

Modelling filters for theoretical data

Carlos Rodrigo Blanco
Enrique Solano

LAEFF-CAB-INTA,
Spanish Virtual Observatory

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Outline

- 1 Problems
 - VOSA
 - VO Photometry
 - Synthetic Photometry

- 2 Solutions?
 - Unified Filter Identification
 - Filter Information Service
 - Synthetic Photometry Service

VOSA

At the Spanish VO we have developed VOSA, a tool that

- Reads user photometry tables.
- Queries VO photometry catalogs to improve/complete the observed SED.
- Fits observed data with synthetic photometry derived from VO-compliant theoretical spectra and estimate physical parameters for the objects.
- etc

<http://svo.laeff.inta.es/theory/vosa>
talk on Wednesday morning.



VO Photometry

- There is little in VO standards about this
 - Spectral data model.
- Important efforts are being done on these subjects
 - Photometry data model.
 - EuroVO-AIDA work package: European coordinated effort.
 - Provenance/characterization data model.
 - etc
- Here we will try to show what we have learned during the development of VOSA.
 - The problems found
 - Our approaches to "solve" them.

VO Photometry

When we look for observed photometry in the VO we find:

```

-<FIELD name="Rmag" ucd="phot.mag;em.opt.R" datatype="float" width="6" precision="3"
unit="mag">
  <!-- ucd="PHOT_PHO_R" -->
  <DESCRIPTION>?Red magnitude</DESCRIPTION>
  <VALUES null=""/>
</FIELD>
-<FIELD name="r_Rmag" ucd="meta.ref;pos.frame" datatype="char">
  <!-- ucd="REFER_000E" -->
  <DESCRIPTION>[BCMYThe] Origin of Rmag (3)</DESCRIPTION>
</FIELD>
-<FIELD name="Jmag" ucd="phot.mag;em.IR.J" datatype="float" width="6" precision="3"
unit="mag">
  <!-- ucd="PHOT_PHO_J" -->
  <DESCRIPTION>?Infrared J magnitude (from 2MASS)</DESCRIPTION>
  <VALUES null=""/>
</FIELD>
-<FIELD name="Hmag" ucd="phot.mag;em.IR.H" datatype="float" width="6" precision="3"
unit="mag">
  <!-- ucd="PHOT_PHO_H" -->
  <DESCRIPTION>?Infrared H magnitude (from 2MASS)</DESCRIPTION>
  <VALUES null=""/>
</FIELD>

```

- Magnitudes.
 - We need to transform them to flux densities.
- A generic description of the photometric band.
 - Not enough in many cases.

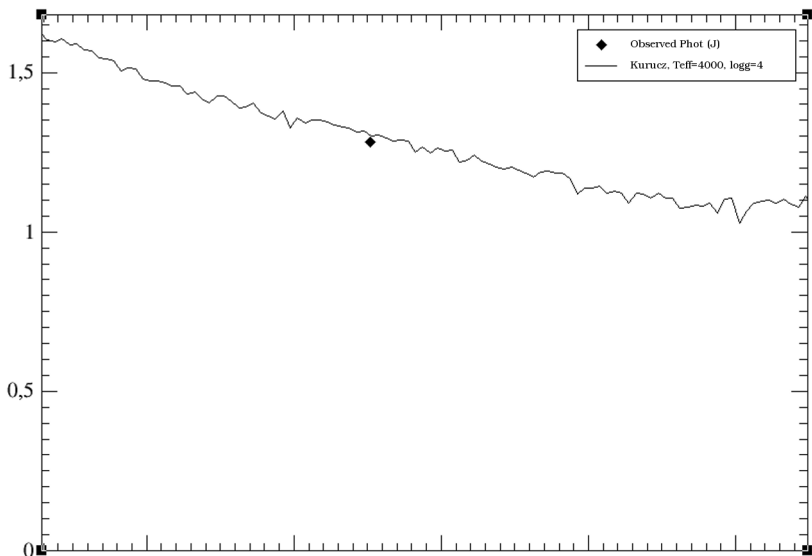


Observed/Synthetic Photometry

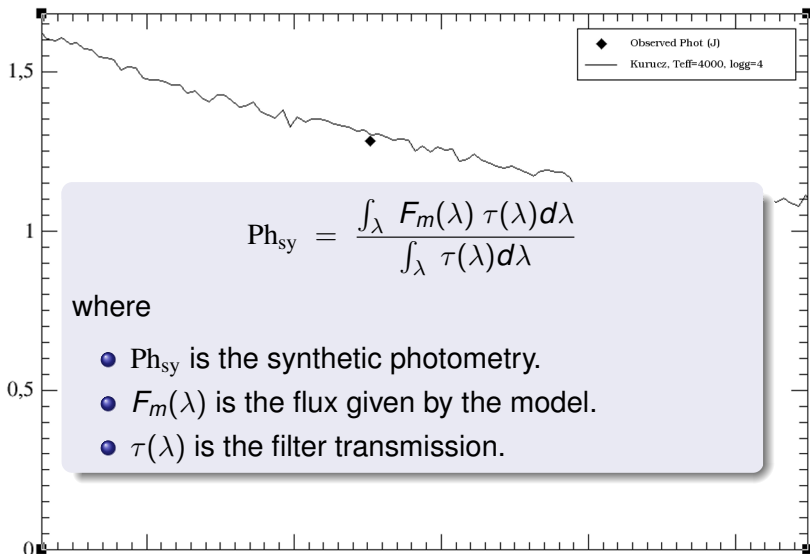
We need more details about the specific filter corresponding to an observed photometric value.

- Transform observed magnitudes to flux densities
 - Filter Zero Point.
- Calculate synthetic photometry:
 - Filter Transmission curve
- phot.mag;em.IR.J is not enough.
 - 2MASS J? UKIDSS J? ...

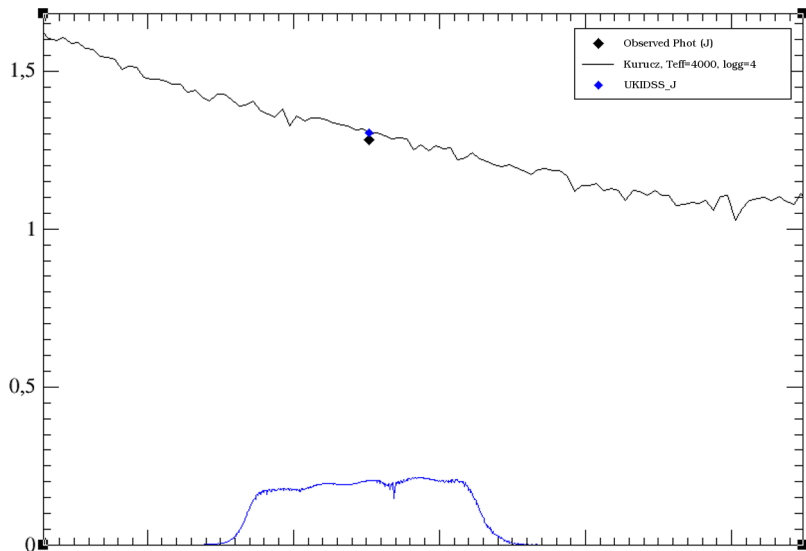
Synthetic Photometry.



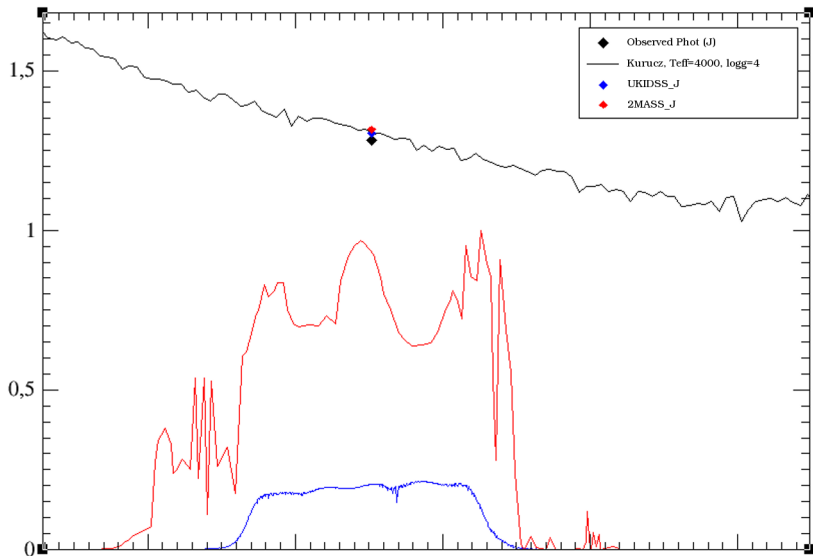
Synthetic Photometry.



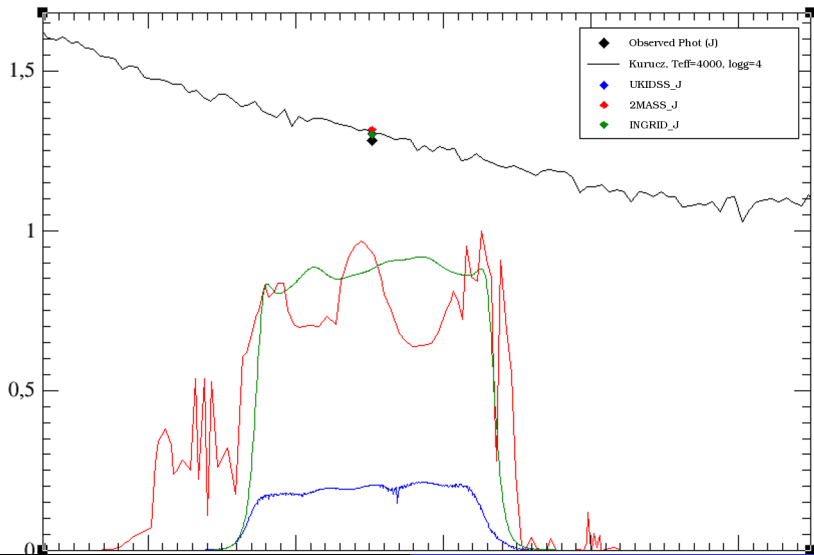
Synthetic Photometry.



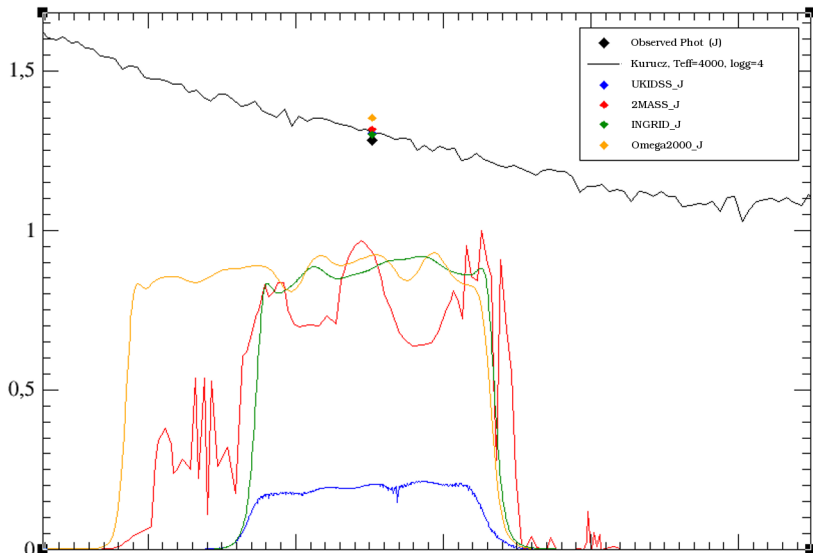
Synthetic Photometry.



Synthetic Photometry.



Synthetic Photometry.





What we need

We need:

- A unified way to name and identify filters
- A way to retrieve information about a filter from its name.



Unified Filter Identification

In practice, in order to describe a particular filter, it is common to say:

- the observational facility to which it corresponds
- and then the filter name.

For instance, it is enough to say

- "H from 2MASS" ,
- "V from Tycho" or
- "24 micron from MIPS".



Unified Filter Identification

We use a similar convention:

FILTERGROUP_FILTERNAME

where FILTERGROUP is a generic way to describe a group of filters as we usually label them. It could be a word describing

- an instrument (IRAC, BUSCA, OMEGA2000, MIPS,...),
- a survey (2MASS, SDSS, DENIS, IPHAS, UKIDSS,...),
- a telescope (KPNO,...)
- an spacial mission (GAIA, HIPPARCOS,...)
- or even a more generic label (STROMGREN, TYCHO,...).



UFI: Unified Filter Id

- For instance, we would have:
 - 2MASS_H
 - 2MASS_J
 - KPNO_b
 - KPNO_v
 - TYCHO_V
 - MIPS_24m

- this could be used, for instance, as a word in a UCD:
 - `ucd="phot.mag;2MASS_H"`



Filter Information Service

A VO service to retrieve information about a filter

- Query the service by filter UFI
- Obtain a VOTable with the relevant information:
 - Zero Point
 - Effective wavelength
 - ...
 - The transmission curve

(Similar to NVO filter service but using UFIs.)

Filter Information Service

Spanish Virtual Observatory - Theoretical models

Funded by



Filter information

Theoretical spectra

- Daliesio ▶
- Coelho ▶
- NextGen ▶
- cond00 ▶
- dusty00 ▶
- Kurucz ▶

Services

- Filters ▶
- TSAP ▶
- VOSA ▶
- Isochrones ▶

Label	λ_{eff}	F_0 (Jy)	A_V/A_V	Descrip	Reference
2MASS_H	16504	1115.71	0.19	2MASS H	Cohen 2003
2MASS_J	12518	1636.77	0.3	2MASS J	Cohen 2003
2MASS_Ks	21539	671.53	0.13	2MASS K	Cohen 2003
BUSCA_b	4658.27	4270.11	1.23	BUSCA b	BUSCA
BUSCA_u	3571.67	4764.38	1.59	BUSCA u	BUSCA
BUSCA_v	4123.49	4881.93	1.39	BUSCA v	BUSCA
BUSCA_y	5488.49	3703.7	1	BUSCA y	BUSCA
CFHT_G	4877.37	3952	1.17	CFHT G	Bessel 1979
CFHT_I	8228	2550	0.58	CFHT I	Bessel 1979
CFHT_R	6582	3080	0.8	CFHT R	Bessel 1979
CFHT_U	3823.29	2640	1.5	CFHT U	Bessel 1979
CFHT_Z	8827.98	2180	0.52	CFHT Z	Bessel 1979
DENIS_J	8044	2550	0.6	Denis I	
GAIA_BP	5439.39	0	1.02	GAIA BP	
GAIA_G	6716.07	0	0.78	GAIA G	
GAIA_GRVs	8605.93	0	0.54	GAIA GRVs	
GAIA_FP	8005.39	0	0.61	GAIA FP	
HIPPARCOS	5275.1	3748	1.06	HIPPARCOS	The HIPPARCOS and TYCHO catalogues
INGRID_H	16440	1115.71	0.19	INGRID H	INGRID
INGRID_J	12549	1636.77	0.3	INGRID J	INGRID
INGRID_Ks	21704	671.53	0.12	INGRID K	INGRID
IPHAS_g1	7746	6052	0.64	IPHAS Gunn I	González-Solares et al 2008
IPHAS_gR	6230.09	5056	0.87	IPHAS Gunn R	González-Solares et al 2008
IPHAS_Ha	6568.17	5808	0.81	IPHAS Halpha	González-Solares et al 2008
IRAC_I1	35634	280.9	0.07	IRAC Channel 1	Spitzer
IRAC_I2	45110	179.7	0.05	IRAC Channel 2	Spitzer
IRAC_I3	57593	115	0.04	IRAC Channel 3	Spitzer
IRAC_I4	79594	64.13	0.04	IRAC Channel 4	Spitzer
KPNO_b	4727.71	4270.11	1.21	KPNO b	KPNO
KPNO_u	3534.22	4764.38	1.61	KPNO u	KPNO
KPNO_v	4101.58	4881.93	1.4	KPNO v	KPNO
KPNO_y	5506.53	3703.7	1	KPNO y	KPNO
UBV	22840	7.17	0.02	UBV	Spitzer

Filter Information Service

The query

http://svo.laeff.inta.es/theory/filters/sfip.php?UFI=2MASS_H

The answer

```
<VOTABLE version="1.1" xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.1">
  <INFO name="QUERY_STATUS" value="OK"/>
  <RESOURCE type="results">
    <PARAM name="UFI" ucd="meta.id;instr.filter" value="2MASS_H" datatype="char" arraysize="**"/>
    <PARAM name="WavelengthEff" ucd="em.wl.effective" unit="Armstrong" value="16504" datatype="float"/>
    <PARAM name="ZeroPoint" ucd="phot.mag;arith.zp" unit="Jy" value="1115.71" datatype="float"/>
    <PARAM name="AFav" ucd="" unit="" value="0.19" datatype="float"/>
    <PARAM name="Description" ucd="meta.note" unit="" value="2MASS H" datatype="char" arraysize="**"/>
    <PARAM name="Reference" ucd="" unit="" value="" datatype="char" arraysize="**"/>
  <TABLE>
    <FIELD name="Wavelength" ucd="em.wl" unit="Armstrong" datatype="float"/>
    <FIELD name="Transmission" ucd="phys.transmission" unit="" datatype="float"/>
    <DATA>
      <TABLEDATA>
        <TR>
          <TB>12890.0</TB>
          <TB>0.000000000</TB>
        </TR>
        <TR>
          <TB>13150.0</TB>
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        </TR>
        <TR>
          <TB>13410.0</TB>
          <TB>0.000000000</TB>
        </TR>
        <TR>
          <TB>13680.0</TB>
          <TB>0.000000000</TB>
        </TR>
        <TR>
          <TB>13970.0</TB>
          <TB>0.000000000</TB>
        </TR>
      </TABLEDATA>
    </DATA>
  </TABLE>
</RESOURCE>
</VOTABLE>
```

Filter Information Service

The query

http://svo.laeff.inta.es/theory/filters/sfip.php?UFI=2MASS_H

The answer

```
<VOTABLE version="1.1" xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.1">
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    <PARAM name="WavelengthEff" ucd="em.wl.effective" unit="Armstrong" value="16504" datatype="float"/>
    <PARAM name="ZeroPoint" ucd="phot.mag;arith.zp" unit="Jy" value="1115.71" datatype="float"/>
    <PARAM name="AFav" ucd="" unit="" value="0.19" datatype="float"/>
    <PARAM name="Description" ucd="meta.note" unit="" value="2MASS H" datatype="char" arraysize="**"/>
    <PARAM name="Reference" ucd="" unit="" value="" datatype="char" arraysize="**"/>
  <TABLE>
    <FIELD name="Wavelength" ucd="em.wl" unit="Armstrong" datatype="float"/>
    <FIELD name="Transmission" ucd="phys.transmission" unit="" datatype="float"/>
    <DATA>
      <TABLEDATA>
        <TR>
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        </TR>
        <TR>
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        </TR>
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        <TR>
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          <TB>0.0000000000</TB>
        </TR>
        <TR>
          <TB>13970.0</TB>
          <TB>0.0000000000</TB>
        </TR>
      </TABLEDATA>
    </DATA>
  </TABLE>
</RESOURCE>
</VOTABLE>
```




Synthetic Photometry Service

A VO service to retrieve synthetic photometry for theoretical spectra.


- Query the service by:
 - Theoretical model
 - (Optionally, theoretical model param ranges)
 - List of filter UFs.
- Obtain a VOTable with the synthetic photometric values.
- Using S3 protocol for theoretical data.

Synthetic Photometry Service

Spanish Virtual Observatory - Theoretical models

Funded by  INTA

URL: http://svo.laefi.inta.es/theory/s3if_//db2v04/syph.php?6&model=Kurucz8

 SVO

Theoretical spectra

- Daliesio ▶
- Ceeho ▶
- NextGen ▶
- cond00 ▶
- dusty00 ▶
- Kurucz ▶

Services

- Filters ▶
- TSAP ▶
- VOSA ▶
- Ischronas ▶

S3 interface

ODFNEW /NOVER models. Newly computed ODFs with better opacities and better abundances have been used.


teff: - (value for the effective temperature for the model. Temperatures are given in K)

logg: - (value for Log(G) for the model.)


meta: - (value for the Metallicity for the model.)

UFI: (Available filters)


[See VOTable](#)



Synthetic Photometry Service



Spanish Virtual Observatory - Theoretical models

Funded by 

URL: http://svo.iaeff.inta.es/theory/s3if...db2v4/syph.php?6&&mode=Kurucz&teff=5000/6000&logg=1.00/2.00&meta=0.00/0.20&UFI=SDSS_R6

Theoretical spectra

- Daliesio ▶
- Coelho ▶
- NextGen ▶
- cond00 ▶
- dusty00 ▶
- Kurucz ▶

Services

- Filtern ▶
- TSAP ▶
- VOSA ▶
- Isocrones ▶

S3 interface

Synthetic photometry for Kurucz ODFNEW /NOVER models. Newly computed ODFs with better opacities and better abundances have been used.

teff	logg	meta	UFI	phot
5000	1.00	0.00	SDSS_F	1.39734087217e-13
5000	1.50	0.00	SDSS_F	1.38714034883e-13
5000	2.00	0.00	SDSS_F	1.37719326443e-13
5250	1.00	0.00	SDSS_F	1.7696765093e-13
5250	1.50	0.00	SDSS_F	1.75586497773e-13
5250	2.00	0.00	SDSS_F	1.74290347396e-13
5500	1.00	0.00	SDSS_F	2.19029620013e-13
5500	1.50	0.00	SDSS_F	2.17163839636e-13
5500	2.00	0.00	SDSS_F	2.15413488457e-13
5750	1.00	0.00	SDSS_F	2.66023807988e-13
5750	1.50	0.00	SDSS_F	2.63624783206e-13
5750	2.00	0.00	SDSS_F	2.61345124187e-13
6000	1.00	0.00	SDSS_F	3.17930670692e-13
6000	1.50	0.00	SDSS_F	3.15149711273e-13
6000	2.00	0.00	SDSS_F	3.1237641431e-13

See VOTable

Synthetic Photometry Service

The query

```
http://svo.laeff.inta.es/theory/db2vo4/syph.php? model=Kurucz
&teff=5000/10000&logg=1,2&meta=0.5
&UFI=2MASS_J,SDSS_R,UKIDSS_K
```

The answer

```
-<DESCRIPTION>
  Synthetic photometry for Kurucz ODFNEW /NOVER models. Newly computed ODFs with better opacities and better
  abundances have been used.
</DESCRIPTION>
<PARAM name="INPUT:teff" ucd="phys.temperature.effective" unit="K" value="5000/10000"/>
<PARAM name="INPUT:logg" ucd="phys.gravity" unit="log(cm/s2)" value="1,2"/>
<PARAM name="INPUT:meta" ucd="phys.abund.Fe" unit="" value="0.5"/>
-<TABLE>
  <FIELD name="teff" ucd="phys.temperature.effective" unit="K" datatype="int"/>
  <FIELD name="logg" ucd="phys.gravity" unit="log(cm/s2)" datatype="float"/>
  <FIELD name="meta" ucd="phys.abund.Fe" unit="" datatype="float"/>
  <FIELD name="UFI" ucd="" unit="" datatype="char" arraysize="*"/>
  <FIELD name="phot" ucd="" unit="erg/cm2/s/A" datatype="float"/>
-<DATA>
  -<TABLEDATA>
    -<TR>
      <TD>5000</TD>
      <TD>1.00</TD>
      <TD>0.50</TD>
      <TD>2MASS_J</TD>
      <TD>5.21076167405e-14</TD>
    </TR>
    -<TR>
      <TD>5000</TD>
      <TD>1.00</TD>
      <TD>0.50</TD>
      <TD>SDSS_R</TD>
      <TD>1.4659542873e-13</TD>
    </TR>
```


Synthetic Photometry Service

The query

```
http://svo.laeff.inta.es/theory/db2vo4/syph.php? model=Kurucz
&teff=5000/10000&logg=1,2&meta=0.5
&UFI=2MASS_J,SDSS_R,UKIDSS_K
```

The answer

```
-<DESCRIPTION>
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  abundances have been used.
</DESCRIPTION>
<PARAM name="INPUT:teff" ucd="phys.temperature.effective" unit="K" value="5000/10000"/>
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  <FIELD name="meta" ucd="phys.abund.Fe" unit="" datatype="float"/>
  <FIELD name="UFI" ucd="" unit="" datatype="char" arraysize="*"/>
  <FIELD name="phot" ucd="" unit="erg/cm2/s/A" datatype="float"/>
-<DATA>
  -<TABLEDATA>
    -<TR>
      <TD>5000</TD>
      <TD>1.00</TD>
      <TD>0.50</TD>
      <TD>2MASS_J</TD>
      <TD>5.21076167405e-14</TD>
    </TR>
    -<TR>
      <TD>5000</TD>
      <TD>1.00</TD>
      <TD>0.50</TD>
      <TD>SDSS_R</TD>
      <TD>1.4659542873e-13</TD>
    </TR>
```



THANK YOU!