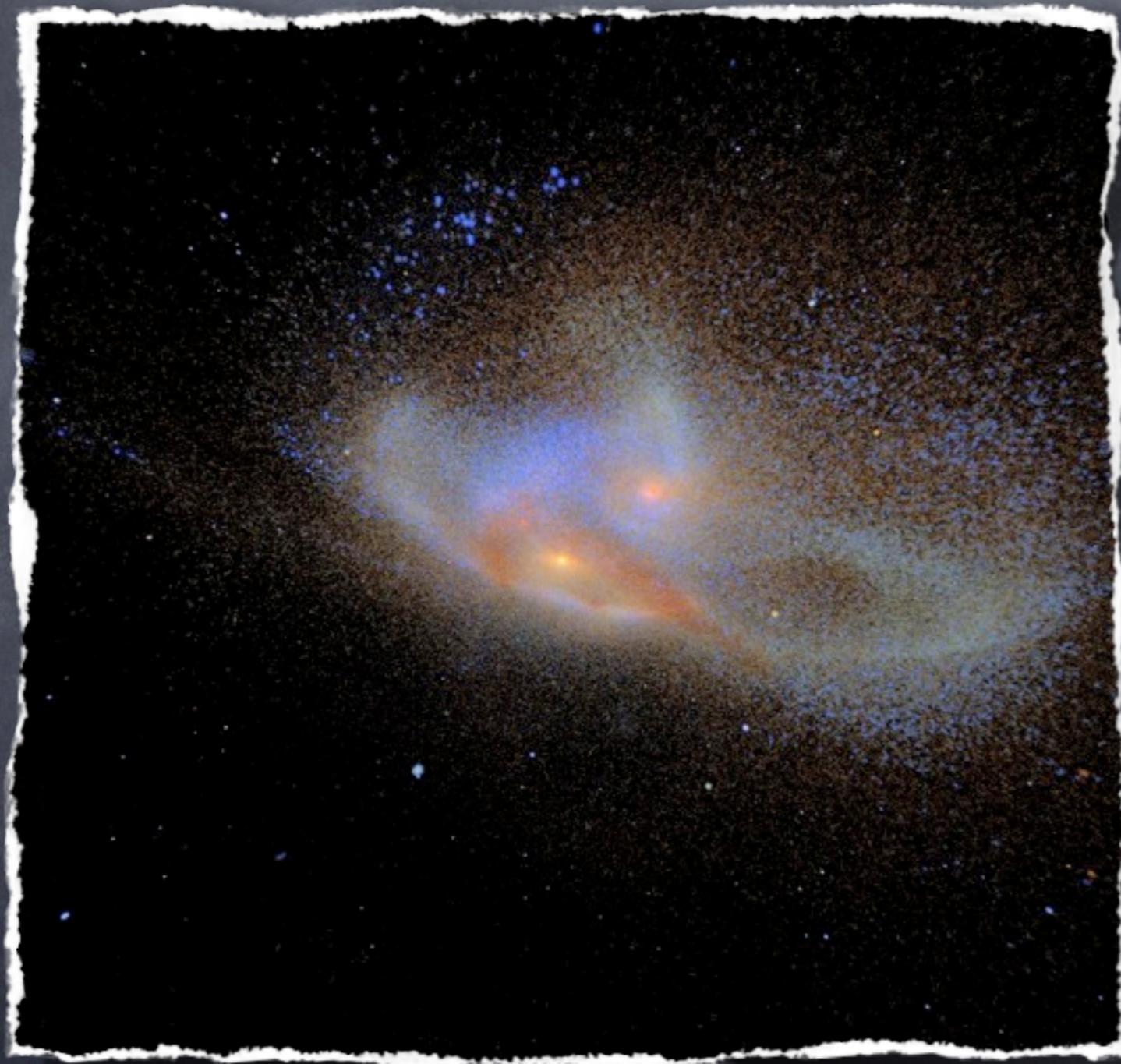


# Sunrise:

## Panchromatic SED Models of Simulated Galaxies



Lecture 1:

# What is Sunrise?

## Patrik Jonsson

Harvard-Smithsonian Center for Astrophysics

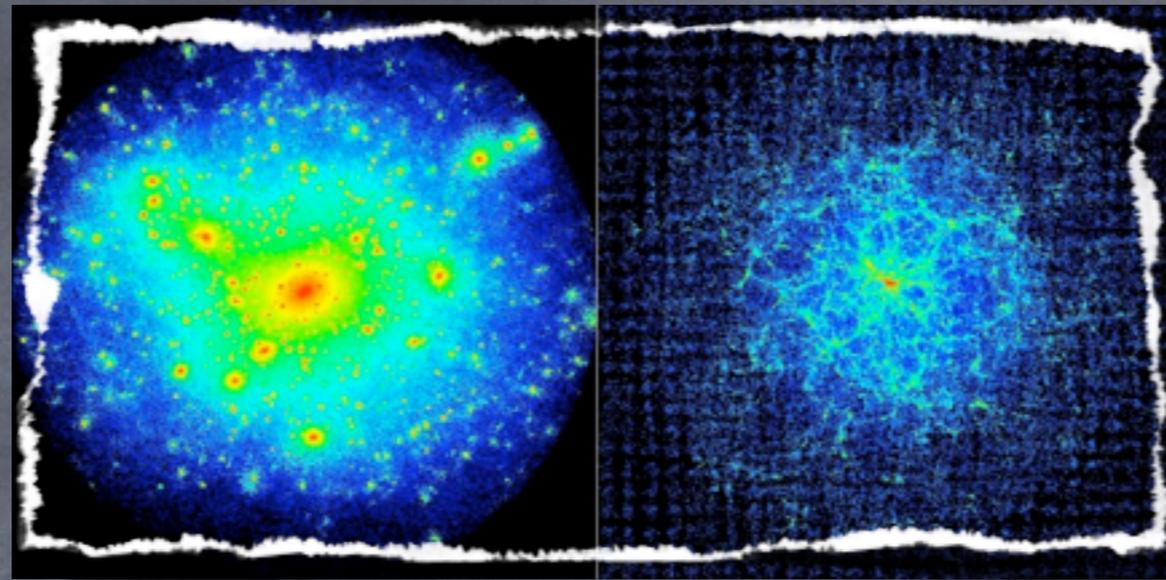
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# Lecture outline

- **Lecture 1:** Why Sunrise? What does it do? Example science. How to use the outputs? Projects?
- **Lecture 2:** Sunrise work flow. Parameters, convergence, other subtleties.
- **Lecture 3:** Radiation transfer theory. Monte Carlo. Polychromatic MC.
- **Lecture 4:** Dust emission, dust self-absorption. Sunrise on GPUs.

What does Sunrise do?

# The point:



Simulations by  
the N-body Shop  
(U. Washington)

# What goes into a galaxy spectrum?

- Stellar (continuum) emission
- Emission lines from HII regions
- Dust & PAH emission
- AGN emission
  
- All this needs to be modeled, and absorption and scattering of light due to dust grains included
- We will defer the “how” to later lectures...

# Simulated spiral galaxies

Sbc+

Sbc

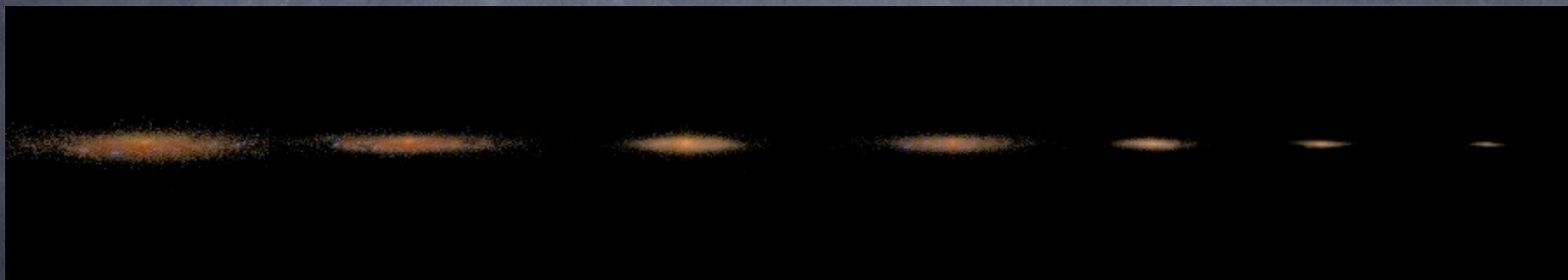
G3

Sbc-

G2

G1

G0



$M_b = 1.6e11 M_{\text{sun}}$

$1.0e11$

$6.2e10$

$5.0e10$

$2.0e10$

$7.0e9$

$1.6e9$

$\text{SFR} = 3.9 M_{\text{sun}}/\text{yr}$

3.4

1.0

1.1

0.4

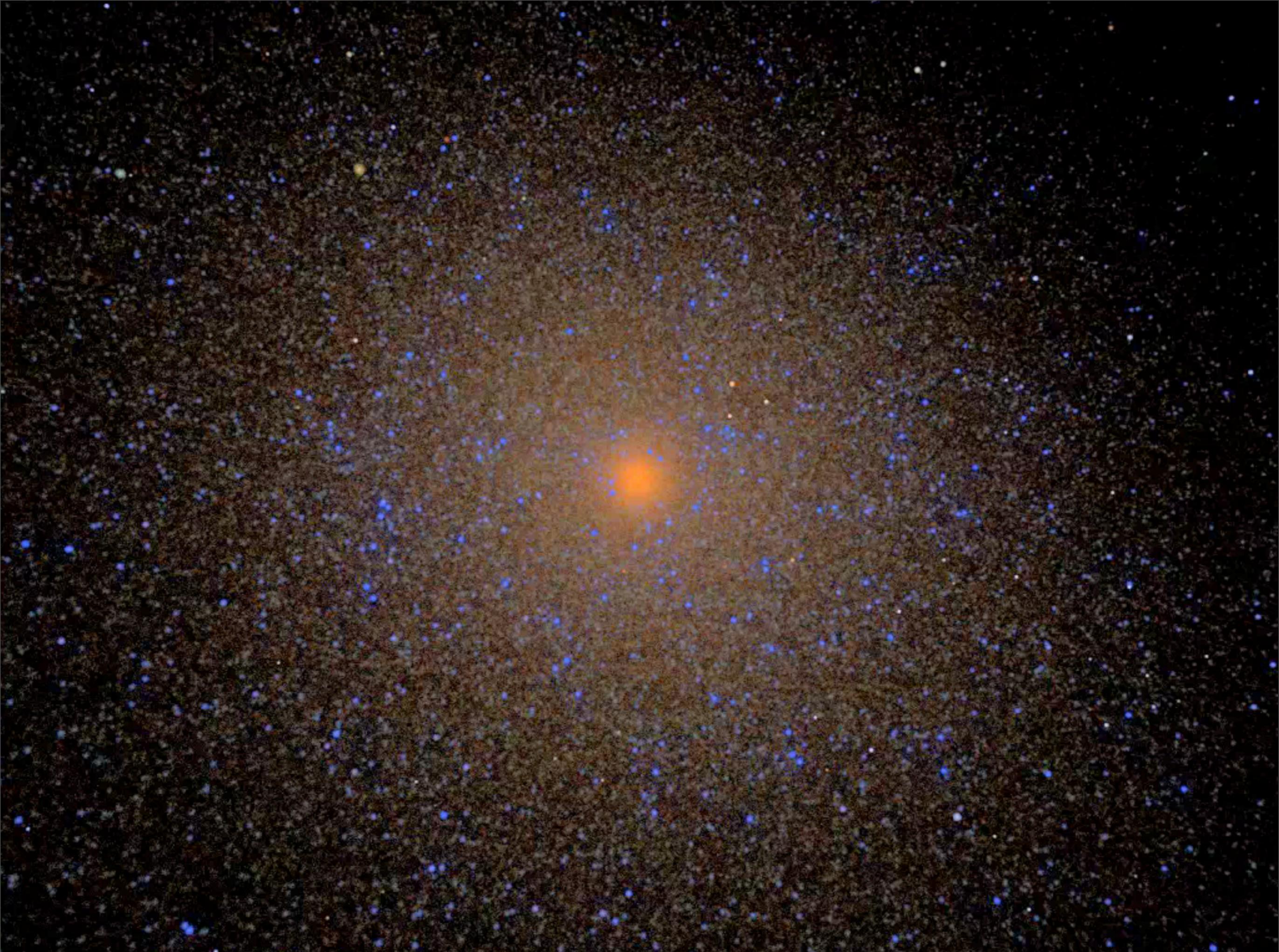
0.07

$1e-3$

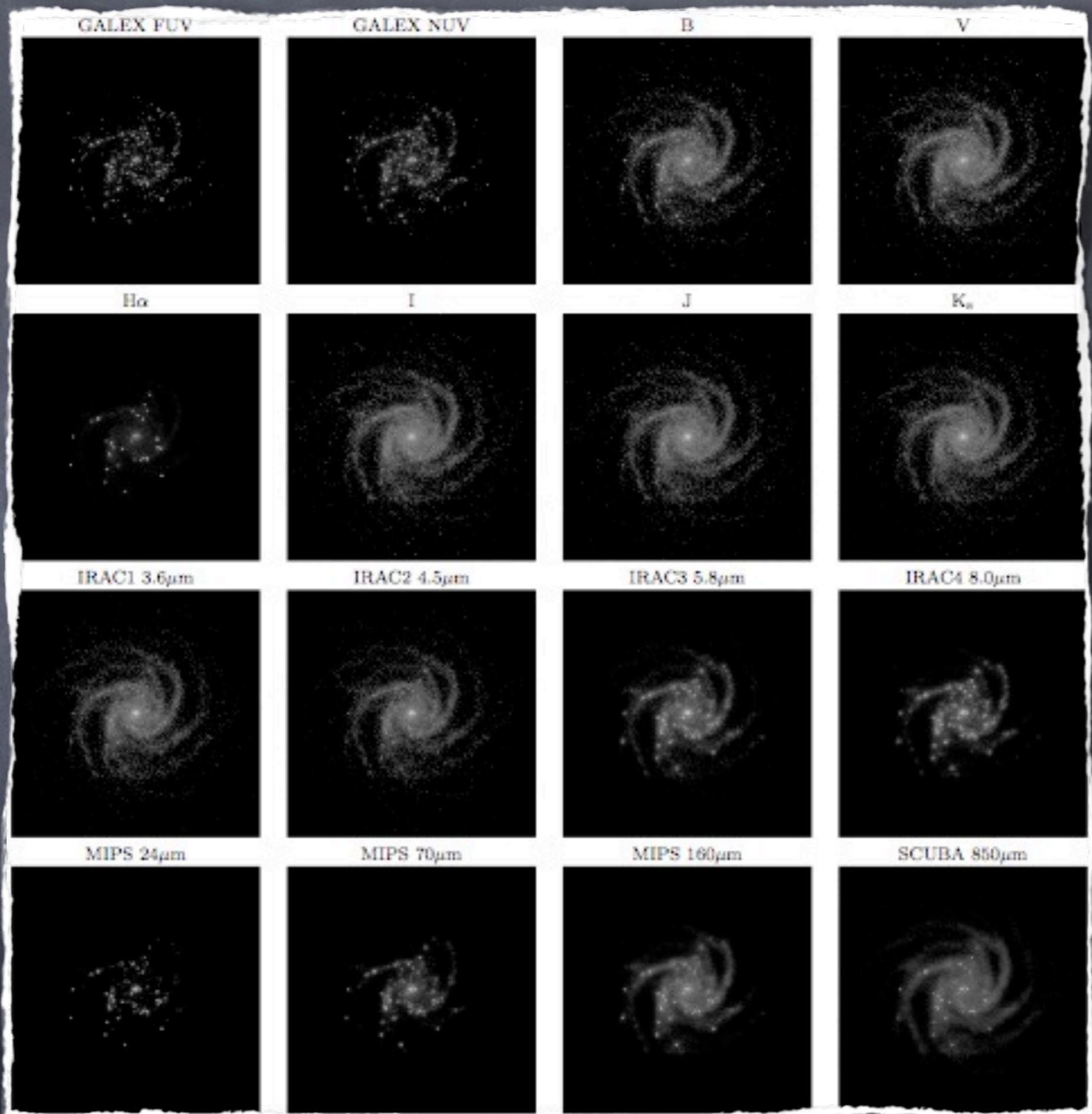
For more info, see: Jonsson, Groves & Cox 2010, MNRAS, 403, 17

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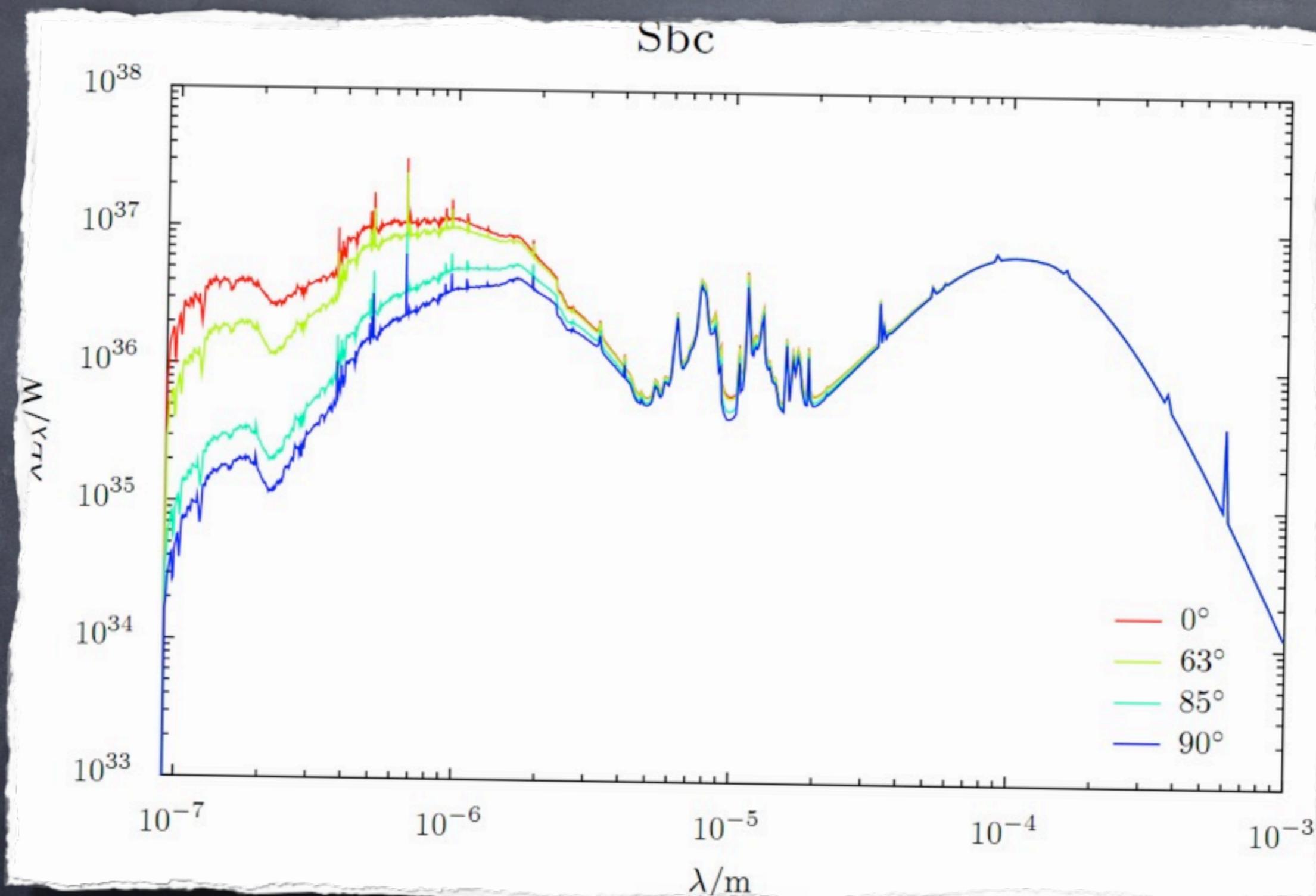


Monday, August 9, 2010

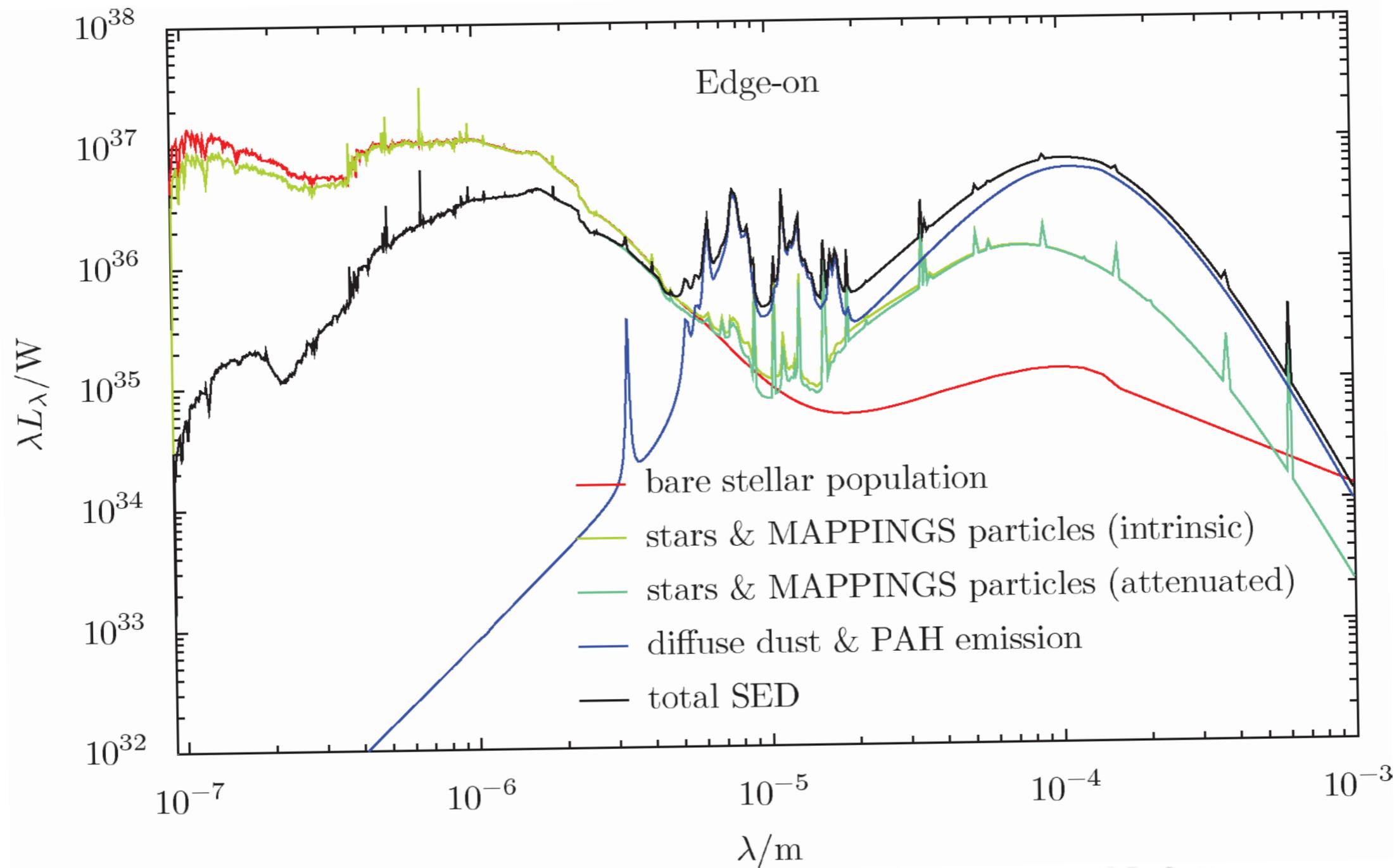


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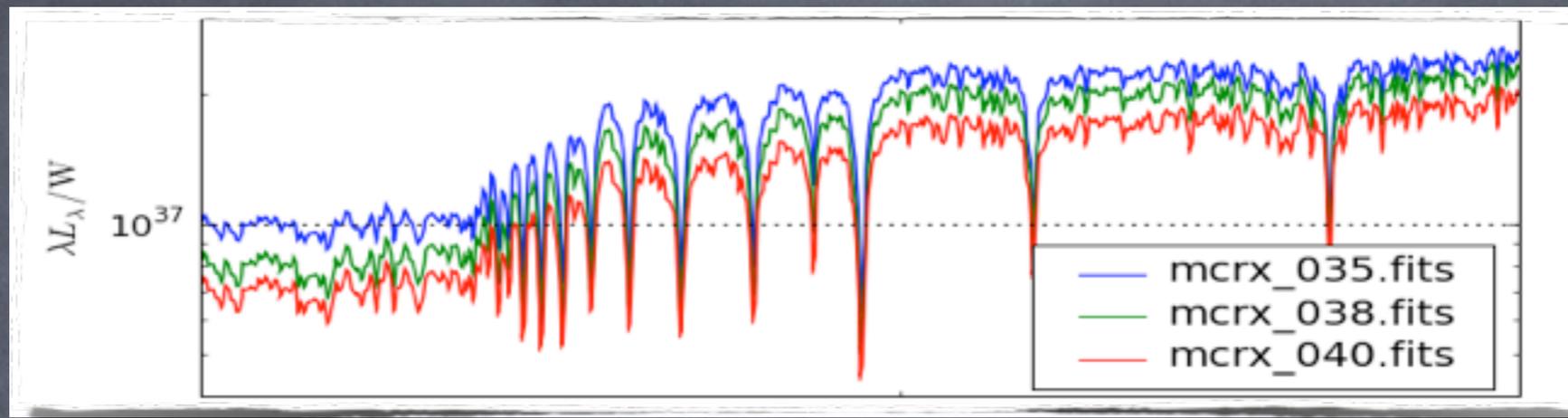
# Spectral Energy Distributions



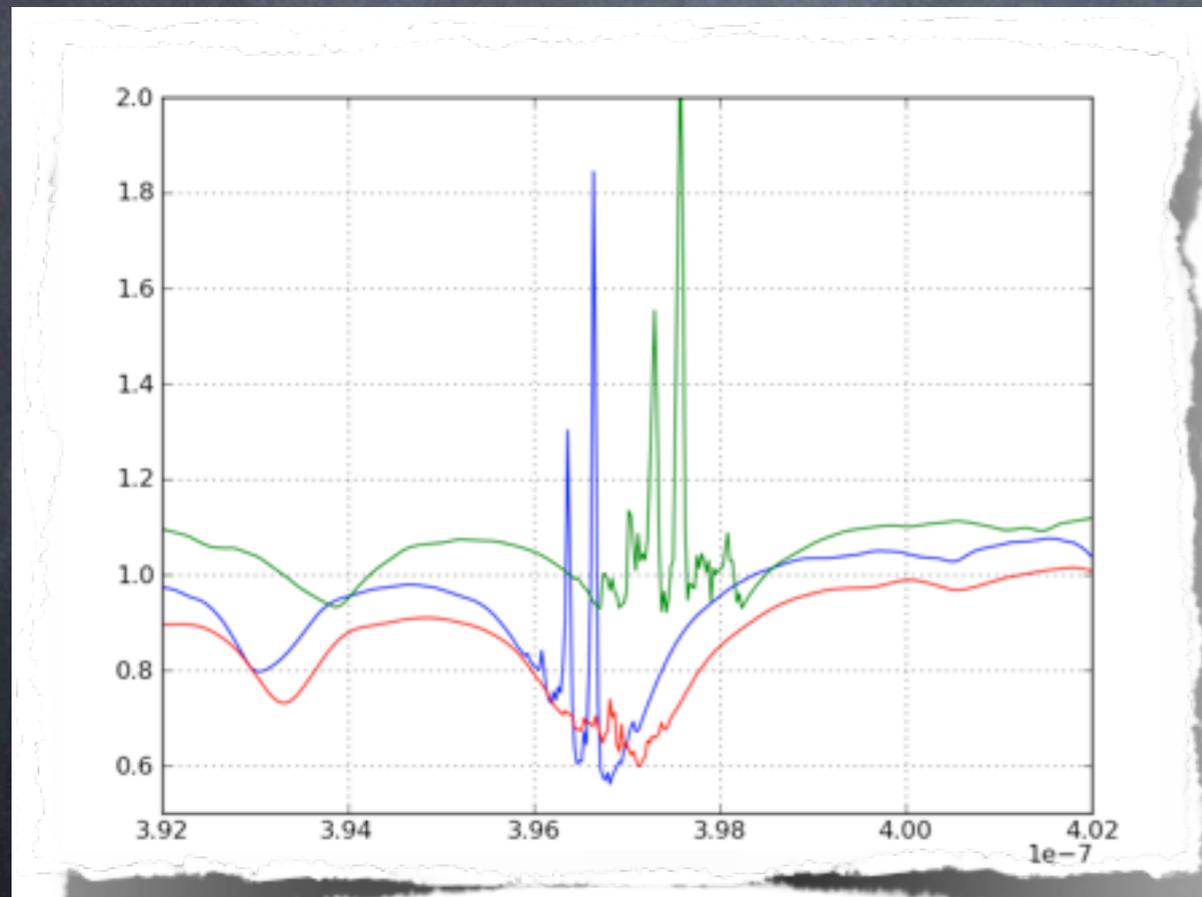
# Different Components



# Very high wavelength resolution possible



Galaxy spectra at  $R=16000$



Support for kinematics is in the works...

# Sunrise outputs

how to use and interpret them

# Sunrise outputs are FITS files

- Used for astronomical data from telescopes
- Contains an arbitrary number of named **extensions**
- Each extension contains either
  - an N-dimensional **image** array, or
  - a **table** with columns of specified type
- There are libraries to read FITS files in most languages. We're going to be using **Python**.

# Outputs

- All this is available on the Sunrise Wiki:  
<http://code.google.com/p/sunrise/wiki/HIPACCProjects>
  - Load up that now and follow along!
- Generally, you'll use two kinds of data:
  - 3D images in extensions called something like "CAMERAi-type"
  - Integrated spectra in extension "INTEGRATED\_QUANTITIES"
    - column "lambda" contains wavelengths
    - column "L\_lambda\_xxi" are spectra

# Let's see how this works...

- Source for this demo is in  
`/home/hipacc-2/sunrise_demo.py`

# Now try it yourselves

- Take a few minutes and follow the instructions at <http://code.google.com/p/sunrise/wiki/HIPACCPrompts>
- set up your Triton account for Sunrise use
- plot the images and spectra as described
- the example data file is located in  
/home/hipacc-2/set5bs
  - mcrx\_034.fits - data cubes & spectra
  - broadband\_034.fits - images in filters

# Projects

- Now that you have some idea of how Sunrise works, let's talk about the projects
- Designed to show you how to run Sunrise and to make you think about the results. And to be quick...
  - Spherical cloud with central point source
  - Externally illuminated "dark" cloud
  - Process a Gadget simulation snapshot
  - Process a Gasoline simulation snapshot
- ... start with one of the 2 first ones