An Analysis of Star Formation in M31 Using Resolved Stars and Ultraviolet Flux

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Outline

I. **Introduction**
   - Estimating quantities from starlight
   - Stellar population synthesis
II. **UV-bright regions in M31**
   - Some other thing
   - One thing more
III. **Synthetic flux maps of M31**
   - An additional item
   - The second item
IV. **Summary and future work**

I. Introduction - starlight

What can we learn about a stellar population looking only at its light?

Jacob Bers (Bersonic)

I. Introduction - starlight

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Stellar population

A collection of associated stars
(clusters, galaxies, etc.).

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Light (integrated flux)

Total light from a stellar population measured in a specific wavelength range (optical, UV, etc.).

I. Introduction - starlight

What can we learn about a stellar population looking only at its light?

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I. Introduction - lightbulbs

What can we learn about a collection of lightbulbs looking only at its light?

Darren Hester

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What can we learn about a collection of lightbulbs looking only at its light?

- Measure the brightness of the room
- ***If*** the brightness of each lightbulb is known,

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\>> Total mass of the stellar population

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- Lightbulbs (and stars) have lifetimes

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>> Age of the stellar population

Simple stellar population (SSP)

All stars formed at the same *time*, in the same *place*, from the same *material*.

I. Introduction - lightbulbs

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> “Lightbulb replacement rate”

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Star formation rate (SFR)

Rate at which stars are formed from the gas in a given environment (M_{sun} yr^{-1}).

I. Introduction - starlight

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- Mass
- Age (*if* SSP)
- SFR (*if* constant)

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What can we learn about a stellar population looking only at its light?

- Mass
- Age (*if* SSP)
- SFR (*if* constant)

Relationships between these quantities and integrated flux are based on stellar population synthesis (SPS).

I. Introduction - SPS

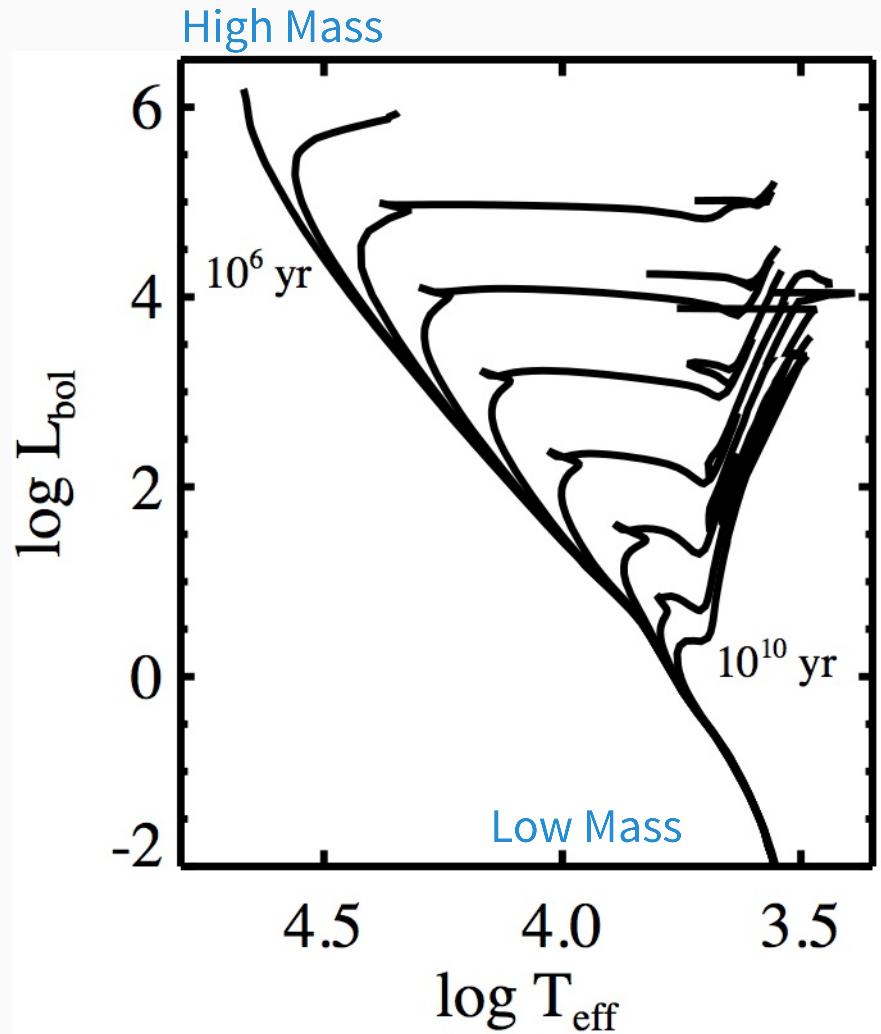
Stellar population synthesis (SPS)
Three main ingredients:

- Stellar isochrones
- Stellar spectra
- Initial mass function

I. Introduction - SPS

Stellar isochrones

Evolution of brightness and temperature as a function of mass.

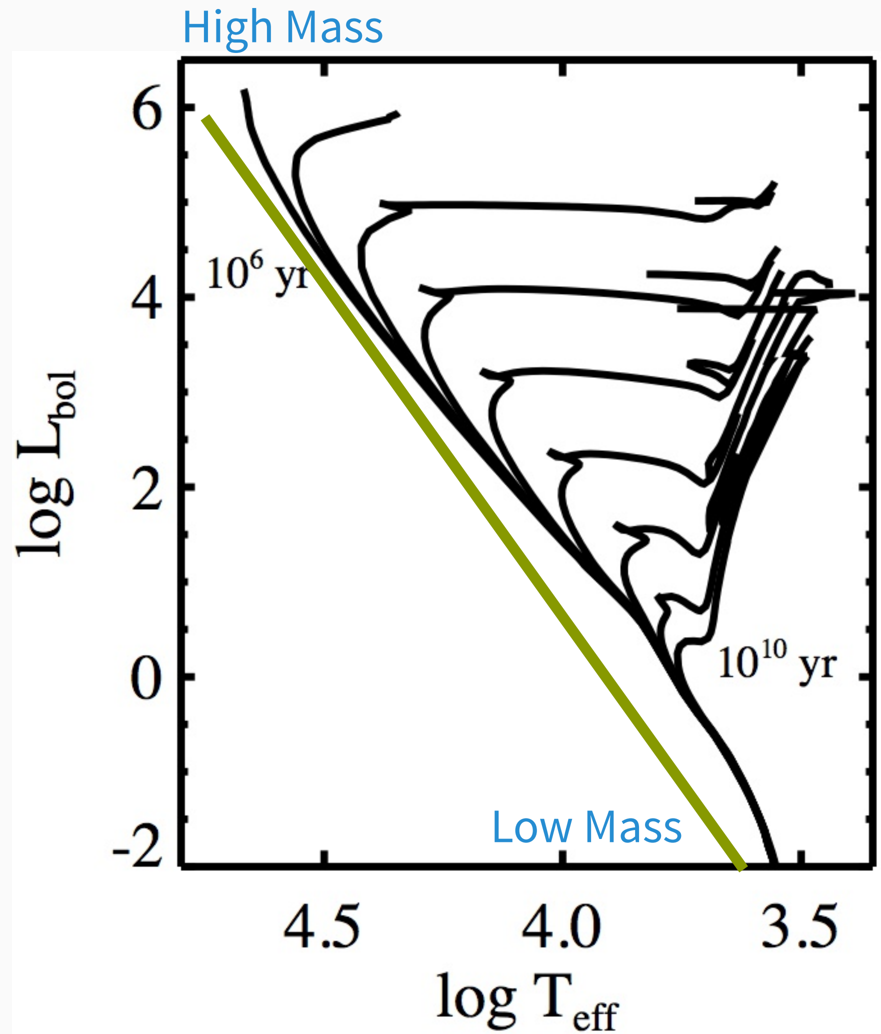


I. Introduction - SPS

Stellar isochrones

Evolution of brightness and temperature as a function of mass.

All stars start out on the main sequence (MS),

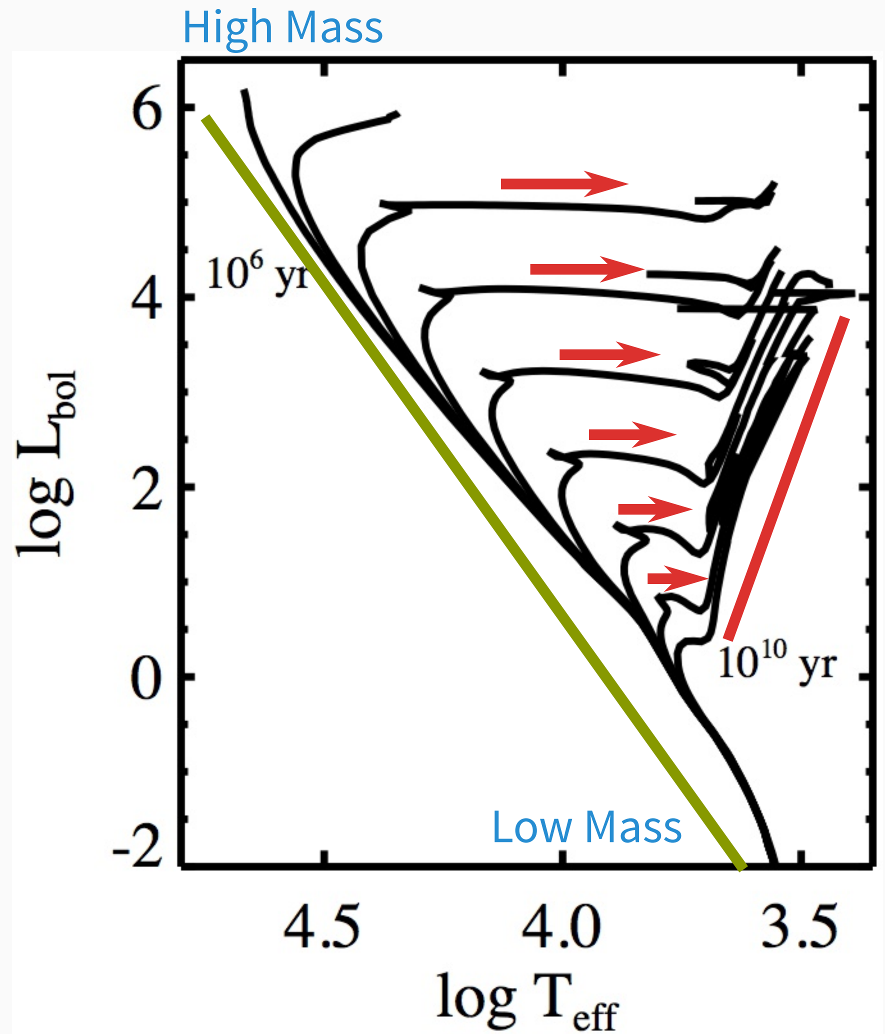


I. Introduction - SPS

Stellar isochrones

Evolution of brightness and temperature as a function of mass.

All stars start out on the main sequence (MS), then evolve to the red giant branch (RGB), etc.



I. Introduction - SPS

Stellar isochrones

Evolution of brightness and temperature as a function of mass.

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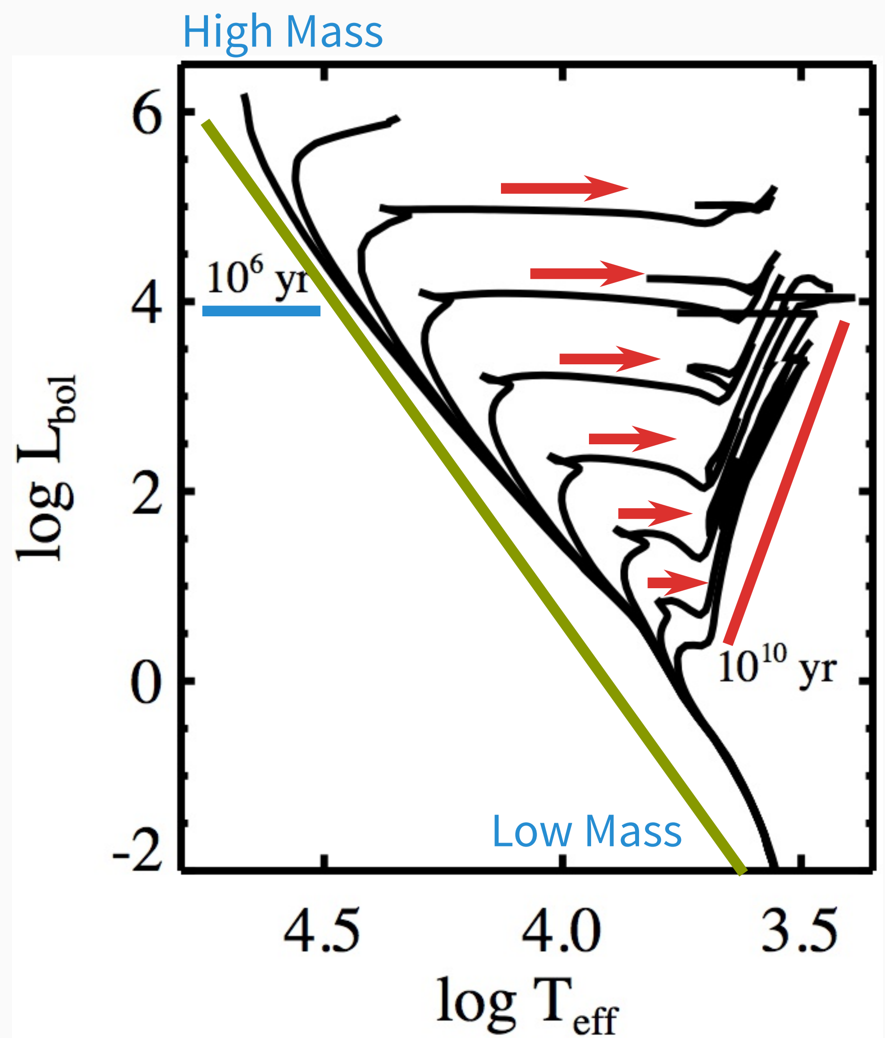
Higher mass stars have shorter lifetimes.



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Stellar isochrones

Evolution of brightness and temperature as a function of mass.

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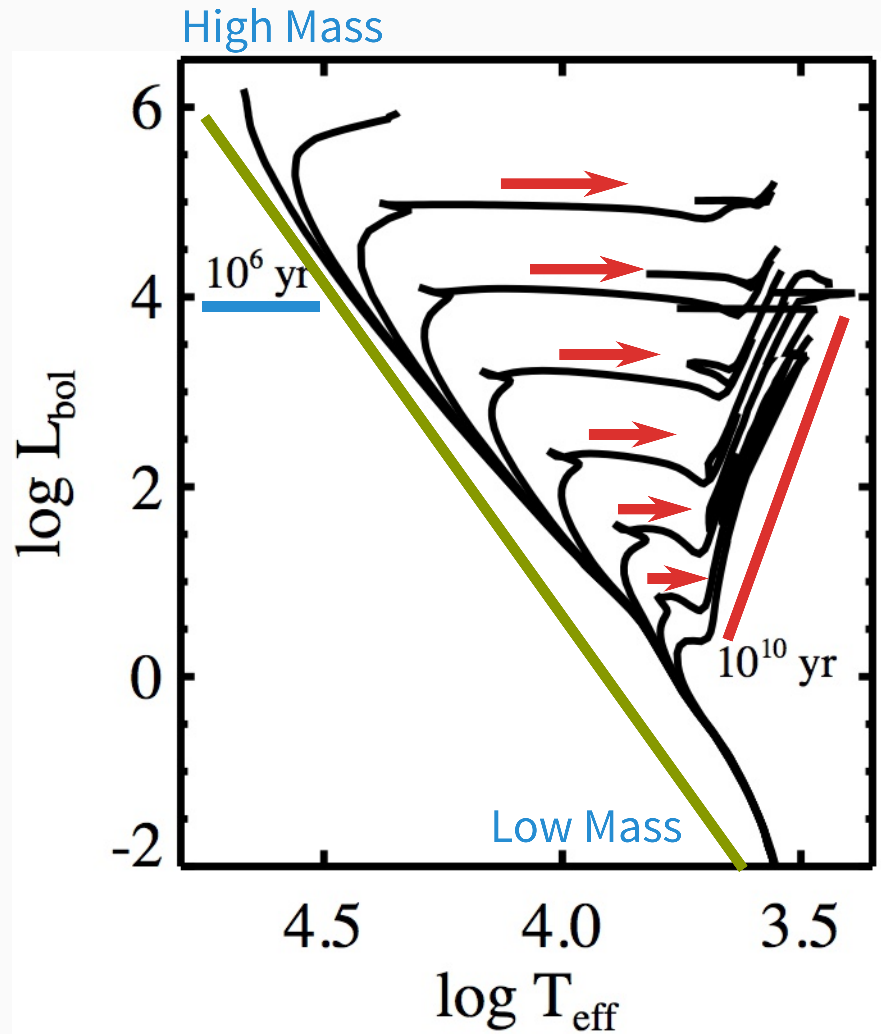
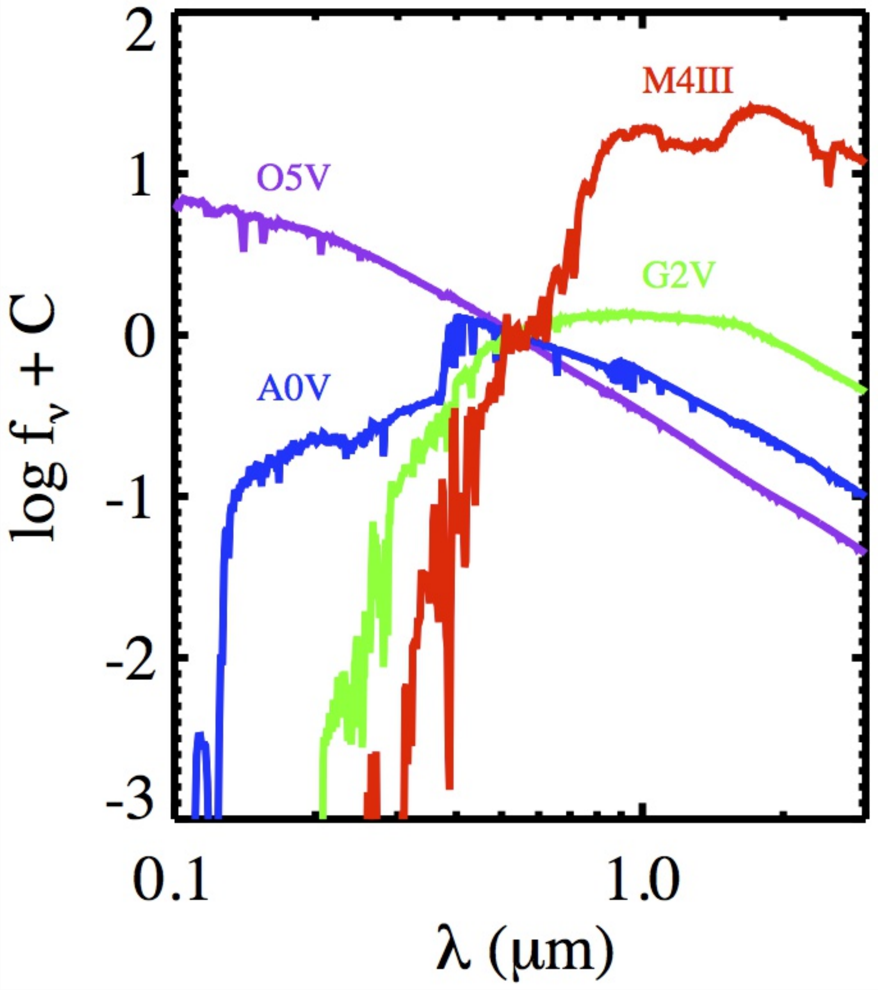
Mass and age determine the type of star (hot vs. cool, MS vs. RGB).



I. Introduction - SPS

Stellar spectra

Spectrum (flux vs. wavelength) for each type of star.



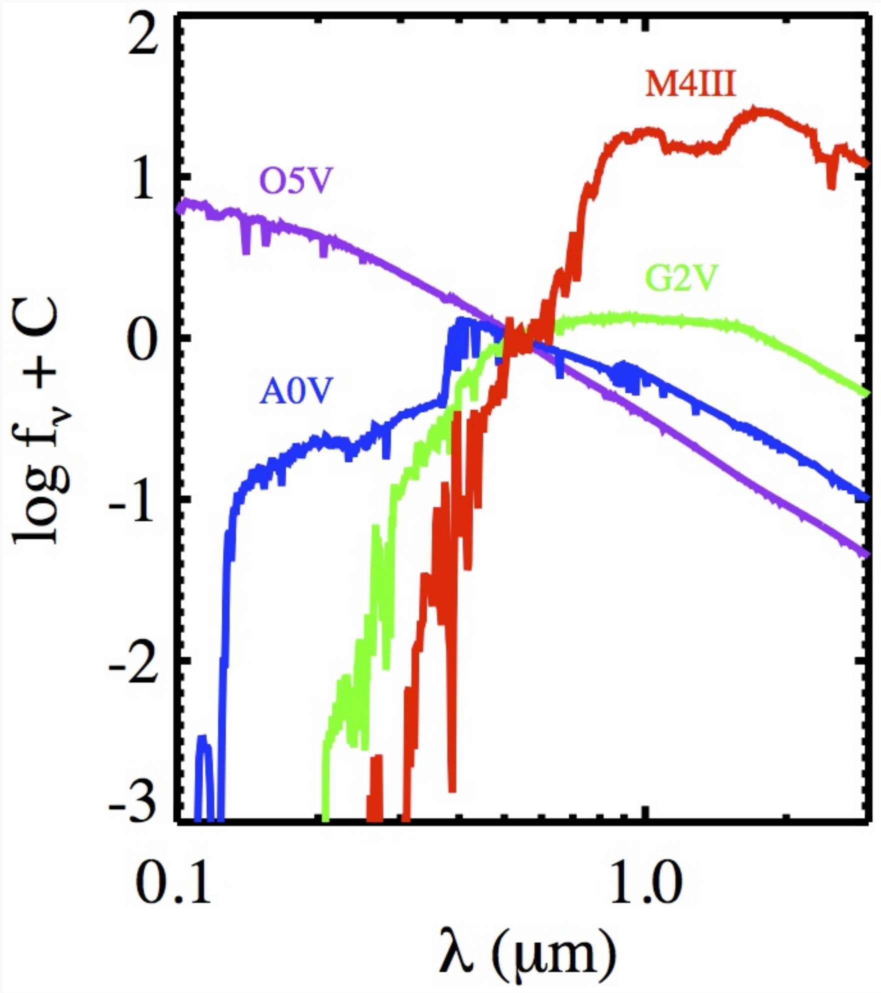
I. Introduction - SPS

Stellar spectra

Spectrum (flux vs. wavelength) for each type of star.

Hotter stars are “bluer”, cooler stars are “redder”.

hot
O5V
A0V
G2V
M4III
cool

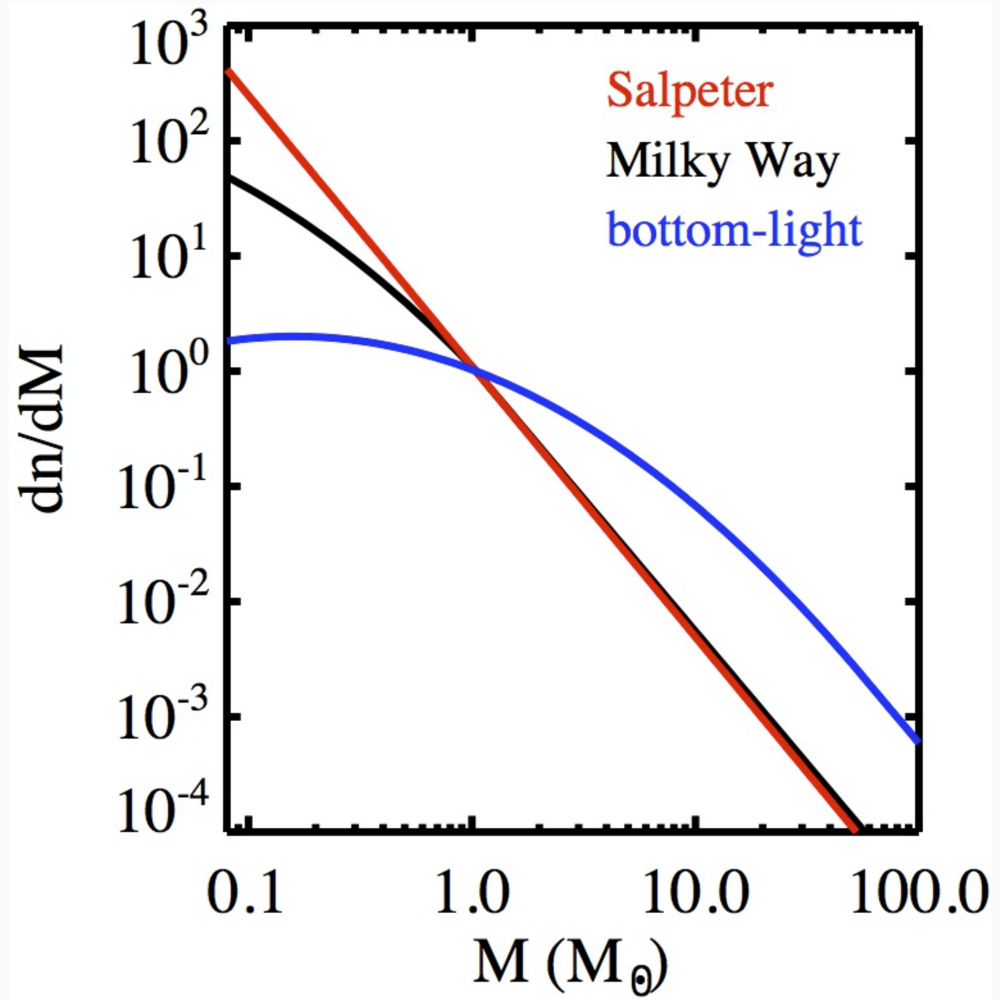


Energy

I. Introduction - SPS

Initial mass function (IMF)

Empirical distribution of stellar masses for a newly formed population.

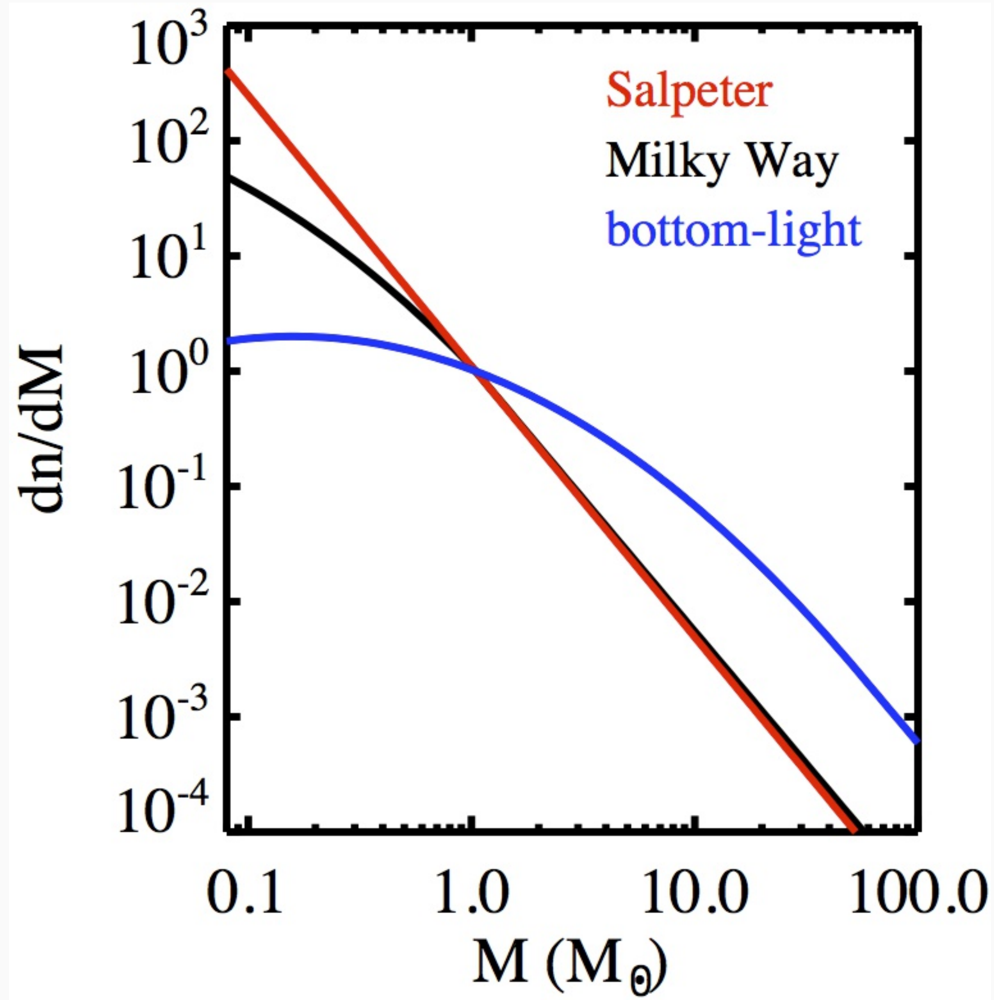


I. Introduction - SPS

Initial mass function (IMF)
Empirical distribution of stellar masses for a newly formed population.

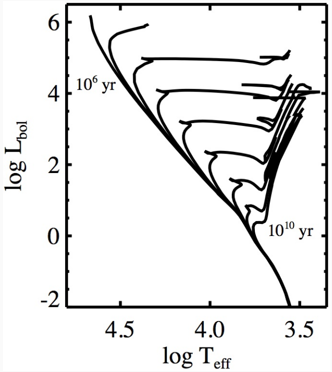
Different studies determine different shapes.

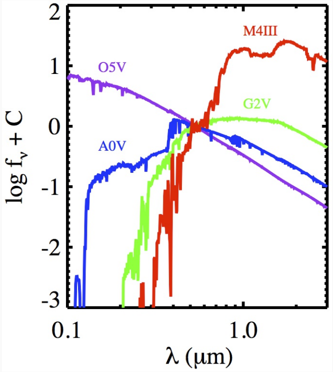
Universal or dependent on environonment?

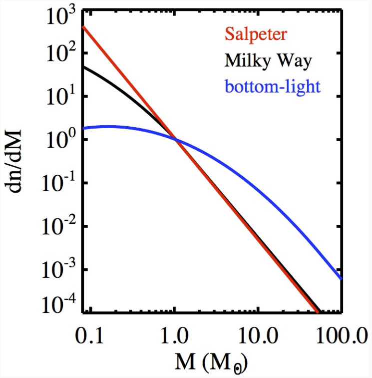


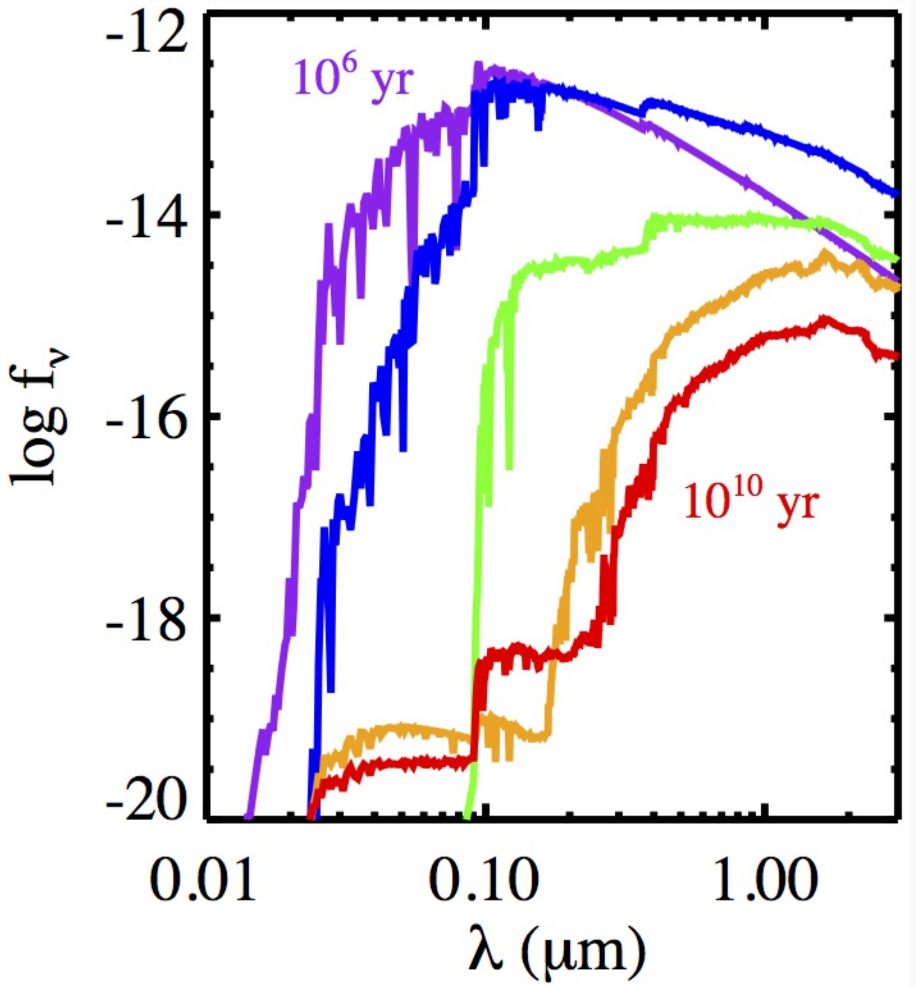
I. Introduction - SPS

SSP spectra







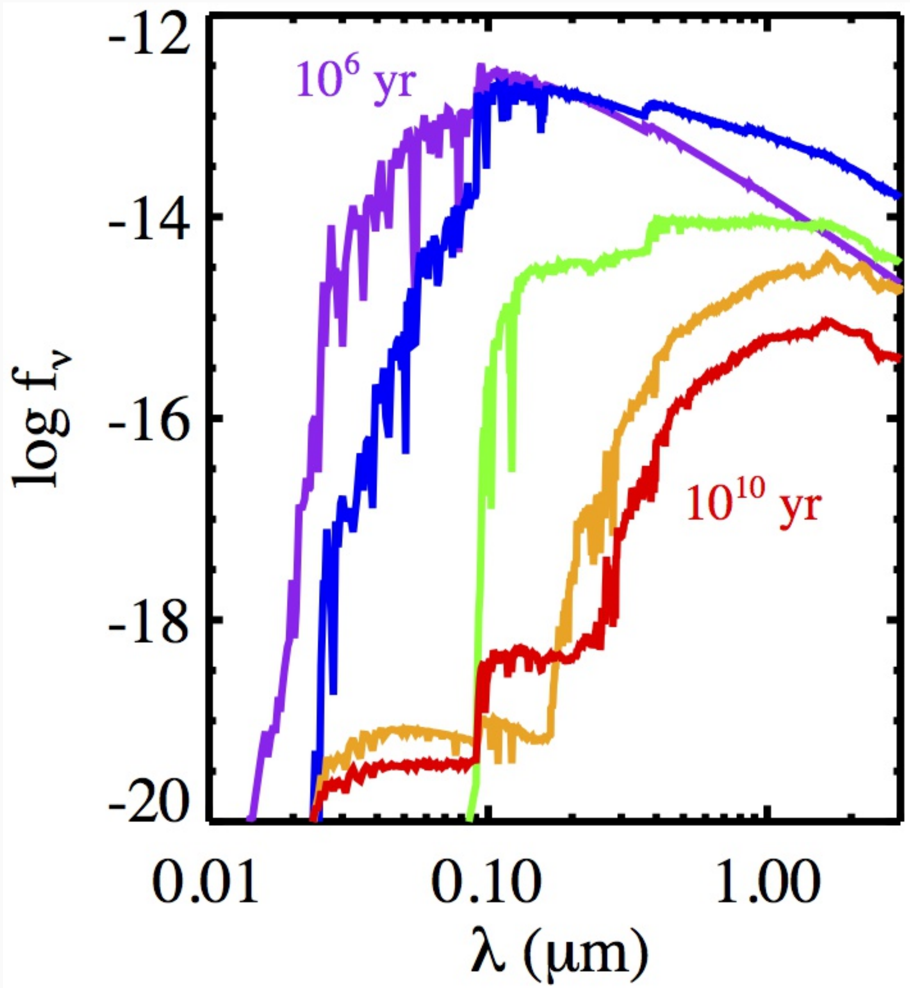


I. Introduction - SPS

SSP spectra

SSPs get fainter and redder with age.

(Stars are more complicated than lightbulbs.)



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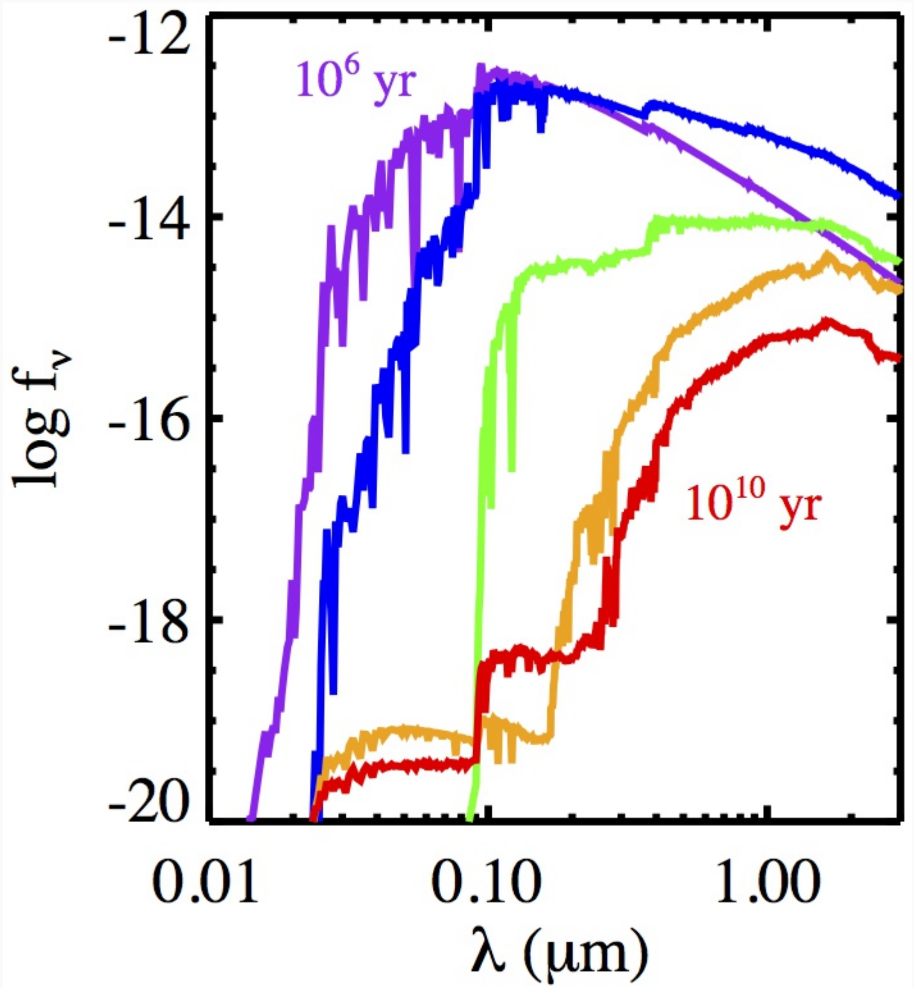
SSPs are the building blocks of SPS.



I. Introduction - SPS

Composite stellar populations

Stellar populations are rarely SSPs.

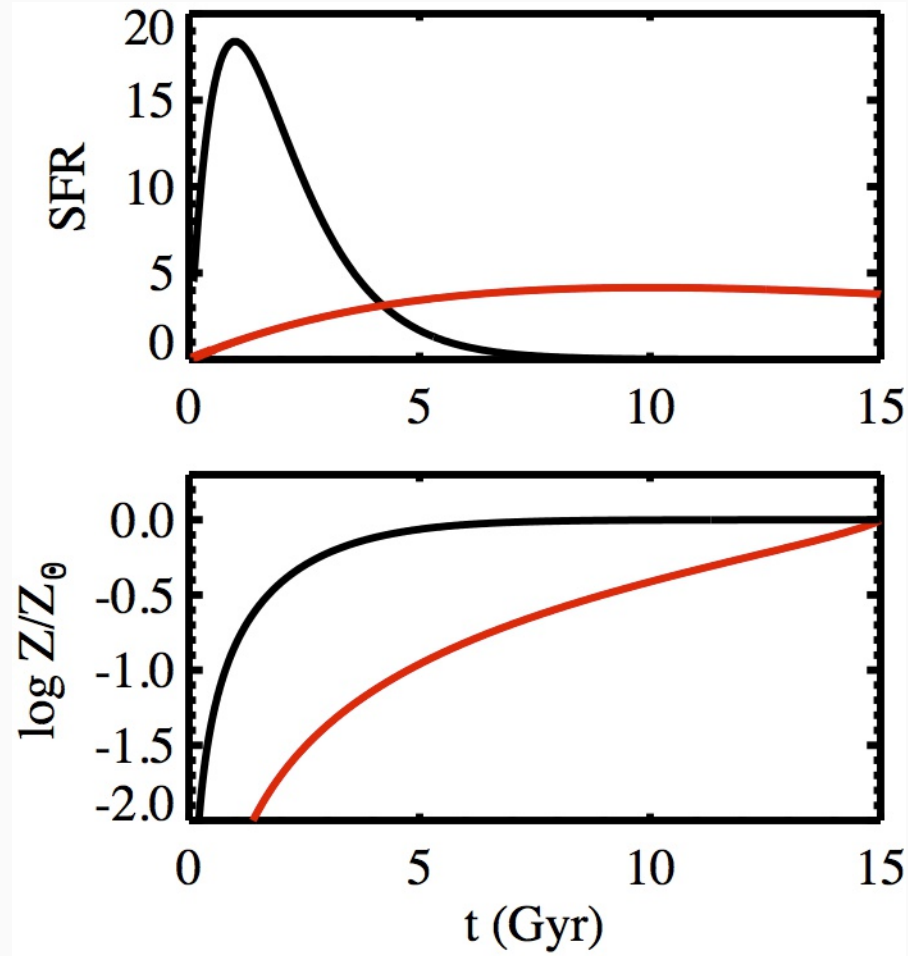
Use SSPs to build more complex (composite) stellar populations:

- Star formation history
- Dust model

I. Introduction - SPS

Star formation history (SFH)

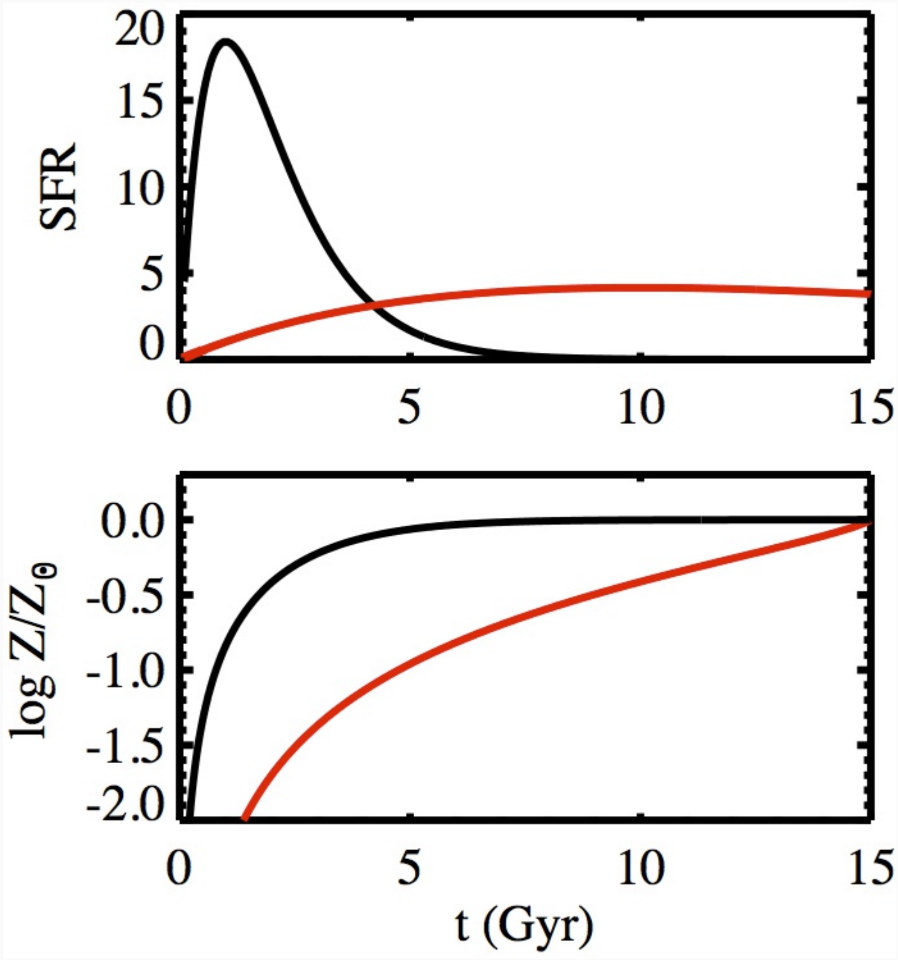
Evolution of SFR and metallicity (chemical composition).



I. Introduction - SPS

Star formation history (SFH)
Evolution of SFR and metallicity (chemical composition).

SFHs can be simple or complex.



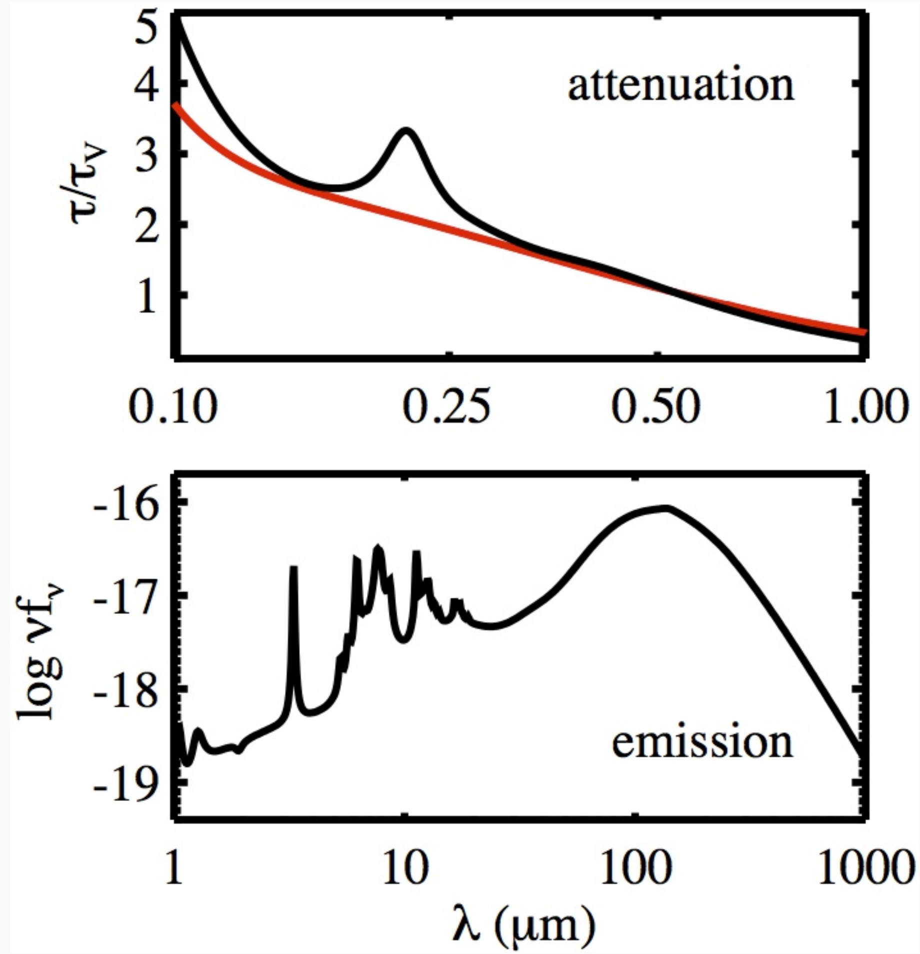
I. Introduction - SPS

Dust model

Dust can significantly affect the spectrum of a stellar population.

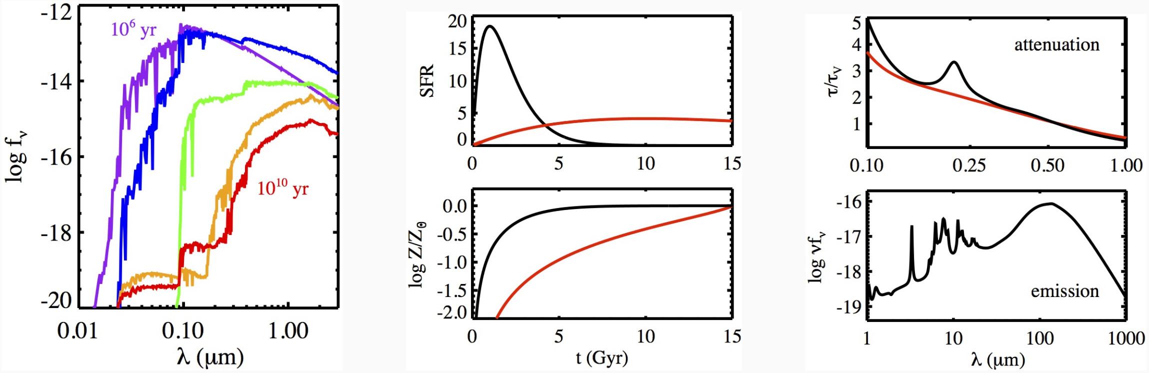
Dust absorbs high energy photons and emits infrared radiation.

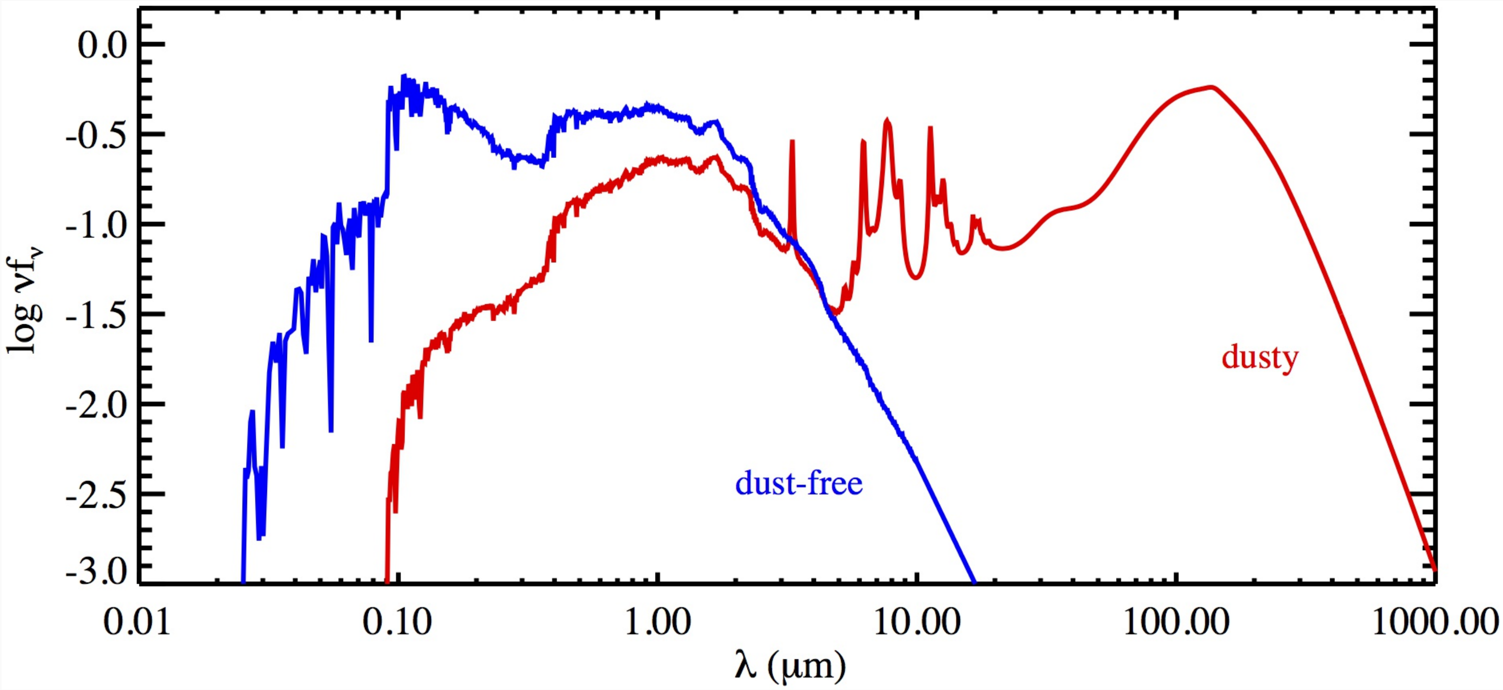
Dust grain models predict how a given amount of dust will attenuate a stellar spectrum and what the dust emission spectrum will look like.



I. Introduction - SPS

Composite stellar population spectra





I. Introduction - SPS

Can use this technique to model any stellar population (clusters, galaxies, etc.) given,

- Stellar evolution models (isochrones)
- Stellar spectra models
- IMF
- SFH
- Dust model

I. Introduction