Ceipheid

January 27, 2023

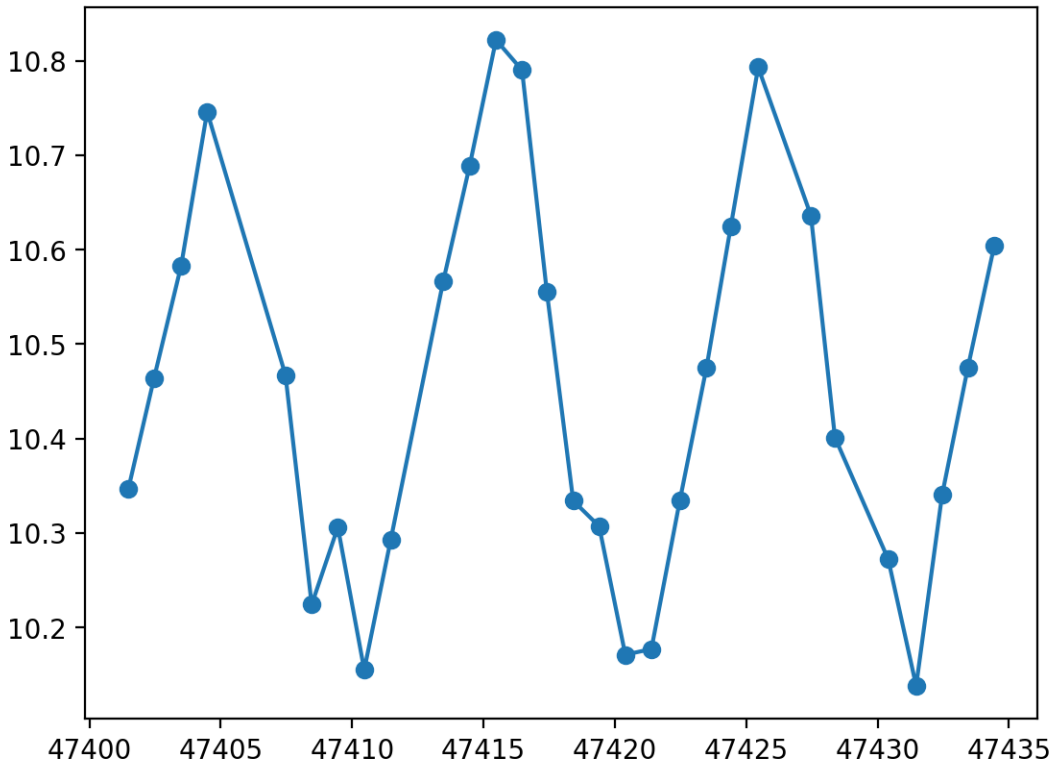
[ ]:
```
%config InlineBackend.figure_format = 'retina'
import pip
import numpy as np
import matplotlib.pyplot as plt
import scipy as sp
import scipy.optimize
import scipy.stats
import scipy.special
import scipy.integrate
import scipy.interpolate
from scipy import constants as consts
import cepheid_variables_functions as cv
import os
```

1 Cepheids

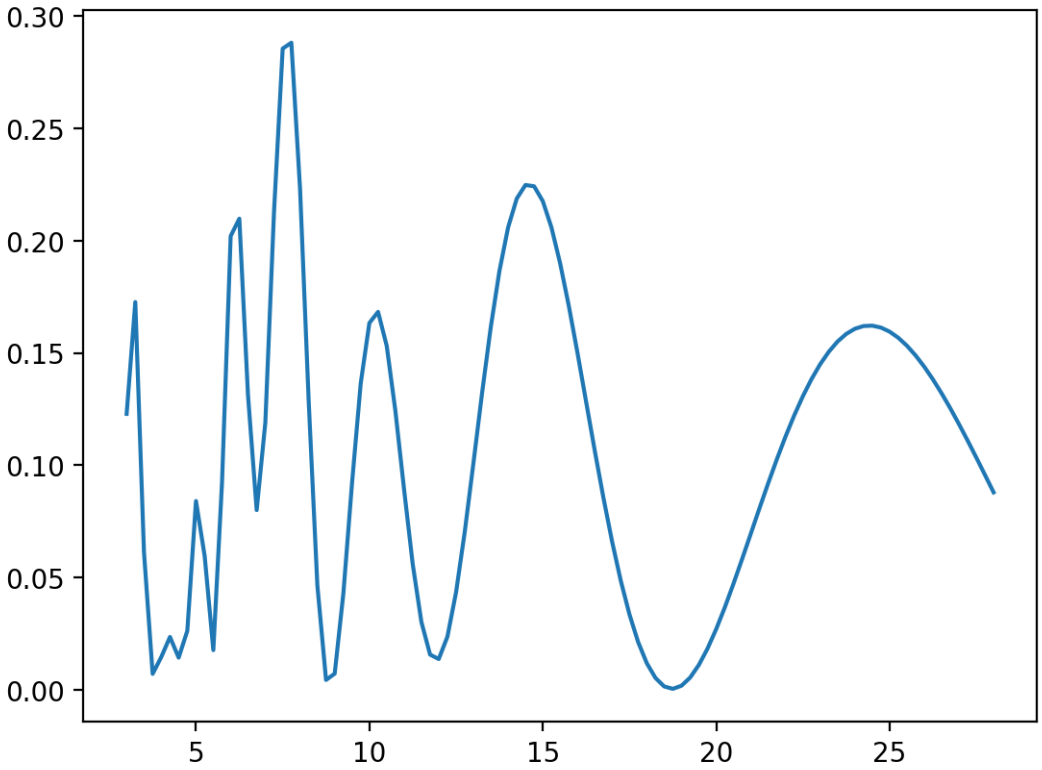
[ ]:
```
entries  = os.scandir('data_files/')
for entry in entries:
    print(entry.name)


AN_Aur = np.loadtxt('data_files/AN_Aur_p.dat', unpack = True, usecols = [0,1])
plt.figure()
plt.plot(AN_Aur[0],AN_Aur[1],'o-')
plt.show()


AN_Aur_time = AN_Aur[0]
AN_Aur_mag = AN_Aur[1]
```

```
.DS_Store
AN_Aur_p.dat
CH_Cas_p.dat
ER_Aur_p.dat
FM_Aql_p.dat
GV_Aur_p.dat
IN_Aur_p.dat
```

```
KK_Cas_p.dat
RS_Cas_p.dat
RX_Aur_p.dat
RY_Cas_p.dat
SW_Cas_p.dat
SY_Aur_p.dat
SY_Cas_p.dat
SZ_Aql_p.dat
TT_Aql_p.dat
U_Aql_p.dat
VW_Cas_p.dat
YZ_Aur_p.dat
```



[ ]:
```
periods = np.linspace(3,28,101)


relative_time = AN_Aur_time - AN_Aur_time[0]

power = cv.powerSpectrum(relative_time, AN_Aur_mag, periods)
plt.figure()
plt.plot(periods, power)
plt.show()
```



[ ]:
```
from scipy.signal import find_peaks
peaks_indices, _ = find_peaks(power, distance=5)
peaks_periods = periods[peaks_indices]
```

[ ]:
```
import os
path = 'data_files/'
file_list = [f for f in sorted(os.listdir(path))
             if f.endswith('.dat')]

for file in file_list:
    filename = path + file
    time, v_mag = np.loadtxt(filename, unpack = True, usecols = [0,1])
    relative_time = time - time[0]
    power = cv.powerSpectrum(relative_time, v_mag, periods)
    peaks_indices, _ = find_peaks(power, distance=5)
    peaks_periods = periods[peaks_indices]
    print(file, peaks_periods)

    """
    plt.figure()
    plt.plot(time, v_mag, 'o-')
    plt.show()
```

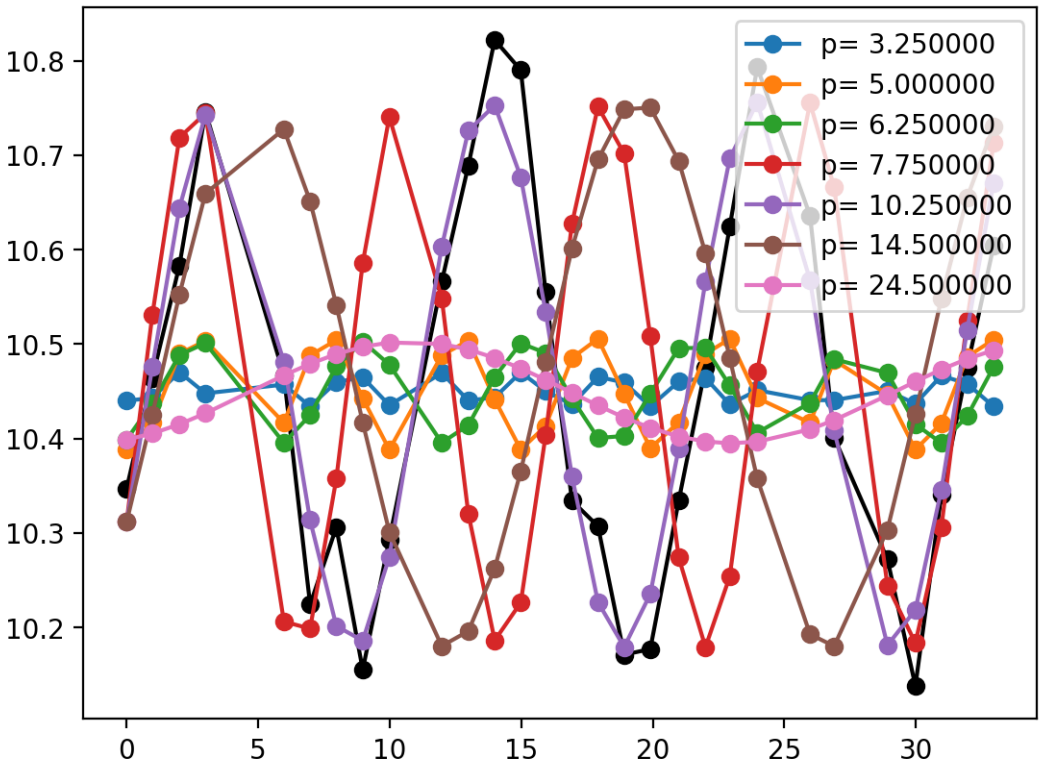
```
    plt.figure()
    plt.plot(periods, power)
    plt.show()
    """
```

```
AN_Aur_p.dat [ 3.25  5.    6.25  7.75 10.25 14.5  24.5 ]
CH_Cas_p.dat [ 3.5   5.    7.25 10.   15.   26.25]
ER_Aur_p.dat [ 3.25  5.    6.25  7.75 10.25 14.5  24.5 ]
FM_Aql_p.dat [ 3.25  4.75  7.    9.5  13.   21.5 ]
GV_Aur_p.dat [ 4.25  5.5   7.75 13.25]
IN_Aur_p.dat [ 4.25  5.5   8.   13.5 ]
KK_Cas_p.dat [ 3.5   5.25  6.75  9.5  14.   23.5 ]
RS_Cas_p.dat [ 3.5   4.75  7.25 17.  ]
RX_Aur_p.dat [ 3.5   5.    6.25  7.75 11.5  22.25]
RY_Cas_p.dat [ 3.5   6.25  7.75 10.   15.25 23.75]
SW_Cas_p.dat [ 3.5   4.75  7.25 18.25]
SY_Aur_p.dat [ 3.25  4.75  6.    8.5  14.75]
SY_Cas_p.dat [ 4.25  6.5   8.25 11.25 15.25 25.25]
SZ_Aql_p.dat [ 4.    6.    7.5   9.75 14.5  24.75]
TT_Aql_p.dat [ 3.25  4.75  7.75 10.5  15.25 26.  ]
U_Aql_p.dat [ 4.5   6.75  9.75 12.5  17.25]
VW_Cas_p.dat [ 3.5   4.75  6.5   8.25 11.   24.75]
YZ_Aur_p.dat [ 3.25  5.    6.25  7.75 10.25 14.75 24.25]
```

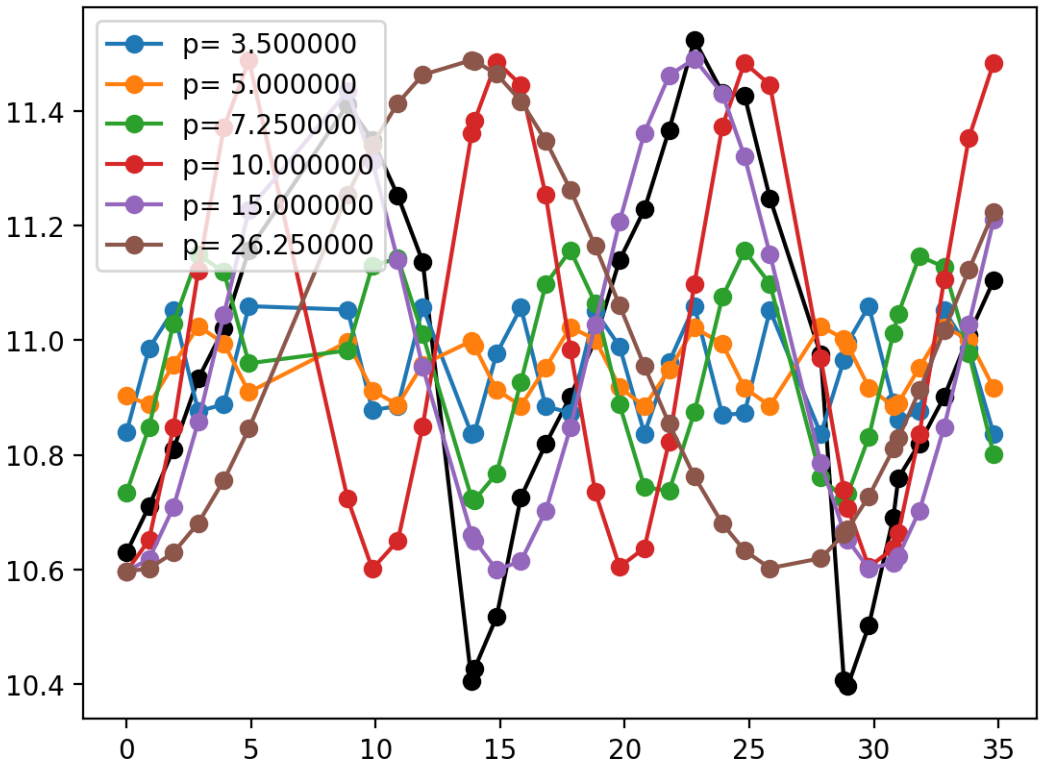
[ ]:
```
def func(t, m_v, phi,m_v0,P):
    return m_v0+m_v*(np.sin((2*np.pi*t/P) +phi))

chi_values = []

for file in file_list:
    filename = path + file
    time, v_mag = np.loadtxt(filename, unpack = True, usecols = [0,1])
    relative_time = time - time[0]
    power = cv.powerSpectrum(relative_time, v_mag, periods)
    peaks_indices, _ = find_peaks(power, distance=5)
    peaks_periods = periods[peaks_indices]
    chi_test = 20
    plt.figure()

    plt.plot(relative_time, v_mag, 'o-', color = 'black')
    for i in peaks_periods:
        m_v = (np.max(v_mag)-np.min(v_mag)/2)
        m_v0 = (np.sum(v_mag)/v_mag.size)
        relative_time = (time - time[0])
        popt, _ = scipy.optimize.curve_fit(func, relative_time, v_mag, p0 =␣
 ↪[m_v0,m_v,1,i], maxfev = 50000)
```

```
        #print('The period is', popt[3], 'days')
        plt.plot(relative_time, func(relative_time, popt[0], popt[1], popt[2],␣
↪i), 'o-', label = f'p= {i:2f}' )
        plt.legend()
        chi = np.sum((v_mag-func(relative_time, popt[0], popt[1], popt[2],␣
↪i))**2)
        chi_values.append(chi)
        if chi < chi_test:
            chi_test = chi
            print('The period that provides the best fit for the data is',␣
↪popt[3], 'days' and 'with a Chi squared value of', chi_test)
            #print('The period that provides the best fit for the data is',␣
↪popt[3], 'days' and 'with a Chi squared value of', chi)


    plt.show()
        #plt.legend(['Ex Data', ])
    #plt.plot(time,func(time,popt[0],popt[1],popt[2],i))
        #for j in popt:
         #   sp.stats.chisquare((v_mag),func(time,popt[0],popt[1],popt[2],j))
        #  print(np.min(j))
```

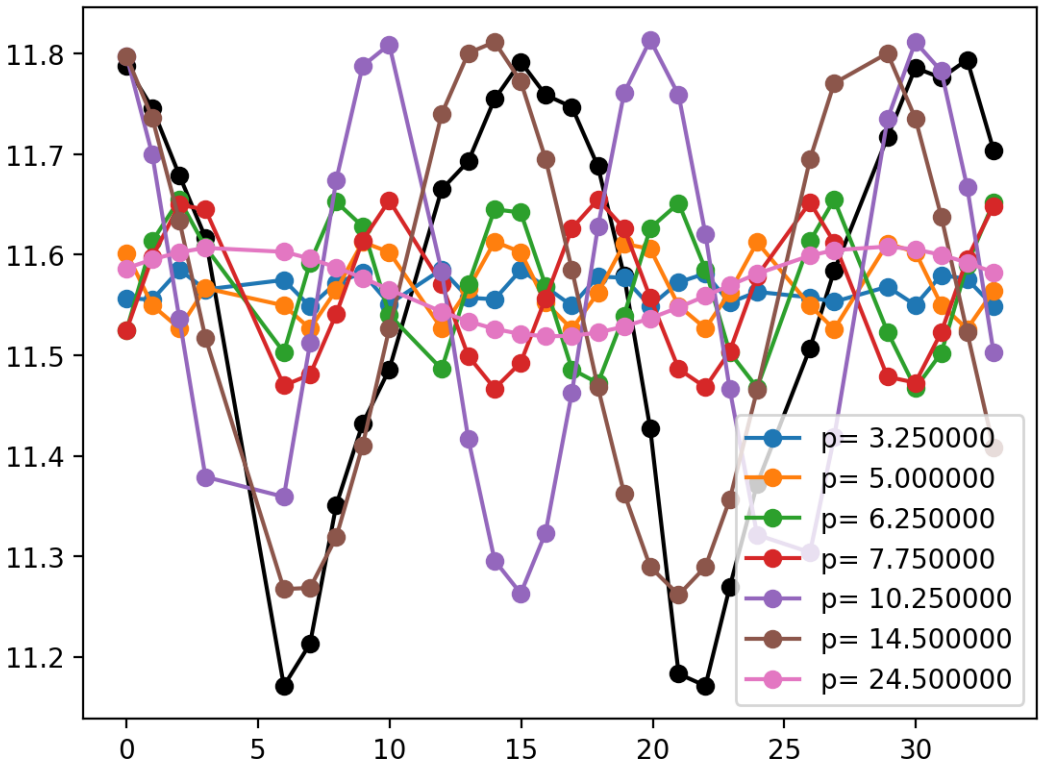
```
The period that provides the best fit for the data is 3.3039438412435906 with a
Chi squared value of 1.1814696514264074
The period that provides the best fit for the data is 5.014190042411235 with a
Chi squared value of 1.132988933643809
The period that provides the best fit for the data is 10.378319237201273 with a
Chi squared value of 0.1005867144482902
```



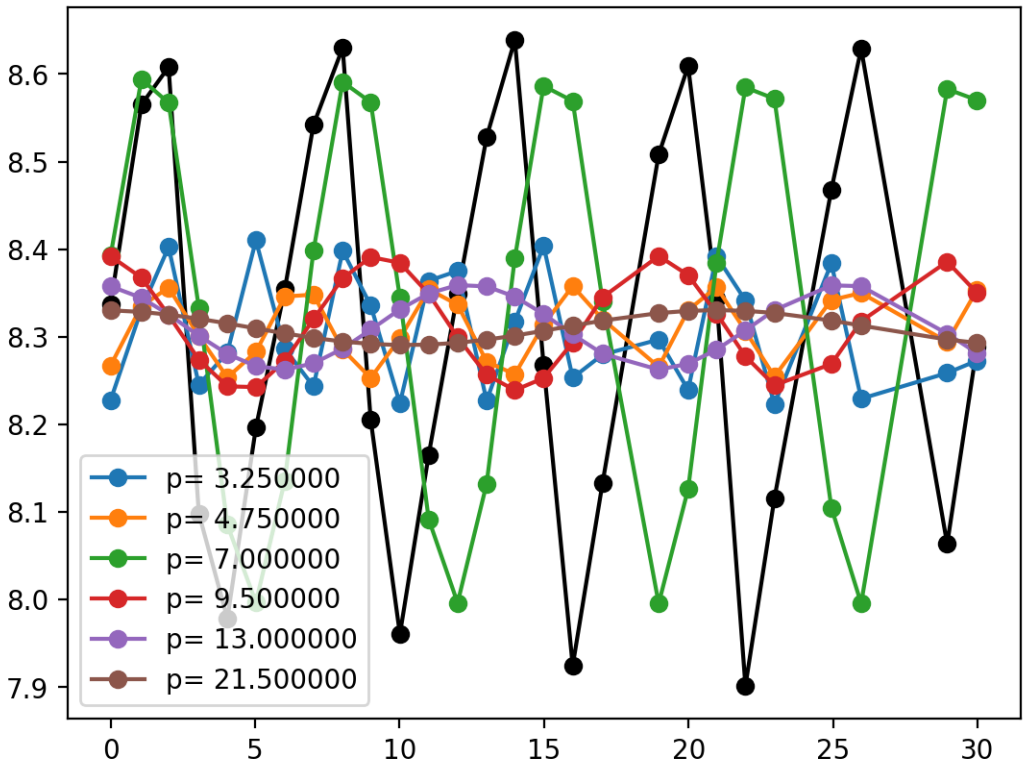

```
The period that provides the best fit for the data is 3.634814517783623 with a
Chi squared value of 3.7508330848339875
The period that provides the best fit for the data is 7.4473020500457 with a Chi
squared value of 3.015756409996738
The period that provides the best fit for the data is 15.008678132774373 with a
Chi squared value of 0.5156812378110329
```



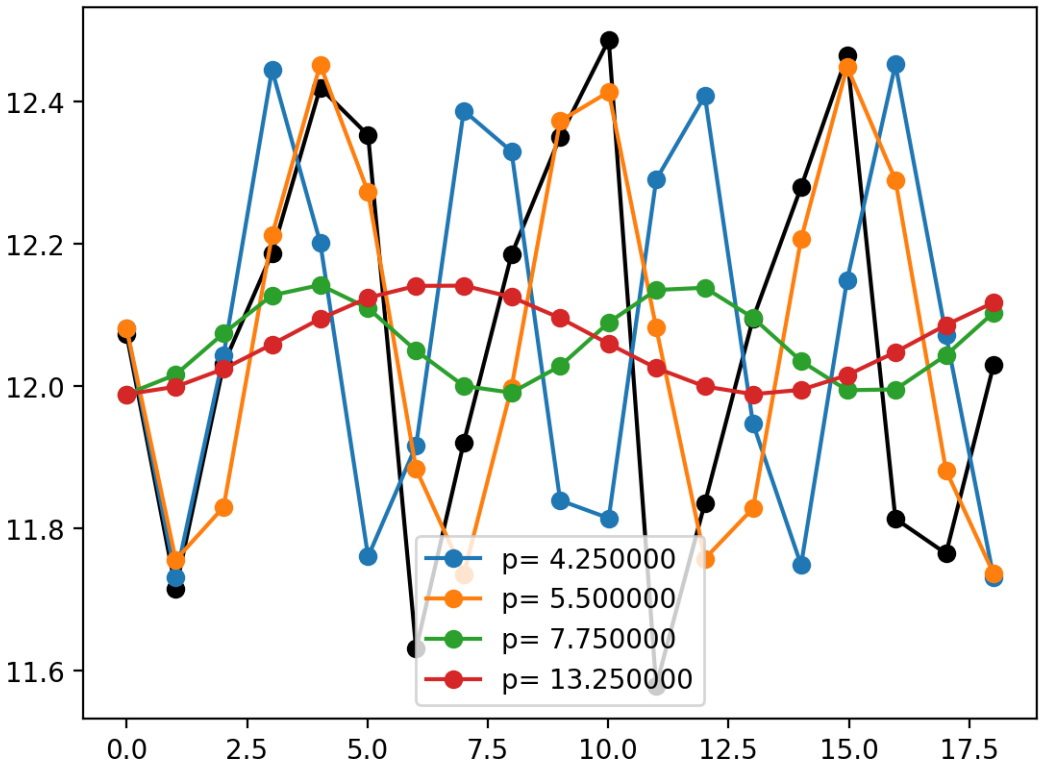

```
The period that provides the best fit for the data is 3.0432822424916246 with a
Chi squared value of 1.290935965645708
The period that provides the best fit for the data is 5.125557134104654 with a
Chi squared value of 1.261097604877699
The period that provides the best fit for the data is 7.445822753690091 with a
Chi squared value of 1.2074747322770578
The period that provides the best fit for the data is 15.646367154991342 with a
Chi squared value of 0.48918396306219725
```



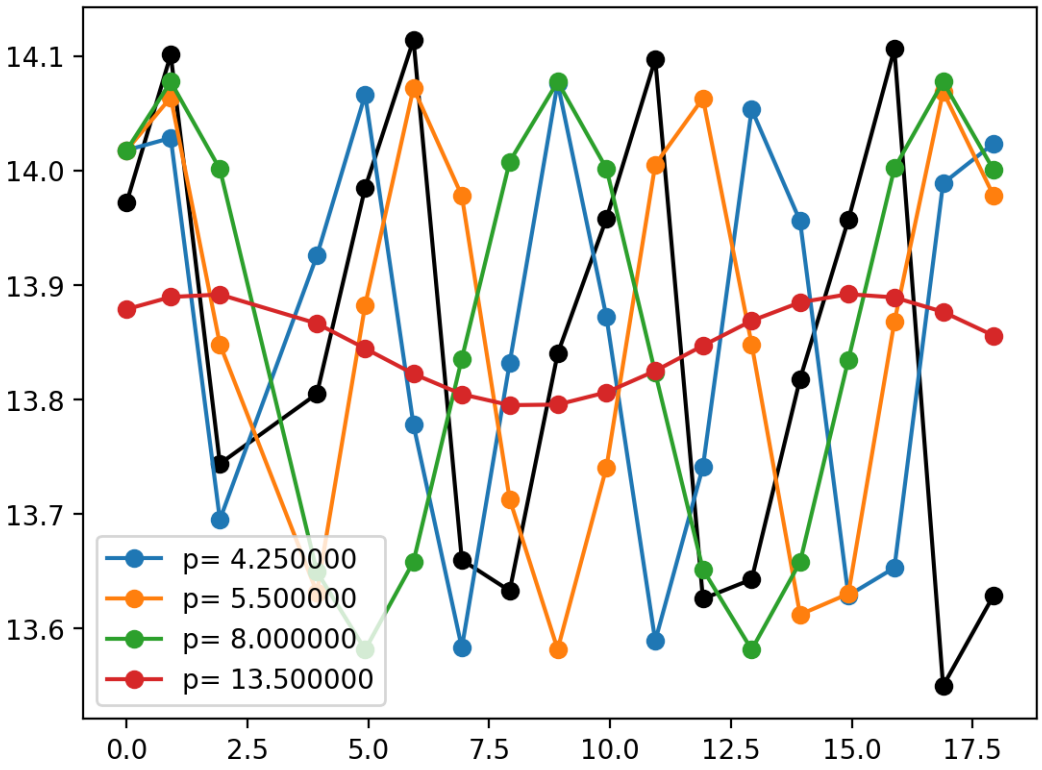

```
The period that provides the best fit for the data is 3.137196287308472 with a
Chi squared value of 1.480486222224301
The period that provides the best fit for the data is 4.692081785812648 with a
Chi squared value of 1.463615668965365
```



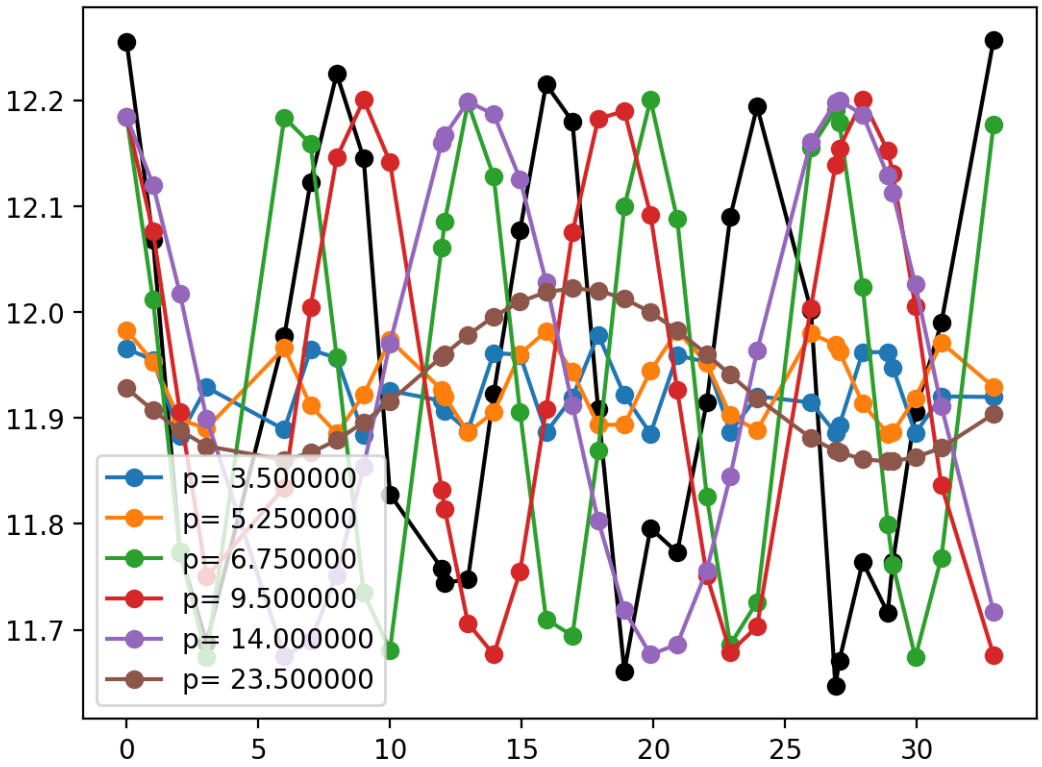

```
The period that provides the best fit for the data is 5.200409546732441 with a
Chi squared value of 3.32779673581343
The period that provides the best fit for the data is 5.200409770813245 with a
Chi squared value of 0.851247074544121
```



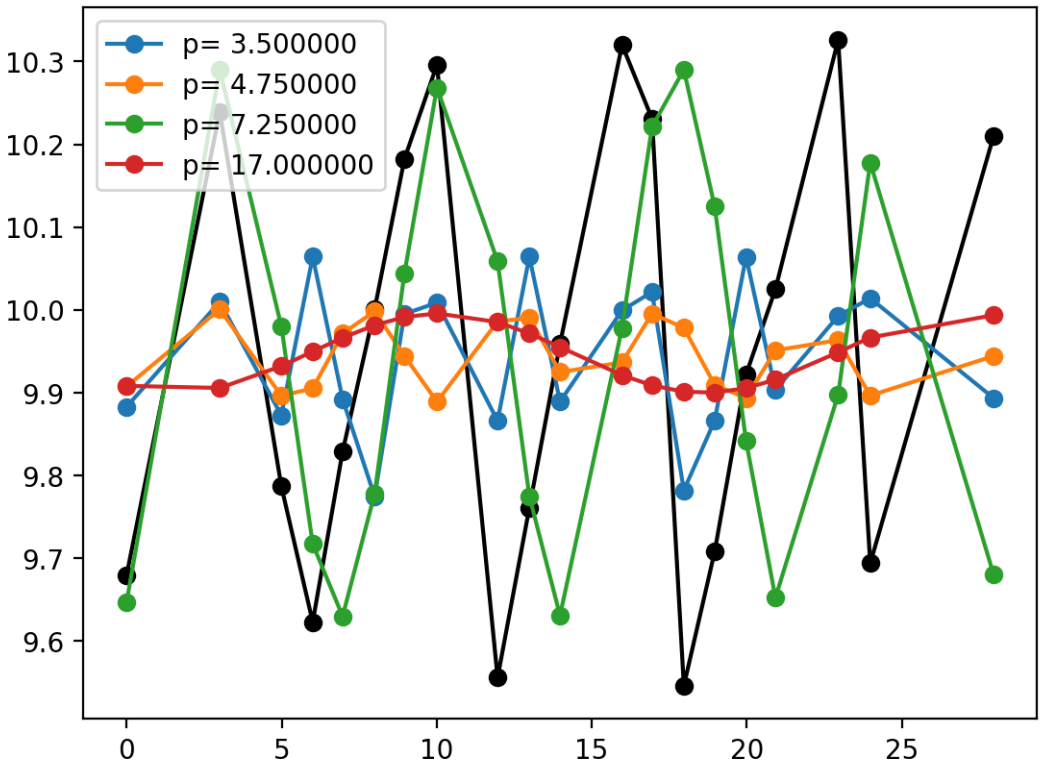

```
The period that provides the best fit for the data is 4.866091927703108 with a
Chi squared value of 1.3720963533545478
The period that provides the best fit for the data is 4.86609123980554 with a
Chi squared value of 1.1161167068764941
The period that provides the best fit for the data is 11.52793281472431 with a
Chi squared value of 0.6435329627895476
```



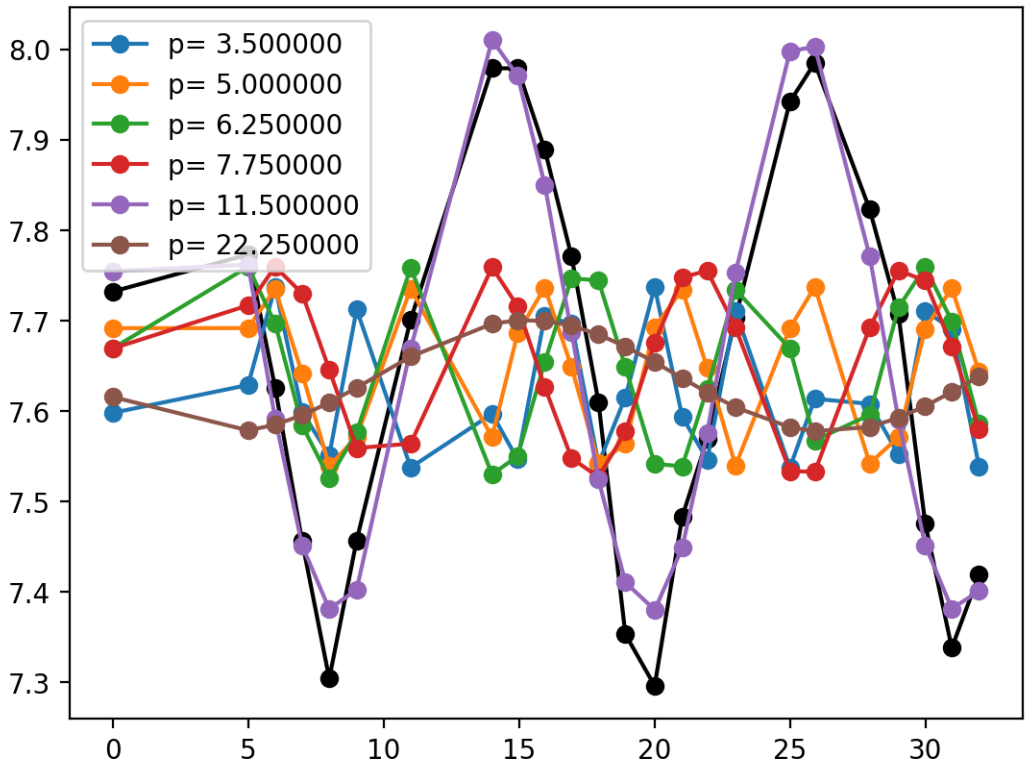

```
The period that provides the best fit for the data is 3.630166999979762 with a
Chi squared value of 1.2114732264155266
The period that provides the best fit for the data is 5.252682075685172 with a
Chi squared value of 1.1914656402872743
```



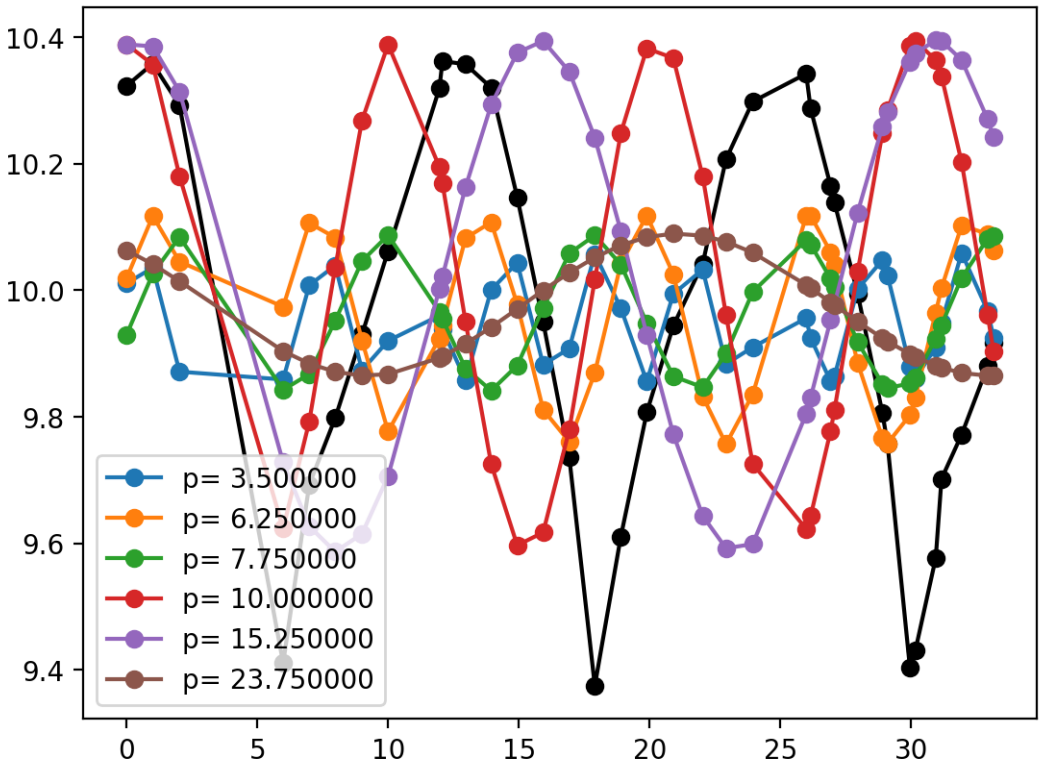

```
The period that provides the best fit for the data is 3.514266393550333 with a
Chi squared value of 1.2376432608235228
```



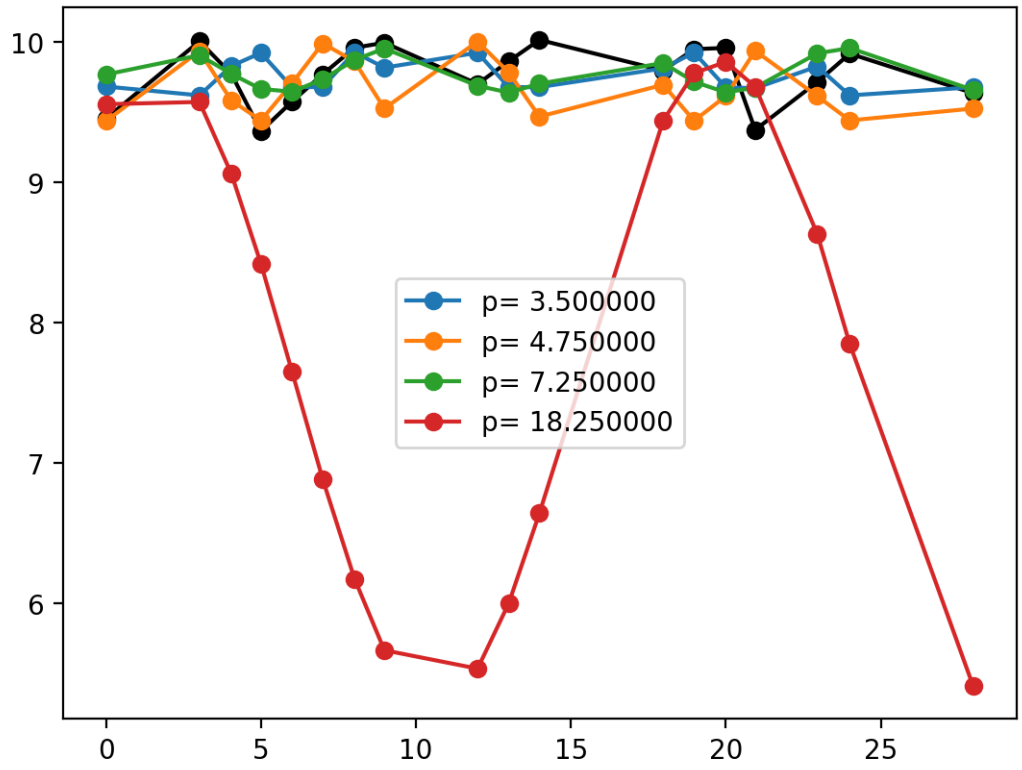

```
The period that provides the best fit for the data is 3.7946978814228056 with a
Chi squared value of 1.443941103503176
The period that provides the best fit for the data is 4.725951132782367 with a
Chi squared value of 1.1930971588992911
The period that provides the best fit for the data is 11.633533918694576 with a
Chi squared value of 0.06535035401051939
```



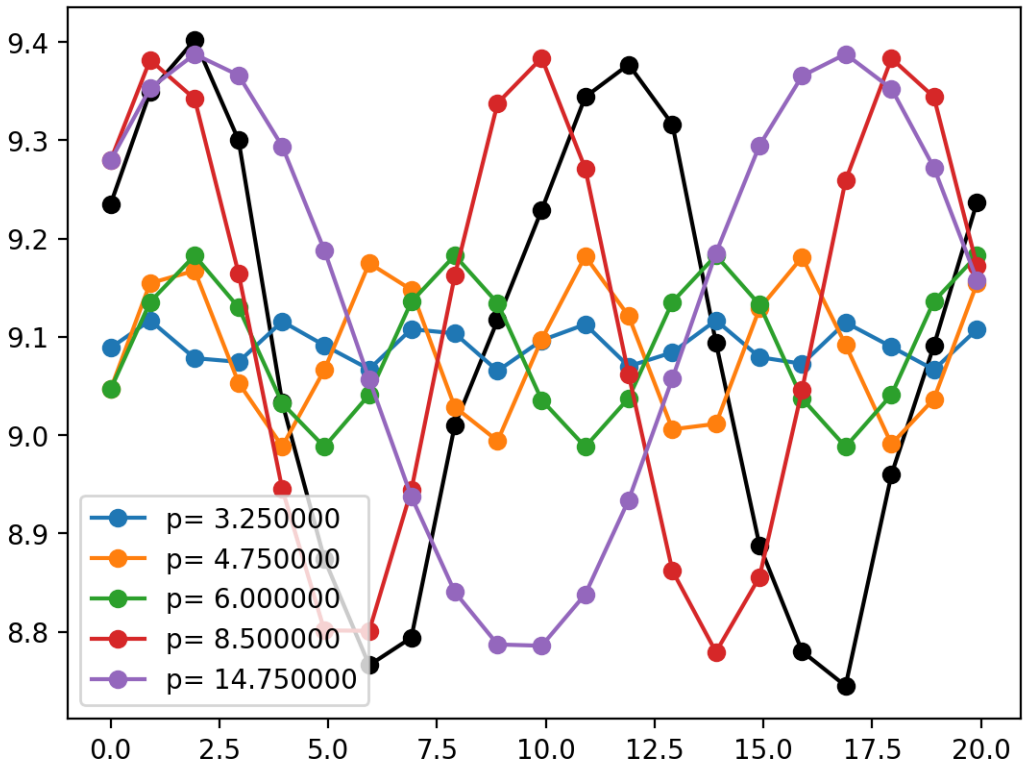

```
The period that provides the best fit for the data is 3.8835663888392435 with a
Chi squared value of 3.5734860862190345
The period that provides the best fit for the data is 6.501520367717564 with a
Chi squared value of 3.2021447885352656
The period that provides the best fit for the data is 23.435801912010252 with a
Chi squared value of 3.1613643545848973
```



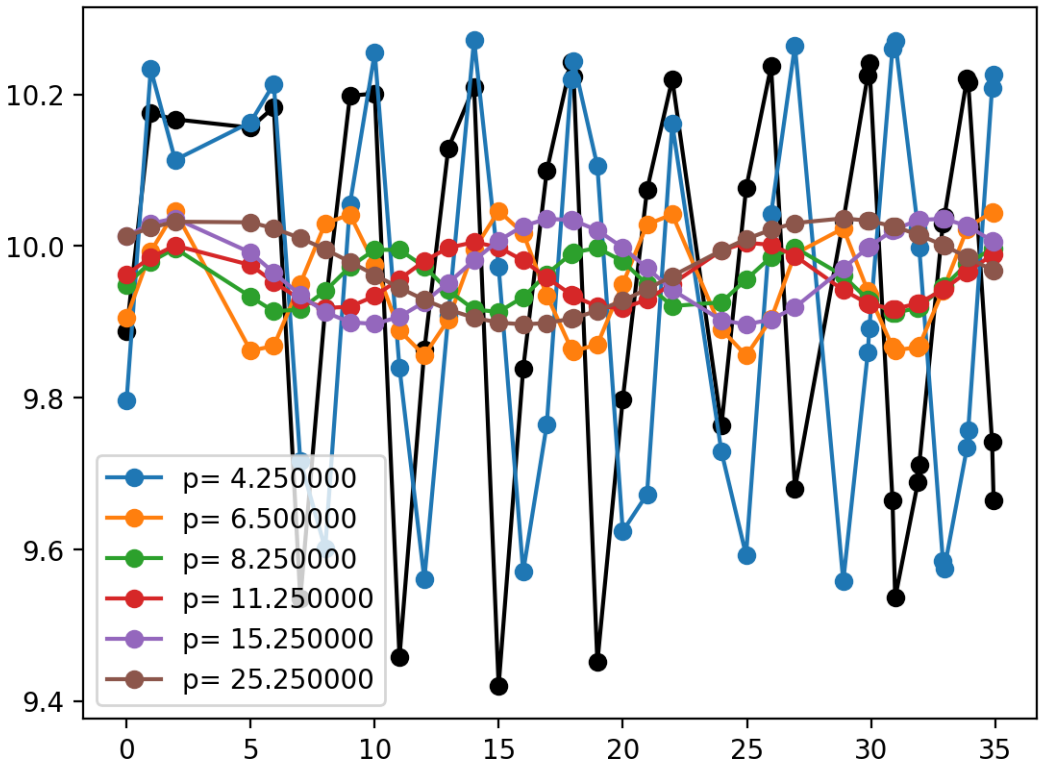

```
The period that provides the best fit for the data is 2.6247776168818424 with a
Chi squared value of 1.031511719072384
The period that provides the best fit for the data is 7.629250482928717 with a
Chi squared value of 0.6525453016395637
```



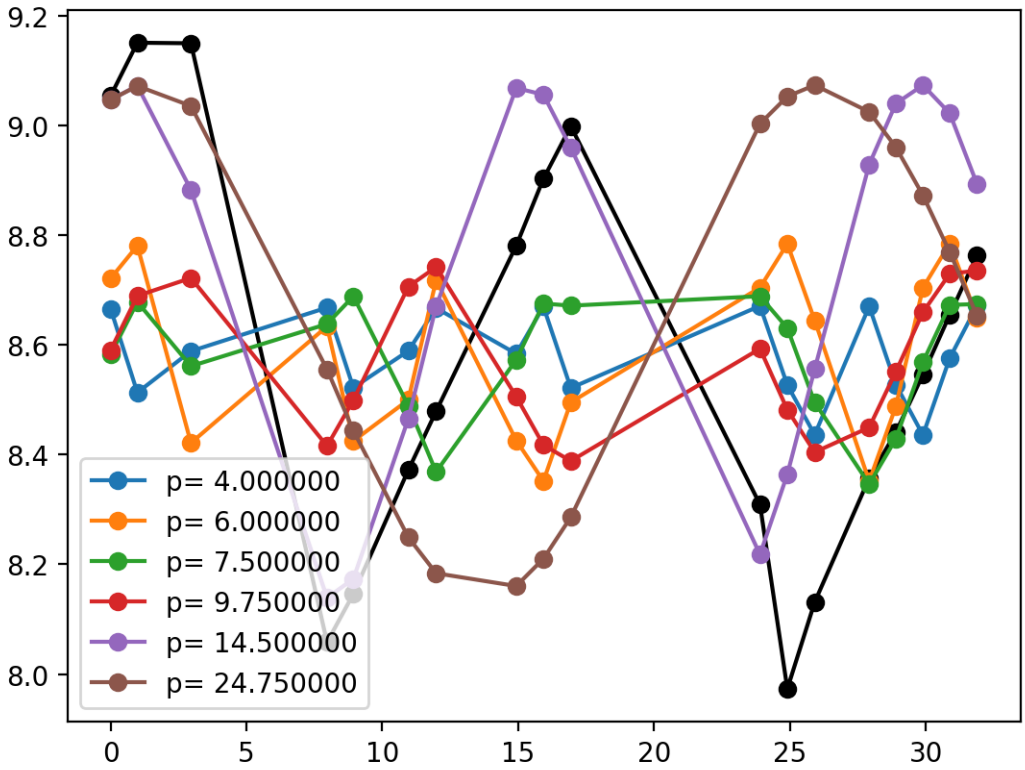

```
The period that provides the best fit for the data is 3.7043448911856527 with a
Chi squared value of 0.998053875161663
The period that provides the best fit for the data is 5.8180704033828885 with a
Chi squared value of 0.9099157409867908
```



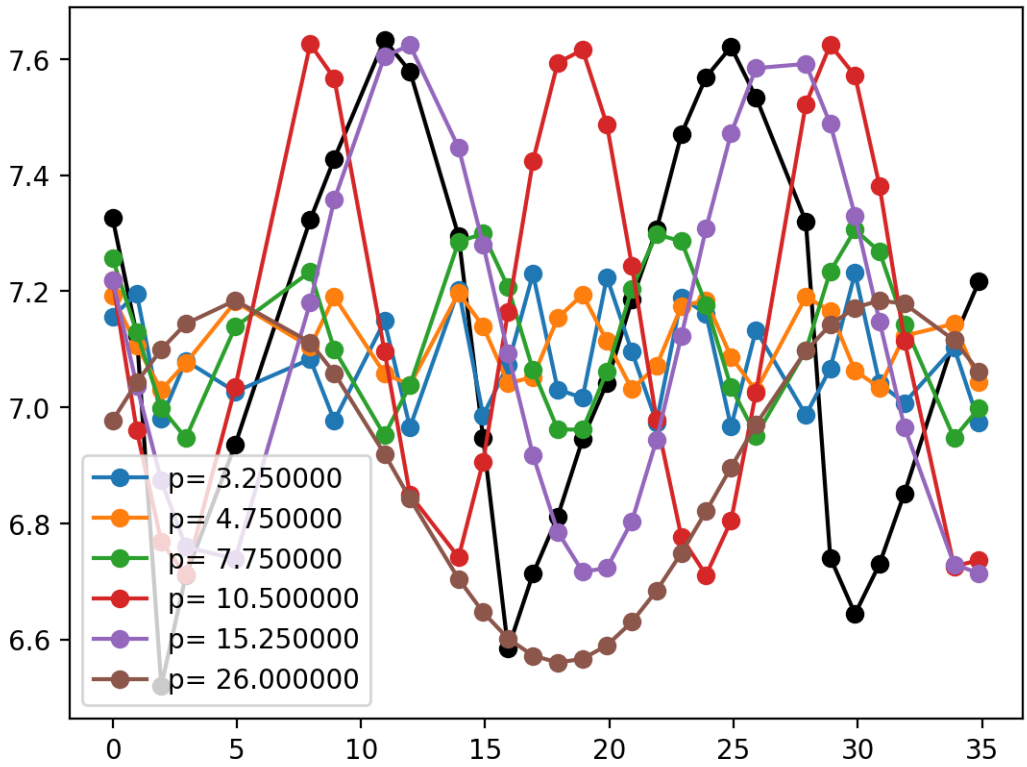

```
The period that provides the best fit for the data is 4.039506284305716 with a
Chi squared value of 5.151472584452925
The period that provides the best fit for the data is 5.340270783221137 with a
Chi squared value of 2.711114733943825
The period that provides the best fit for the data is 8.302851578057496 with a
Chi squared value of 2.6798872571816923
```



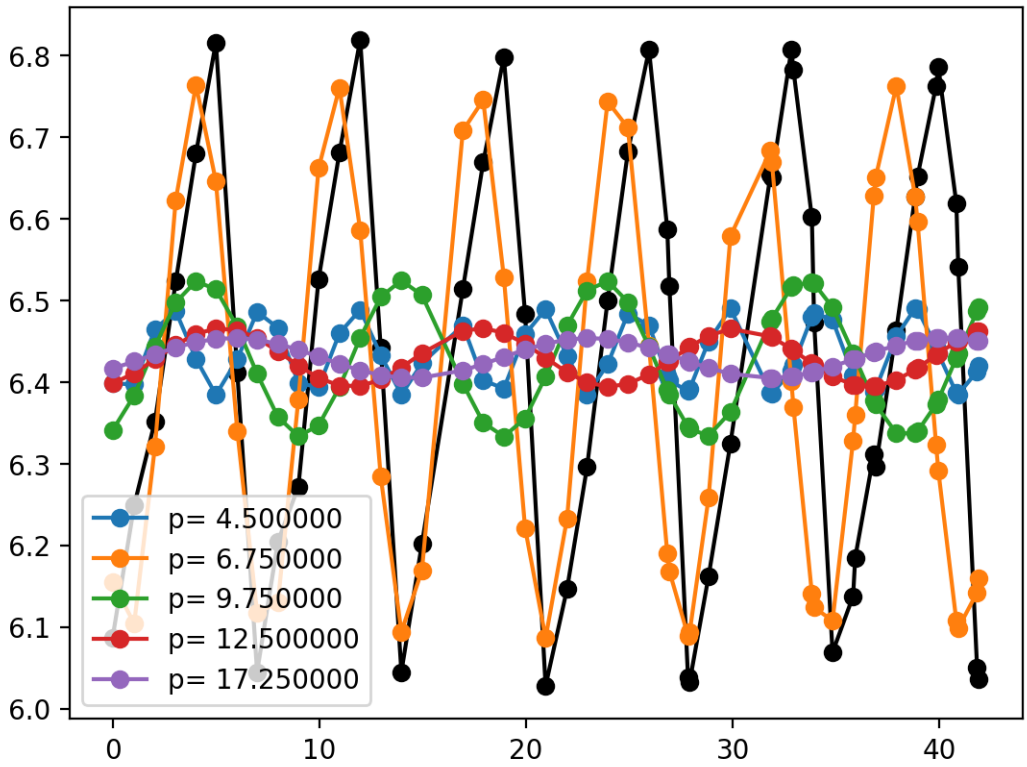

```
The period that provides the best fit for the data is 3.904895566921796 with a
Chi squared value of 2.4535509453158397
The period that provides the best fit for the data is 7.205153082201225 with a
Chi squared value of 2.3702492781088713
The period that provides the best fit for the data is 9.817999101857412 with a
Chi squared value of 2.1835805506163357
The period that provides the best fit for the data is 16.743280092800667 with a
Chi squared value of 1.6962296281203555
```



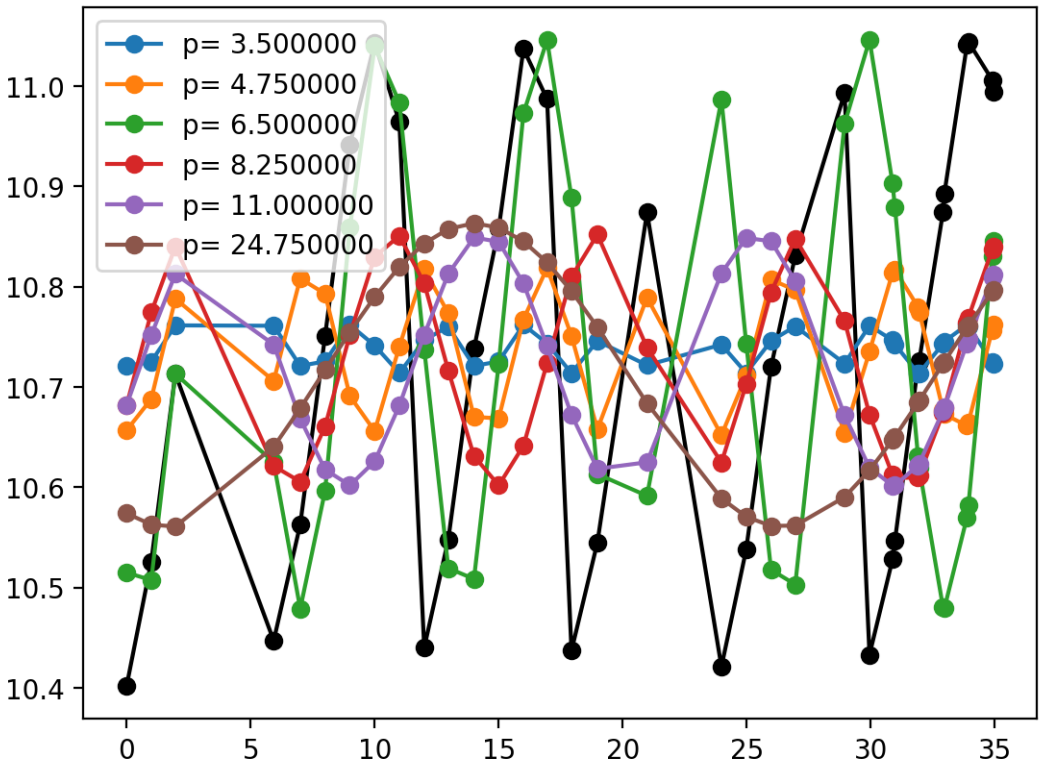

```
The period that provides the best fit for the data is 3.4711997012199576 with a
Chi squared value of 3.562282883698572
The period that provides the best fit for the data is 4.7596419204899725 with a
Chi squared value of 3.1800618668994094
The period that provides the best fit for the data is 13.67144678005264 with a
Chi squared value of 2.9890268458643385
```



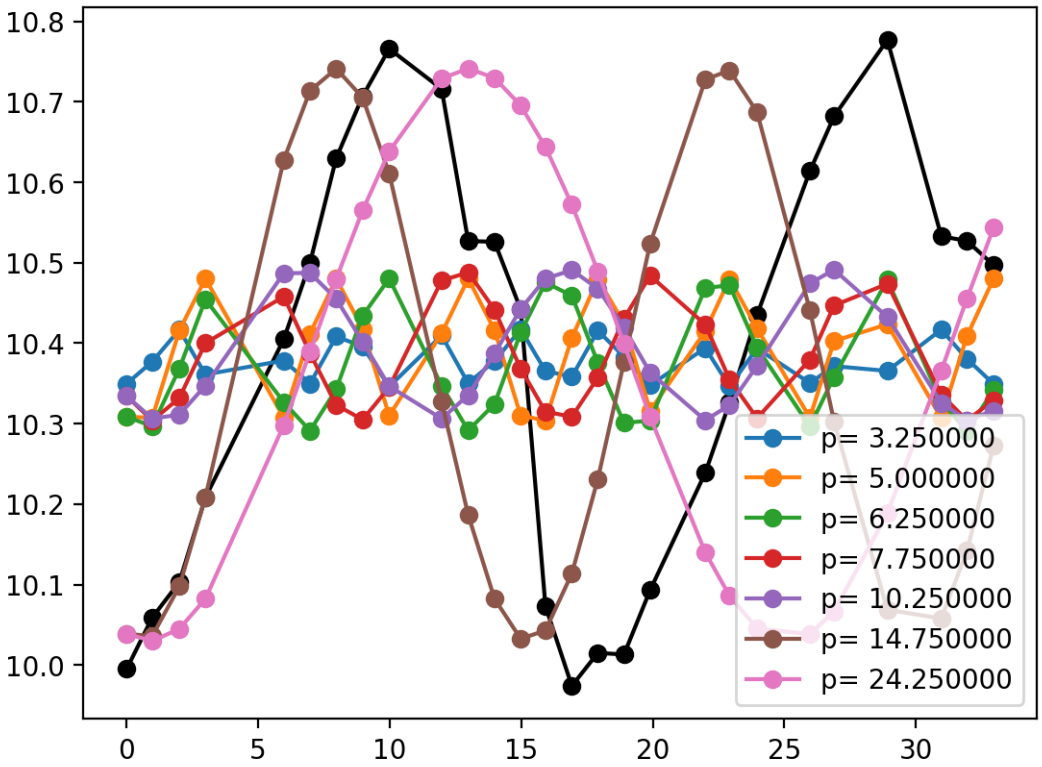

```
The period that provides the best fit for the data is 4.574898336715466 with a
Chi squared value of 3.478698094172736
The period that provides the best fit for the data is 7.020473090331237 with a
Chi squared value of 2.9810106794190627
```




```
The period that provides the best fit for the data is 3.5447667203726927 with a
Chi squared value of 1.6418755866171844
The period that provides the best fit for the data is 7.975850897517353 with a
Chi squared value of 1.5153102641401894
The period that provides the best fit for the data is 22.74445427941665 with a
Chi squared value of 1.4181399963243497
```




```
The period that provides the best fit for the data is 3.3914478290387784 with a
Chi squared value of 1.8560135300483471
The period that provides the best fit for the data is 8.152135435079826 with a
Chi squared value of 1.7682984799738046
```



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```
print(time)
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```
[47401.494  47402.4685 47403.4987 47404.4881 47407.4693 47408.4656
 47409.4616 47410.4654 47411.4759 47413.4681 47414.4786 47415.4801
```

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47416.4735 47417.4154 47418.4182 47419.4068 47420.4007 47421.3944
47423.4931 47424.4125 47425.4581 47427.4678 47428.3866 47430.4132
47432.4616 47433.4419 47434.4518]
```