Hands-on Project 4

Spectrophotometric Modeling of Galaxies

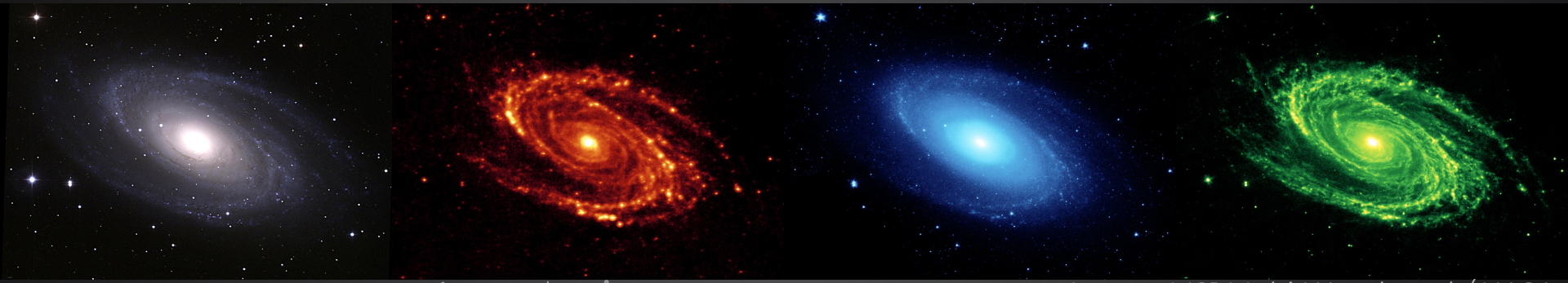

Image: M81 Multi-Wavelength/ NASA

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Supervisors:

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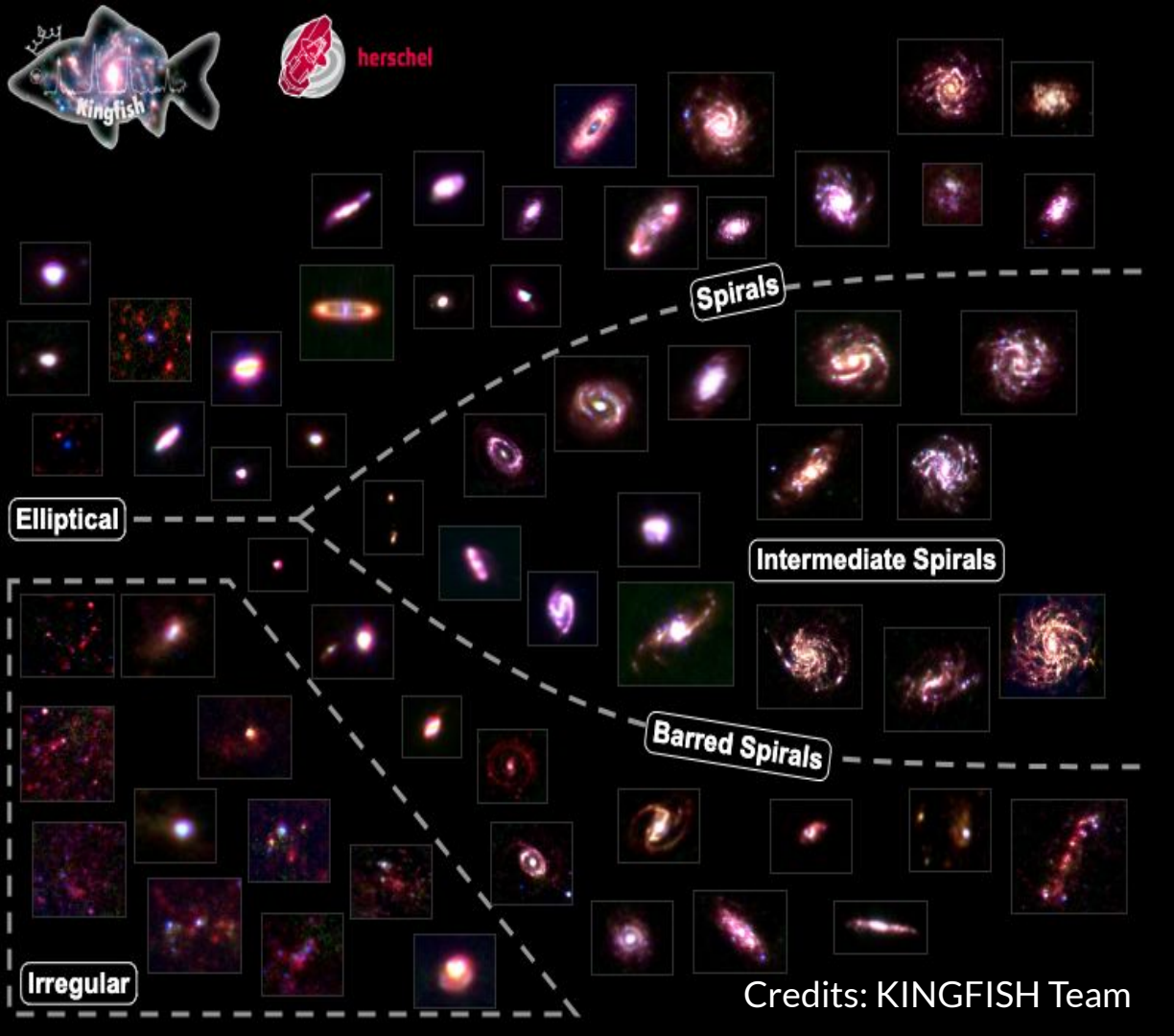
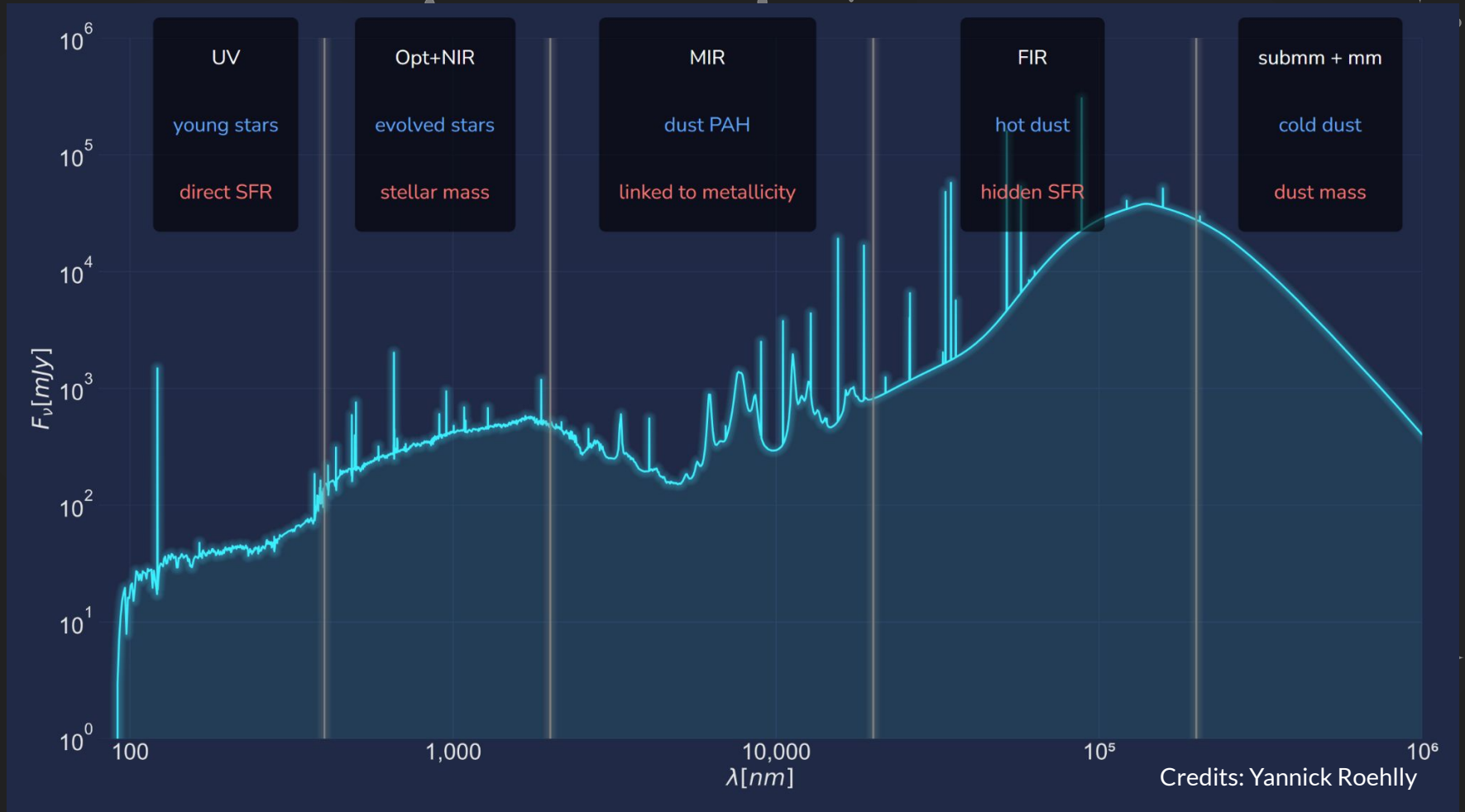
SAMPLE: SINGS / KINGFISH

- A subset of 33 Nearby Galaxies from **KINGFISH**
- Combined 23 photometric observations (GALEX, SDSS, 2MASS, IRAC, WISE, MIPS, PACS, and SPIRE)
- Covers different types of galaxies – S, E, Irr



Credits: KINGFISH Team

Let's dissect the SED



Methodology: SED Fitting with CIGALE

- ★ Star Formation History (SFH)
- ★ Single Stellar Populations (SSP) models
- ★ Nebular emission (lines & continuum)
- ★ Dust attenuation
- ★ Dust emission in the infrared (IR)
- ★ AGN emission
- ★ X-ray
- ★ Redshifting
- ★ Absorption by the intergalactic medium

★ **Bonus:** CIGALE includes energy balance between stellar and dust emission.

Credit: Boquien et, al. (2019)

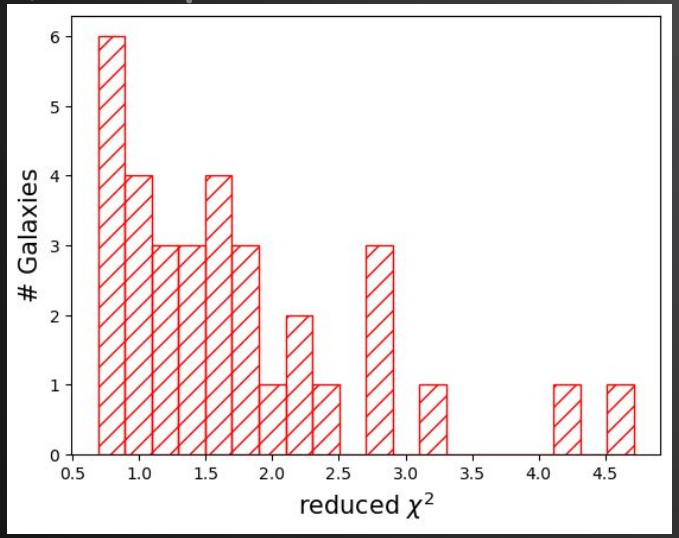
CIGALE: a python Code Investigating GALaxy Emission

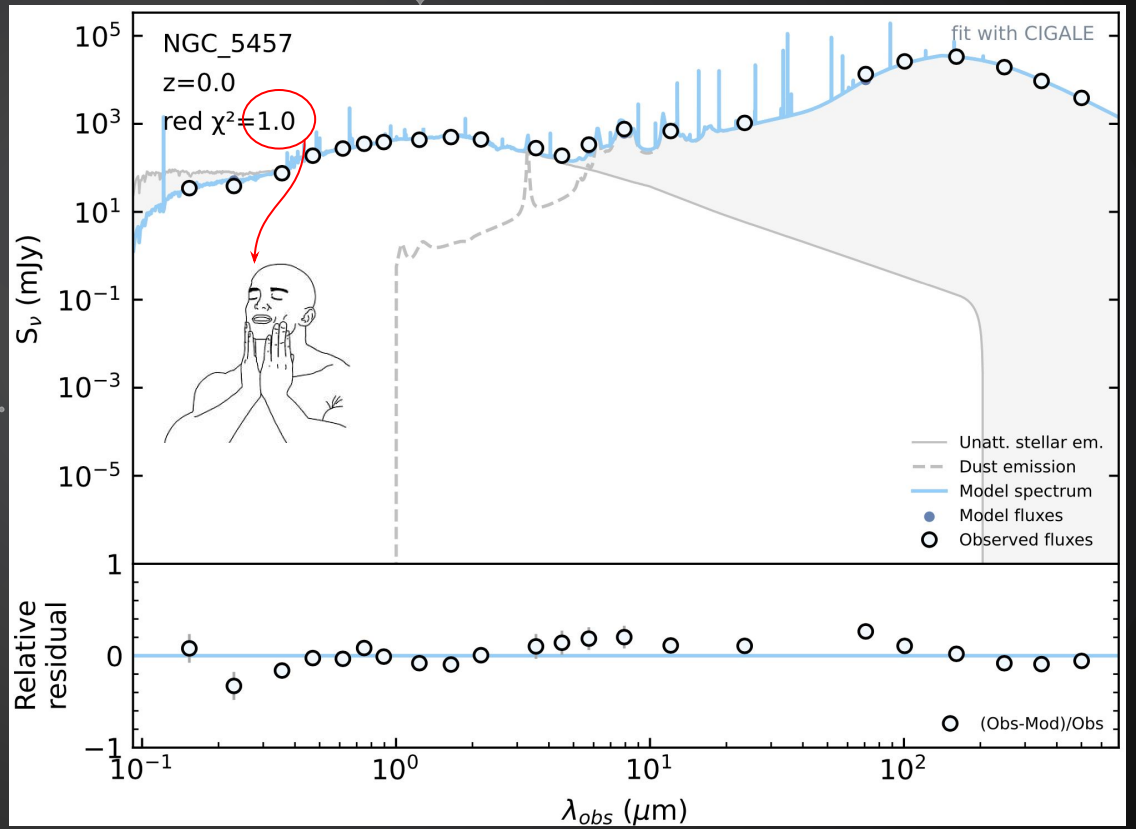
pngegg.com

Cigale (fr)
=
Cicada (en)

SED FITTING WITH CIGALE

Here is an example with reduced $\chi^2 = 1.05$. We use “Bayesian” (not “best”) fits to estimate the parameters.

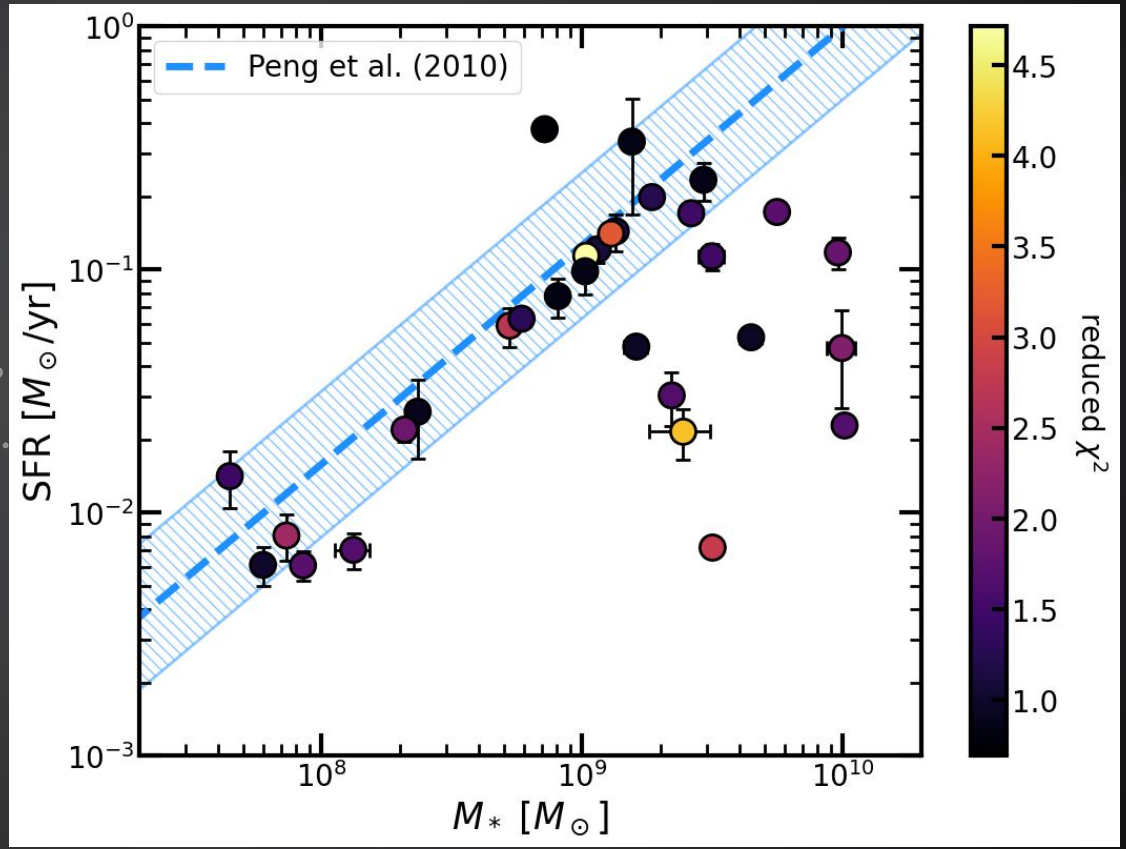




SFR-Stellar Mass Relation

SFR-M* relation estimated using **only photometry in the SED fit** provides reasonable values

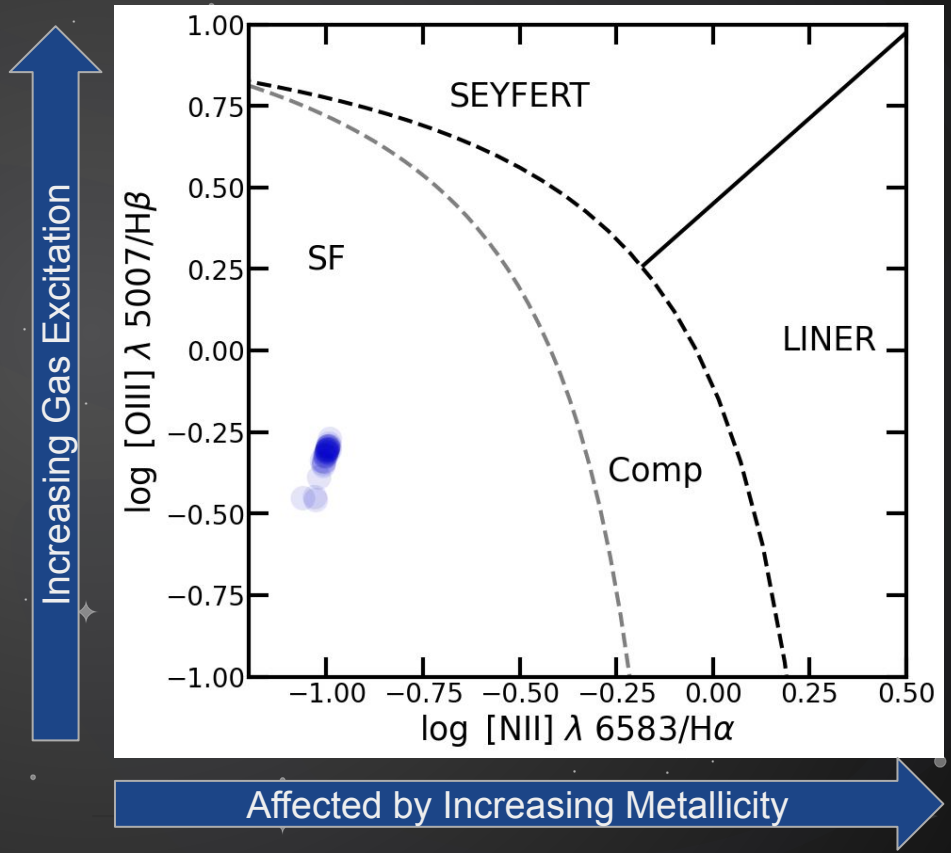
Underestimating SFR?



Baldwin, Phillips & Terlevich (BPT) Diagram

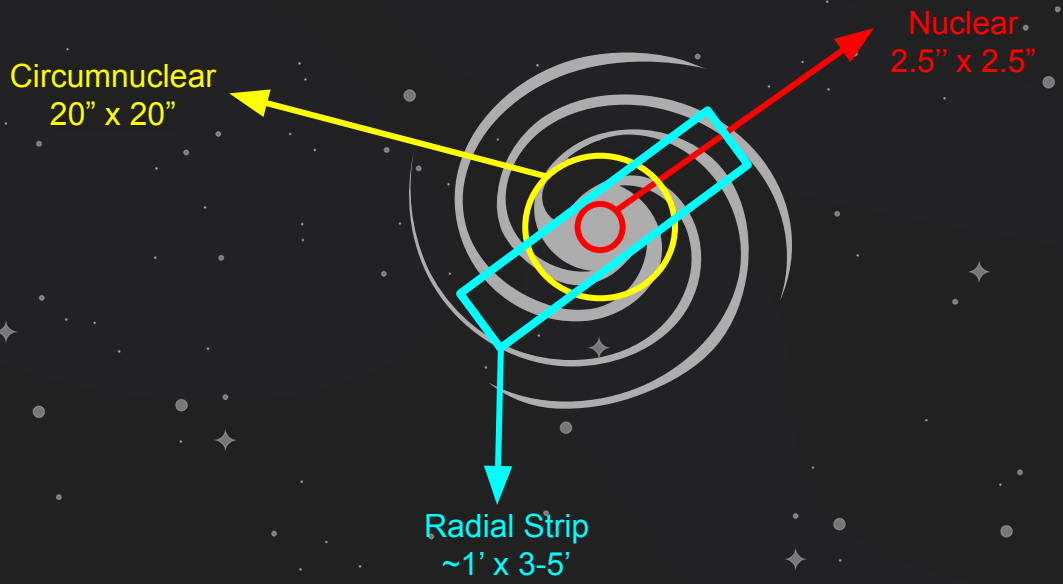
The BPT diagram shows the limitation of using only photometry to estimate ***predicted*** line fluxes.

Line fluxes depend on nebular parameters such as the ionization parameter, gas phase metallicity, and electron number density.



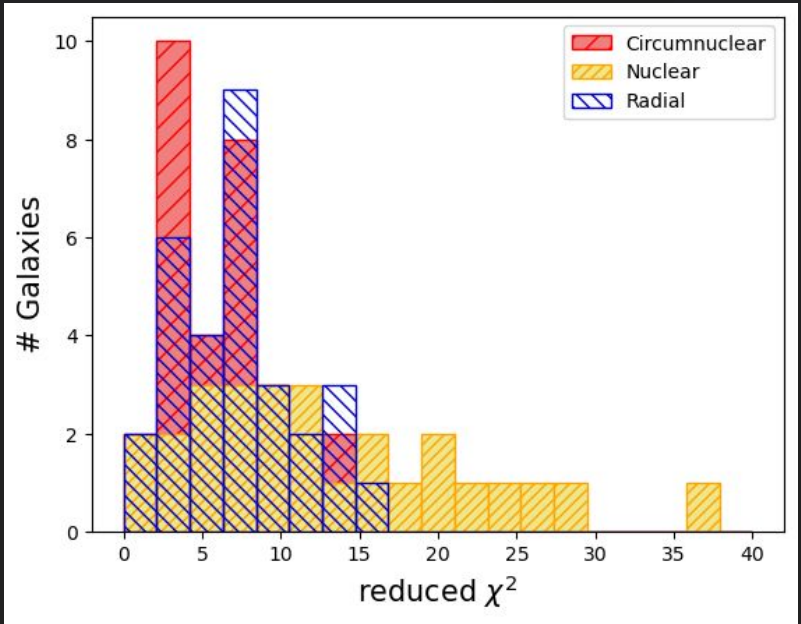
Adding Line Fluxes to Photometry

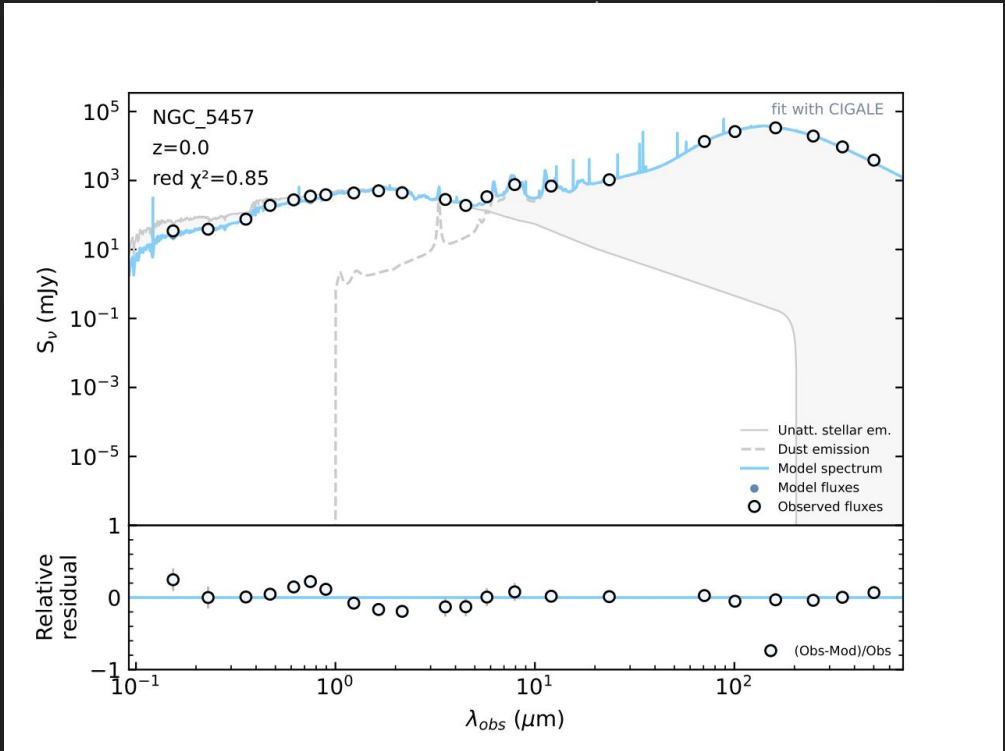
We take line intensity measurements from Moustakas et al. (2010) and add them as an input for CIGALE. Three measurements are available for each galaxies, targeting different spatial components: nuclear, circumnuclear and radial.



Adding Line Fluxes to Photometry in the fits

Here is an example with reduced χ^2 = 0.85

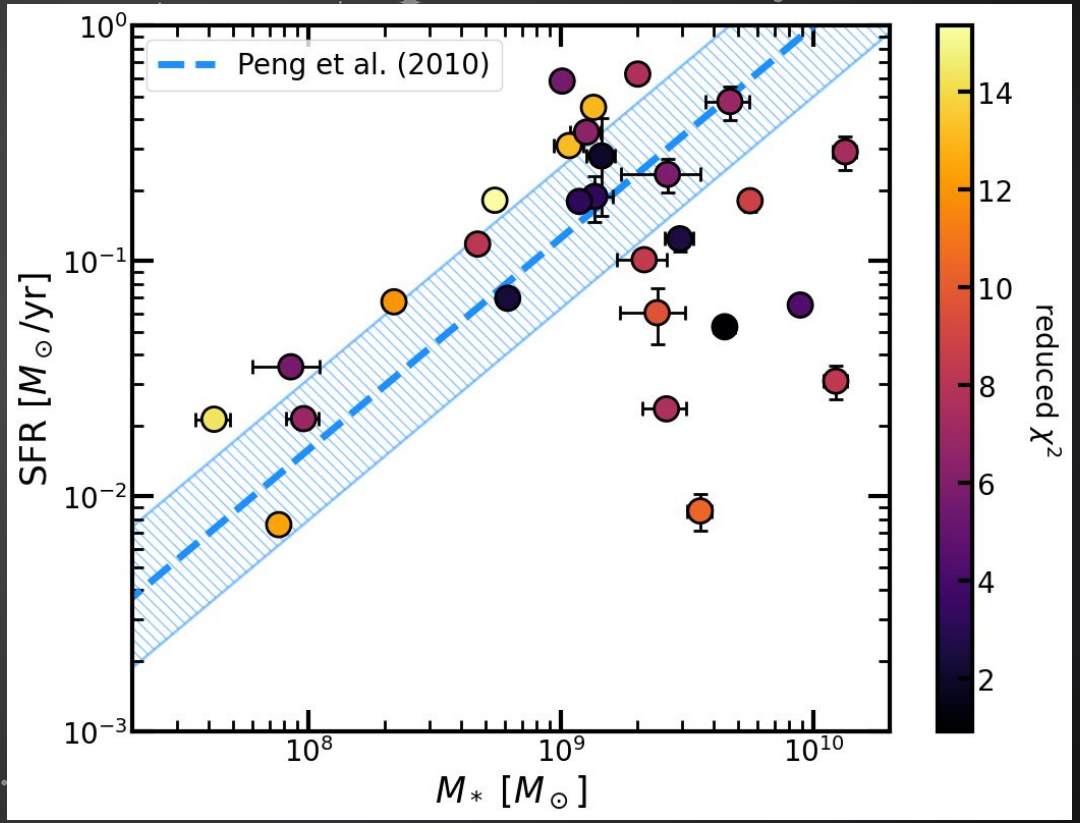




SFR-Mass Diagram with Line Fluxes included in fit

SFR-M* relation after adding measured line intensities as input

- Scatter ~unchanged
- Seems to be better centered around Peng+2010

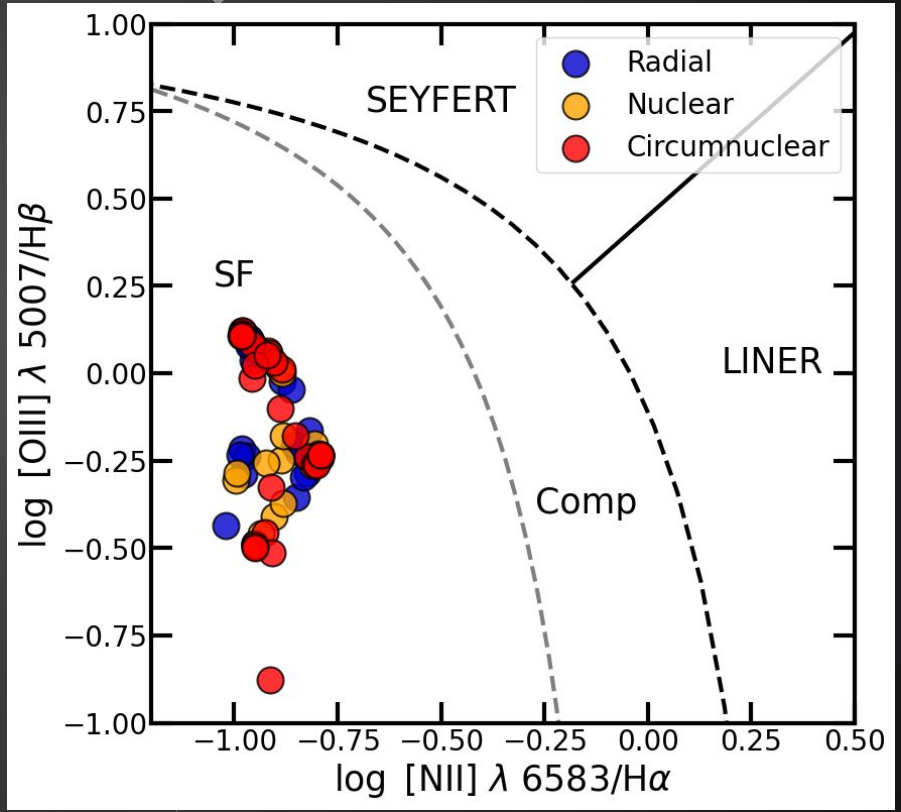


BPT DIAGRAM with ***Predicted*** Line Fluxes

BPT diagram after adding measured lines intensity as input.

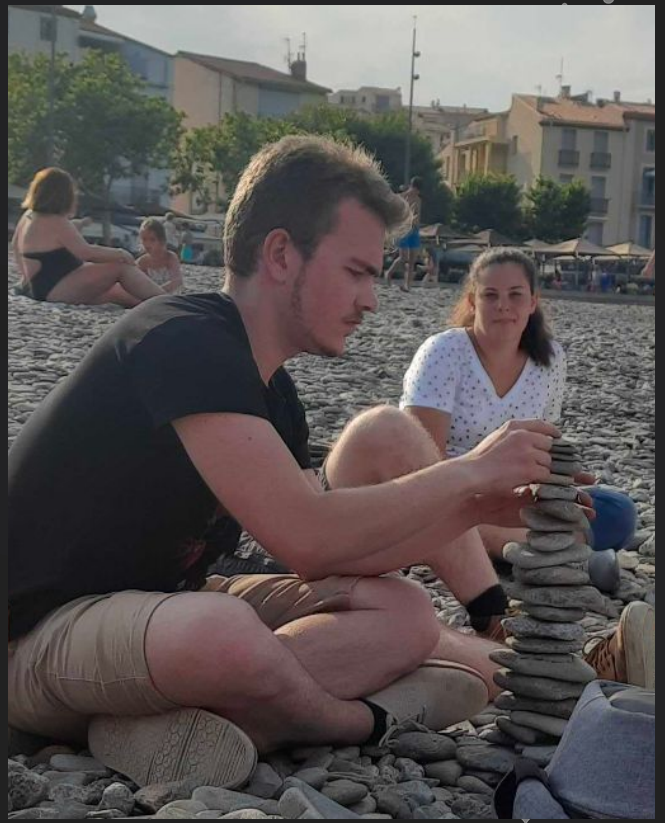
CIGALE predictions still lie in the SF region, and they more fully fill the parameter space.

There is no visible change in the locations of predicted lines for different components: **photometric information is still dominating.**



Main Takeaways

1. CIGALE is a **versatile tool** for fitting SEDs of galaxies and estimating physical properties of diverse systems.
2. The **goodness of fit** is sensitive to the choice of model (especially SFH) and grid of parameters used.
3. It is possible to estimate physical properties but difficult to predict emission line fluxes **simply from photometry**.
4. **Adding measured line intensities** to the fit improve ***predicted*** line fluxes, but inflate $\square^2$.



Us building models with CIGALE

In Conclusion…

… CIGALE may cause global warming

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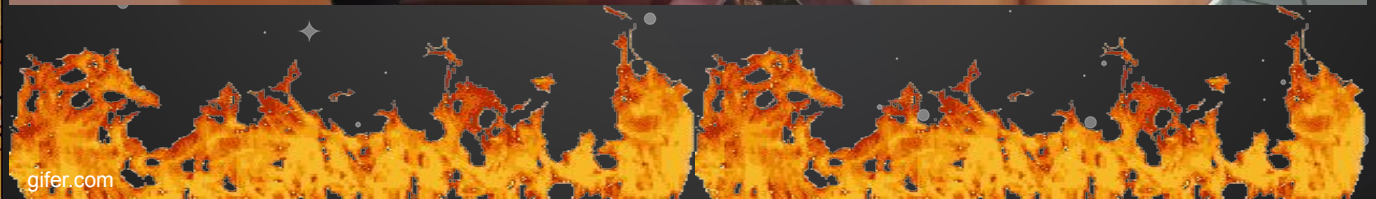

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THANK YOU!