

# Um Universo de Galáxias

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Como estudamos a nossa e outras galáxias hoje?

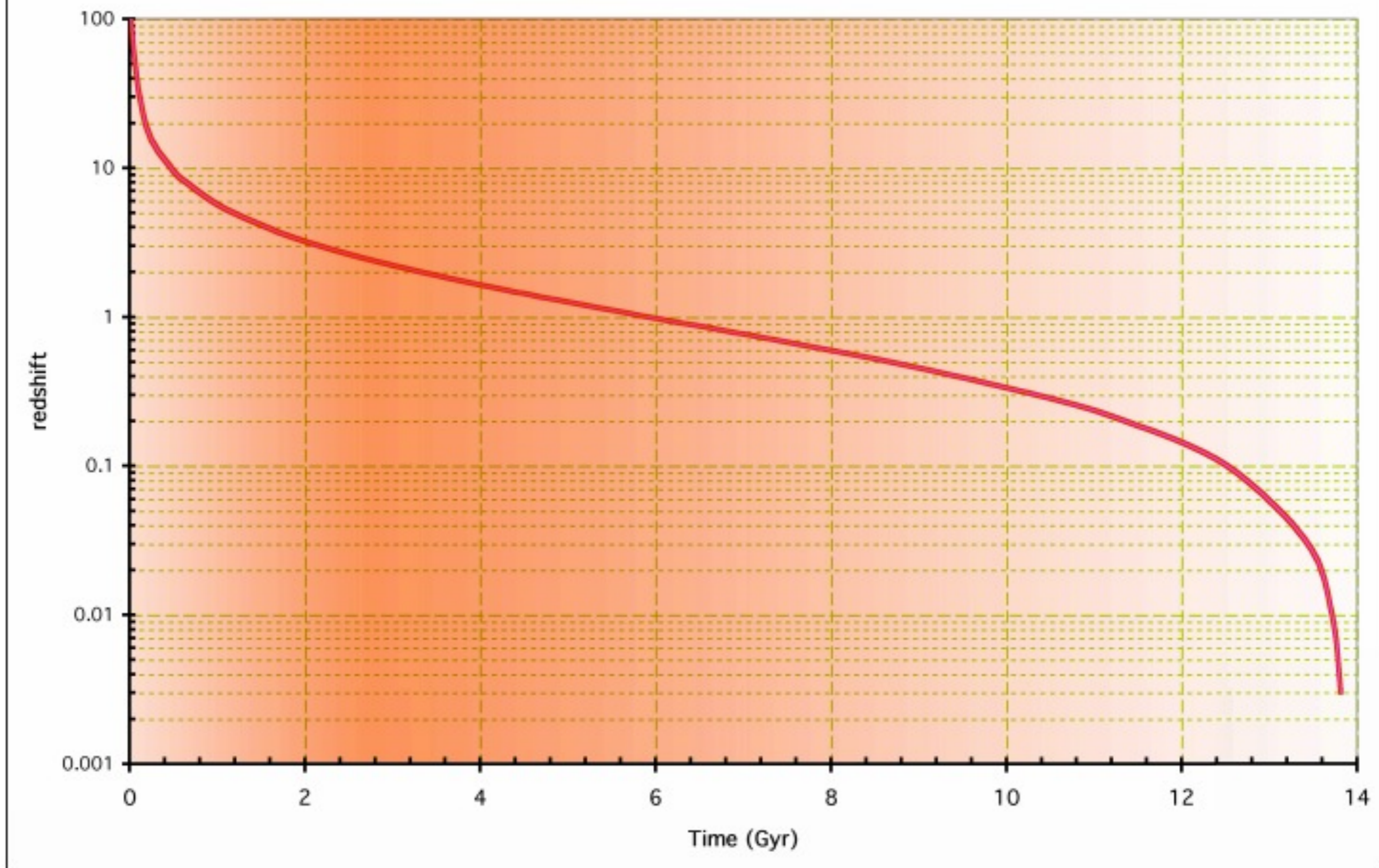


Um Universo de  
Estrelas e Galáxias

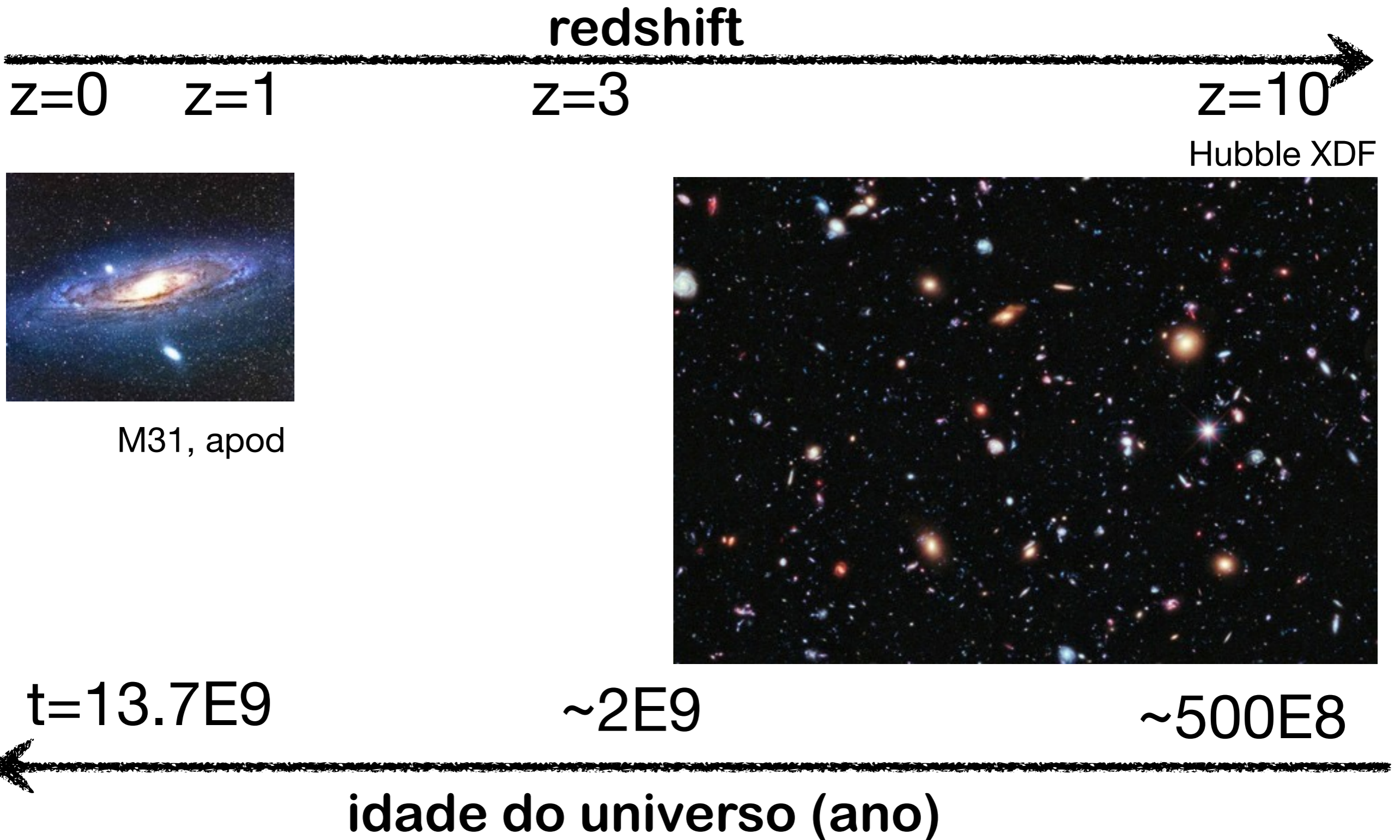
Como estudamos a nossa e outras galáxias  
hoje?

*"Lookback time" versus Arqueologia*

$H_0 = 68 \text{ km/s/Mpc}$ ,  $\Omega_m = 0.3$ ,  $\Omega_{\Lambda} = 0.7$

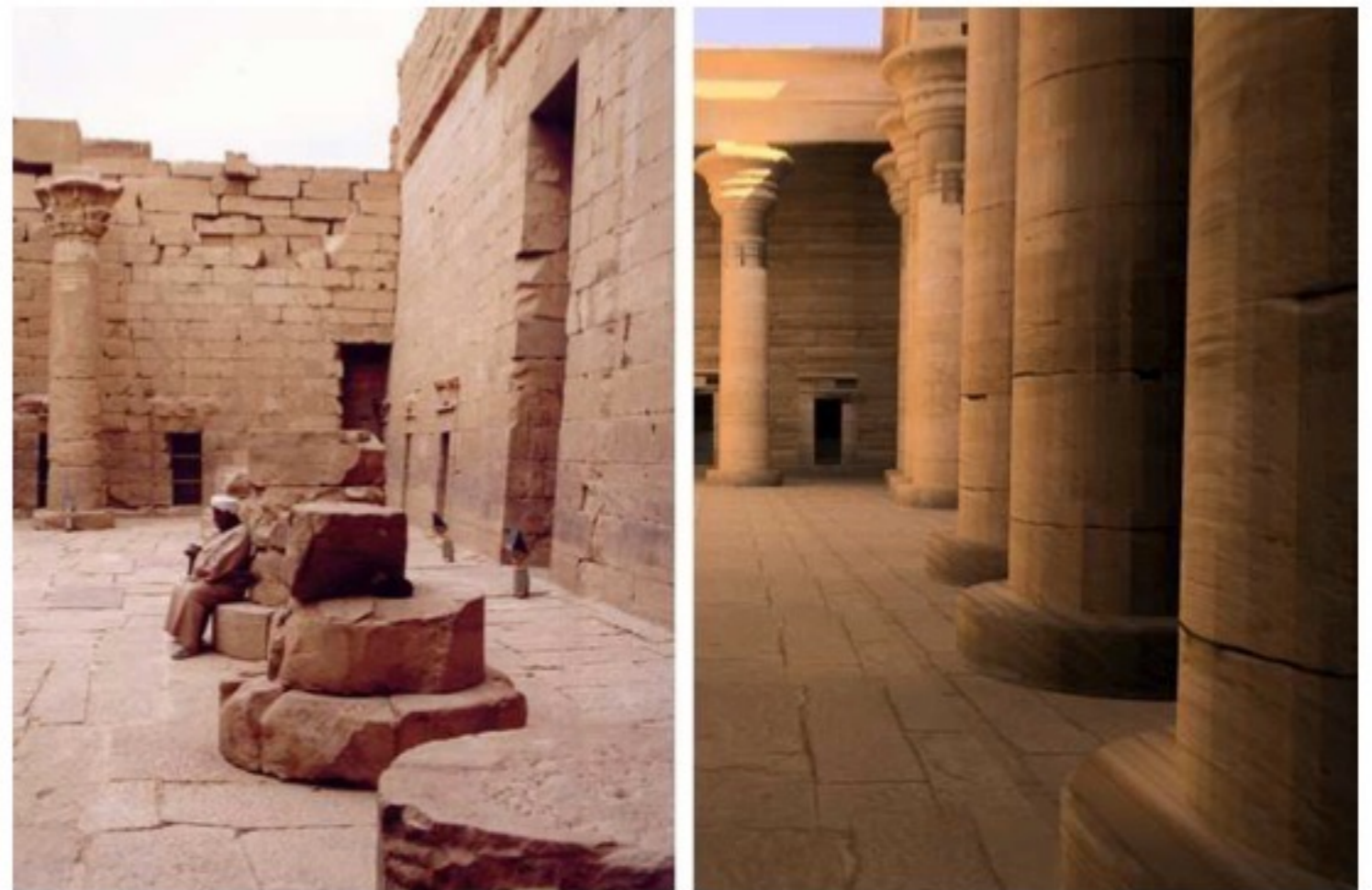


# Estudando as galáxias com lookback time



# Arqueologia

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**Figure 9: (a) View of the courtyard today and (b) how it may have appeared in 30BC.**

*Credit: High Fidelity Reconstruction of the Ancient Egyptian Temple of Kalabsha, Sundstedt, Chalmers & Martinez (2004)*



Nosso sítio arqueológico:

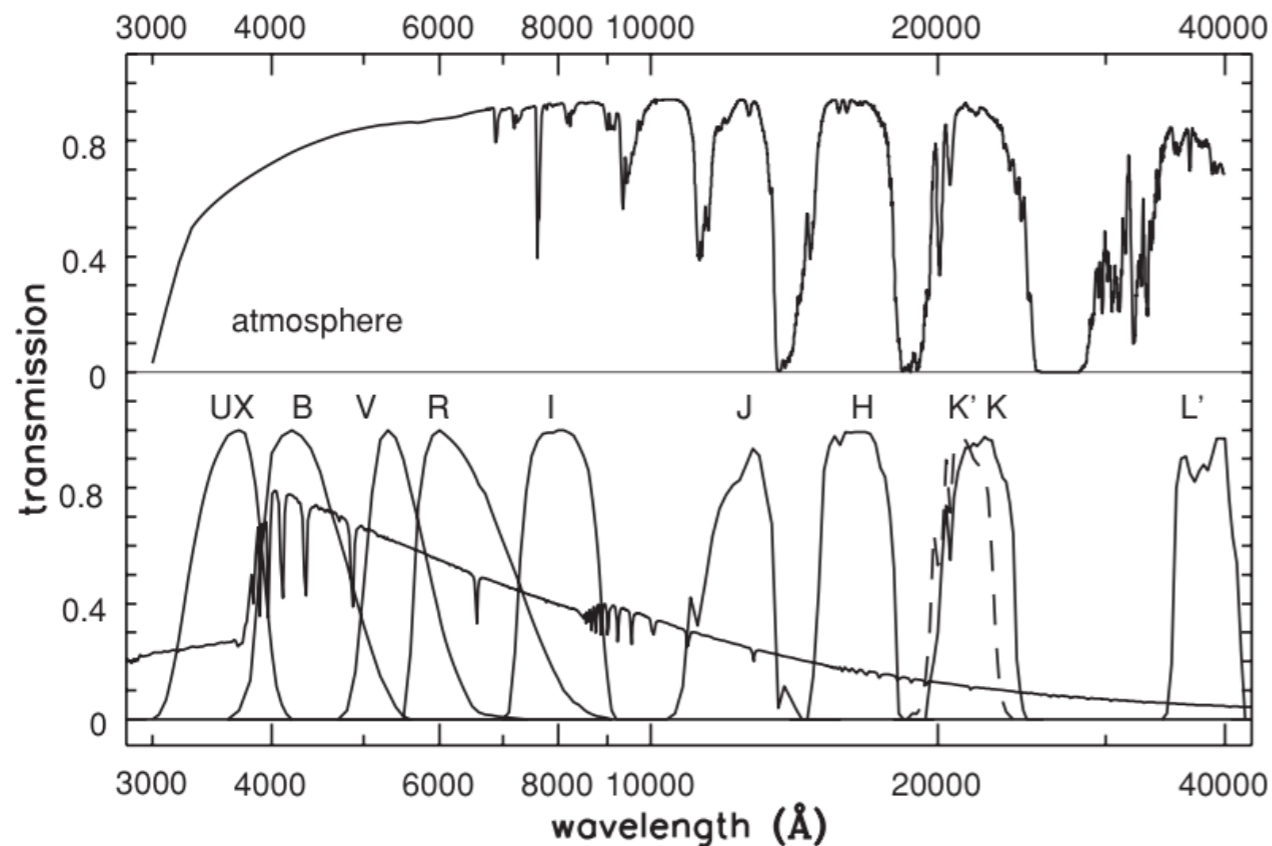
Assinaturas observacionais em estrelas  
e galáxias próximas

# Estudando a nossa e outras galáxias

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- Fotometria: número de objetos observados é ordens de grandeza maior (~1 bilhão de detecções de imageamento no SDSS DR13 vs. ~4 milhões de espectros; <http://www.sdss.org/dr13/scope/>)
- Espectroscopia: a mais usada em estudos de arqueologia da Galáxia
- Multispectral imaging (e.g. J-PAS)
- Cubo de dados (e.g. MUSE)
- Contagem de fótons (e.g. Altas energias...)





M106: IR (vermelho), x-ray (azul), radio (violeta) e visível  
 (Crédito: NASA, ESA, the Hubble Heritage Team (STScI/AURA), and R. Gendler)

**Fig. 1.7.** Above, atmospheric transmission in the optical and near-infrared. Below, flux  $F_\lambda$  of a model A0 star, with transmission curves  $T(\lambda)$  for standard filters (from Bessell 1990 *PASP* **102**, 1181).  $UX$  is a version of the  $U$  filter that takes account of atmospheric absorption. For  $JHK'KL'$ ,  $T(\lambda)$  describes transmission through the atmosphere and subsequently through the filter.



$$F_{BP} \equiv \int_0^\infty T_{BP}(\lambda) F_\lambda(\lambda) d\lambda$$

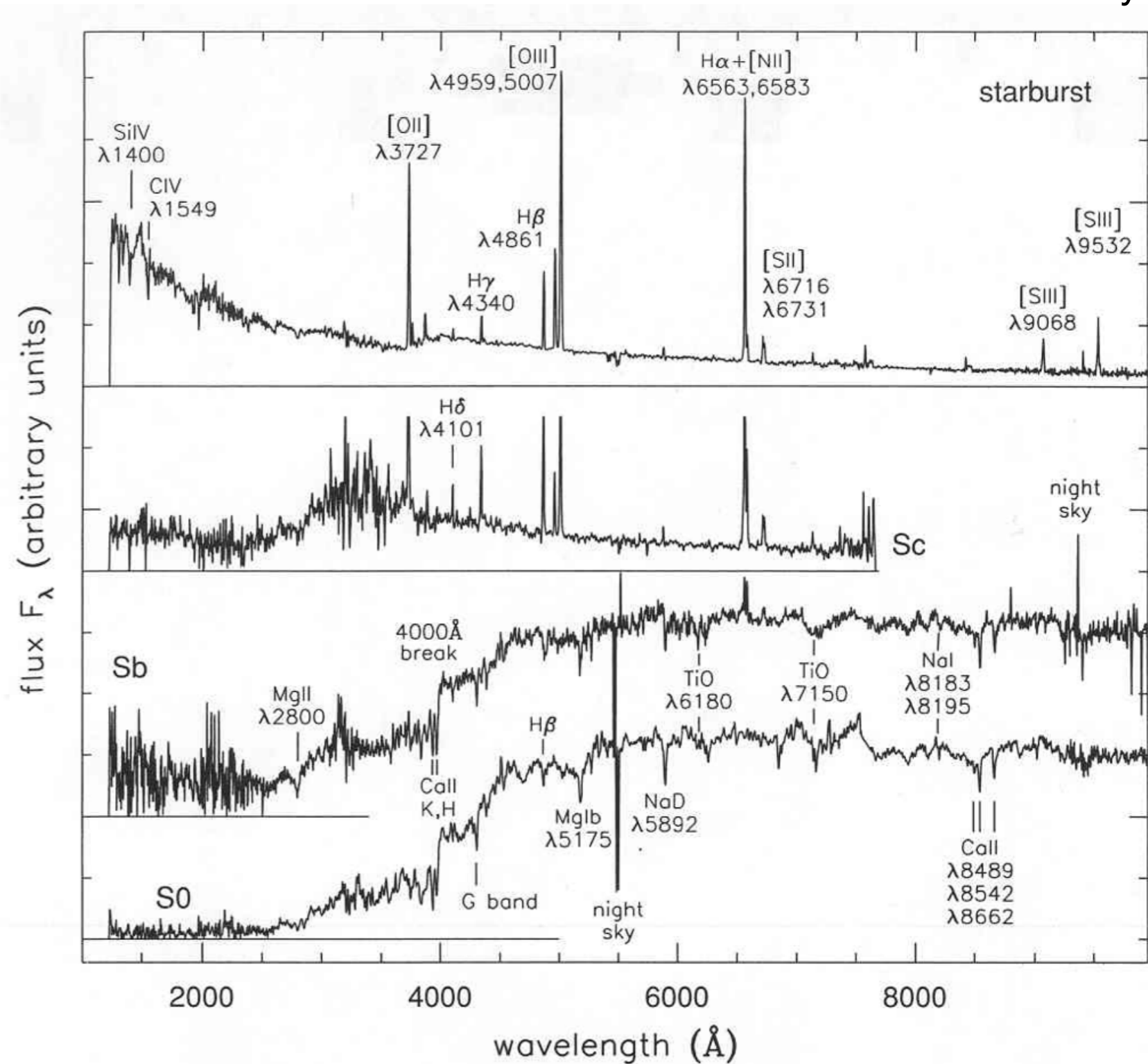
$$m_{1,BP} - m_{2,BP} = -2.5 \log_{10} \left\{ \frac{\int_0^\infty T_{BP}(\lambda) F_{1,\lambda}(\lambda) d\lambda}{\int_0^\infty T_{BP}(\lambda) F_{2,\lambda}(\lambda) d\lambda} \right\}$$

# Fotometria

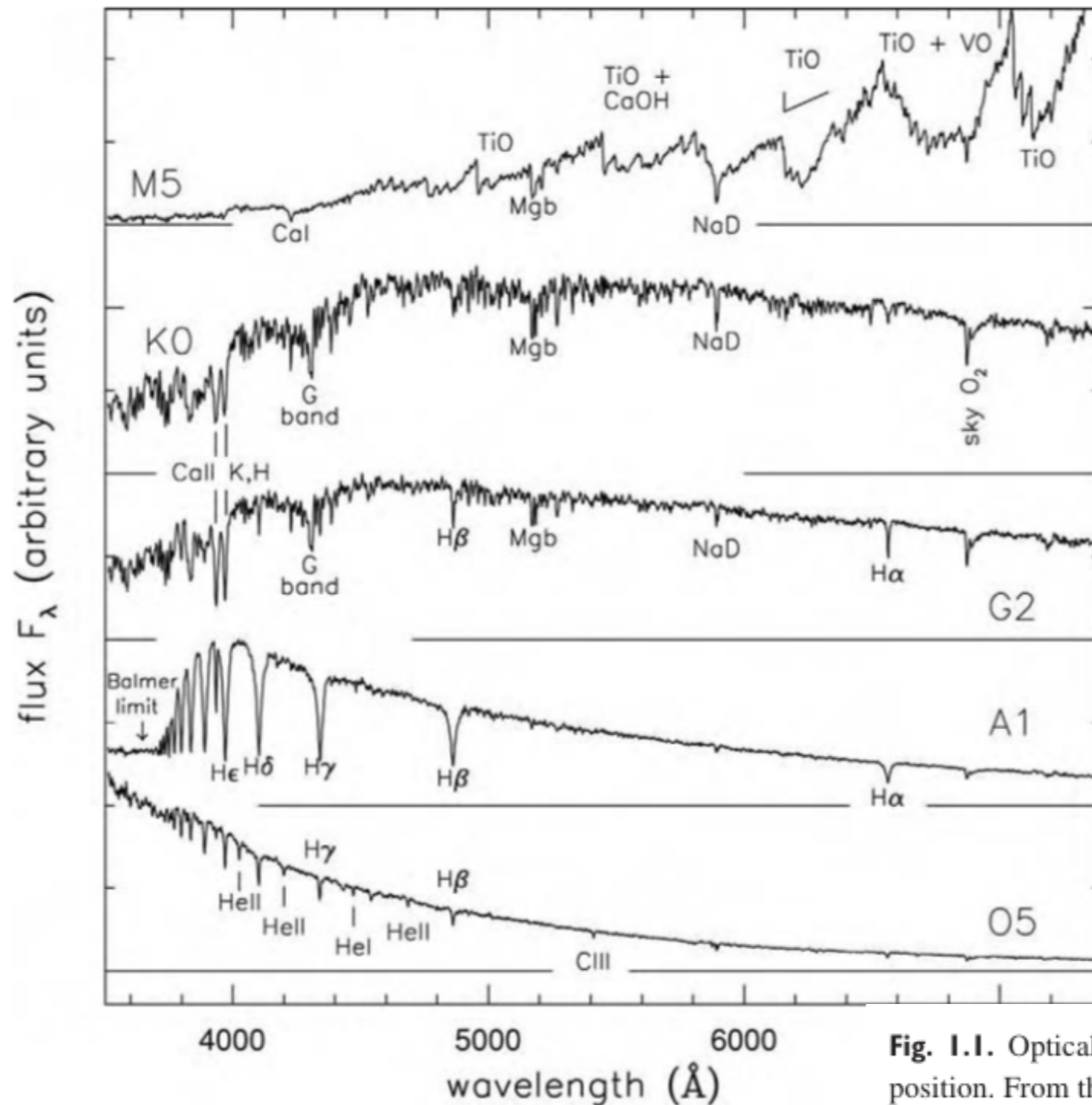
Não apresenta tantos detalhes quanto espectroscopia, mas pode observar ordens de magnitude mais galáxias

# Assinaturas em espectros de galáxias

Credit: A. Kinney

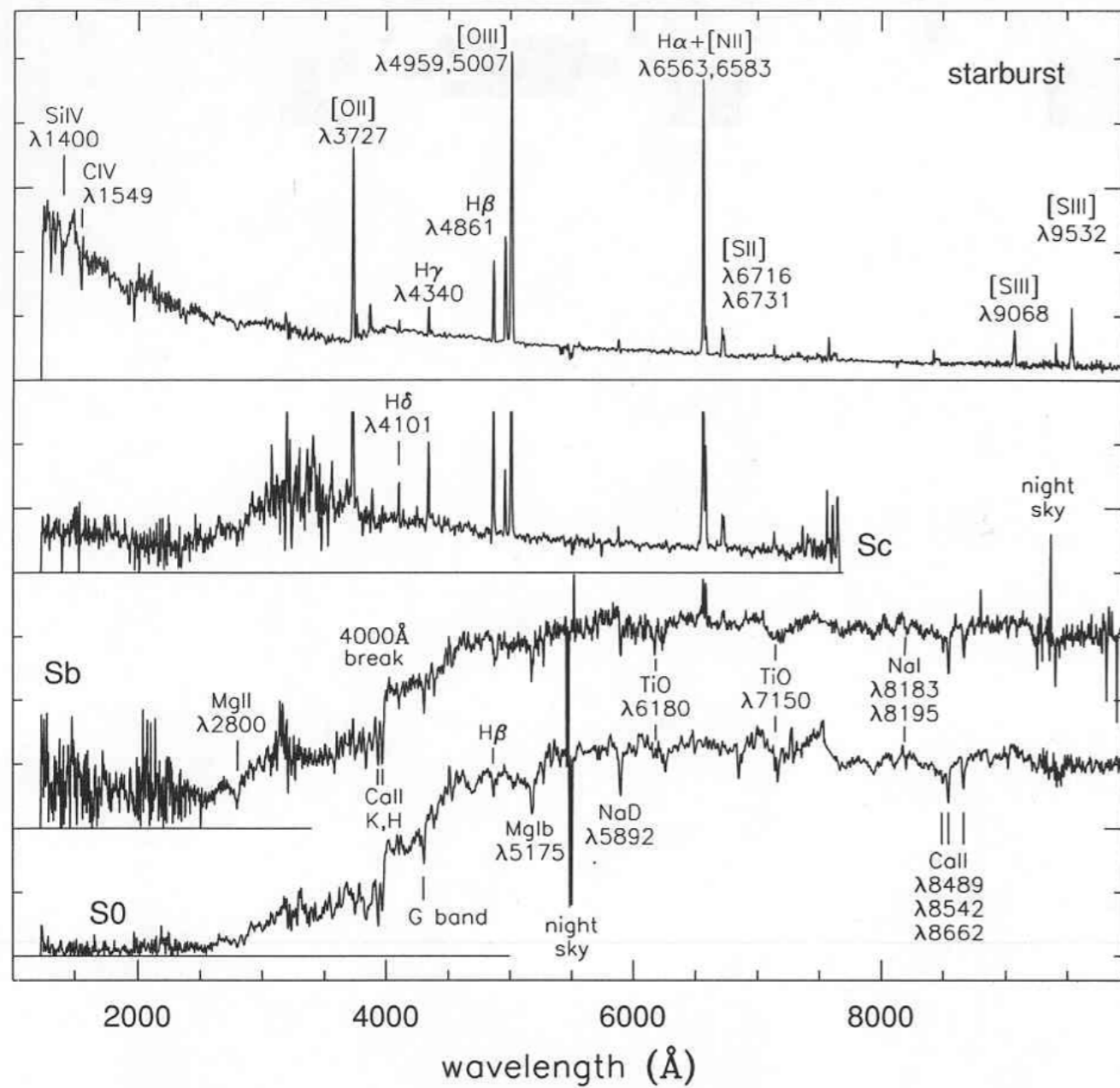


# Assinaturas em espectros de estrelas

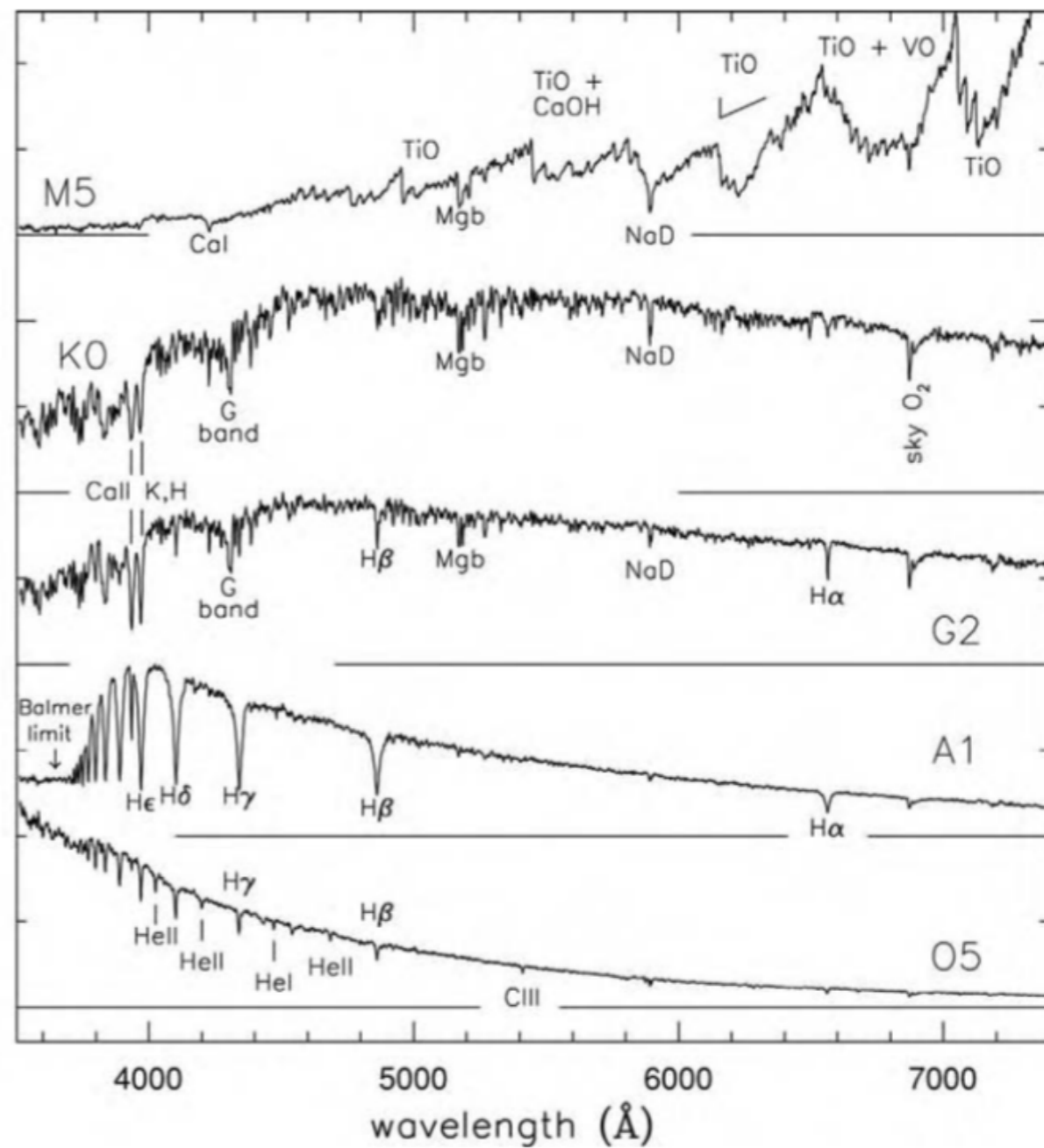


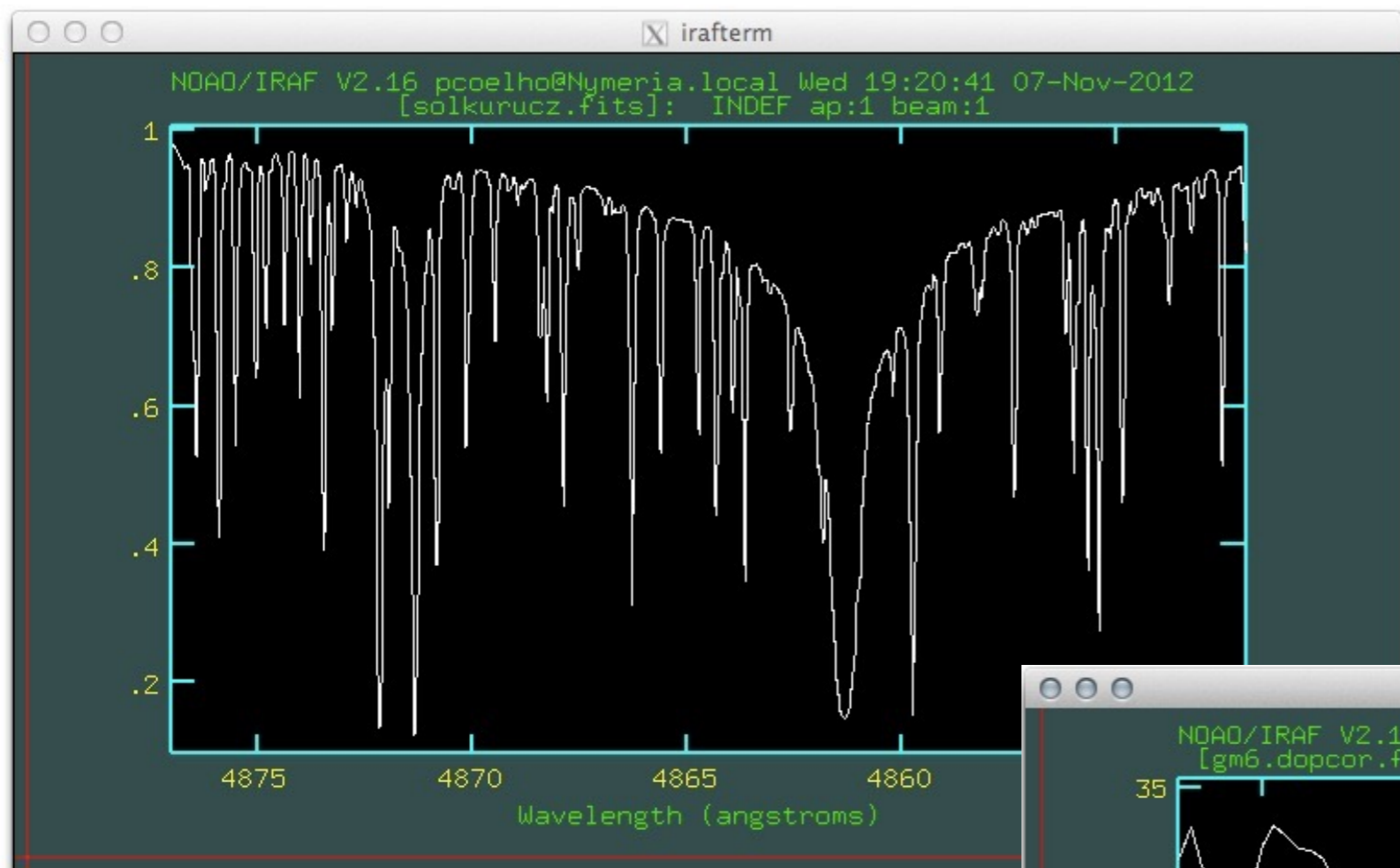
**Fig. 1.1.** Optical spectra of main-sequence stars with roughly the solar chemical composition. From the top in order of increasing surface temperature, the stars have spectral classes M5, K0, G2, A1, and O5 – G. Jacoby *et al.*, spectral library.

flux  $F_\lambda$  (arbitrary units)

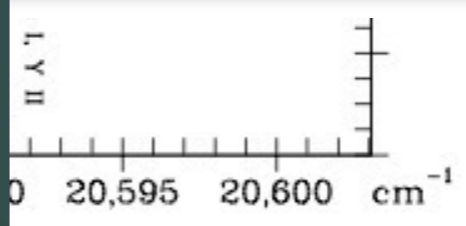
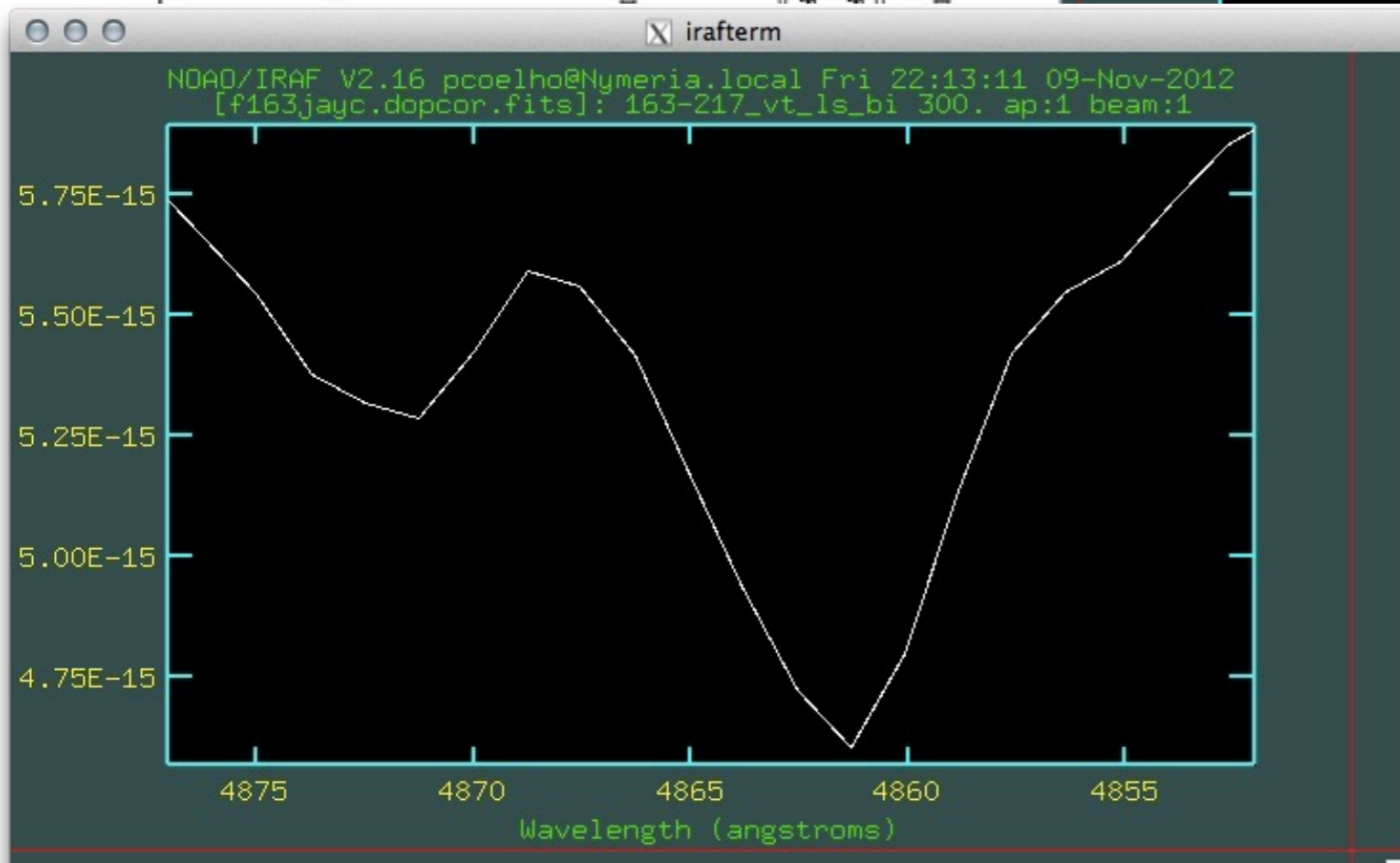
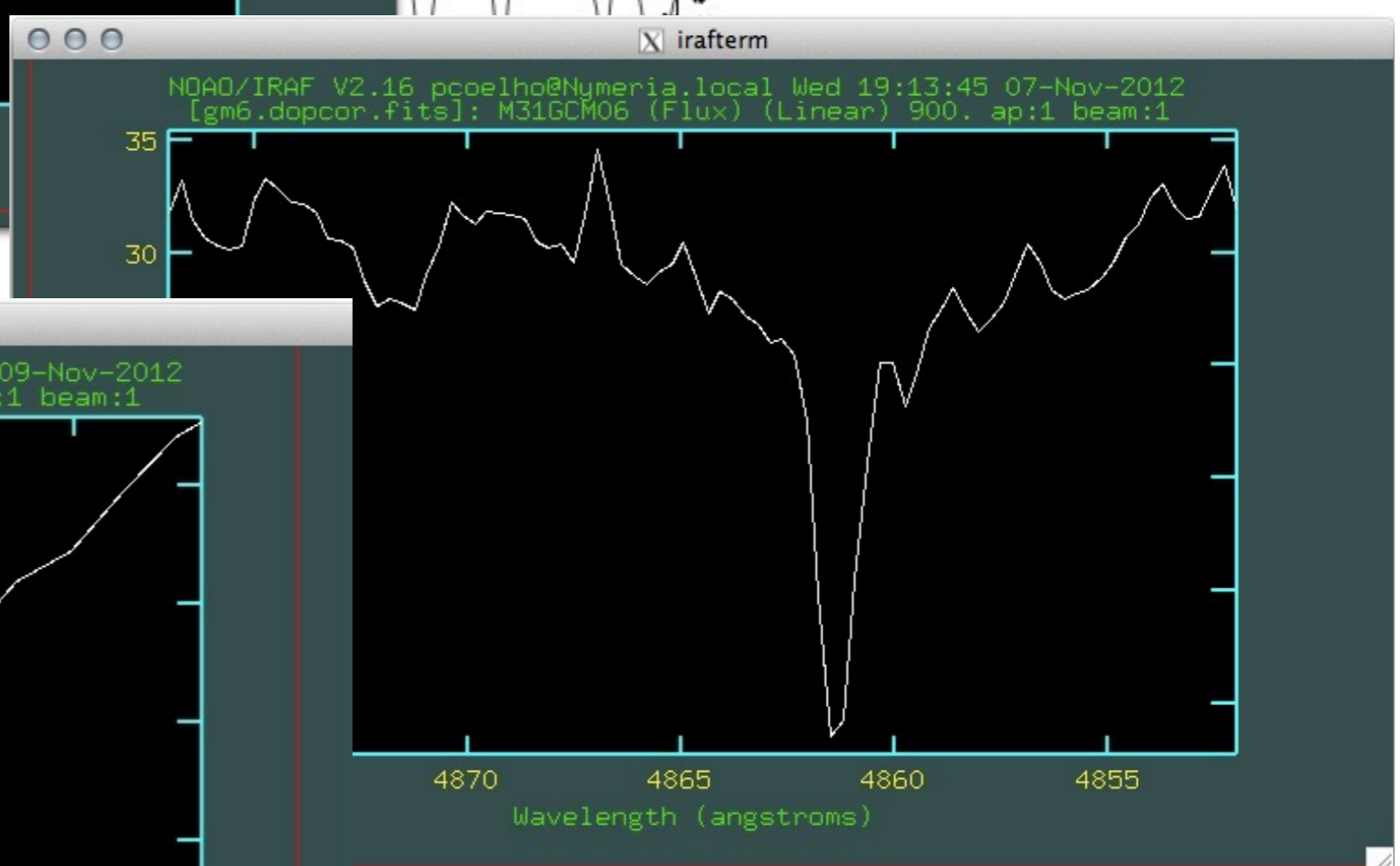
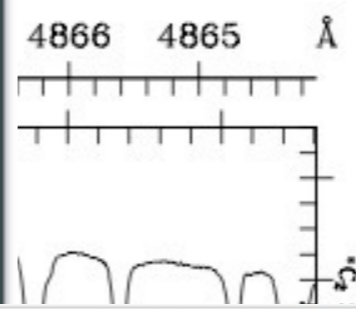


flux  $F_\lambda$  (arbitrary units)





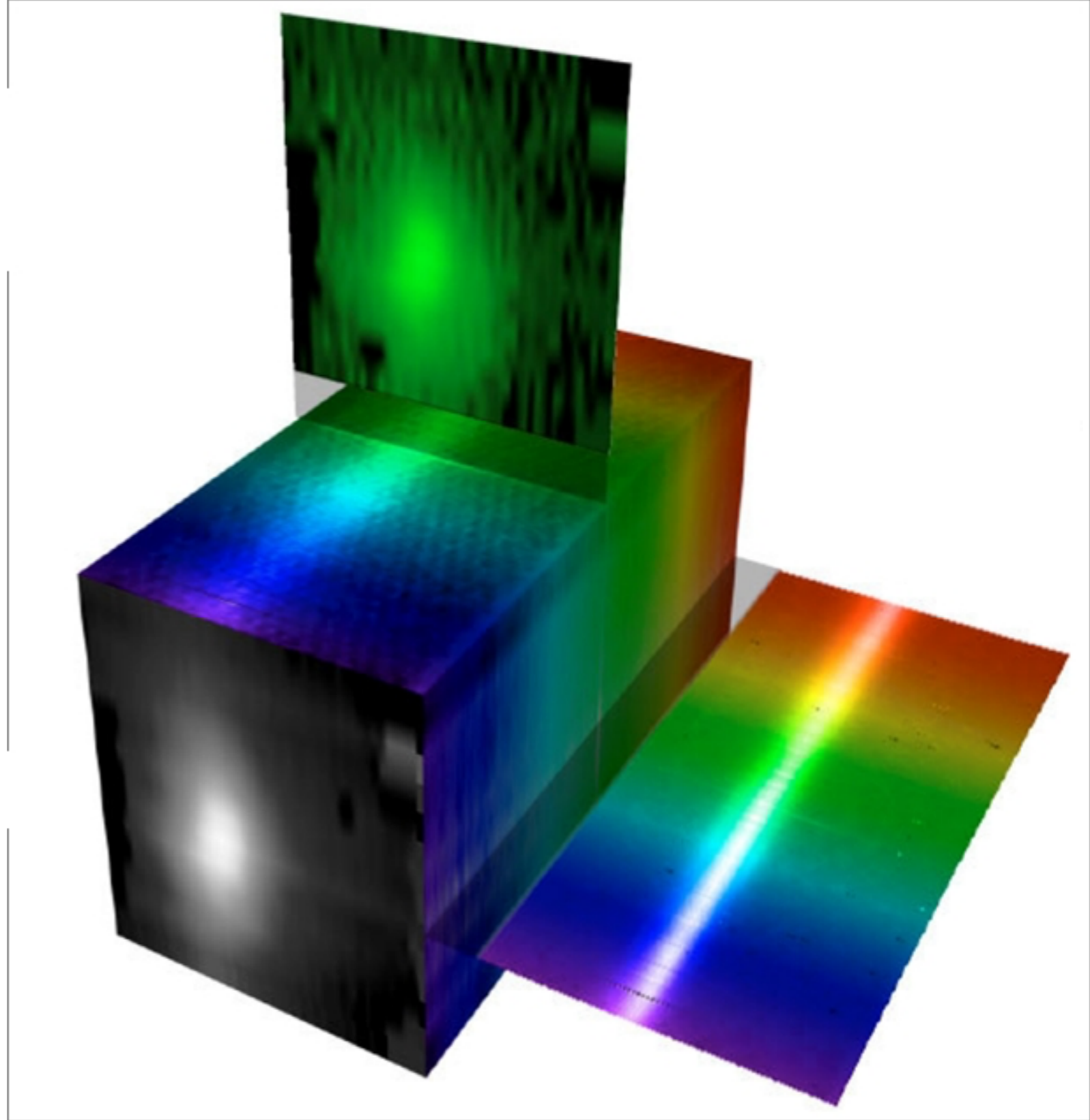
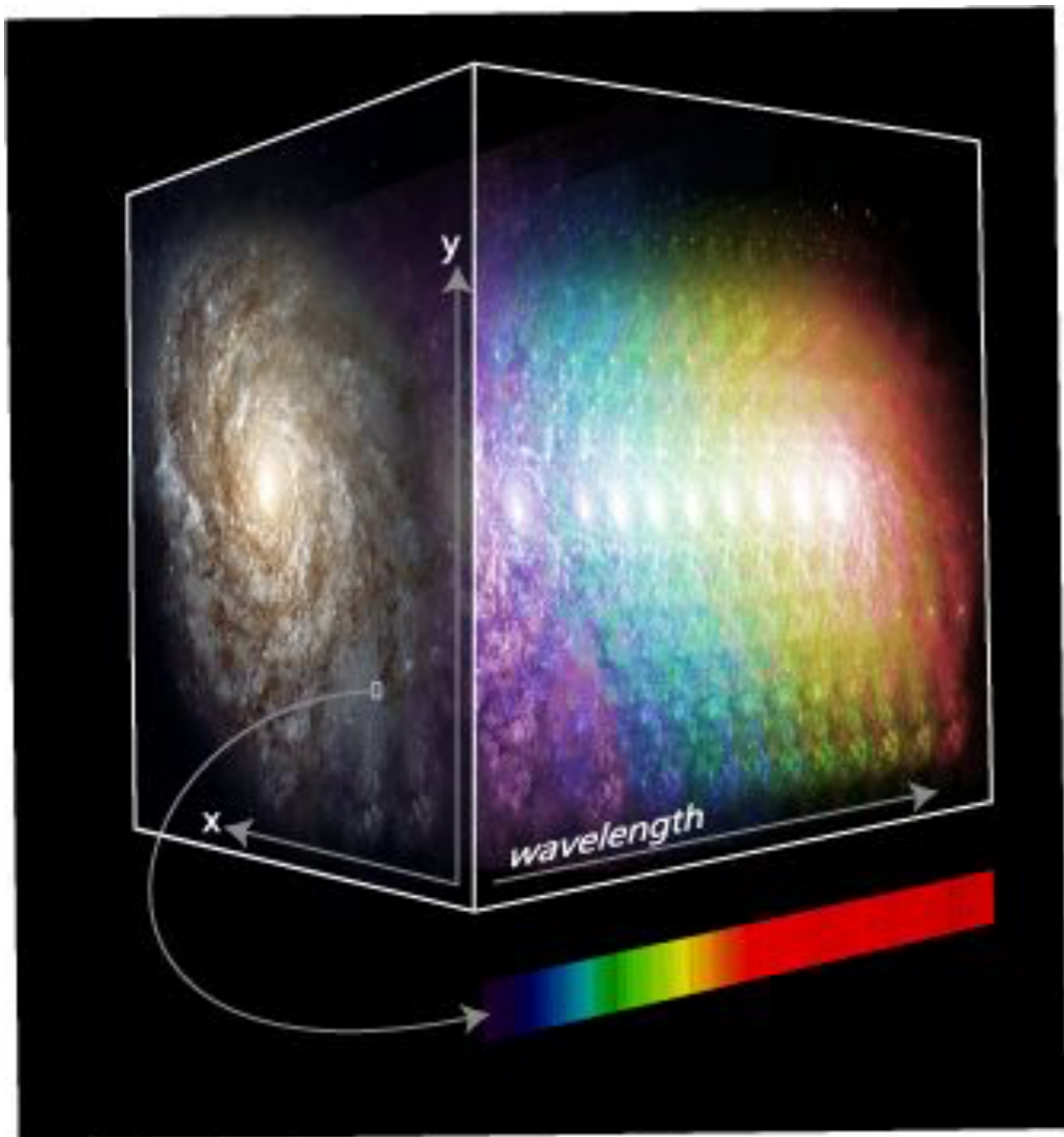
$$R = \frac{\lambda}{\Delta\lambda} = \frac{c}{\Delta\nu}$$



# Fotometria *E* espectroscopia ?

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- Meio termo entre fotometria e espectroscopia
  - Integral Field Spectrographs (cubos de dados)
  - Multispectral / Hyperspectral imaging / Quasi-spectroscopy (usado em agricultura, imagens biomédicas, geociências, física, segurança...)

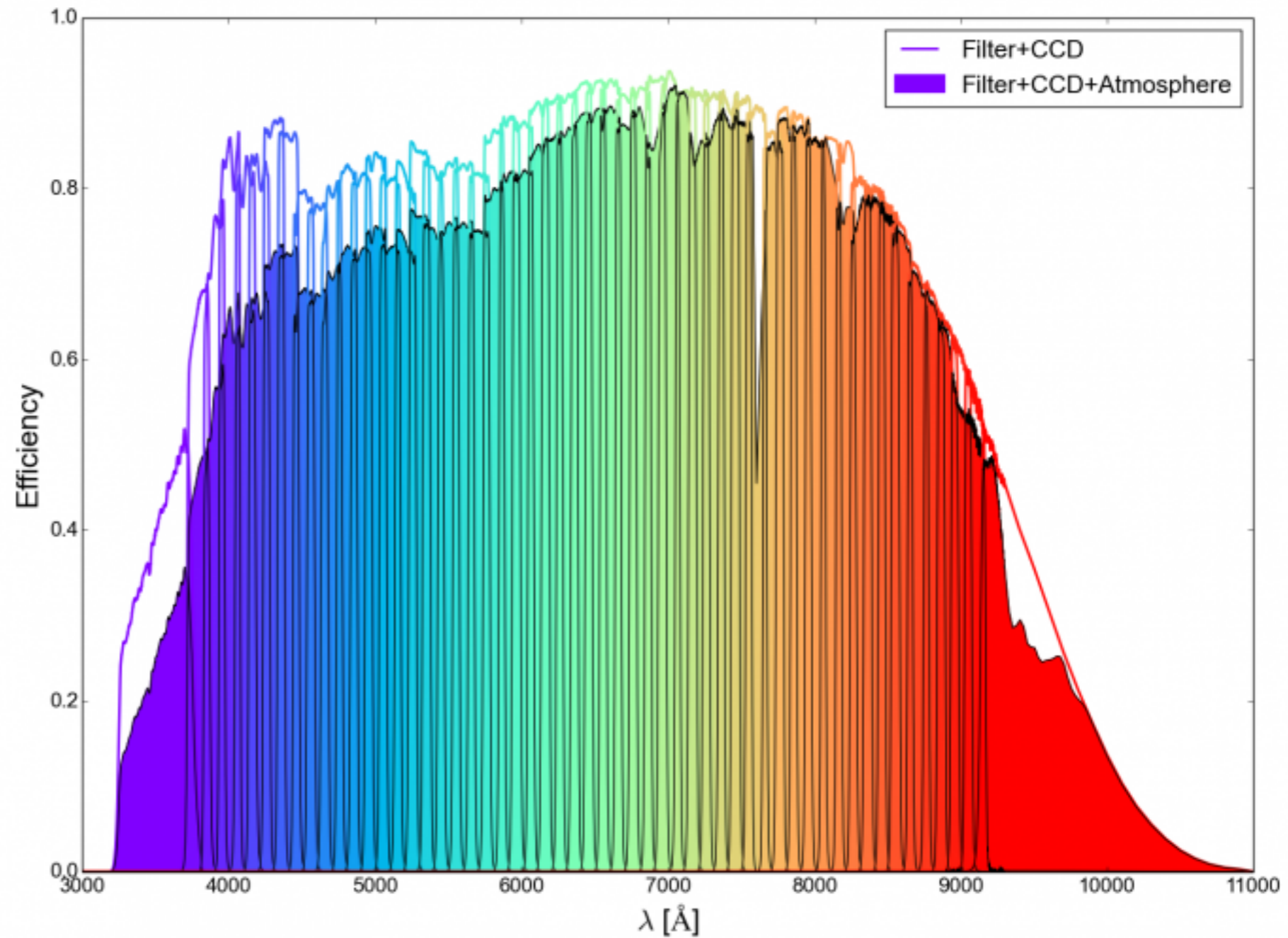
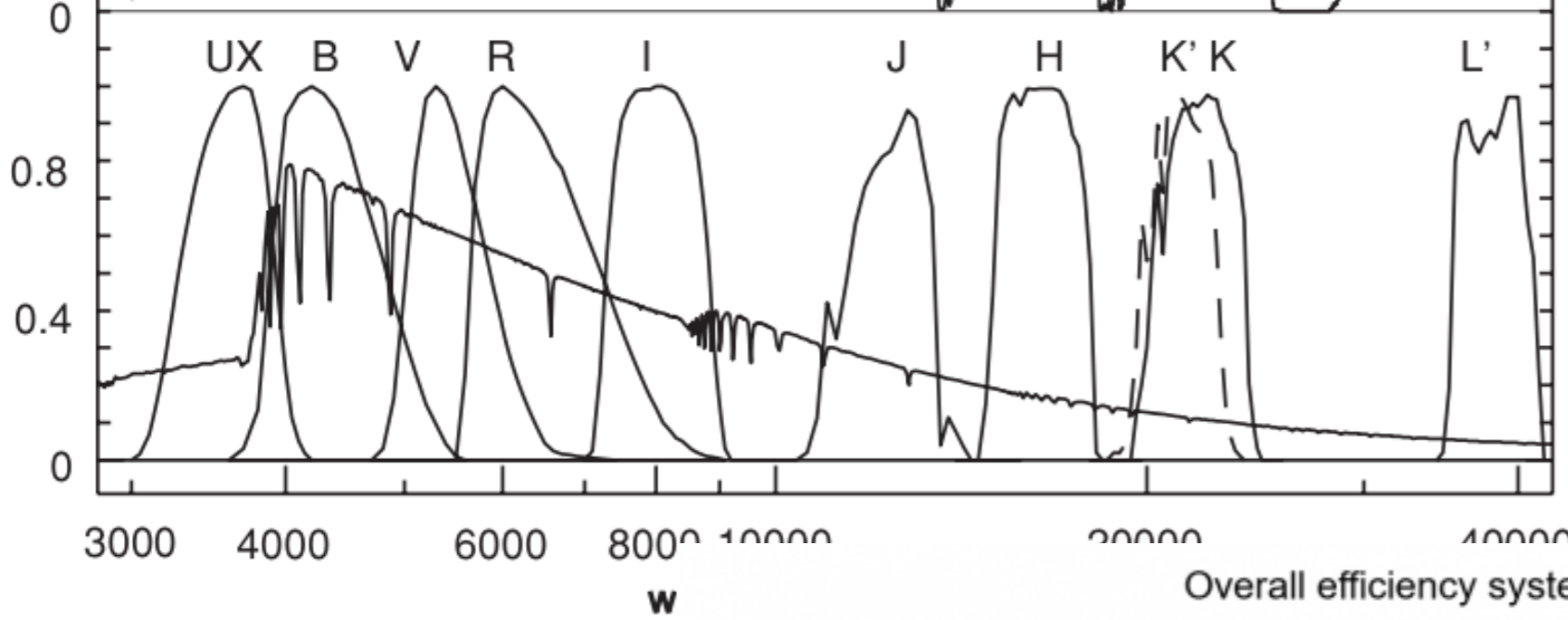


## Data Cubes

<https://angelrls.wordpress.com/2014/10/01/dissecting-galaxies-of-the-local-universe-with-the-califa-survey/>

<http://lsiit-miv.u-strasbg.fr/paseo/cubevisualization.php>

# Multispectral imaging



R ~ 50



a galaxy



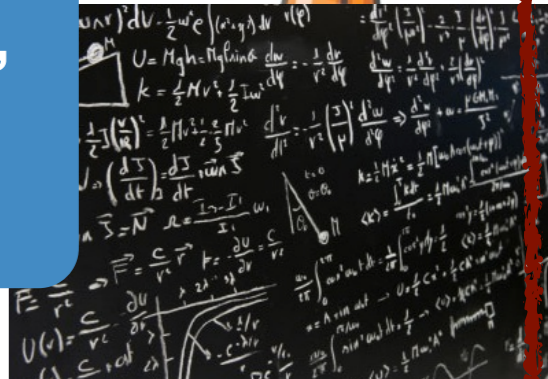
what we think a galaxy is



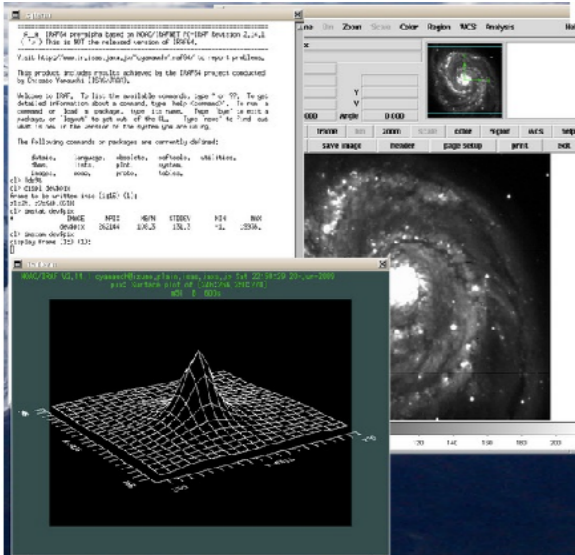
telescope



math. model, numerical algorithm



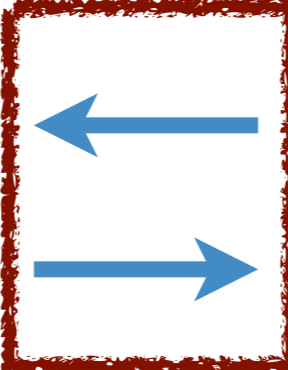
data reduction/processing



computer simulation



observed data



simulated data

knowledge



**espectroscopia**



**fotometria**



**multi-spectral  
imaging**



**IFS**



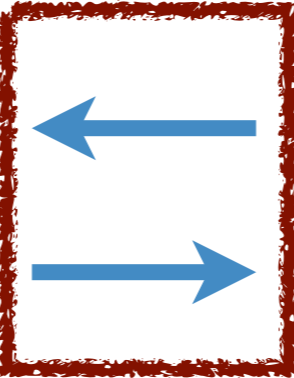
**dados  
(telescópio ou  
surveys, big  
data)**

**modelos,  
teorias físicas**

**processamento  
de dados (ou  
data mining)**

**simulações  
computacionais**

**dados  
observacionais**



**dados  
simulados**

**Estatística, ciência  
da computação**