

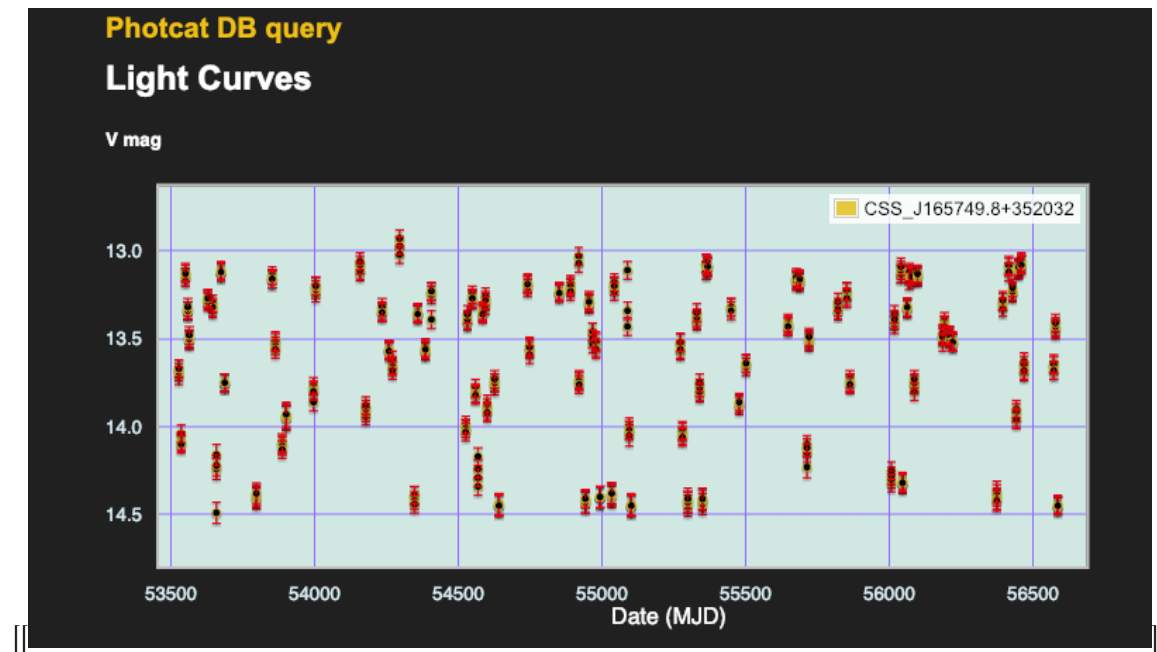
# Ph21 Problem Set 1

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## Introduction

Here we are looking at data from the Catalina Real-Time Transient Survey. Earlier in the set, the website [http://nesssi.cacr.caltech.edu/cgi-bin/getcssconedbid\\_release2.cgi](http://nesssi.cacr.caltech.edu/cgi-bin/getcssconedbid_release2.cgi) was searched manually for the Her X-1 binary system. This is the plot the website generated in terms of intensity over time:



We will now attempt to recreate this plot by accessing the website data using python. We will parse the data first using string methods and next using `astropy.io.votable`.

## Imports

```
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import urllib.request
from astropy.io.votable import parse
sns.set(font_scale=1.5)
```

---

## Reading in the Data

These value queries were found by inspecting the source code of website, checking the values of 'name =' fields:

```
url = 'http://nesssi.cacr.caltech.edu/cgi-bin/getcssconedbid_release2.cgi'
values = {"Name": "Her X-1", "SHORT": "short", "DB": "photcat", "OUT": "web",
         "Rad": .1}
data = urllib.parse.urlencode(values)
data = data.encode('ascii') # data should be bytes
with urllib.request.urlopen(url, data) as response:
    html = response.read()
```

---

Now we need to decode this to convert it back to a string:

```
data_str = html.decode('ascii')
```

---

## Parsing the Output Using String Methods

Here we find that the real table begins somewhere in the middle of the file, after a </tr><tr><td> tag combination. We'll truncate this and see what we get:

```
ind_str = '</tr><tr><td>'
truncated_data = data_str[data_str.index(ind_str):]
```

---

```
print(truncated_data[:1000])
```

---

```
</tr><tr><td>1135075<td> 253.01875<td> 35.27778<td> 1<td> 2.8<td> 251.246<td> 254.795<td> 33.842
</table><br><p><table bgcolor="#c0c0c0" border><tr><Caption>Master Objs in Region</Caption></tr>
</table><br><p>
<table border=1 width=500 bgcolor="#c0c0c0"><tr><Caption>Photometry of Objs:</Caption></tr><tr><
<tr><td>1135075045477<td>13.34<td>0.05<td>254.4575<td>35.3423<td>53557.33004</tr>
```

```

<tr><td>1135075045477<td>13.34<td>0.05<td>254.4575<td>35.3424<td>53557.33418</tr>
<tr><td>1135075045477<td>13.32<td>0.05<td>254.4576<td>35.3424<td>53557.33834</tr>
<tr><td>1135075045477<td>13.51<td>0.05<td>254.4575<td>35.3423<td>53562.24598</tr>
<tr><td>1135075045477<td>13.50<td>0.05<td>254.4575<td>35.3423<td>53562.25304</tr>
<tr><td>11

```

Here we see about four sections separated by newline characters before getting to the actual Photometry data table. So we just need to split over the newline character and then take all the elements beyond:

---

```
table_data = truncated_data.split('\n')[4:]
```

---

Let's check out the data now:

---

```
table_data[:10]
```

---

```

['<tr><td>1135075045477<td>13.34<td>0.05<td>254.4575<td>35.3423<td>53557.33004</tr>',
 '<tr><td>1135075045477<td>13.34<td>0.05<td>254.4575<td>35.3424<td>53557.33418</tr>',
 '<tr><td>1135075045477<td>13.32<td>0.05<td>254.4576<td>35.3424<td>53557.33834</tr>',
 '<tr><td>1135075045477<td>13.51<td>0.05<td>254.4575<td>35.3423<td>53562.24598</tr>',
 '<tr><td>1135075045477<td>13.50<td>0.05<td>254.4575<td>35.3423<td>53562.25304</tr>',
 '<tr><td>1135075045477<td>13.50<td>0.05<td>254.4575<td>35.3423<td>53562.26014</tr>',
 '<tr><td>1135075045477<td>13.48<td>0.05<td>254.4575<td>35.3423<td>53562.26718</tr>',
 '<tr><td>1135075045477<td>13.71<td>0.05<td>254.4575<td>35.3423<td>53526.30884</tr>',
 '<tr><td>1135075045477<td>13.69<td>0.05<td>254.4575<td>35.3423<td>53526.31949</tr>',
 '<tr><td>1135075045477<td>13.67<td>0.05<td>254.4575<td>35.3423<td>53526.32984</tr>']

```

Here we see that we just need to take out the <tr>s and <td>s found in each line:

---

```

def parse_line(table_line):
    splitted = table_line.split('<td>')
    # remove first element, which is just <tr>
    tr_rem = splitted[1:]
    # get rid of </tr> from the last element
    tr_rem[-1] = tr_rem[-1].strip('</tr>')
    # make every item a float
    return list(map(float, tr_rem))

```

---



---

```
parse_line(table_data[1])
```

---

```
[1135075045477.0, 13.34, 0.05, 254.4575, 35.3424, 53557.33418]
```

Looks like the parser works. Now we can just parse over the whole table. But, the end of data has some other elements not from the table, so we need to check and see which lines only contain the table.

---

```
table_data[-4:]
```

---

```
['<tr><td>1135075045477<td>14.45<td>0.05<td>254.4576<td>35.3424<td>56588.10323</tr>',
 '</table><br><p>',
 '<p><br><p></HTML>',
 '']
```

So, we'll parse over everything but the last 3 lines:

---

```
parsed_data = np.array(list(map(parse_line, table_data[:-3])))
```

---

Now, in np-array form, we can just pull out the magnitude, uncertainties, and times of each line from the headers in the HTML code earlier:

---

```
mags = parsed_data[:, 1]
uncerts = parsed_data[:, 2]
MJDs = parsed_data[:, 5]
```

---

## Plotting the Parsed Data

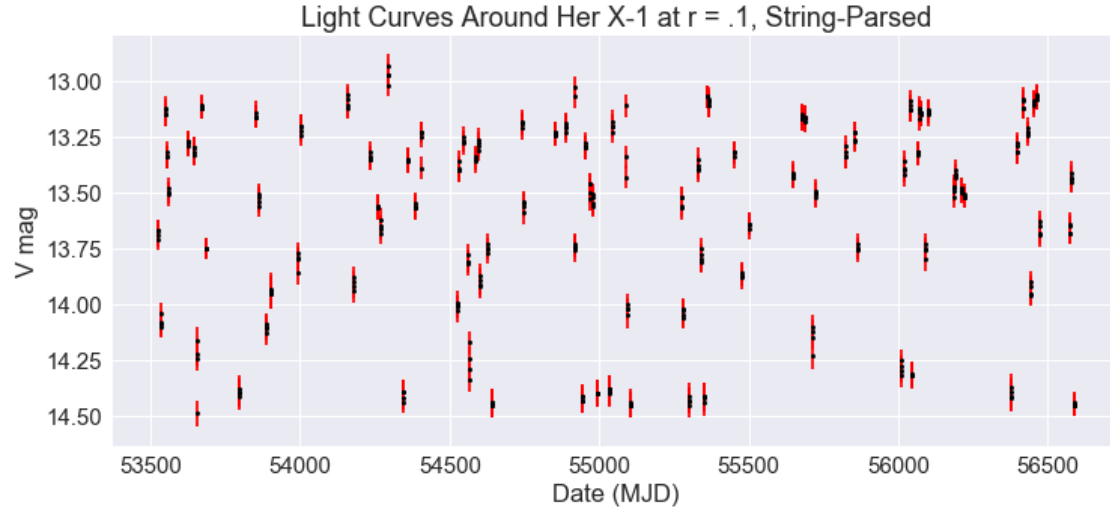
Now, we just need to plot this with error bars:

---

```
def plot_mag_data(mags, magerrs, MJDs):
    plt.figure(figsize=(12, 5))
    plt.errorbar(MJDs, mags, color='black', yerr=magerrs, fmt='o', markersize=3,
                 ecolor='r', capthick=2)
    plt.gca().invert_yaxis()
    plt.xlabel('Date (MJD)')
    plt.ylabel('V mag')

plot_mag_data(mags, uncerts, MJDs)
plt.title('Light Curves Around Her X-1 at r = .1, String-Parsed')
plt.show()
```

---



## Parsing the data from the XML file in VOTable Format:

Now we can get the VOTable XML data from online and use the voparser to parser the data in a much easier fashion:

---

```
votable = parse("result_web_fileDR8owK.vot", pedantic=False)
vo_data = votable.get_first_table().to_table()
```

---



---

vo\_data

---

<Table masked=True length=378>

MasterID	RAJ2000	DEJ2000	ObsTime [1]	Mag [1]	Magerr [1]	Blend [1]
deg	deg	d				
object	float32	float32	float32	float32	float32	int32
1135075045477	254.45757	35.34235	53557.324	13.338659	0.052161247	0
1135075045477	254.45753	35.34234	53557.33	13.339489	0.052163184	0
1135075045477	254.45753	35.34235	53557.336	13.342177	0.052178945	0
1135075045477	254.45757	35.34235	53557.34	13.324588	0.05213488	0
1135075045477	254.45750	35.34233	53562.246	13.510649	0.052456874	0
1135075045477	254.45750	35.34233	53562.254	13.49694	0.052435752	0
1135075045477	254.45750	35.34231	53562.26	13.500379	0.052439135	0
1135075045477	254.45750	35.34234	53562.266	13.475543	0.052392595	0
1135075045477	254.45750	35.34233	53526.31	13.70976	0.052931767	0
...	...	...	...	...	...	...
1135075045477	254.45757	35.34233	56574.137	13.675402	0.05290823	0

1135075045477	254.45757	35.34234	56574.14	13.675675	0.052921385	0
1135075045477	254.45753	35.34234	56580.086	13.435135	0.052297443	0
1135075045477	254.45757	35.34232	56580.09	13.445594	0.052325822	0
1135075045477	254.45757	35.34232	56580.098	13.42858	0.052298788	0
1135075045477	254.45755	35.34232	56580.105	13.405985	0.052251775	0
1135075045477	254.45757	35.34234	56588.082	14.451928	0.05430378	0
1135075045477	254.45755	35.34236	56588.09	14.453248	0.0543382	0
1135075045477	254.45757	35.34235	56588.098	14.436412	0.05427364	0
1135075045477	254.45757	35.34235	56588.1	14.448011	0.054356683	0

Here we see the relevant fields we need to find:

---

```
vo_mags = np.array(vo_data['Mag'])
vo_errs = np.array(vo_data['Magerr'])
vo_MJDs = np.array(vo_data['ObsTime'])
```

---

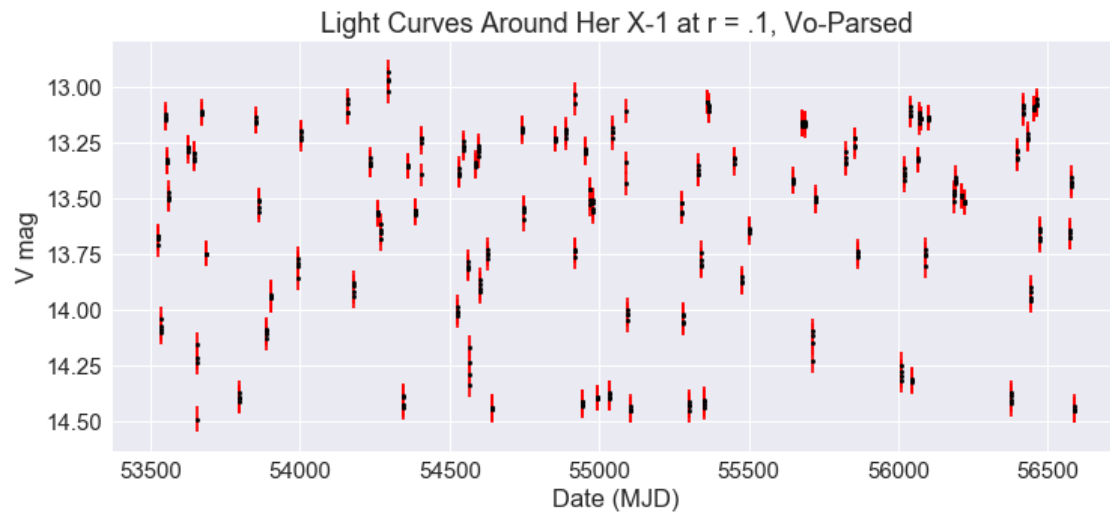
## Plotting the VOTable Data

Now we can plot the data just as before:

---

```
plot_mag_data(vo_mags, vo_errs, vo_MJDs)
plt.title('Light Curves Around Her X-1 at r = .1, Vo-Parsed')
plt.show()
```

---



Looks like both plots match each other, as well as the plot generated by the website.

## Exploring a Period in the Data

Here we'll explore a period of 1.7 MJD in the data by simply modding the date values by 1.7.

---

```
plot_mag_data(vo_mags, vo_errs, (vo_MJDs % 1.7))  
plt.xlabel('Date mod 1.7 (MJD)')  
plt.title('Light Curves Around Her X-1, Exploring a Period of 1.7MJD')  
plt.show()
```

---

