

Characterizing Nearby Galaxies with CIGALE



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Instructor: Patrice Theulé

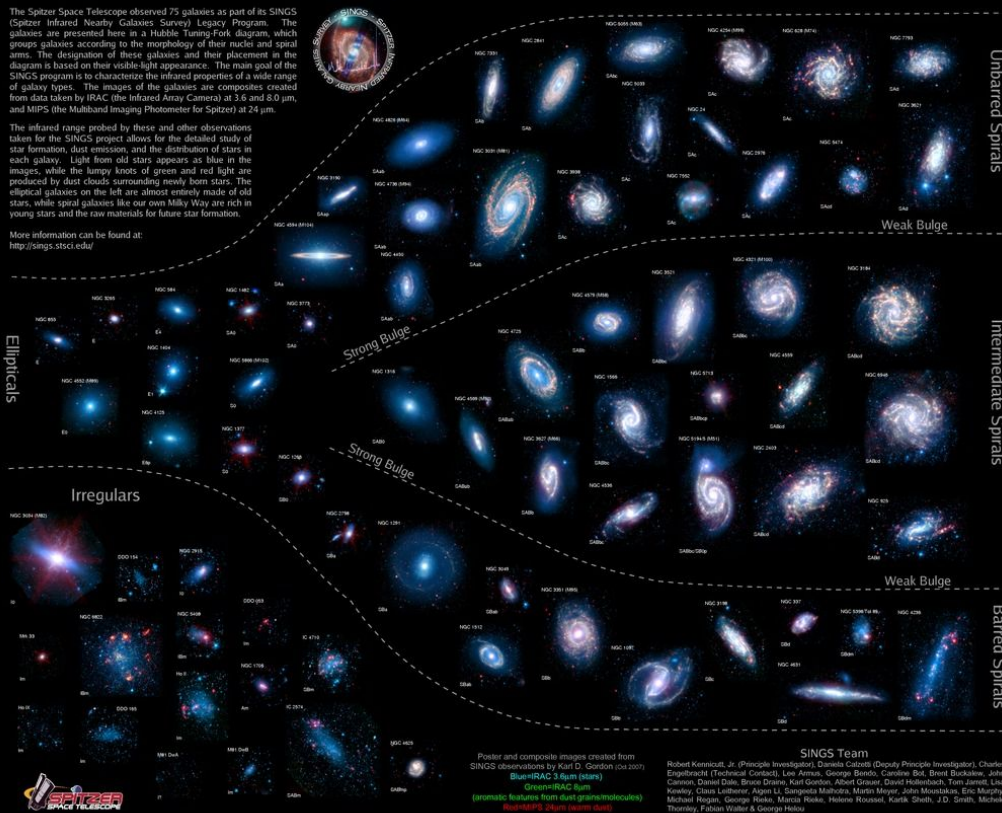
Sample: SINGS and KINGFISH

The Spitzer Infrared Nearby Galaxies Survey (SINGS) Hubble Tuning-Fork

The Spitzer Space Telescope observed 75 galaxies as part of its SINGS (Spitzer Infrared Nearby Galaxies Survey) Legacy Program. The galaxies are presented here in a Hubble Tuning-Fork diagram, which groups galaxies according to the morphology of their nuclei and spiral arms. The designation of these galaxies and their placement in the diagram is based on their visible-light appearance. The main goal of the SINGS program is to characterize the infrared properties of a wide range of galaxy types. The images of the galaxies are composites created from data taken by IRAC (the Infrared Array Camera) at 3.6 and 8.0 μm , and MIPS (the Multiband Imaging Photometer for Spitzer) at 24 μm .

The infrared range probed by these and other observations taken for the SINGS project allows for the detailed study of star formation, dust emission, and the distribution of stars in each galaxy. Light from old stars appears as blue in the images, while the lumpy knots of green and red light are produced by dust clouds surrounding newly born stars. The elliptical galaxies on the left are almost entirely made of old stars, while spiral galaxies like our own Milky Way are rich in young stars and the raw materials for future star formation.

More information can be found at:
<http://sings.stsci.edu/>



Sample: SINGS and KINGFISH



SINGS

The Spitzer Infrared Nearby Galaxies Survey

survey: [Kennicutt et al. \(2003\)](#)

spectra: [Moustakas et al. \(2010\)](#)



KINGFISH

The Key Insights on Nearby Galaxies: a Far-Infrared Survey with Herschel

survey: [Kennicutt et al. \(2011\)](#)

Integrated properties and local interstellar medium (ISM) environments found in the local Universe for 61 nearby ($d < 30$ Mpc) galaxies

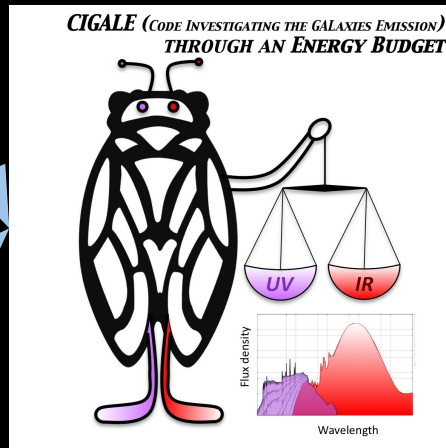
CIGALE: Code Investigating GALaxy Emission

Boquien et al 2019

Observed
photometry+spectroscopy

Input Parameters:

- Redshift
- Stellar population
 - SFH and SSP
- Dust
 - Attenuation and emission
- Nebular Emission
- Metallicity
- etc

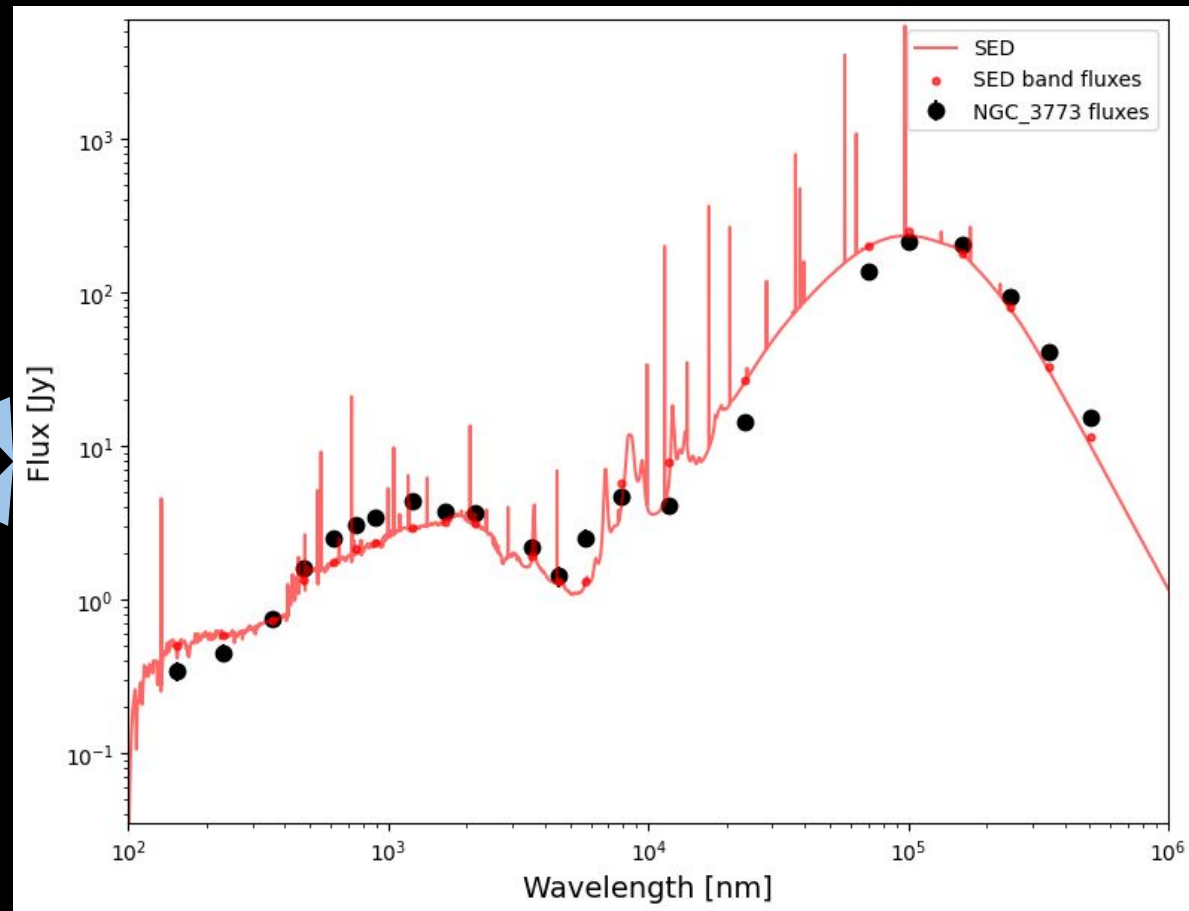


Model SED

Output Parameters:

- Best fit parameters
- Emission line flux

CIGALE: Code Investigating GALaxy Emission Example



Observed
spectrophotometry

Input
Parameters

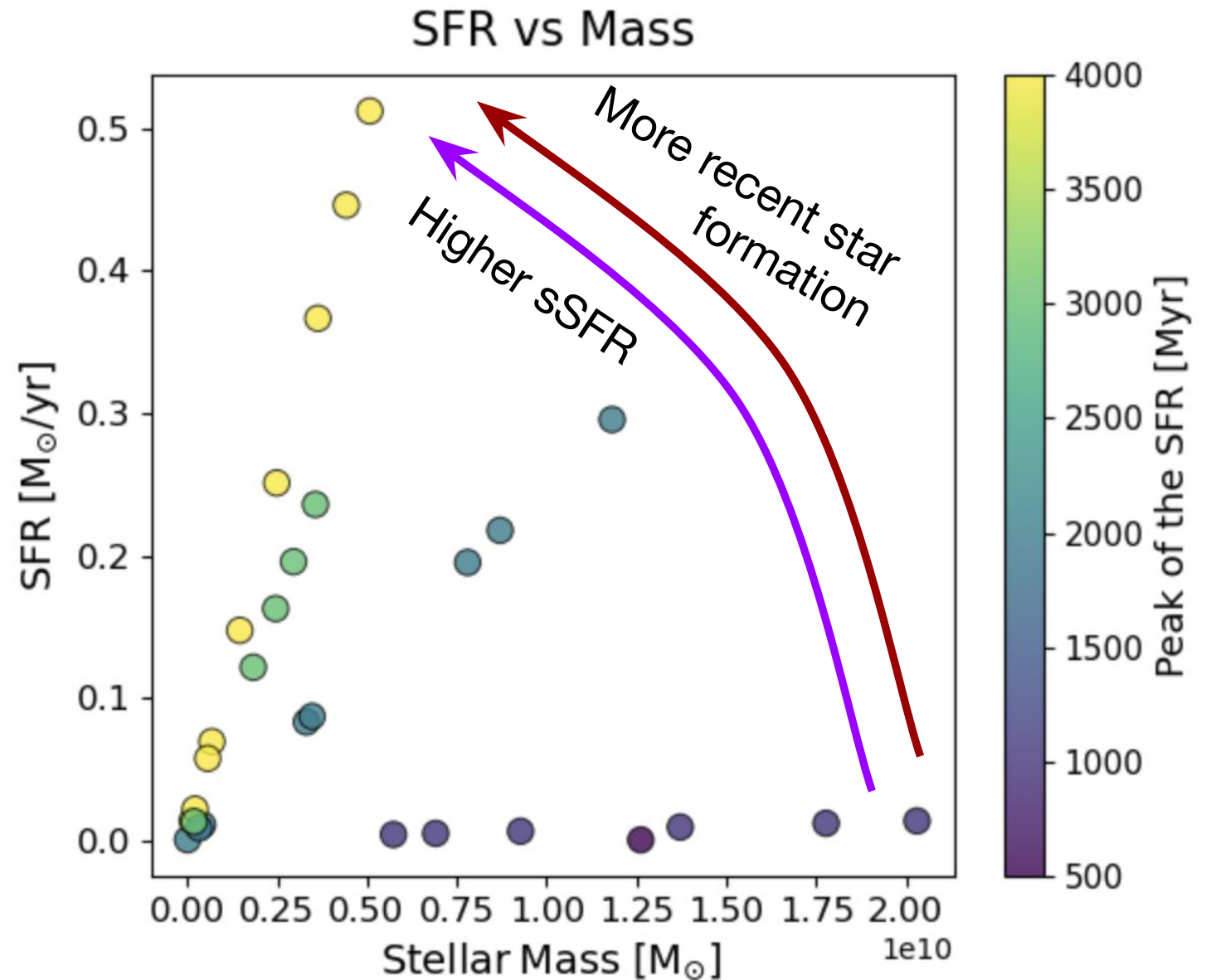
Model
Spectrum

Output
Parameters

Star Formation Rate vs Mass

CIGALE fits to
KINGFISH/SINGS
observations

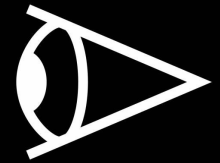
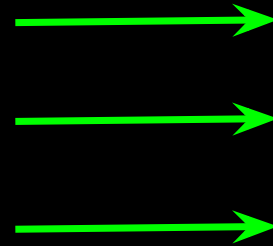
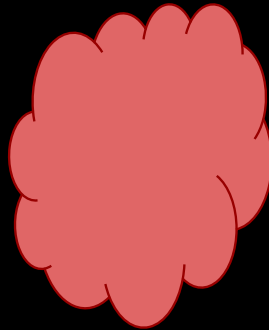
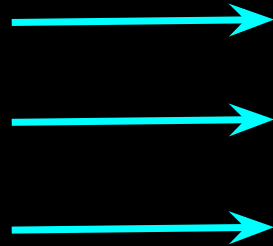
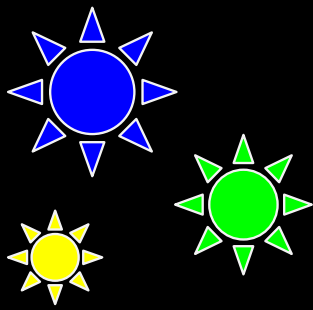
We find that there
are no current
starburst



Cloudy & Associates

Photoionization simulations for the discriminating astrophysicist since 1978

- Produces a spectrum based on input parameters (similar to CIGALE) like metallicity and ionization parameter
- Cloudy produces **emission lines** that are used in CIGALE fits



Incident SED



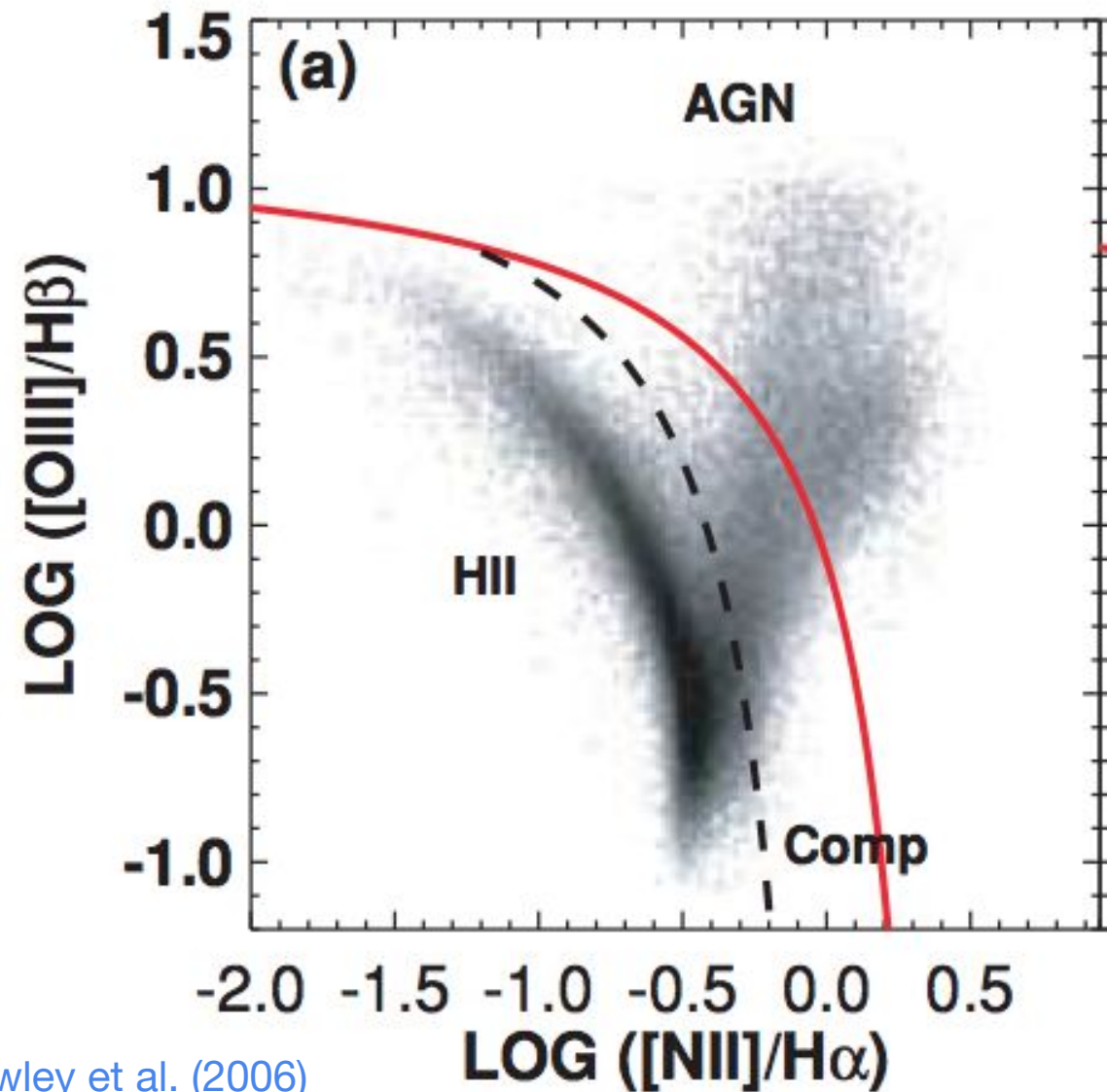
Nebular gas and dust



Resulting SED

BPT Diagram

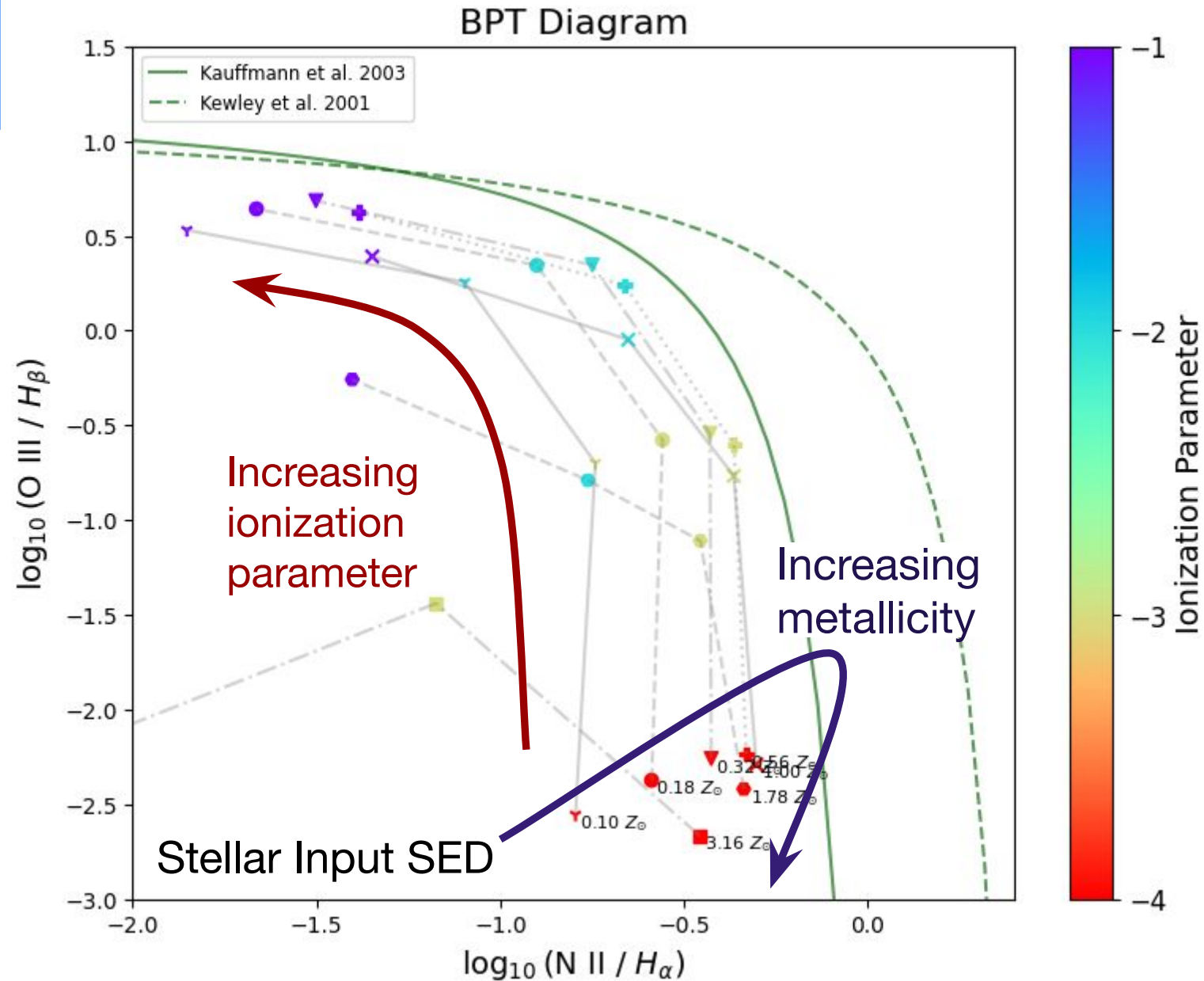
Based on placement of observations on BPT diagram, we can determine the source of ionization in nebular gas (AGN vs OB stars)



[Kewley et al. \(2006\)](#)

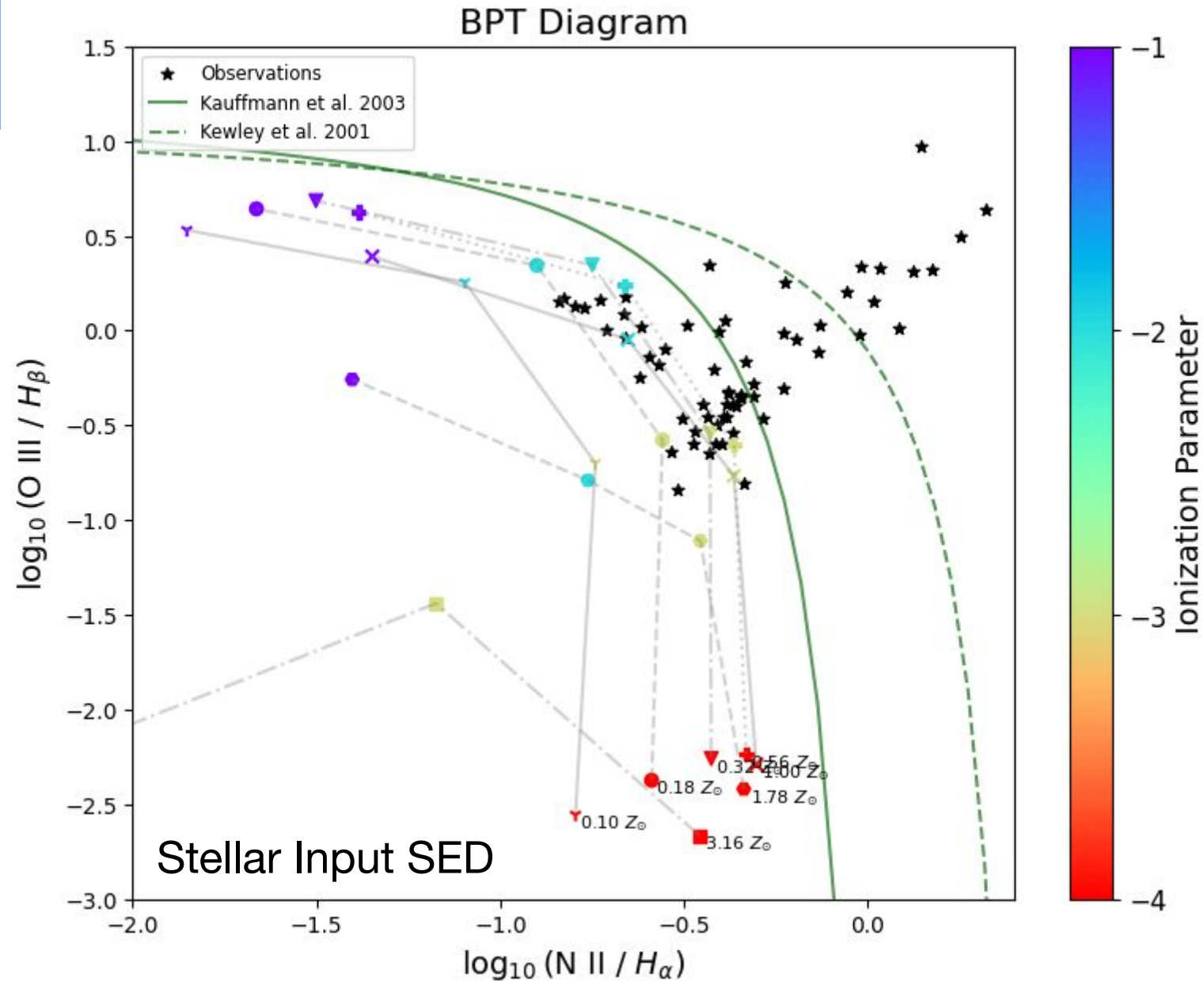
Results

We want to characterize the ionization, metallicity, density, and SED of the observations by analyzing their placement on the BPT diagram



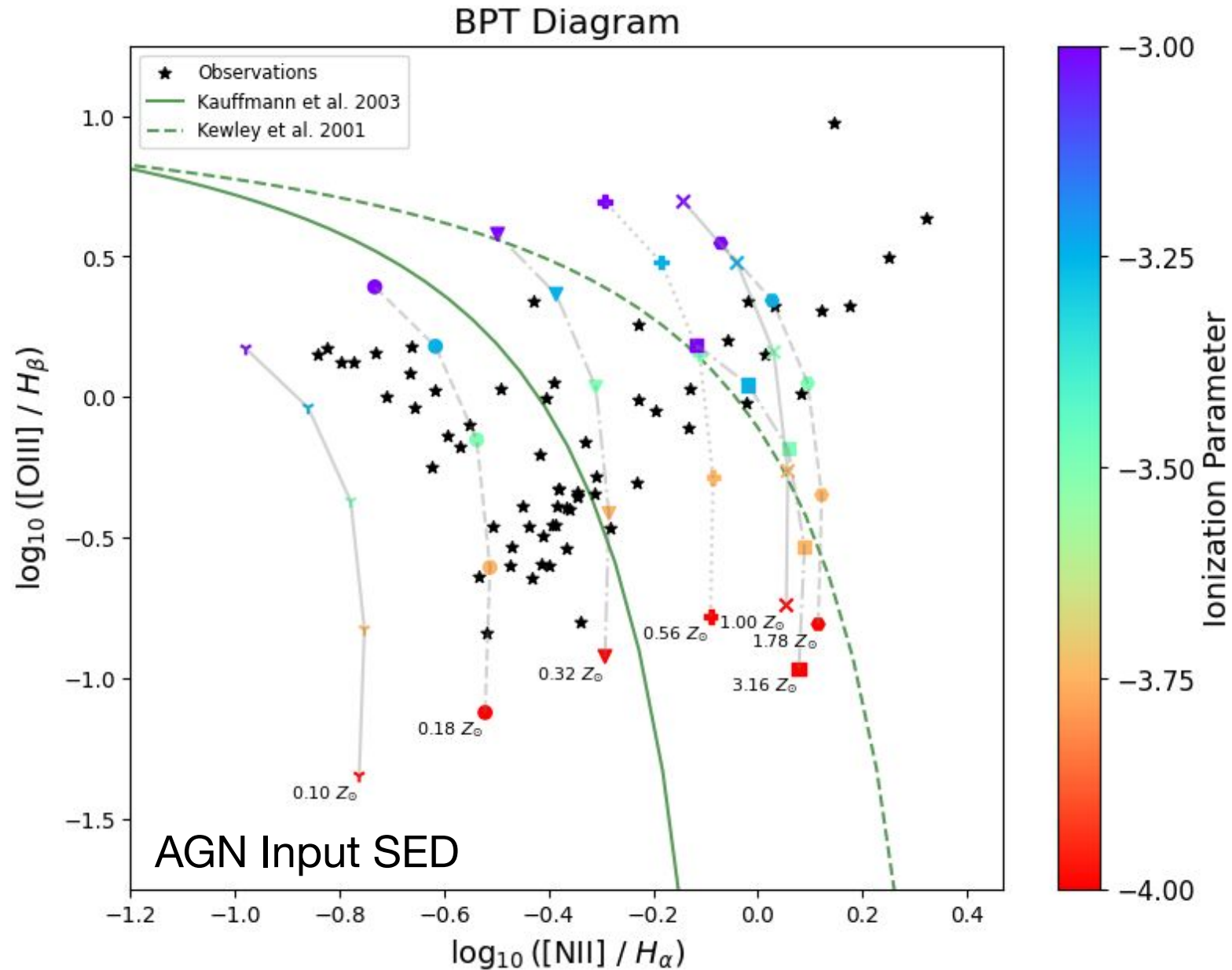
Results

We want to characterize the ionization, metallicity, density, and SED of the observations by analyzing their placement on the BPT diagram



Results

We find that the KINGFISH/SINGS sample contains contributions from AGN and low (gas phase) metallicity galaxies



What have we learned?

- How to fit SEDs to spectro-photometric observations with CIGALE
- What parameters go into constructing an SED
- How to characterize nearby galaxies with SED fitting and the BPT diagram



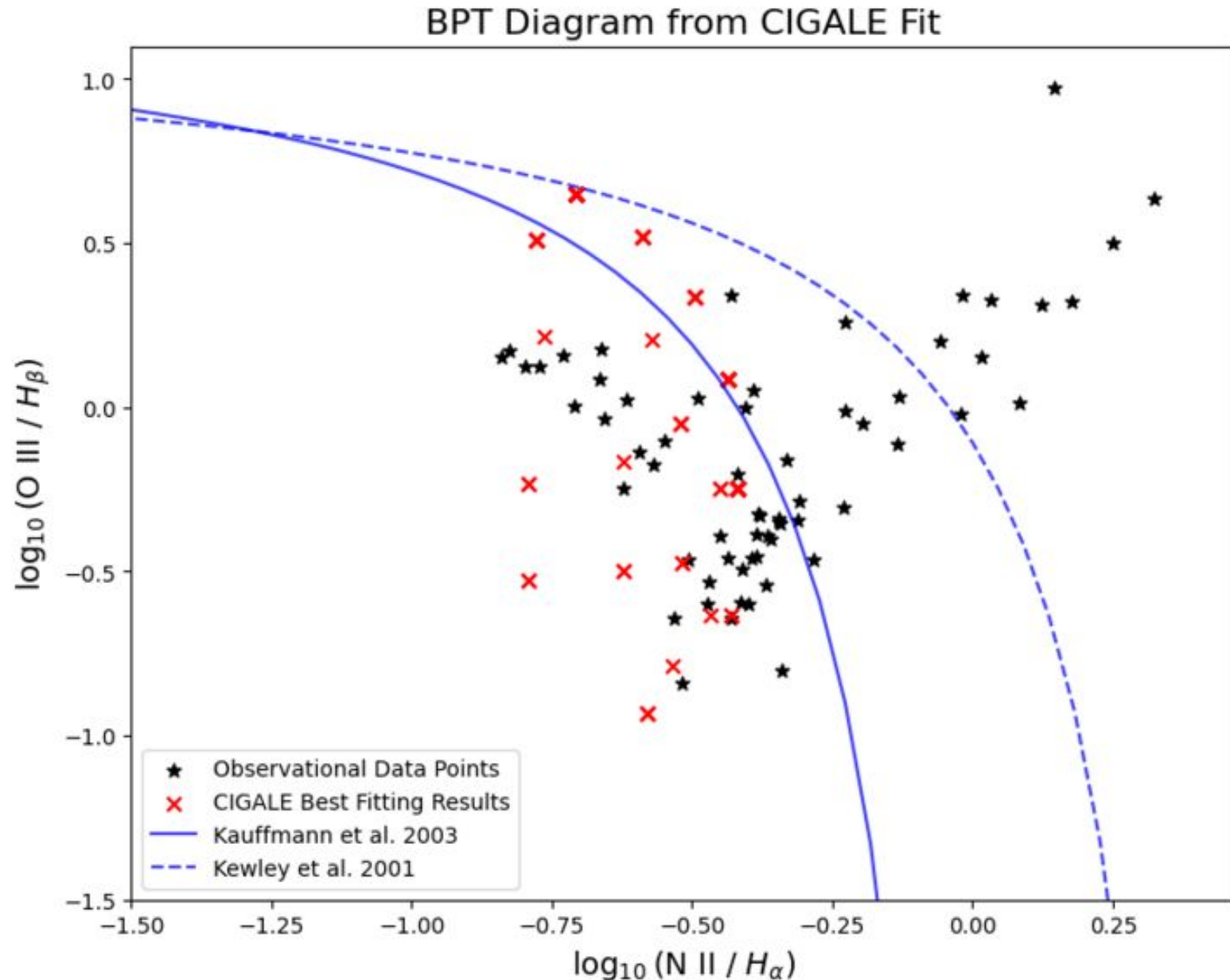
Thank you!

Results

Red crosses show CIGALE best fit parameters

Black stars show spectroscopic measurements

The same best fit may correspond to the multiple galaxies



SED models

