

# Time Series: annotation of light curves in VOTable

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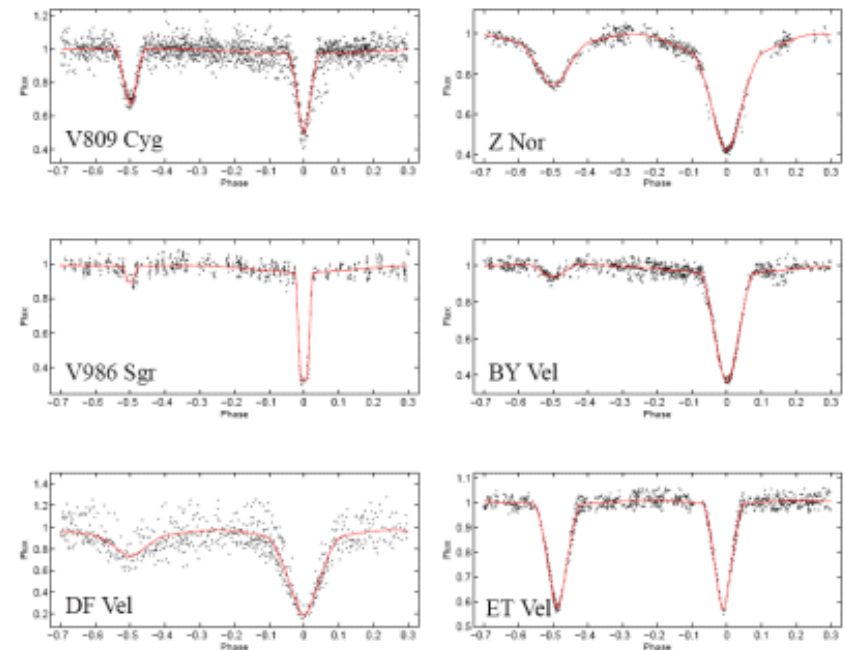
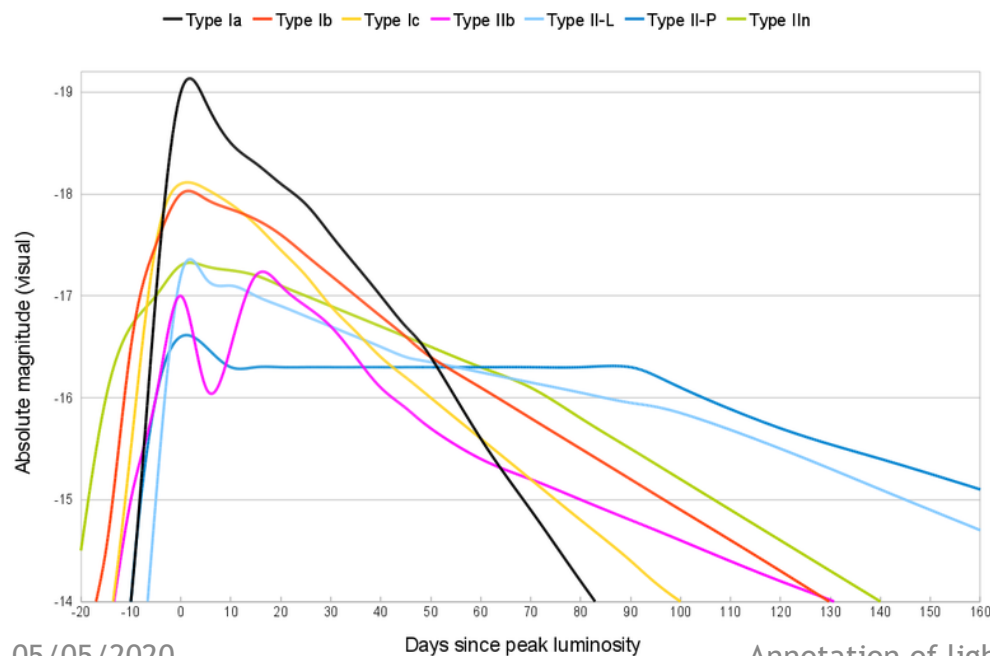
**GitHub:** <https://github.com/AdaNebot/TimeSeries>



# □ Goal of the proposed annotation

## 1. Combine photometry and light curves of a given object in the same photometric band

- Supernova classification using the light curve
- Long-term analysis of variable and binary stars
- Discovery of brown dwarfs through microlensing events
- Discovery and study of binary systems (eclipses, ellipsoidal variation, irradiation...)



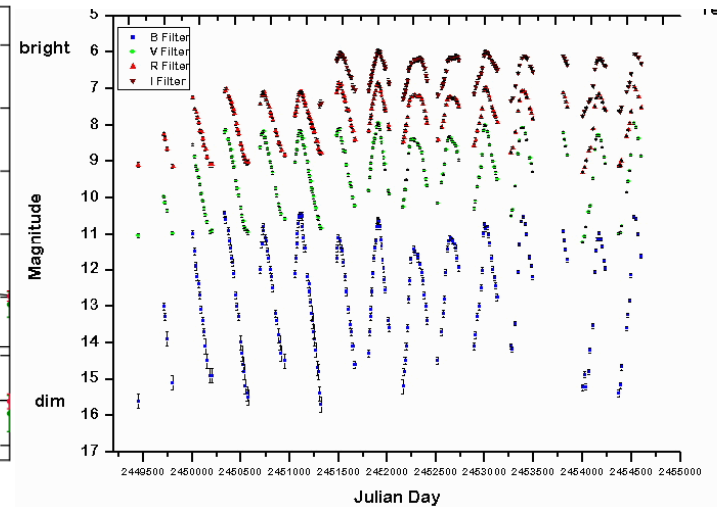
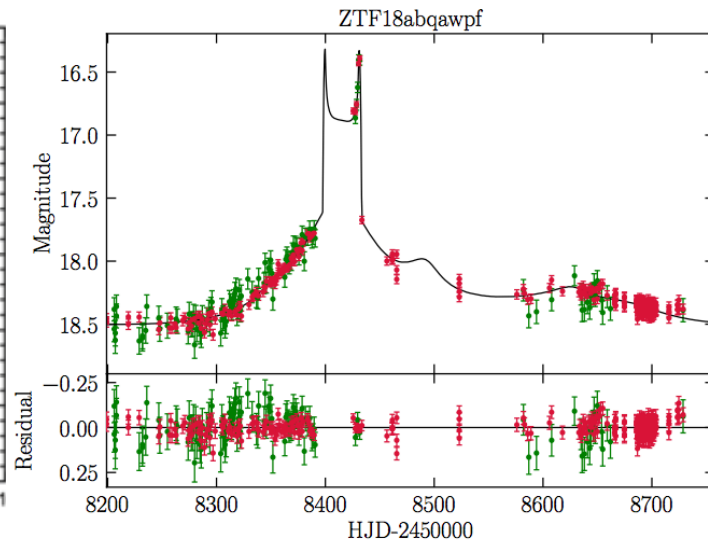
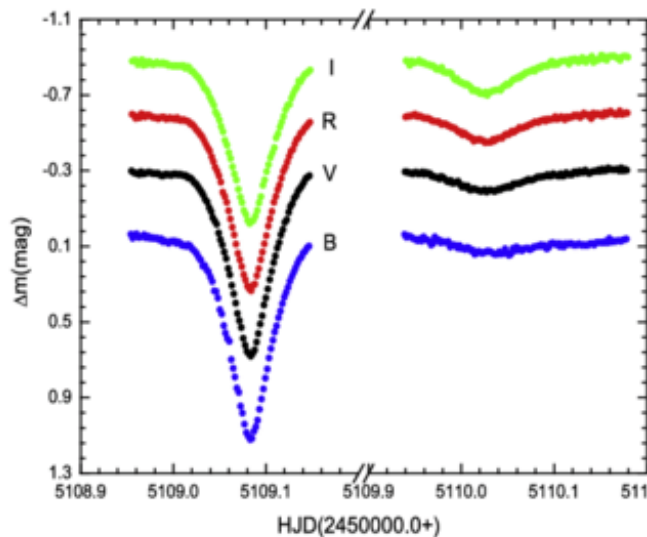
05/05/2020

Annotation of light curves in VOTable

# □ Goal of the proposed annotation

## 2. Combine **photometry and light curves** of a given object/list of objects in **different photometric bands**

- Eclipsing binary systems
- Study microlensing events in detail
- Pulsating variable stars



# □ Minimal requirements

## Definition of the minimum metadata for light curves

### 1. Characterise the time —> **TIMESYS**

- 1.time scale (UTC, TT, TAI...)
- 2.time reference frame (Topocenter, geocenter,...)
- 3.offset (JD-XXX)

### 2. Characterise the filter —> **PHOTCAL**

- 1.filterIdentifier
- 2.zero point
- 3.photometric system
- 4.effective wavelength

### 3. Characterise the lightcurve —> **TIMESYS & PHOTCAL**

# □ Minimal requirements

## Definition of the minimum metadata for light curves

### 1. Characterise the time —> **TIMESYS**

- 1.time scale (UTC, TT, TAI...)
- 2.time reference frame (Topocenter, geocenter,...)
- 3.offset (JD-XXX)

**TIMESYS**  
already in  
**VOTable 1.4**

### 2. Characterise the filter —> **PHOTCAL**

- 1.filterIdentifier
- 2.zero point
- 3.photometric system
- 4.effective wavelength

**We propose a  
common way to  
annotate this part**

### 3. Characterise the lightcurve —> **TIMESYS & PHOTCAL**

**and this part**

# □ Photcal GROUP

We propose a way to annotate the metadata of the photometric part in VOTable, using PARAMs defined as elements from PhotDM:

## 1. We define a **GROUP** with a specific name: **PhotCal**

1. A **DESCRIPTION** with human readable information
2. Several **PARAMs** in this GROUP, one for each attribute
3. We propose to inherit concepts and **utypes** from PhotDM
4. We propose the use of certain **UCDs**

# □ Photcal GROUP

```
<GROUP name="photcal" ID="phot_sys" ucd="phot"
  utype="PhotDM:PhotCal" >
  <DESCRIPTION>Photometric system description </DESCRIPTION>
  <PARAM name="filterIdentifier" ucd="meta.id;instr.filter"
    utype="photDM:PhotometryFilter.identifier"
    datatype="char" unit="" value="Palomar/ZTF.g"/>
  <PARAM name="zeroPointFlux" ucd="phot.mag;arith.zp"
    utype="photDM:PhotCal.zeroPoint.flux.value"
    datatype="float" unit="Jy" value="3963.97"/>
  <PARAM name="magnitudeSystem" ucd="meta.code"
    utype="photDM:PhotCal.magnitudeSystem.type"
    datatype="char" unit="" value="Vega"/>
  <PARAM name="effectiveWavelength" ucd="em.wl.effective"
    utype="photDM:PhotometryFilter.spectralLocation.value"
    datatype="float" unit="Angstrom" value="4722.74"/>
</GROUP>
```

# □ **TABLE** to annotate the timeseries

We propose to annotate the **TABLE** as timeseries using PARAMs defined as elements from Obscore:

1. A **DESCRIPTION** with human readable information
2. A **PARAM** describing the data product type “**timeseries**”
3. A **PARAM** describing the data product subtype “**lightcurve**”
4. We propose to inherit **utypes** from Obscore
5. One or several columns referencing a **TIMESYS** element
  - Clients can use any such column as the independent variable of the time series.
6. One or more columns referencing a **PHOTCAL GROUP**
  - Clients can use any such column as a dependent variable of a time series.



# □ TABLE to annotate the timeseries

```
<TABLE name="mytable"
  <DESCRIPTION>Light curve showing an eclipse for SDSSJ121258.25-012310.1
</DESCRIPTION>
  <PARAM name="dataprodect_type" ucd="meta.code.class"
    utype="obscore:ObsDataset.dataProductType" datatype="char"
    arraysize="*" value="timeseries" />
  <PARAM name="dataprodect_subtype" ucd="meta.code.class"
    utype="obscore:ObsDataset.dataProductSubtype" datatype="char"
    arraysize="*" value="lightcurve" />
  <!-- perhaps more PARAMs, then COLUMNS and data -->
</TABLE>
```

# □ VOTable structure

One PHOTCAL GROUP per filter

1. Light curves in **one filter** of the type:

time	mag	mag_err	...
2458664.850875	16.3	0.02	
...	...	...	...

- One or more FIELDS with **ref** to the corresponding PHOTCAL

2. Light curves in **multiple filters** of the type:

time	mag	mag_err	filter_name	...
2458664.850875	16.30	0.03	<b>B</b>	
2458665.873147	15.98	0.02	<b>V</b>	
...	...	...	...	...

- One TABLE per PHOTCAL. One or more FIELDS with **ref** to the corresponding PHOTCAL



Examples of VOTable under:  
<https://github.com/AdaNebot/TimeSeries>



**THANKS!**