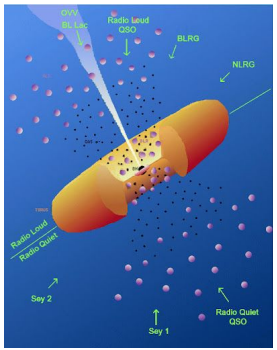
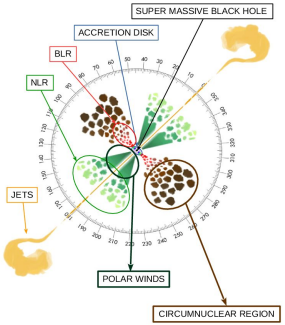
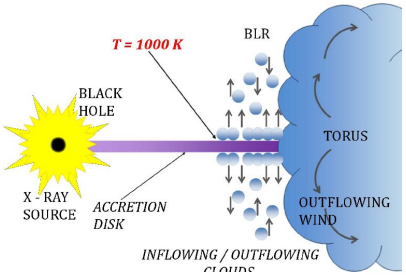
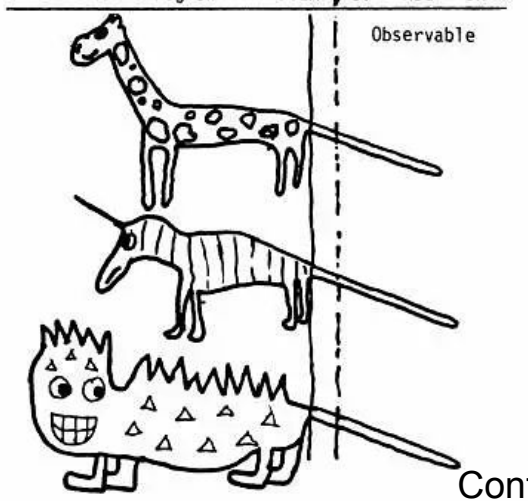
SED modeling with an AGN component



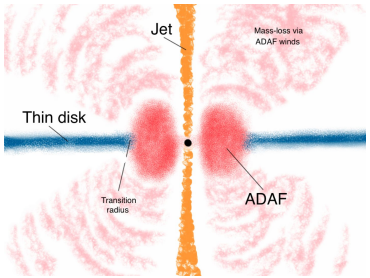


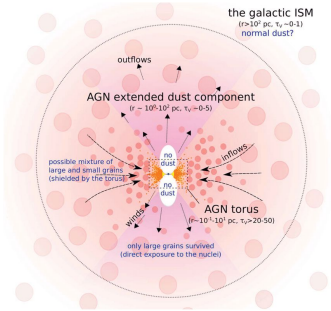


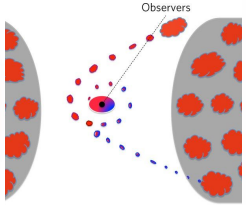
PROBLEMS WITH CONTINUUM MEASURES
OF ~~HOT STARS~~ ... AGN
(with apologies to H.J.G.L.M.L.)



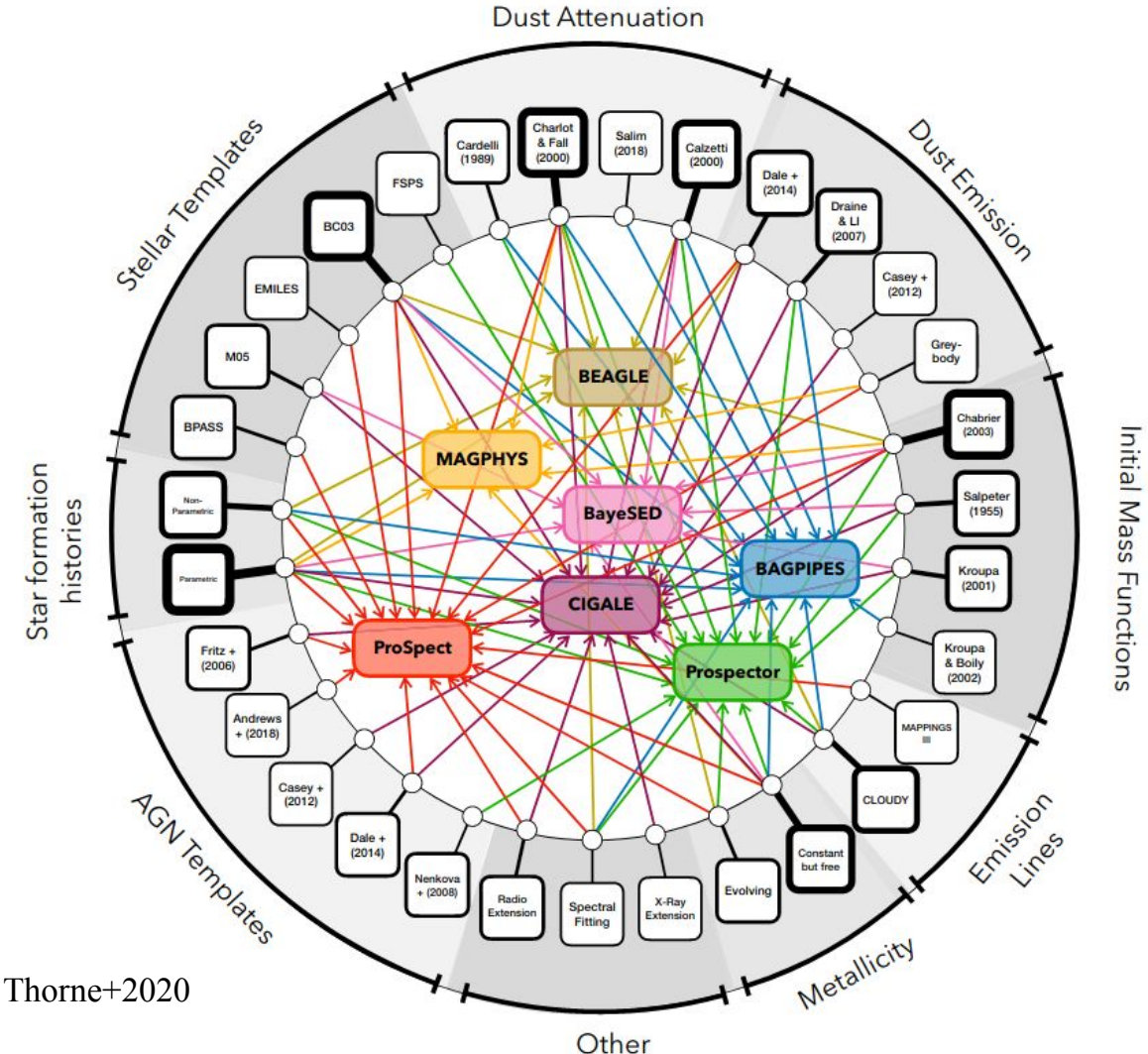
Conti, 1986







Jianwei Lyu
#262, IR wing
jianwei@arizona.edu



Thorne+2020

SED fitting models are becoming more and more complicated …

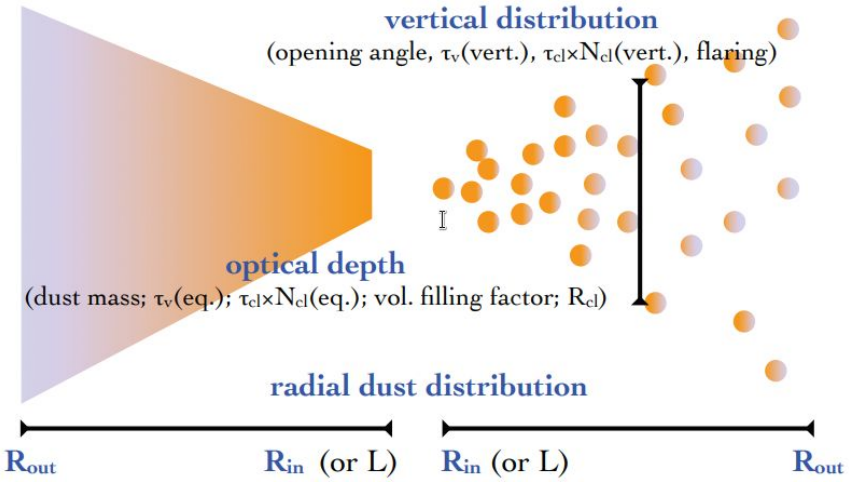
Many fitting packages do provide an AGN component

CIGALE
Prospector
ProSpect
BEAGLE-AGN
….

Two types of SED models

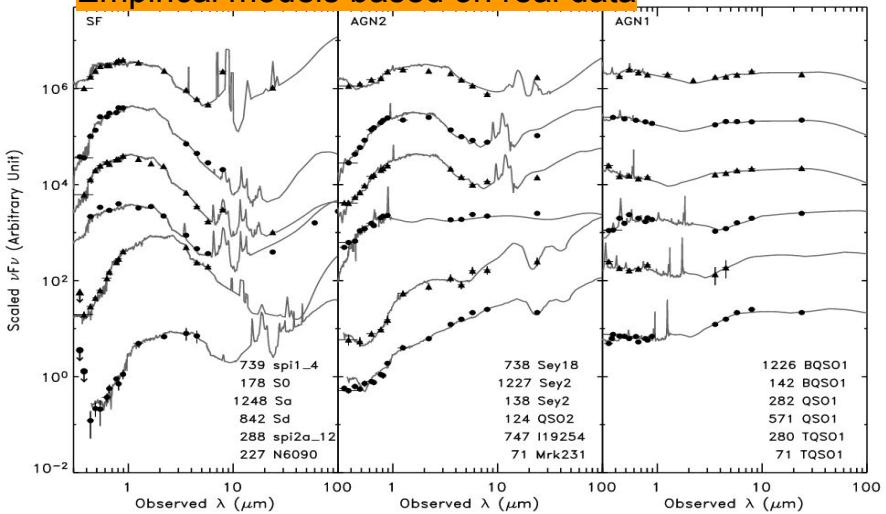
You can find an incomplete list of various models at http://www.sedfitting.org/

Theoretical models with radiation transfer



Smooth: Pier & Krolik 92, Loska+ 93, Rowan-Robinson+ 93,
Granato & Danese 94, Schartmann+ 05, 06, Fritz+ 06, Jud+17
Clumpy: Rowan-Robinson 1995, Heymann & Siebenmorgen 2012, , Stalevski+ 12, 16, Cat3D (Honig+ 06), RADMC (Dullemond & van Bemmel 05), Schartmann+ 2008, Clumpy (Nenkova+ 2008)
Smooth + Clumpy: Siebenmorgen+15
Addition of polar dust:: Honig+17, Stalevski+17

Empirical models based on real data



SWIRE templates (Polletta, Rowan-Robinson)
Brown et al.
Elivs Quasar SEDs
Rieke+09 IR galaxies
Lyu & Rieke AGN templates
Symeonidis FIR QSO
Shang+13 quasar
Kirkpatrick+ galaxies
Salvato et al.

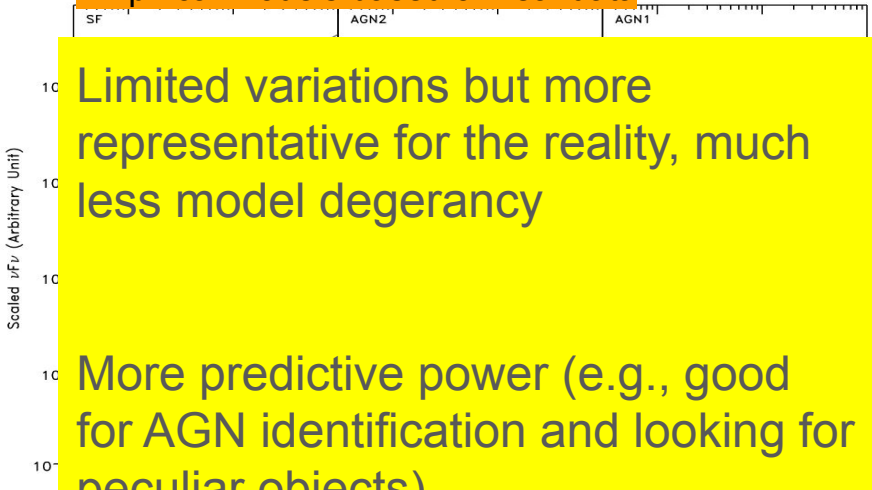
Two types of SED models

Theoretical models with radiation transfer

Very flexible, you can have good-looking SED fitting results in many cases

Feeling of being more physical, as you can say something about the dust structures (e.g., dust covering factor, torus size, etc)

Empirical models based on real data

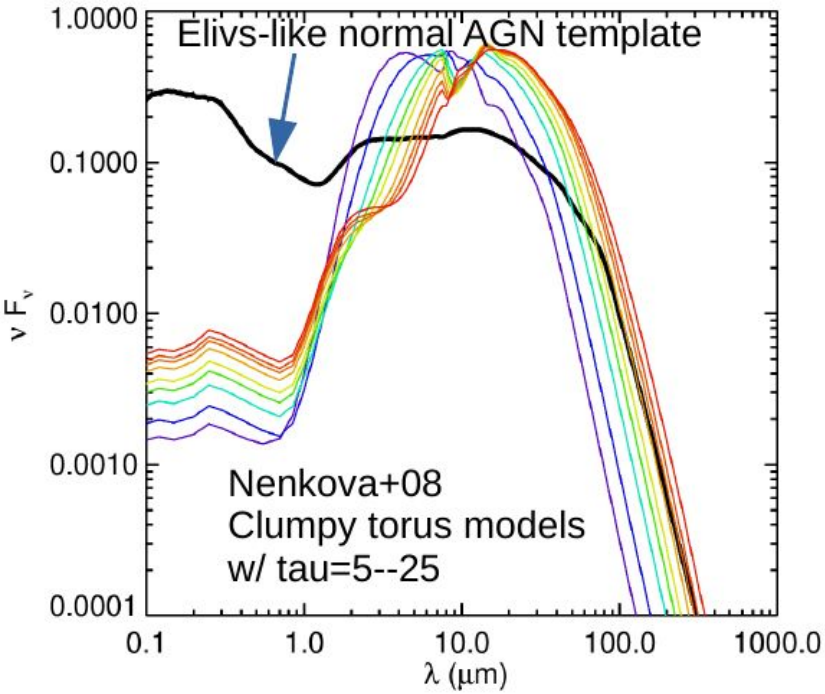


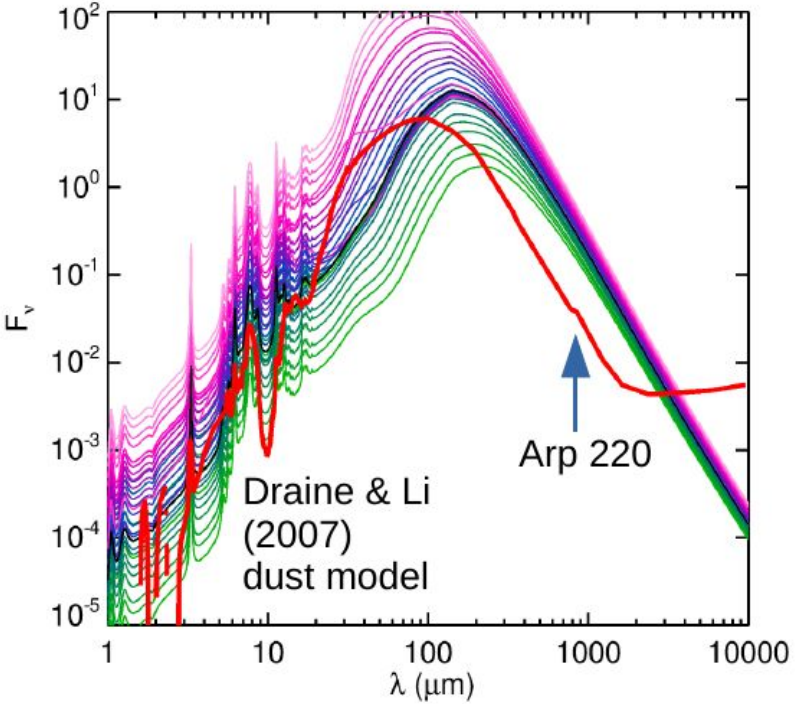
Limited variations but more representative for the reality, much less model degerancy

More predictive power (e.g., good for AGN identification and looking for peculiar objects)

See Lyu & Rieke 2022, Universe for a review (e.g., Section 2.4)

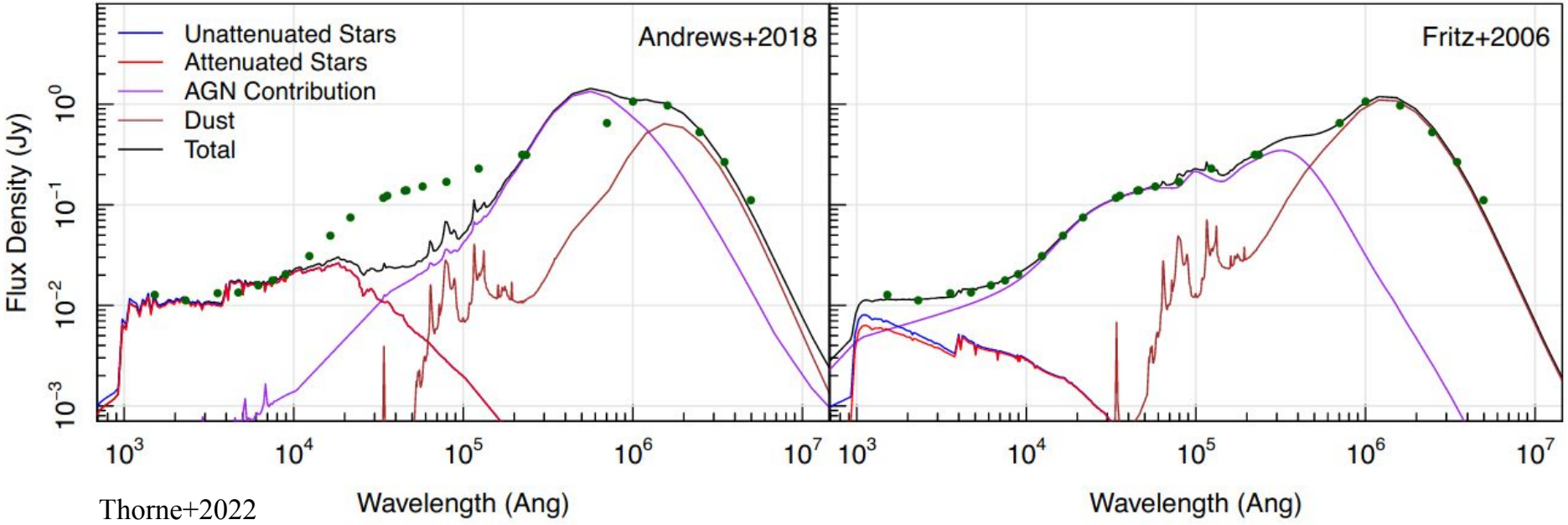
Problems with the theoretical models





Toys, not reality, cannot match some real features and observational tests are limited
Model degeneracy and redundancy due to large number of free parameters
Hard to make observational tests to see if the fitted parameters make sense

Problems with empirical models

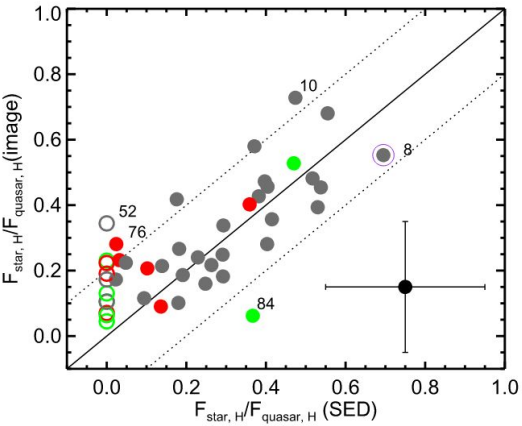


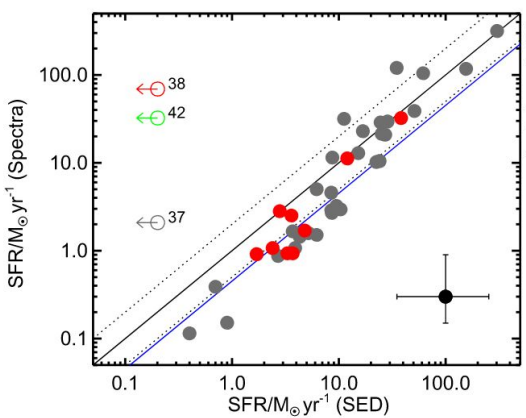
Thorne+2022

Limited variation range as most templates are based on individual objects or some sample average
Some templates are not pure AGN but with contamination from other sources
Typically do not give insight to the underlying causes of that behavior

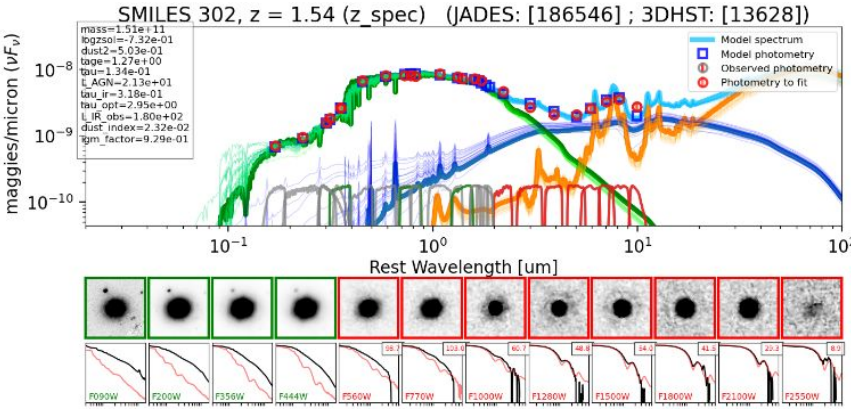
Given the various limitations of SED fittings, only first order properties are useful in most cases (assuming your models are OK):

(1) AGN SED shape and luminosity;
(2) Host galaxy properties directly reflected by the luminosity (e.g, stellar mass, SFR)
(3) Identifying candidates for (obscured) AGNs





Lyu et al. 2017



Lyu et al. 2023

Questions to ask

1. Why do you need to include AGN in your fittings?
2. Which rest-frame wavelengths are you interested in? What is the expected AGN contribution?
3. What is the model resolution you want? (e.g., do you need to add AGN emission lines? broad FeII component?)
4. Do your sample have some special properties? (e.g., dwarf galaxy? Very high-z? Heavily obscured? Your models may not function well)
5. What do you want to learn about the AGN?
6. Are there any ways to validate the models and fitting results?