Photometric Redshifts in Astro-Wise

PhotRedCatalog

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Astro-Wise Workshop Leiden 2008

Introduction

- Photometric redshifts
  deducing redshifts from photometry in multiple optical and NIR filter bands

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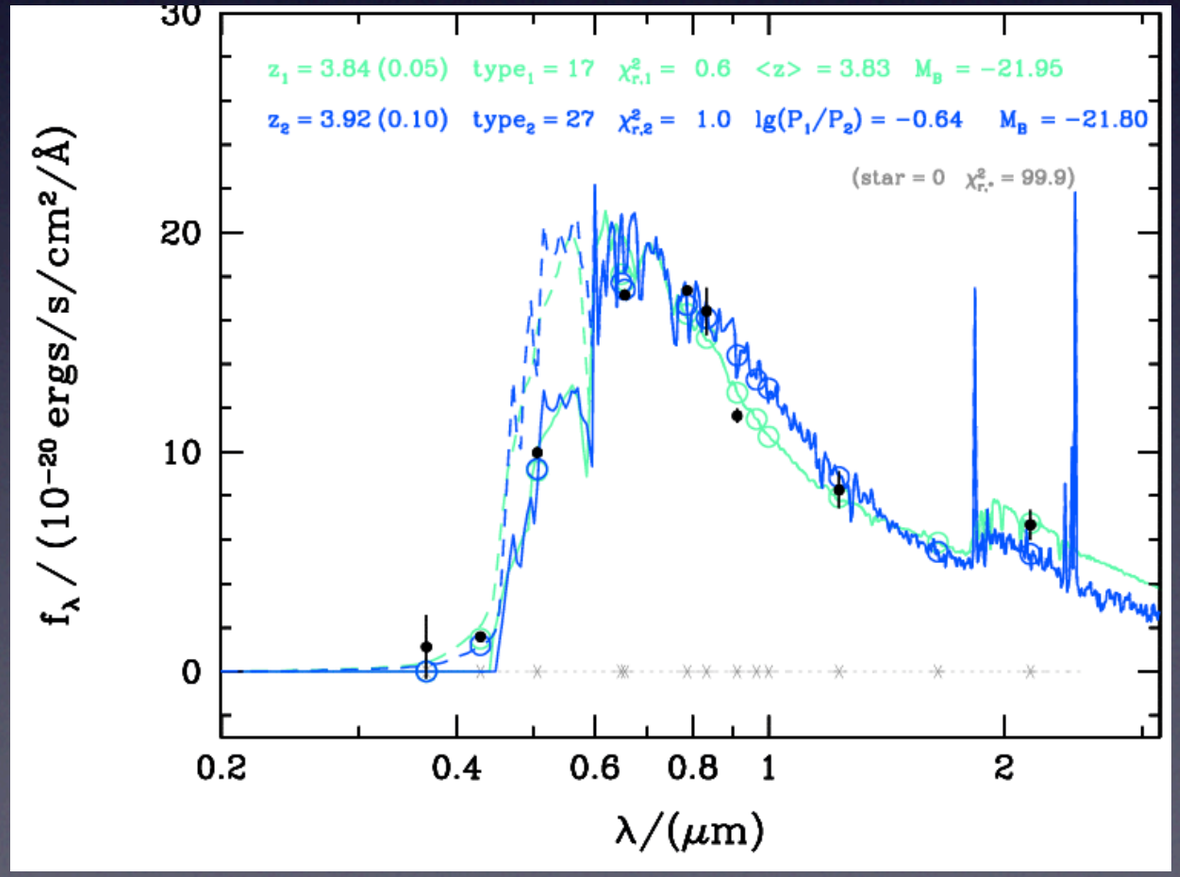
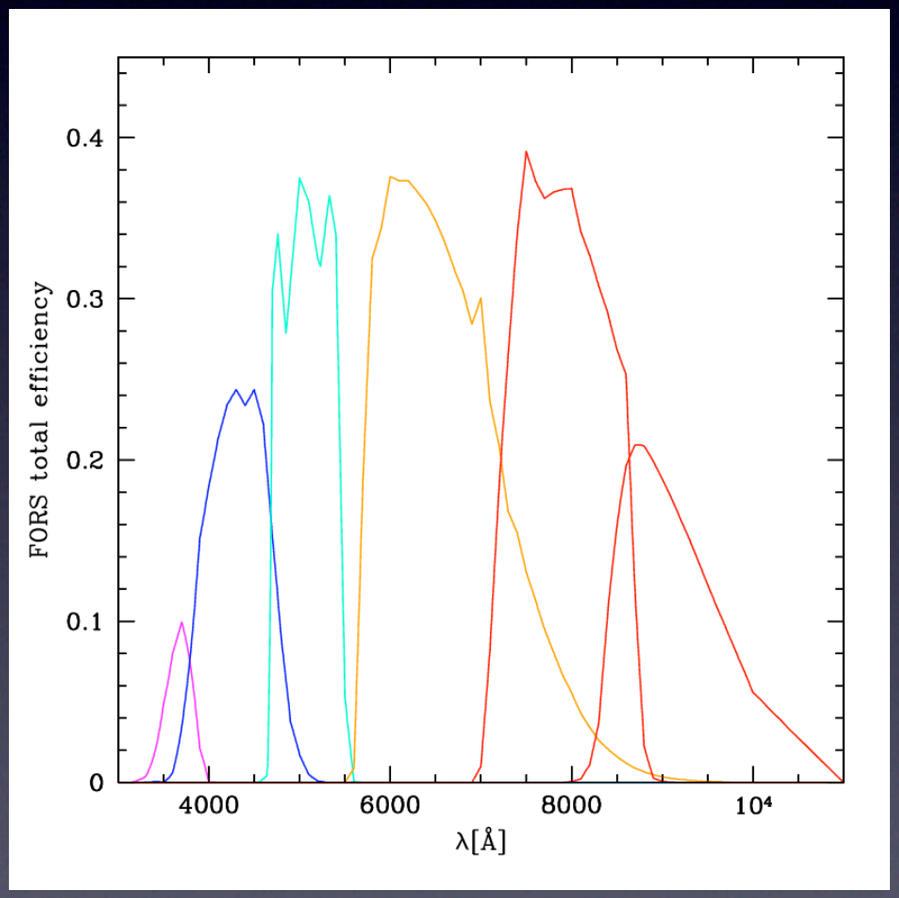


Photometric redshifts

- Redshift estimation and source identification
- Luminoisty function
- Galaxy clusters
- Large scale structures
- Search for special objects (AGNs, L-stars)

Introduction

- Basic method:



Filter curves

* SEDs convolved with observed filters

* Stepped in redshift

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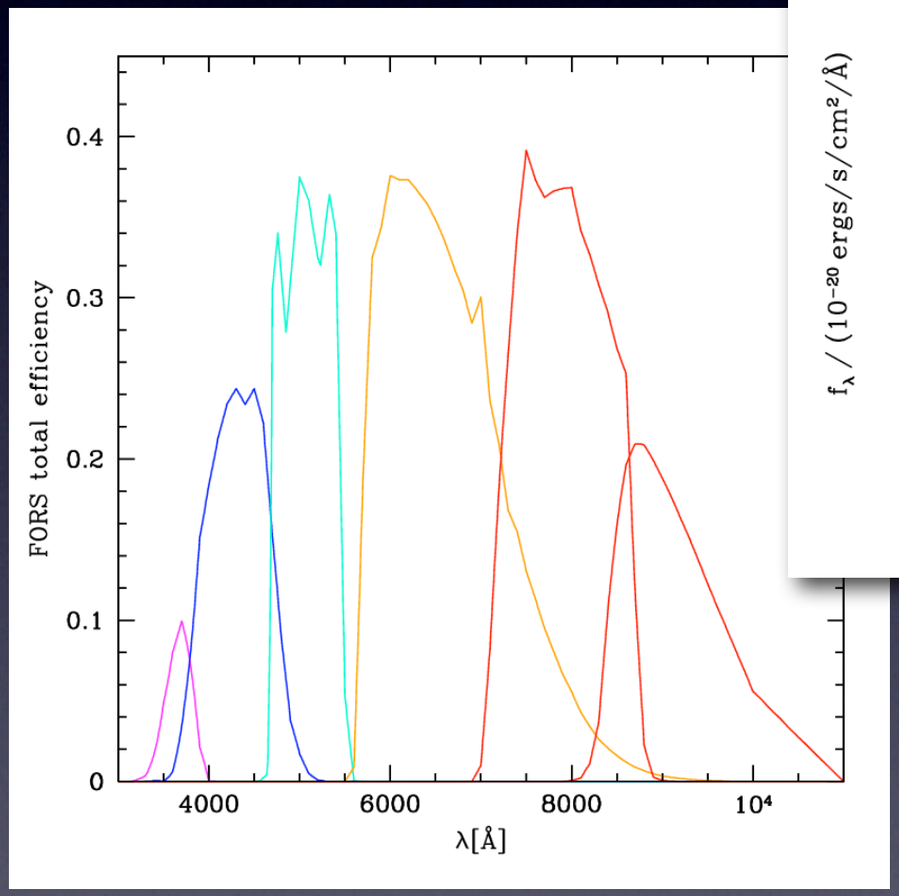
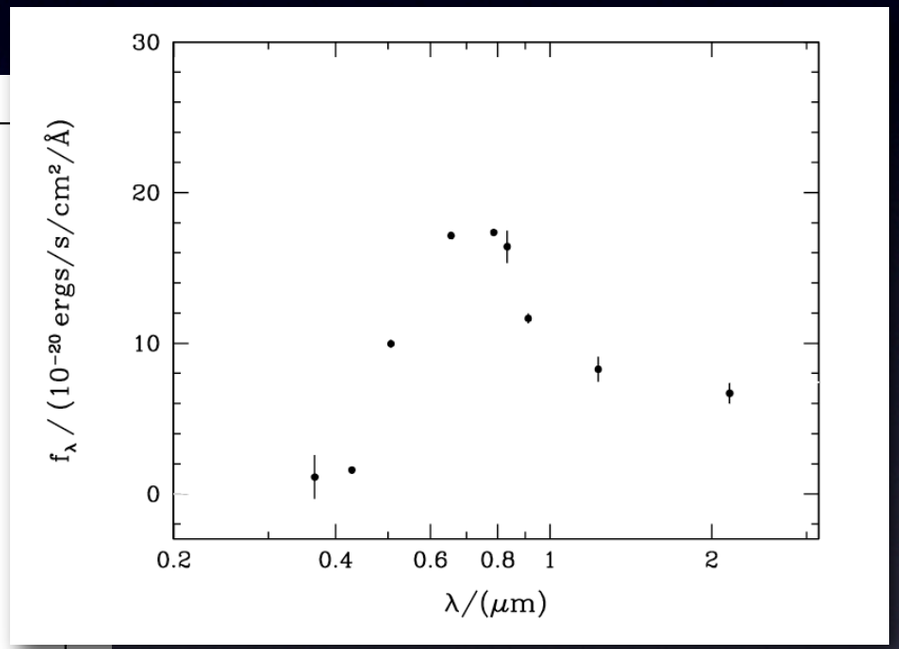


Filter curves



Observed fluxes

* SEDs convolved with observed filters

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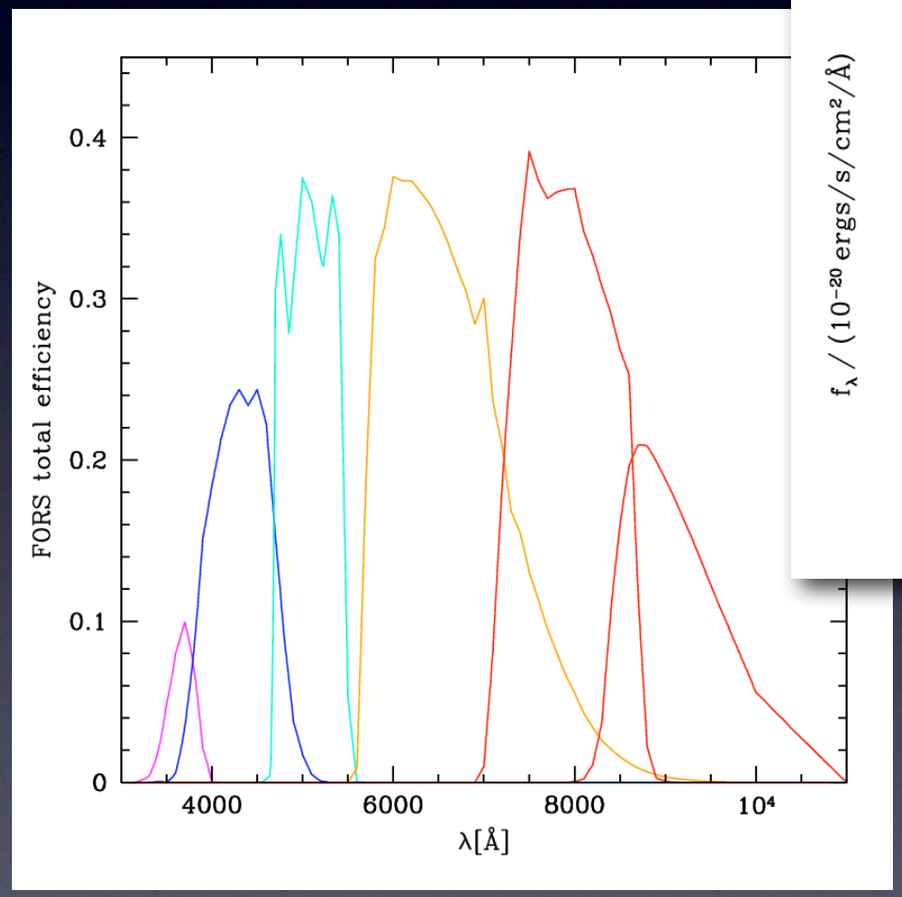
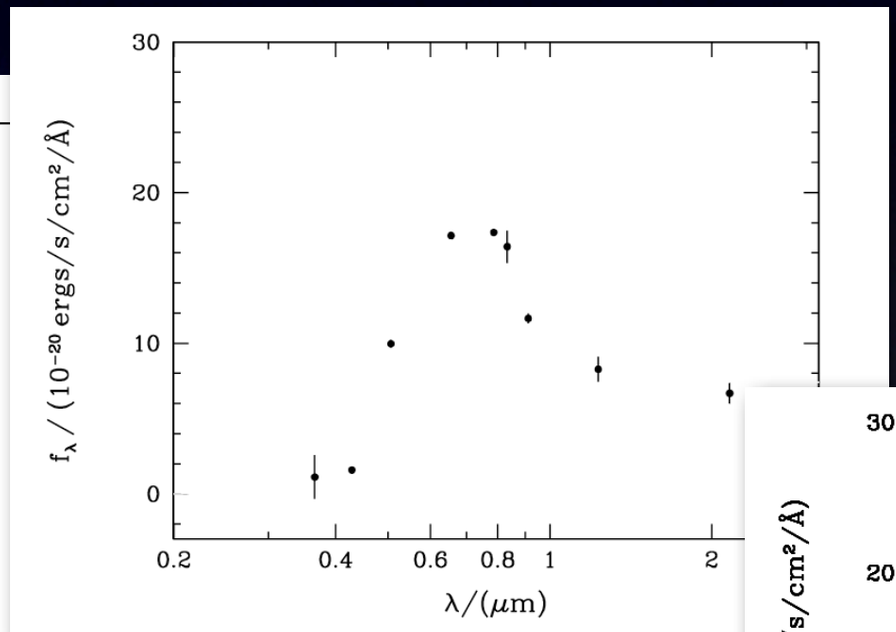


Filter curves



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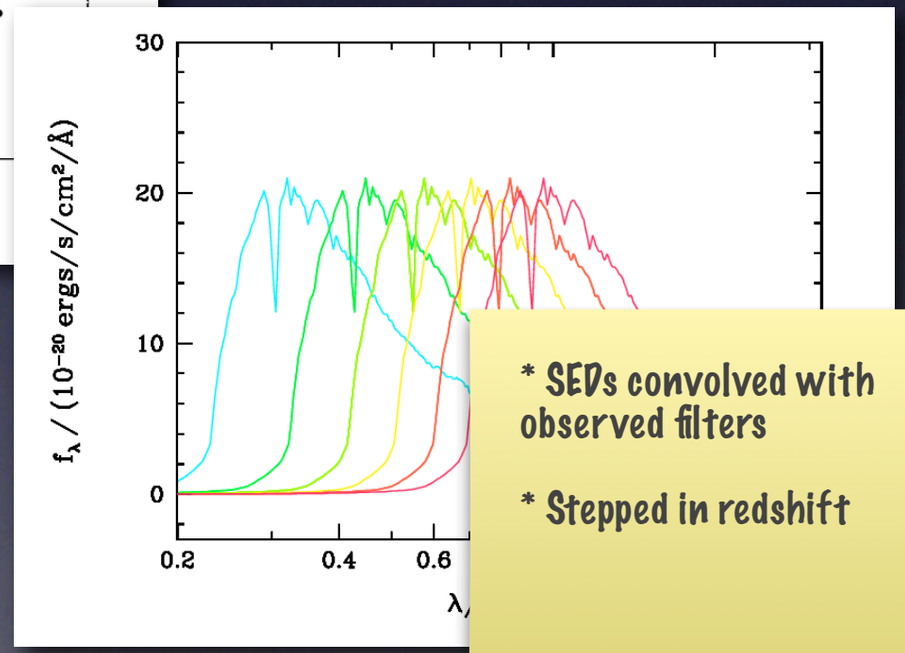

SEDs

* SEDs convolved with observed filters

* Stepped in redshift

Introduction

- Best fitting z and SED are determinded by minimizing:

$$\chi^2(z, SED) = \frac{1}{N_{filt}} \sum_{i=1}^{N_{filt}} \frac{[f_i - \alpha f_i(z, SED)]^2}{\sigma_i^2 + [0.05\alpha f_i(z, SED)]^2}$$

- The probability of a a source being at a given redshift is:

$$P_T = P_\chi \cdot P_L \cdot P_z = e^{-\frac{1}{2}\chi^2} \cdot e^{-k_\beta\left(\frac{M-M_\star}{\sigma}\right)^\beta} \cdot e^{-k_\gamma\left(\frac{z}{z_{lim}}\right)^\gamma}$$

Input files

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- Galactic and stellar SEDs - PhotRedSED

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- Filter transmission curves - PhotRedFilter

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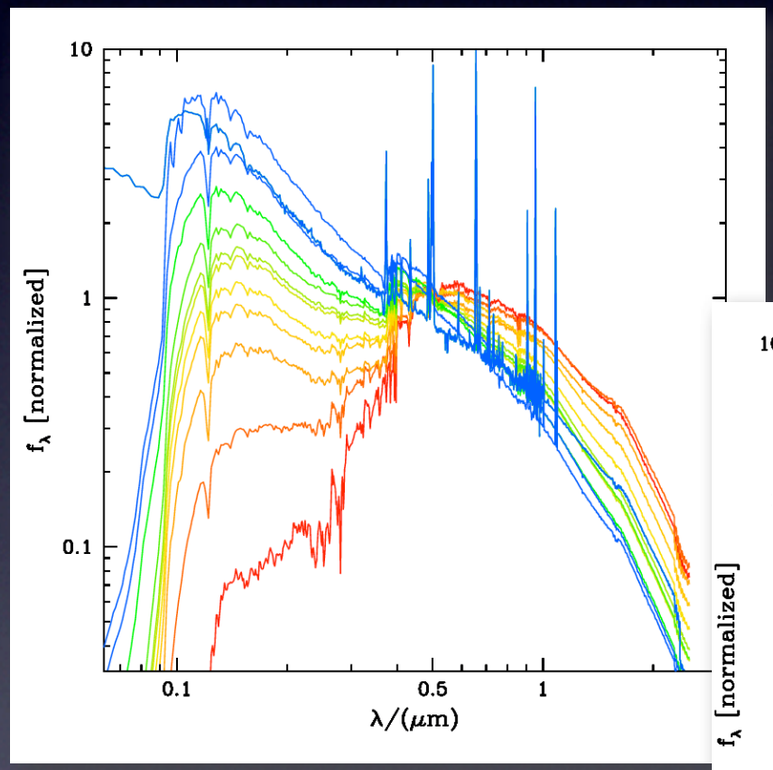
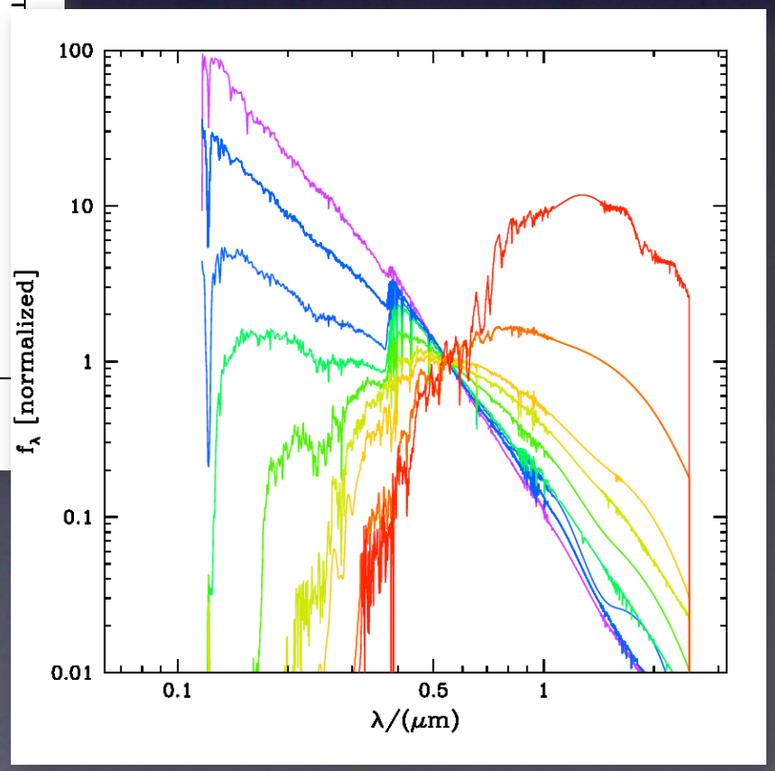
PhotRedSED

- Galactic and stellar SEDs

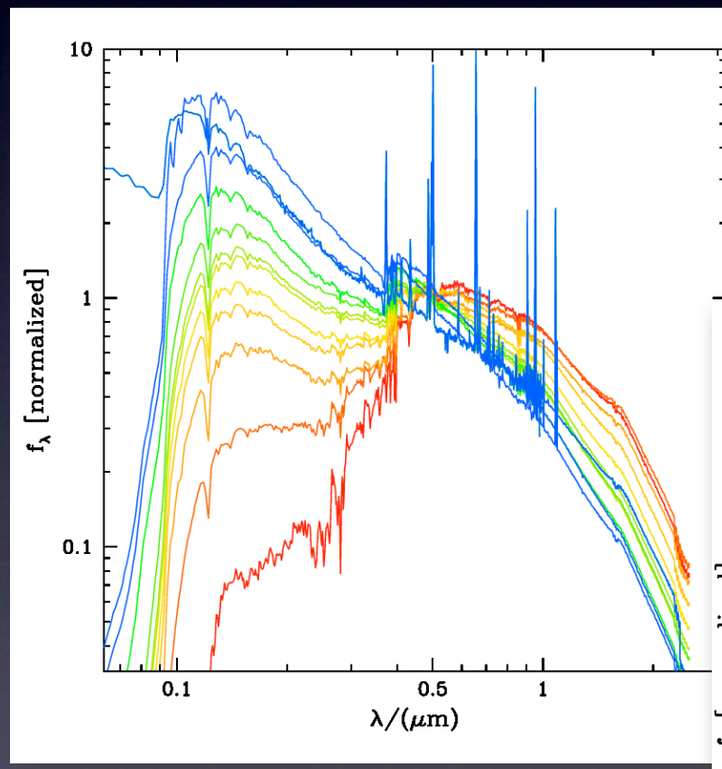


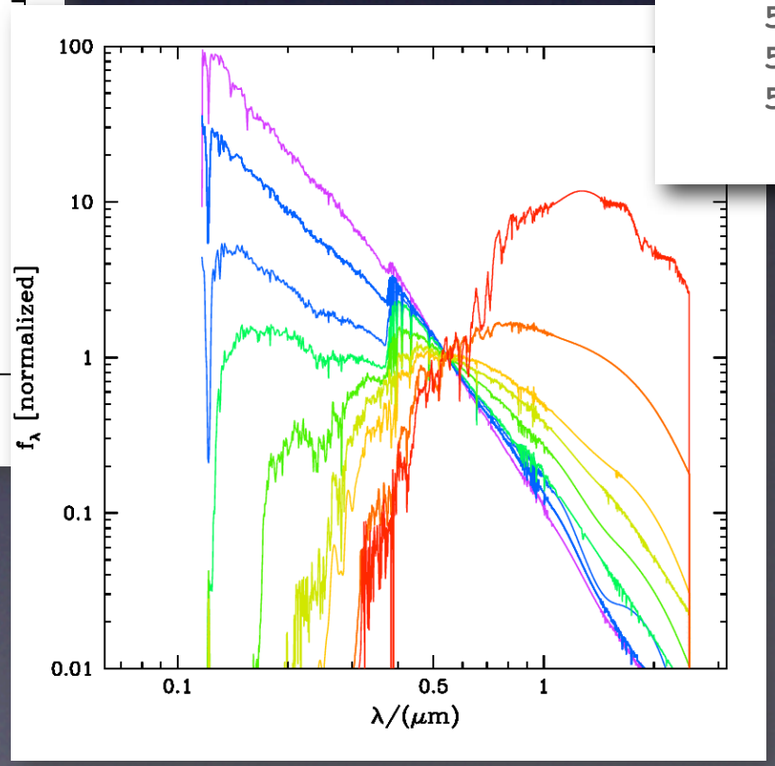


Wavelength and flux

PhotRedSED

- Galactic and stellar SEDs



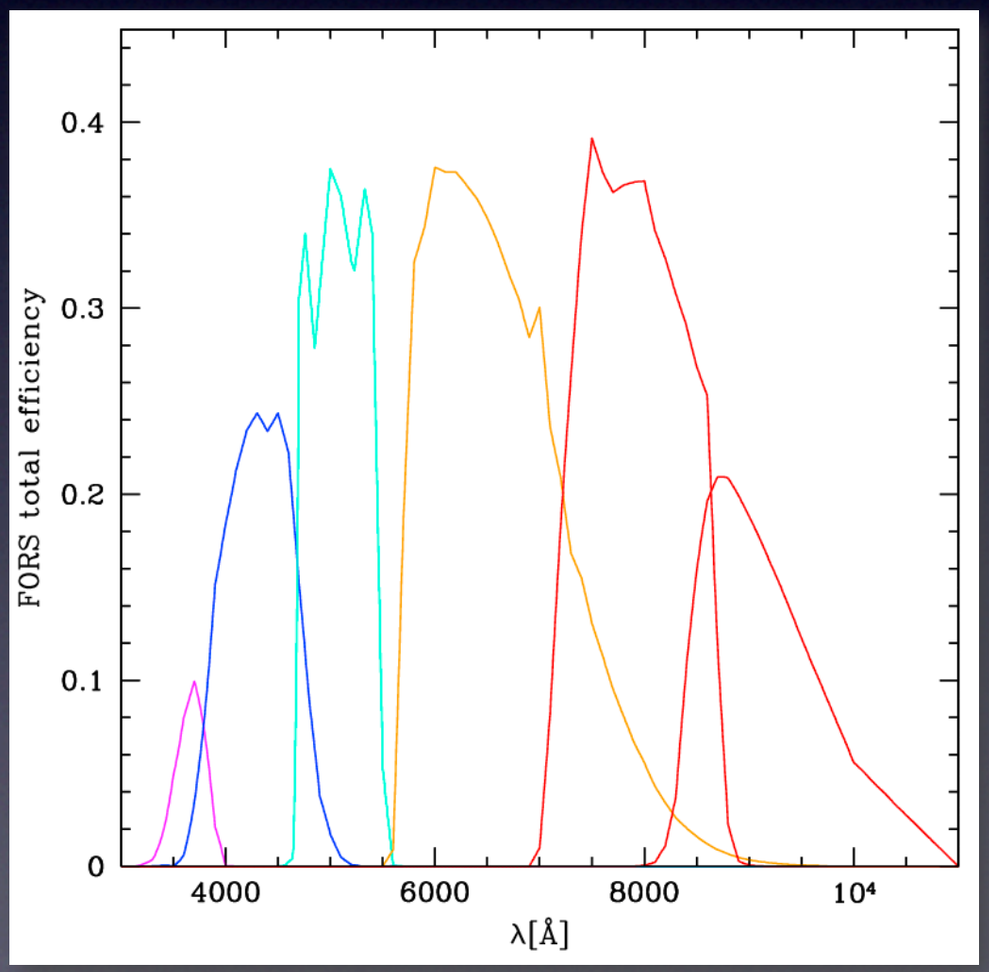


Wavelength and flux

```
# manucci_soc.sed
#    lambda                flux
      ...
     5.39000e+03      1.02960e+00
     5.39500e+03      1.00520e+00
     5.40000e+03      9.91200e-01
     5.40500e+03      9.76800e-01
     5.41000e+03      9.89200e-01
     5.41500e+03      1.01550e+00
     5.42000e+03      1.04220e+00
      ...
```

PhotRedFilter

- Filter transmission curve



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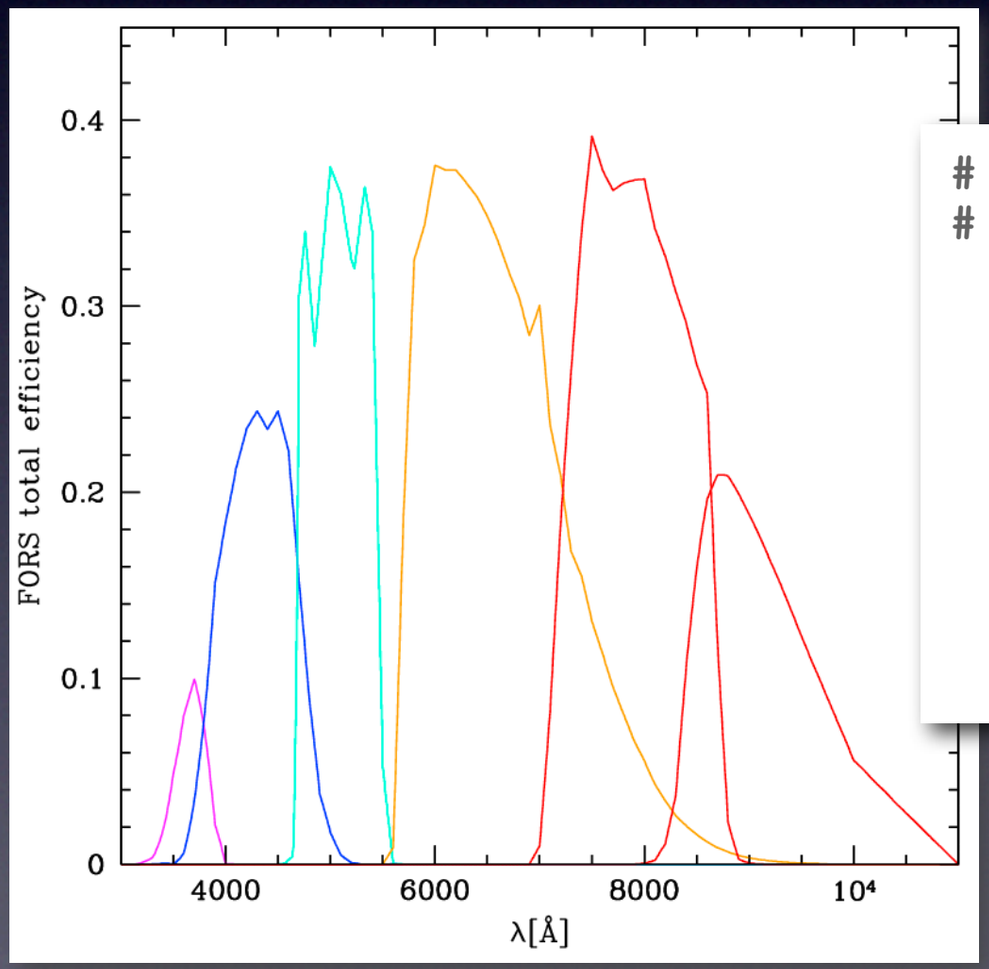


```
# 843.filter
#   wavelength transmission
     ...
     5180      0.8363
     5185      0.84207
     5190      0.8474
     5195      0.8524
     5200      0.85657
     5205      0.86059
     5210      0.86385
     ...
```

Wavelength and transmission

PhotRedConfig

- Convolves SEDs with filter curves
- Needs only to be created once for a combination of SEDs/filters
- Supports up to 15 filters
- The filters used for the photoz run can be a subset of the filters used for config

PhotRedCatalog

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- Uses one “master” detection sourcelist and photometry from the other sourcelists (associating them by their position)
- The use of sourcelists created using the sextractor double image mode is recommended.

PhotRedCatalog

```
RA,DEC,Xpos,Ypos,A,B,POSANG  - Standard photred parameters
obj                          - Object ID
best_z,err_z                 - redshift and error of best fit
mod                          - Model id
rchi2                        - reduced chi^2
z2                           - second best fitting z
lg_Pz2z1                     - Ratio of the probabilities of z2/z
<z>                          - weighted mean of the z distribution

fU,fB,fV,fR,fI,fJ,fH,fK,fF1,fF2,fF3,fF4,fF5,fF6,fF7
M_B,M_R,M_I,M_K              - fluxes of object and derived
absolute magnitudes

DMOD                         - derived distance modulus

f_dat/f_mod                  - Ratio between observed/model flux

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```
RA,DEC,Xpos,Ypos,A,B,POSANG  - Standard photred parameters
obj                          - Object ID
best_star                    - Model id of bestfitting star
rchi2                        - reduced chi²

fU,fB,fV,fR,fI,fJ,fH,fK,
fF1,fF2,fF3,fF4,fF5,fF6,fF7  - object fluxes

f_dat/f_mod                  - Ratio between observed/model flux
```

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```
RA,DEC,Xpos,Ypos,A,B,POSANG  - Standard photred parameters
obj                          - Object ID
best_star                    - Model id of bestfitting star
rchi2                        - reduced chi²

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```

PhotRedCatalog

```
awe>
```

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```
awe> from astro.recipes.PhotRedCatalog import PhotRedCatalogTask

awe>
```

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awe> from astro.recipes.PhotRedCatalog import PhotRedCatalogTask

awe> task=PhotRedCatalogTask(
```

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awe> from astro.recipes.PhotRedCatalog import PhotRedCatalogTask

awe> task=PhotRedCatalogTask( master_sl=1122110,

...
```

PhotRedCatalog

```
awe> from astro.recipes.PhotRedCatalog import PhotRedCatalogTask

awe> task=PhotRedCatalogTask( master_sl=1122110,

...   sls=[1122110,1122111,1122112,1122113],

...
```

PhotRedCatalog

```
awe> from astro.recipes.PhotRedCatalog import PhotRedCatalogTask

awe> task=PhotRedCatalogTask( master_sl=1122110,

...   sls=[1122110,1122111,1122112,1122113],

...   config='WFI_all_filters',
```

PhotRedCatalog

```
awe> from astro.recipes.PhotRedCatalog import PhotRedCatalogTask

awe> task=PhotRedCatalogTask( master_sl=1122110,

...   sls=[1122110,1122111,1122112,1122113],

...   config='WFI_all_filters', min_num_sources=5,
```

PhotRedCatalog

```
awe> from astro.recipes.PhotRedCatalog import PhotRedCatalogTask

awe> task=PhotRedCatalogTask( master_sl=1122110,

...   sls=[1122110,1122111,1122112,1122113],

...   config='WFI_all_filters', min_num_sources=5, name='z_test')

awe>
```

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awe> from astro.recipes.PhotRedCatalog import PhotRedCatalogTask

awe> task=PhotRedCatalogTask( master_sl=1122110,

...   sls=[1122110,1122111,1122112,1122113],

...   config='WFI_all_filters', min_num_sources=5, name='z_test')

awe> task.execute()

awe>
```

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awe> from astro.recipes.PhotRedCatalog import PhotRedCatalogTask

awe> task=PhotRedCatalogTask( master_sl=1122110,

...   sls=[1122110,1122111,1122112,1122113],

...   config='WFI_all_filters', min_num_sources=5, name='z_test')

awe> task.execute()

awe> p=(PhotRedCatalog.name=='z_test')[0]

awe>
```

PhotRedCatalog

```
awe> from astro.recipes.PhotRedCatalog import PhotRedCatalogTask

awe> task=PhotRedCata

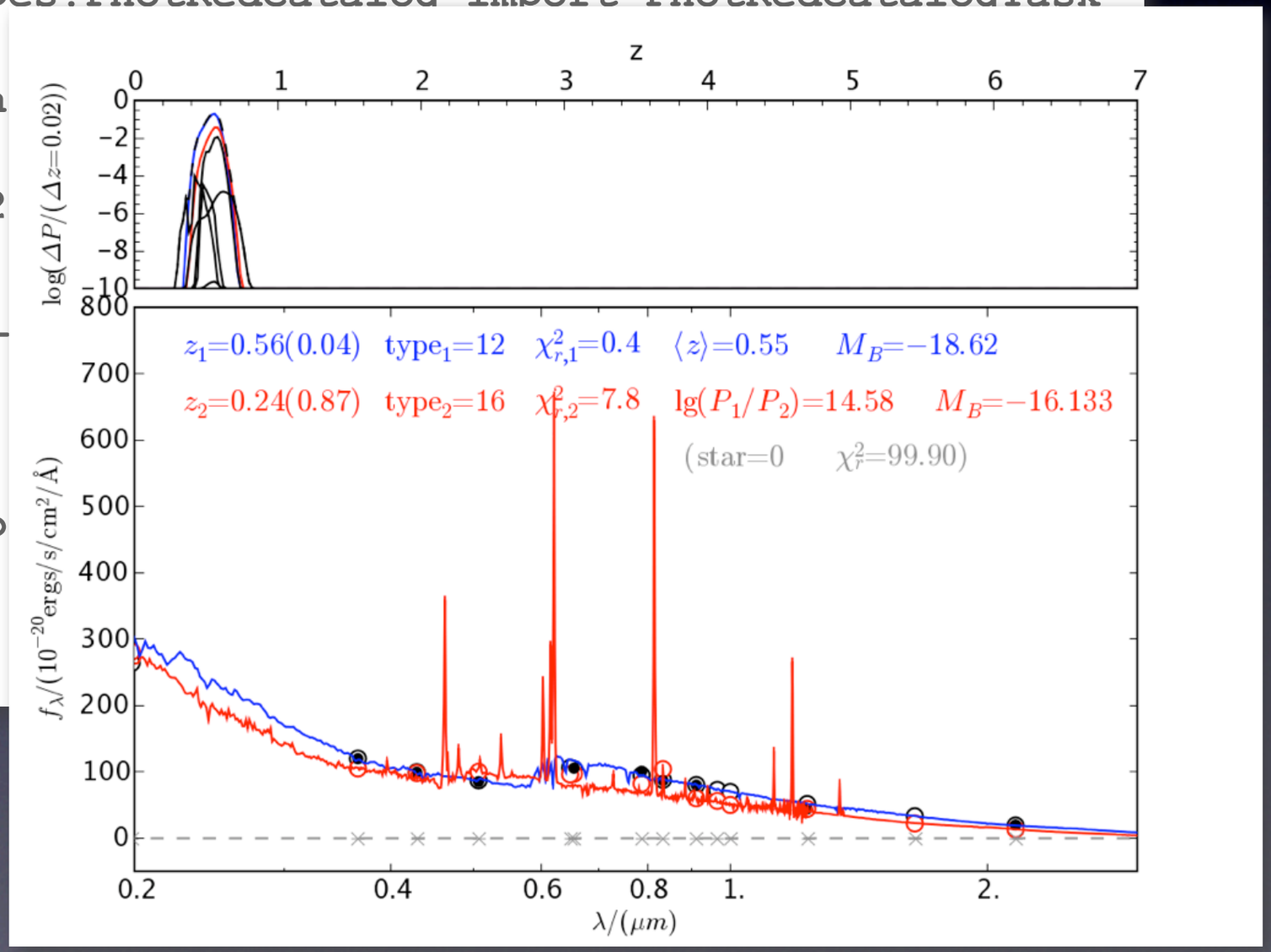
...   sls=[1122110,112

...   config='WFI_all_

awe> task.execute()

awe> p=(PhotRedCatalo

awe> p.plot(23)
```



Caveats

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- Adequate spectral coverage is needed, i.e. at least 4-5 filters, including NIR

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- SEDs degenerate for certain redshifts

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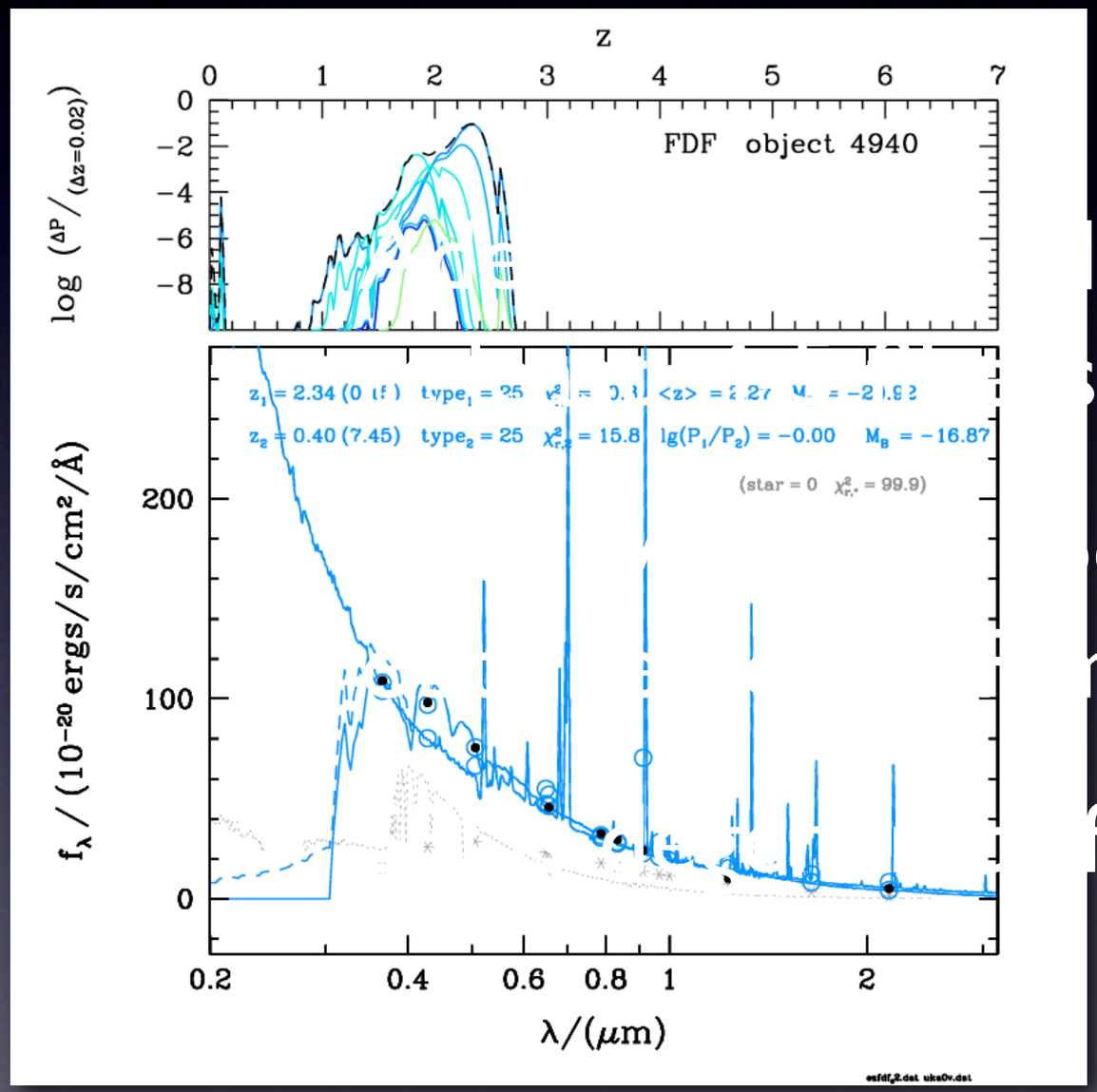
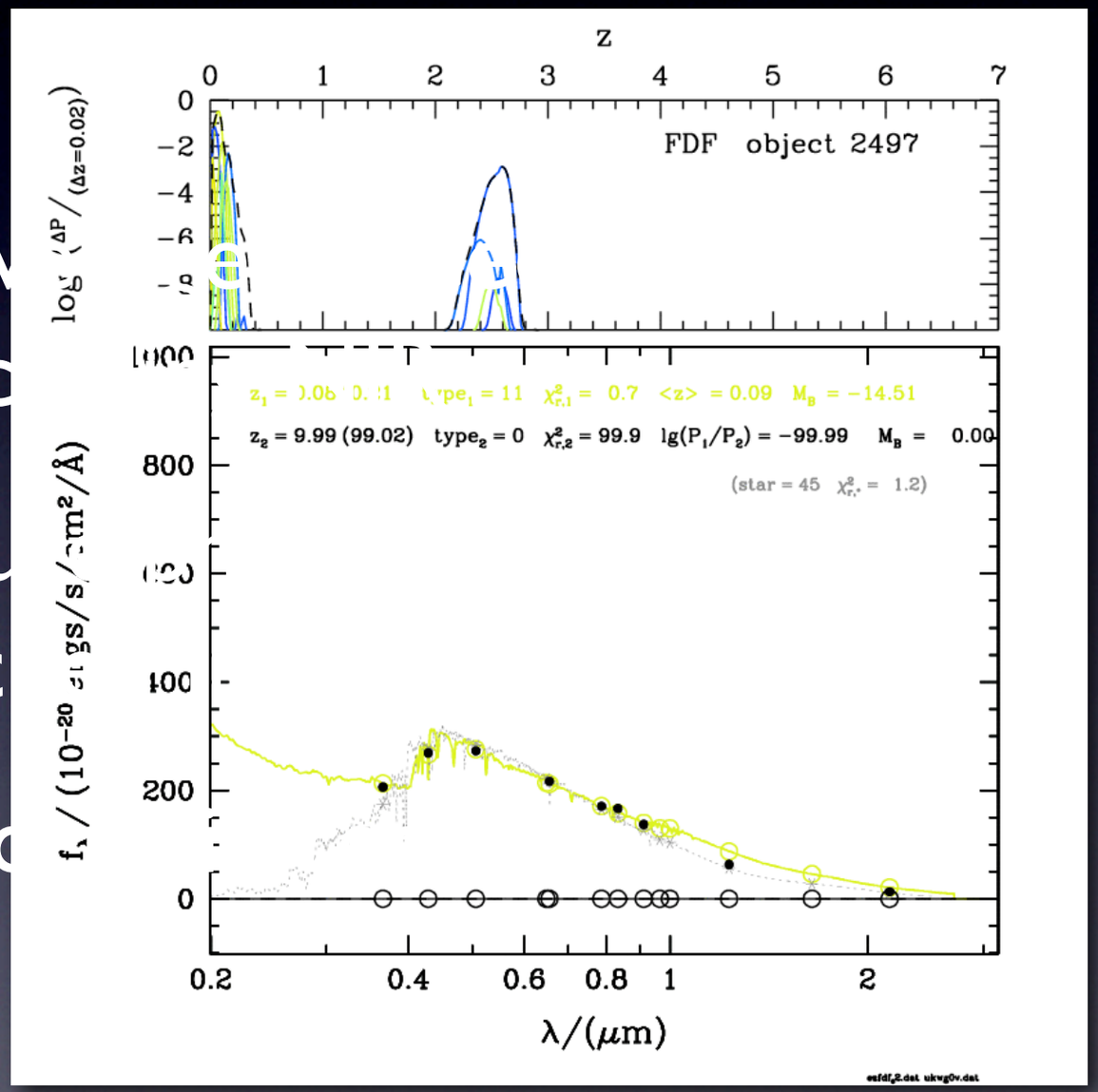

z
FDF object 4940
log (ΔP/(Δz=0.02))
z1 = 2.34 (0.[illegible]) type1 = 25 χ²r,1 = 0.1 <z> = 2.27 MB = −21.82
z2 = 0.40 (7.45) type2 = 25 χ²r,2 = 15.8 lg(P1/P2) = −0.00 MB = −16.87
(star = 0 χ²r,* = 99.9)
fλ / (10⁻²⁰ ergs/s/cm²/Å)
λ/(μm)
esfdf_2.dat uke0v.dat


z
FDF object 2497
log (ΔP/(Δz=0.02))
z1 = 0.06 0.11 type1 = 11 χ²r,1 = 0.7 <z> = 0.09 MB = −14.51
z2 = 9.99 (99.02) type2 = 0 χ²r,2 = 99.9 lg(P1/P2) = −99.99 MB = 0.00
(star = 45 χ²r,* = 1.2)
fλ / (10⁻²⁰ ergs/s/cm²/Å)
λ/(μm)
esfdf_2.dat ukwg0v.dat

News

- Photoz code and FDF SED set available in the federated AW system

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- Recipe now available, parallel version planned

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- Move of photoz code to new codebase this summer