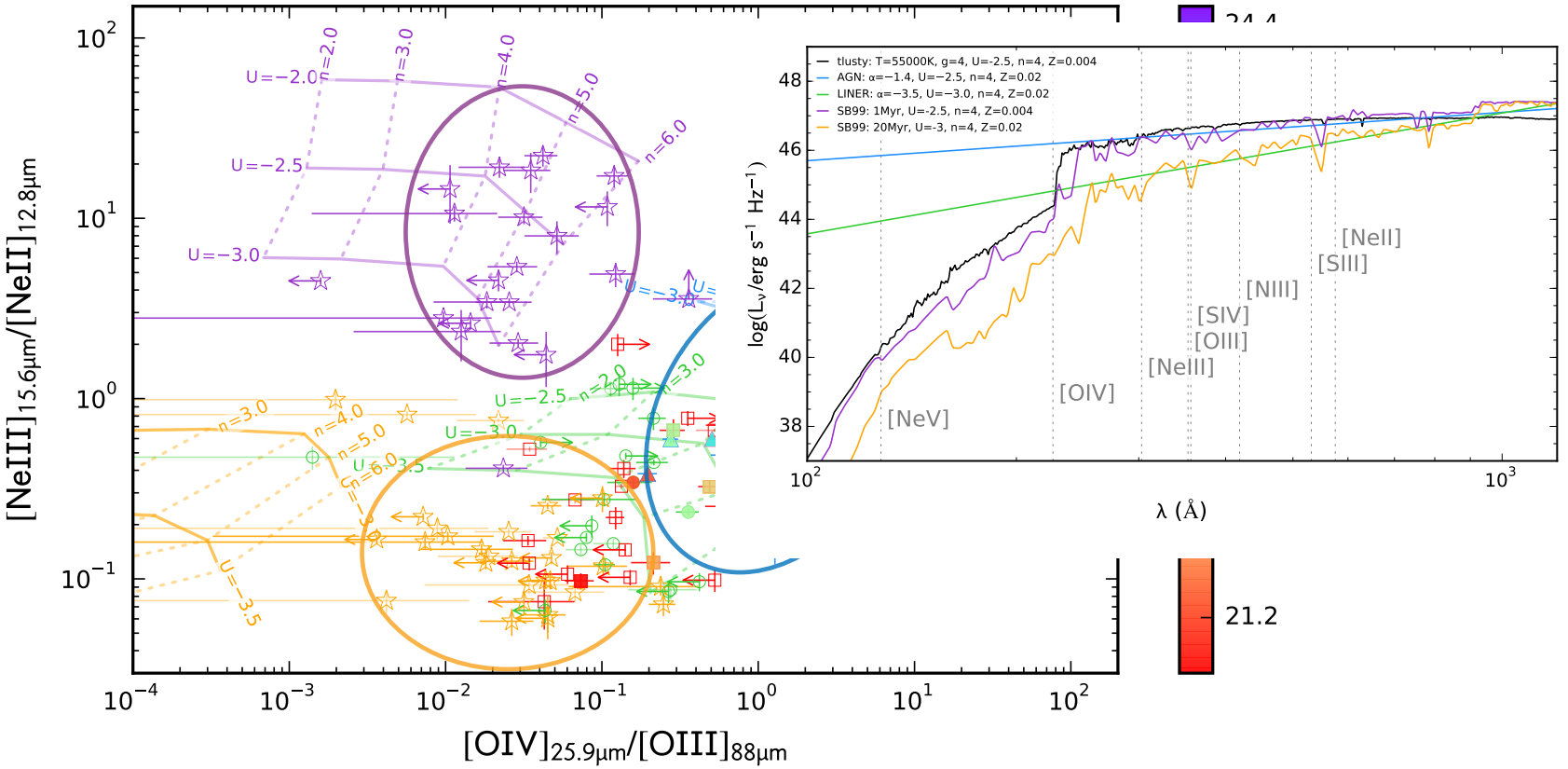

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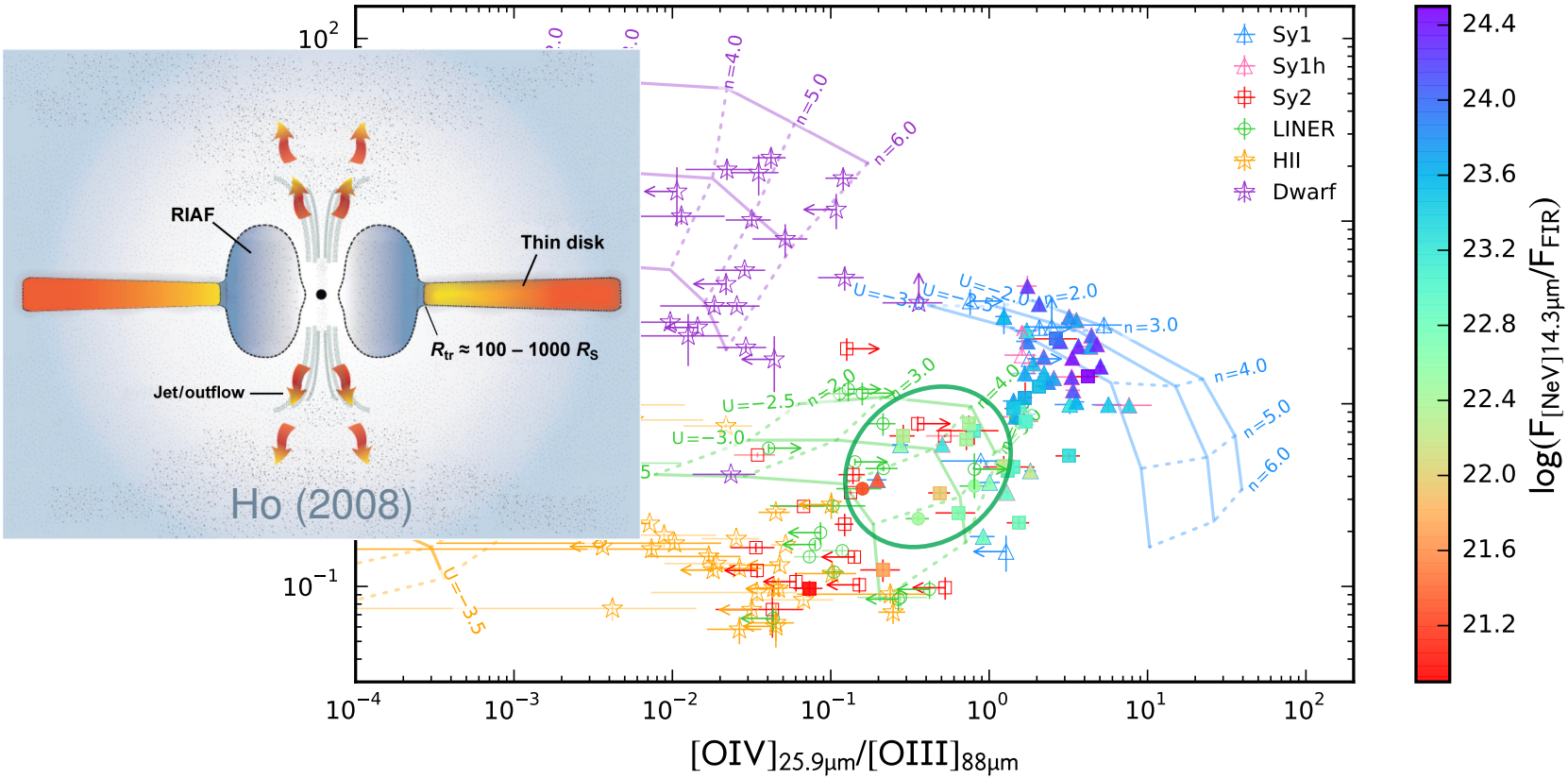

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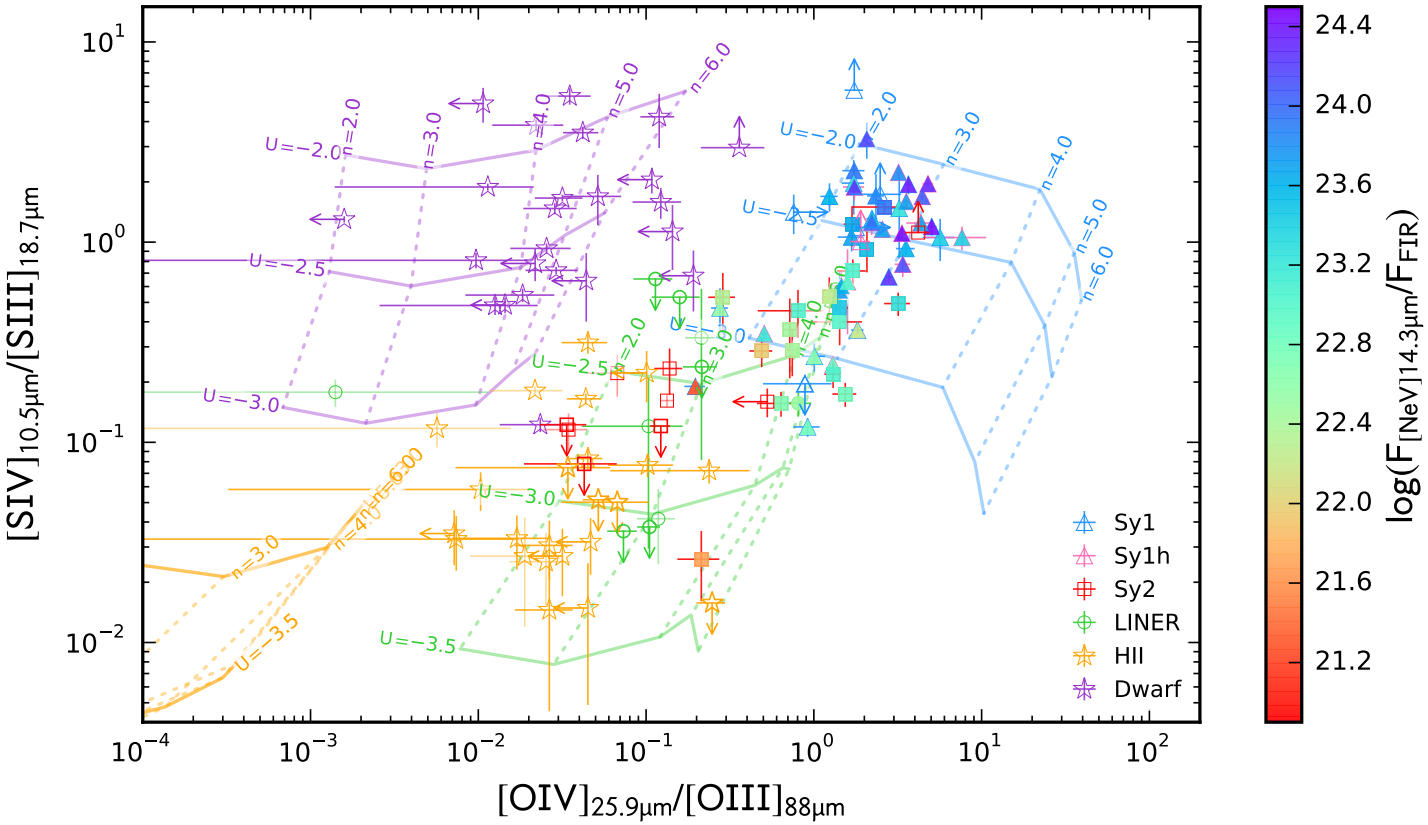

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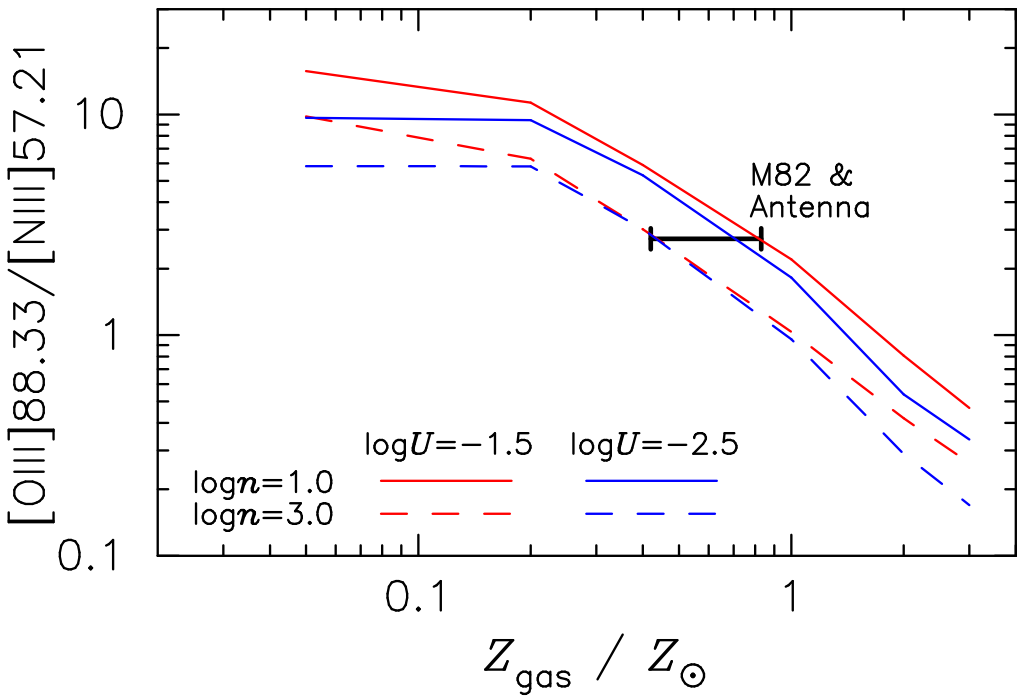

- FIR **metallicity** diagnostic
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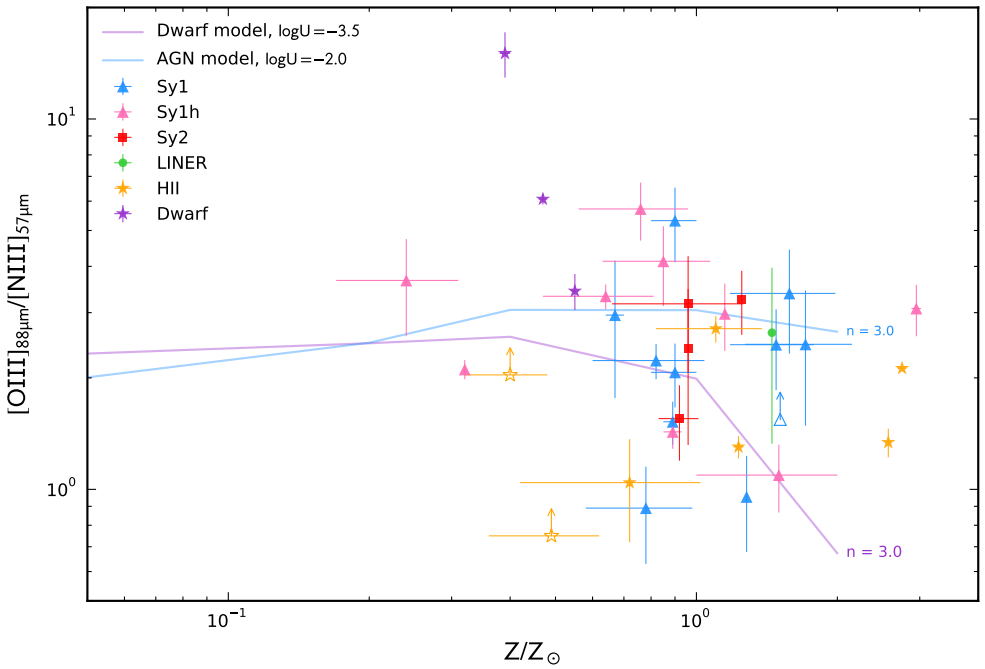

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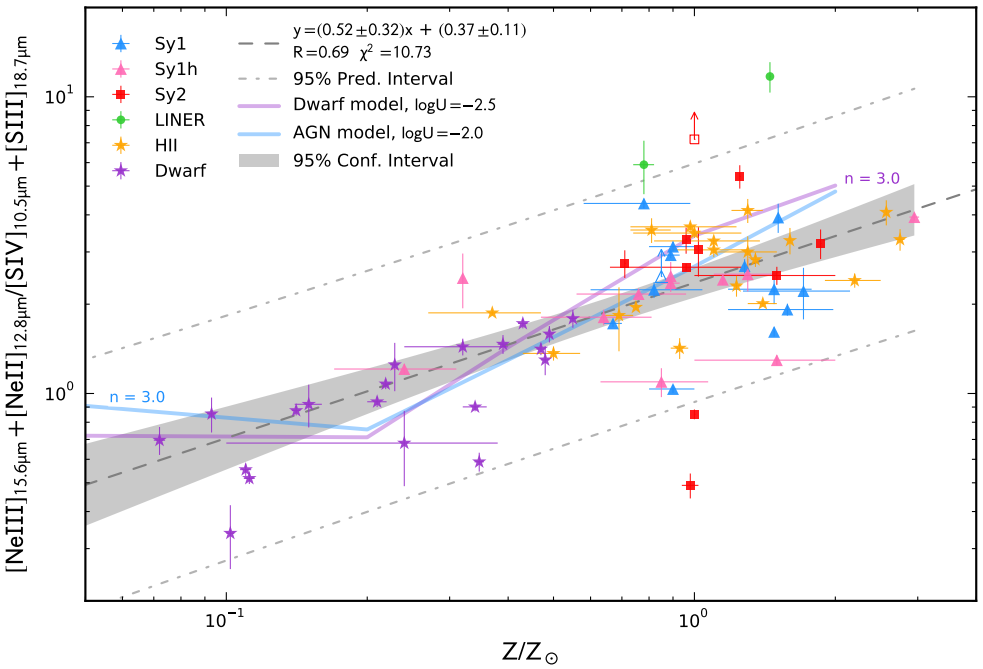

Fernández-Ontiveros, Spinoglio, et al. (2016)

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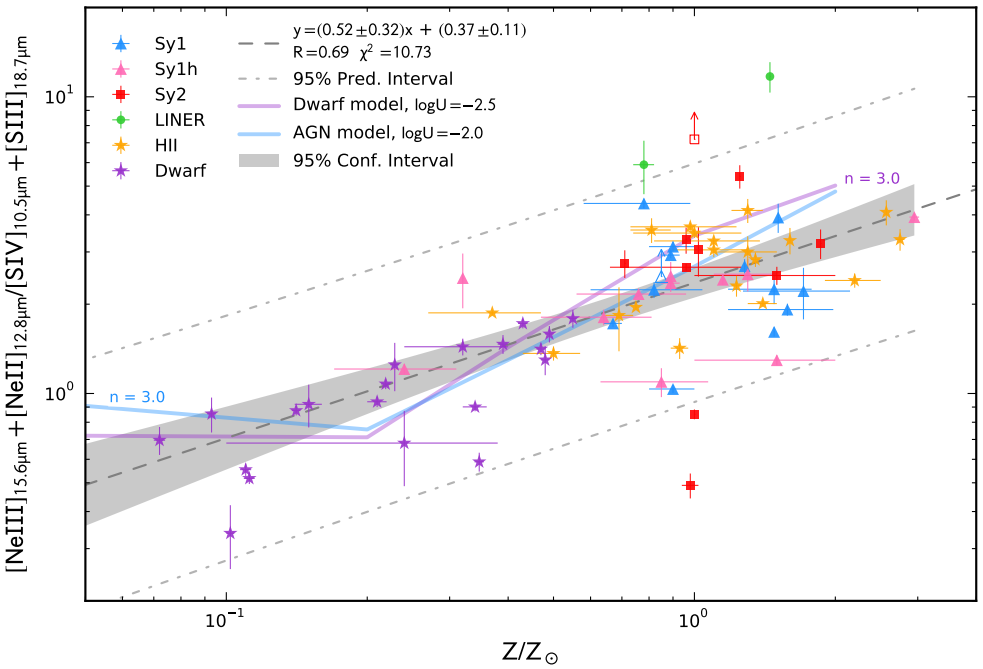

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- **Extinction-free** metallicity tracer for Local Universe (*JWST*) and Cosmological Surveys (*SPICA*)

Summary

- **Mid- + Far-IR** lines are excellent **diagnostics**
- Confirm **density stratification**
- $\frac{[\mathrm{OIV}]_{25.9}}{[\mathrm{OIII}]_{88}}$ separates **AGN** and **star-formation**
- Starburst templates underestimate $\frac{[\mathrm{OIV}]_{25.9}}{[\mathrm{OIII}]_{88}}$
- $\frac{[\mathrm{NeII}]_{12.8}+[\mathrm{NeIII}]_{15.6}}{[\mathrm{SIV}]_{10.5}+[\mathrm{SIII}]_{18.7}}$ **metallicity tracer**
- **Local sample** to test diagnostics for local and high-z studies with *JWST*, *SPICA* and ALMA