Line Identification Plots Documentation

Release 0.6

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Contents

Manually placing labels in plots of spectrum is cumbersome. Functions in this module attempt to automatically position labels, in such a way that they do not overlap with each other.

The module can be installed using *pip* and *easy_install*:

```
$ pip install lineid_plot
```

The source code is available at https://github.com/phn/lineid_plot .

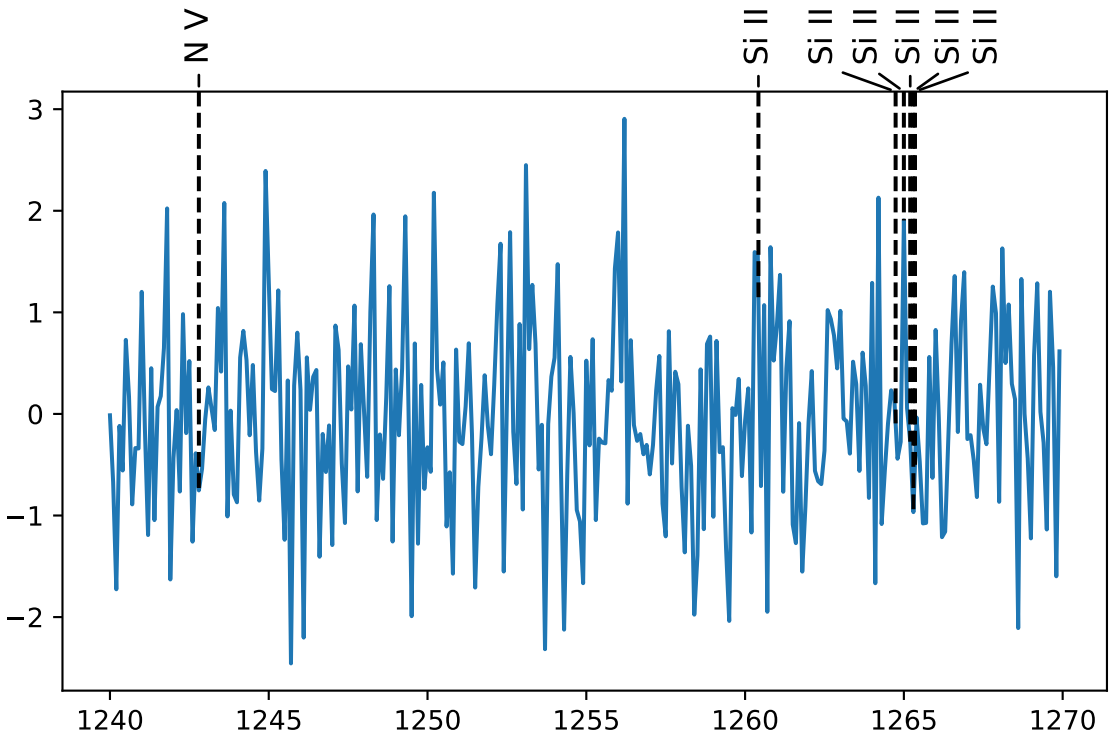
The function *plot_line_ids()* takes several keyword parameters that can be used to customized the placement of labels. The labels are generated using the *annotate* function in Matplotlib. The function returns the Figure and Axes instances used, so that further customizations can be performed.

Some example are shown below.

CHAPTER 1

Minimal plot with automatic label layout

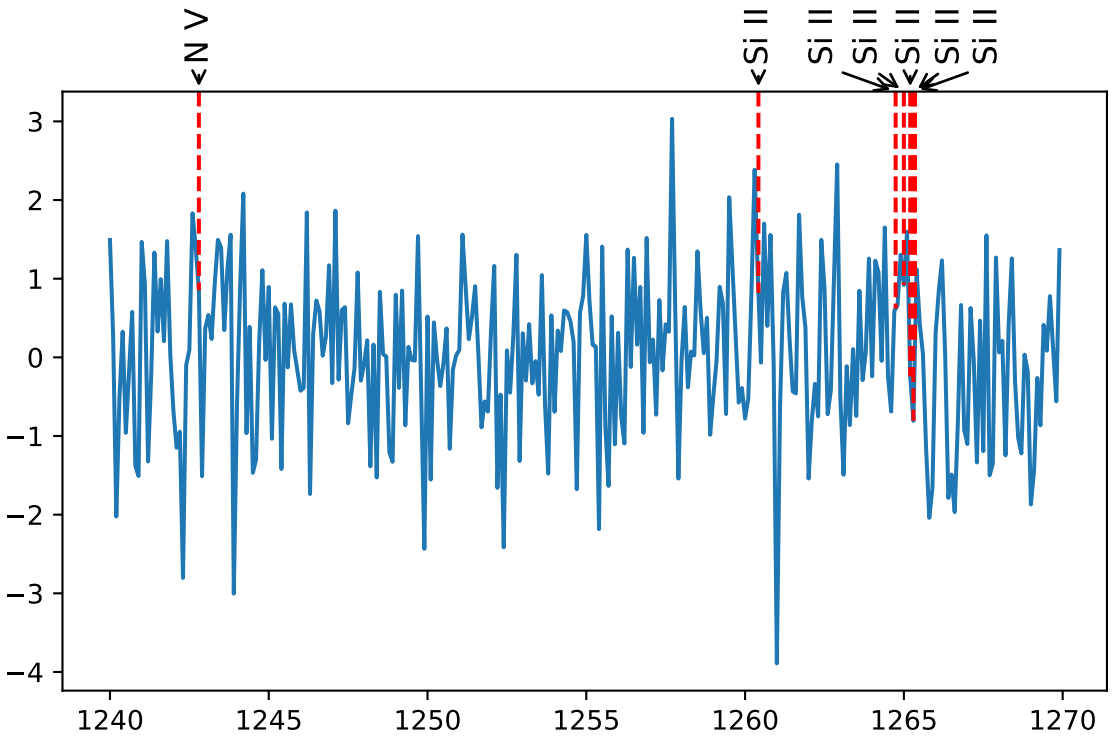
```
import numpy as np
from matplotlib import pyplot as plt
import lineid_plot

wave = 1240 + np.arange(300) * 0.1
flux = np.random.normal(size=300)

line_wave = [1242.80, 1260.42, 1264.74, 1265.00, 1265.2, 1265.3, 1265.35]
line_label1 = ['N V', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II']

lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1)

plt.show()
```


N V
Si II
Si II
Si II
Si II
Si II
Si II
3
2
1
0
−1
−2
1240
1245
1250
1255
1260
1265
1270

CHAPTER 2

Customize label and line using keyword arguments

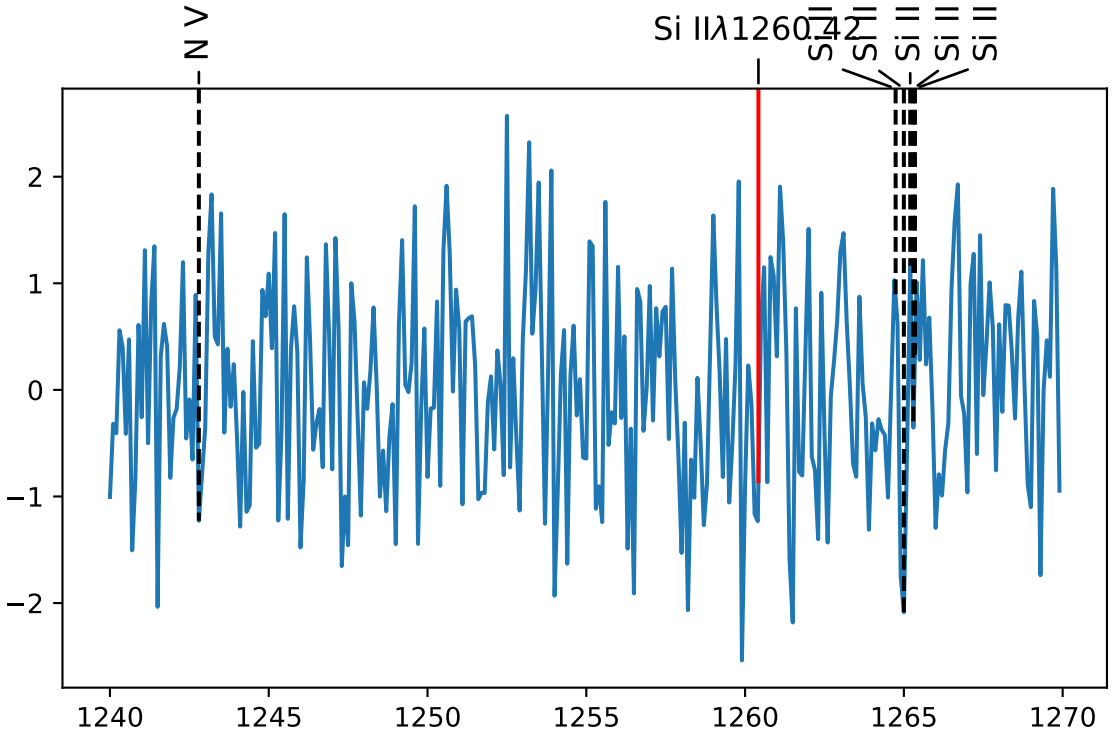
```
import numpy as np
from matplotlib import pyplot as plt
import lineid_plot

wave = 1240 + np.arange(300) * 0.1
flux = np.random.normal(size=300)

line_wave = [1242.80, 1260.42, 1264.74, 1265.00, 1265.2, 1265.3, 1265.35]
line_label1 = ['N V', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II']

ak = lineid_plot.initial_annotate_kwargs()
ak['arrowprops']['arrowstyle'] = "->"

pk = lineid_plot.initial_plot_kwargs()
pk['color'] = "red"

lineid_plot.plot_line_ids(
   wave, flux, line_wave, line_label1, annotate_kwargs=ak, plot_kwargs=pk)

plt.show()
```


N V
Si II
Si II
Si II
Si II
Si II
Si II
3
2
1
0
−1
−2
−3
−4
1240
1245
1250
1255
1260
1265
1270

CHAPTER 3

Customize label and line using reference to matplotlib objects

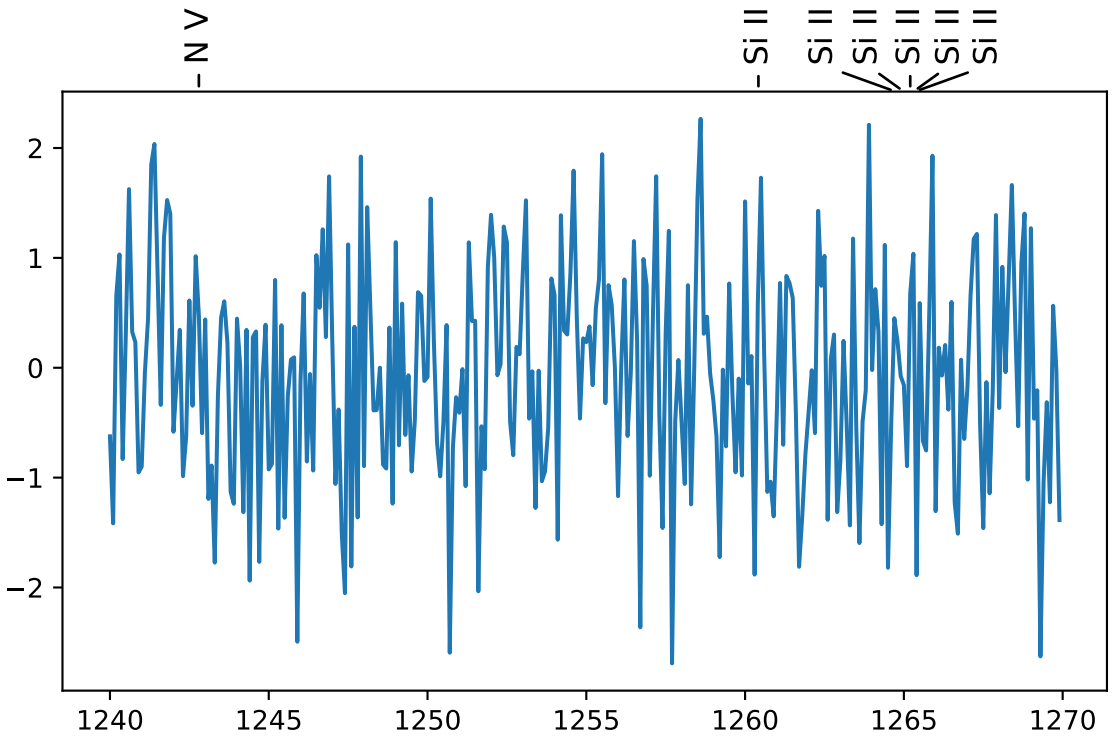
```
import numpy as np
from matplotlib import pyplot as plt
import lineid_plot

wave = 1240 + np.arange(300) * 0.1
flux = np.random.normal(size=300)

line_wave = [1242.80, 1260.42, 1264.74, 1265.00, 1265.2, 1265.3, 1265.35]
line_label1 = ['N V', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II']

fig, ax = lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1)

b = ax.findobj(match=lambda x: x.get_label() == 'Si II_num_1')[0]
b.set_rotation(0)
b.set_text("Si II$\lambda$1260.42")

line = ax.findobj(match=lambda x: x.get_label() == 'Si II_num_1_line')[0]
line.set_color("red")
line.set_linestyle("-")

plt.show()
```


N V
Si IIλ1260.42
Si II
Si II
Si II
Si II
Si II
2
1
0
−1
−2
1240
1245
1250
1255
1260
1265
1270

CHAPTER 4

Plot without line from annotation point to flux level

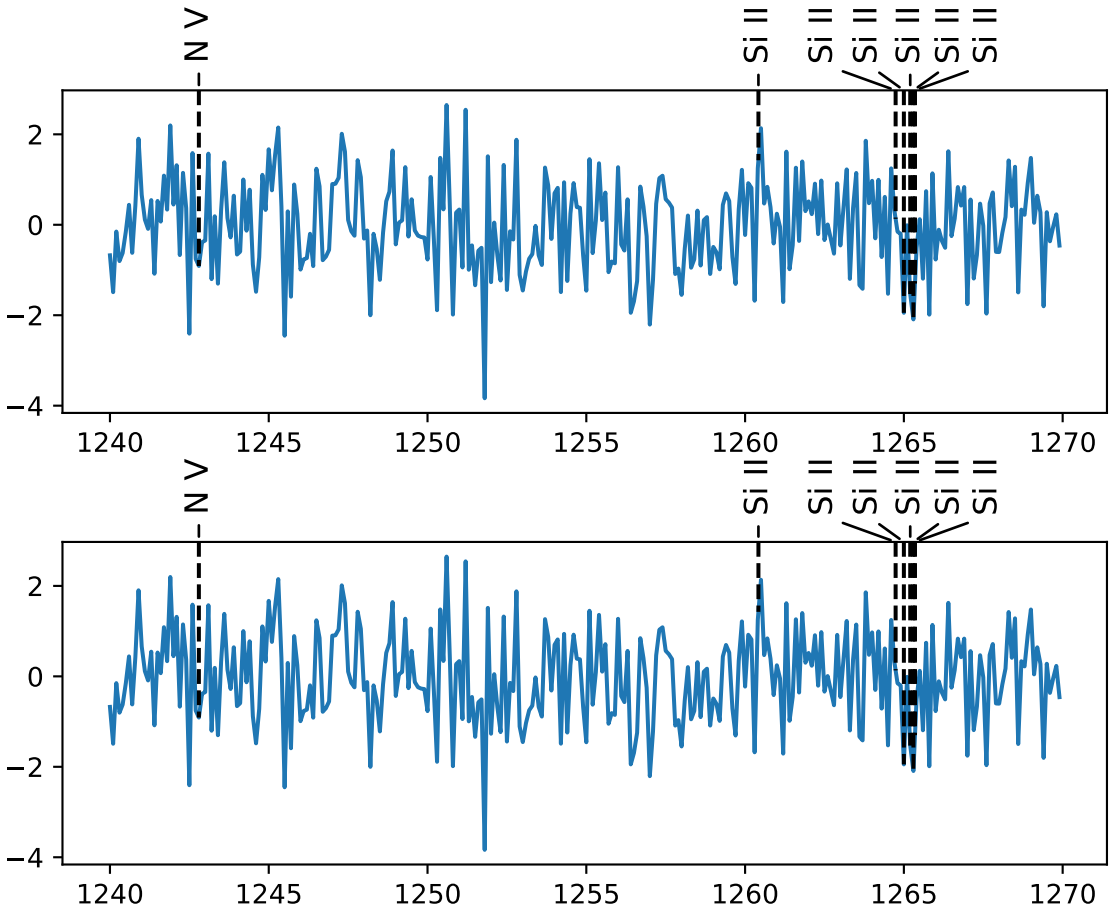
```
import numpy as np
from matplotlib import pyplot as plt
import lineid_plot

wave = 1240 + np.arange(300) * 0.1
flux = np.random.normal(size=300)

line_wave = [1242.80, 1260.42, 1264.74, 1265.00, 1265.2, 1265.3, 1265.35]
line_label1 = ['N V', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II']

# Set extend=False.
lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1, extend=False)

plt.show()
```


N V
Si II
Si II
Si II
Si II
Si II
Si II
2
1
0
−1
−2
1240
1245
1250
1255
1260
1265
1270

CHAPTER 5

Multiple plots using user provided Axes instances

```
import numpy as np
from matplotlib import pyplot as plt
import lineid_plot

wave = 1240 + np.arange(300) * 0.1
flux = np.random.normal(size=300)
line_wave = [1242.80, 1260.42, 1264.74, 1265.00, 1265.2, 1265.3, 1265.35]
line_flux = np.interp(line_wave, wave, flux)
line_label1 = ['N V', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II']
label1_sizes = np.array([12, 12, 12, 12, 12, 12, 12])

fig = plt.figure()

# First Axes
ax = fig.add_axes([0.1,0.06, 0.85, 0.35])
ax.plot(wave, flux)

# Pass the Axes instance to the plot_line_ids function.
lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1, ax=ax)

# Second Axes
ax1 = fig.add_axes([0.1, 0.55, 0.85, 0.35])
ax1.plot(wave, flux)

# Pass the Axes instance to the plot_line_ids function.
lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1, ax=ax1)

plt.show()
```


N V
Si II
Si II
Si II
Si II
Si II
Si II
2
0
−2
−4
1240
1245
1250
1255
1260
1265
1270
N V
Si II
Si II
Si II
Si II
Si II
Si II
2
0
−2
−4
1240
1245
1250
1255
1260
1265
1270

CHAPTER 6

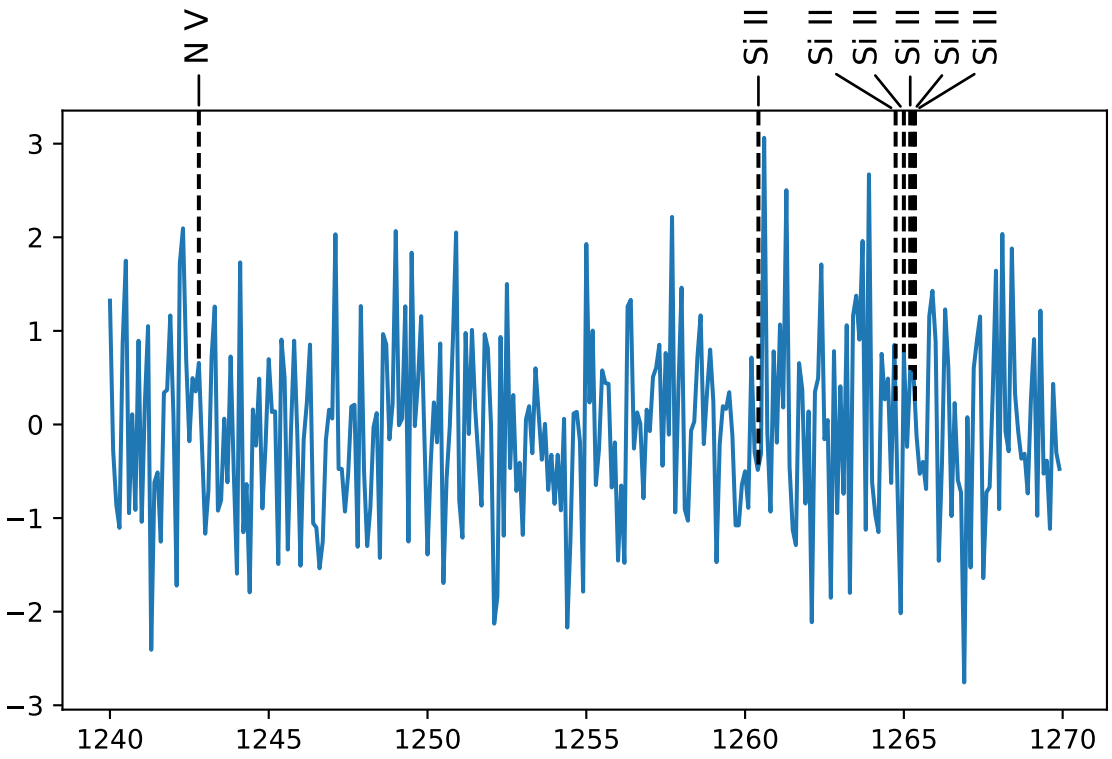
Applying small change to y axis location of label

By default the annotation point is placed on the y-axes upper bound and the box is placed 0.06 *figure fraction* units above the annotation point. Figure fraction units is used so that the appearance doesn't depend on the y range of data. The default box location i.e., 0.06 can be changed using the keyword parameter *box_axes_space*.

It is better not to use large values for this keyword. Large values can lead to *RuntimeError* when Matplotlib tries to render the plot.

Examples of changing y axis locations of annotation points and label locations using data coordinates are show later. These methods are preferred when major changes are required.

```
# box_axes_space takes numbers in figure fraction units. Keep this
# small.
lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1,
  box_axes_space=0.08)
```


N V
Si II
Si II
Si II
Si II
Si II
Si II
3
2
1
0
−1
−2
−3
1240
1245
1250
1255
1260
1265
1270

CHAPTER 7

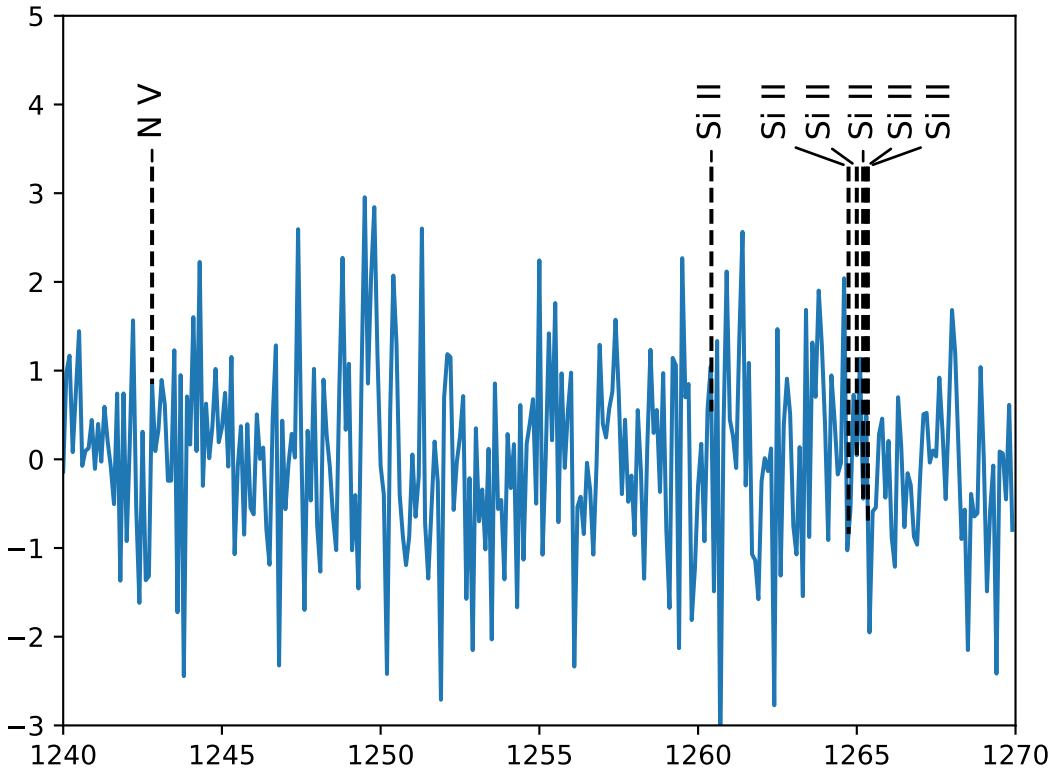
Custom y axis location for annotation points (arrow tips)

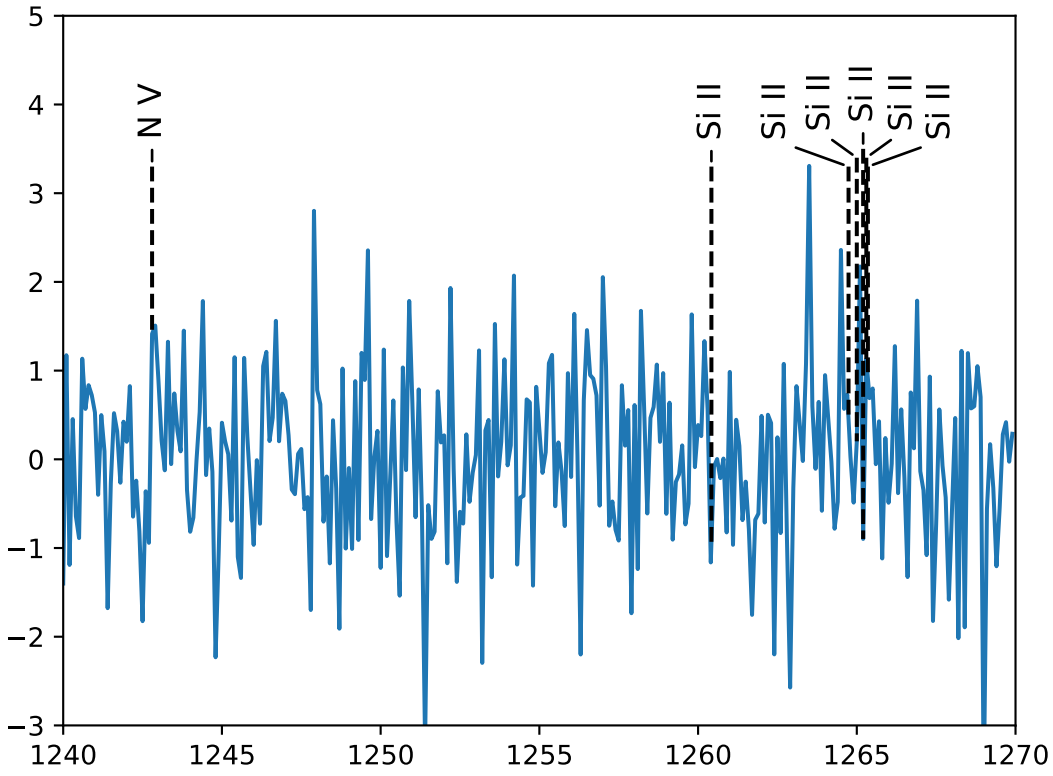
Use arrow_tip keyword to alter the annotation point. When assigning custom y axis locations, it is best to plot the data, set appropriate range for the Axes and then pass the Axes instance to *plot_line_ids()*.

```
# Use arrow_tip keyword.
lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1,
  arrow_tip=3.3, ax=ax)
```

Each label can have its own annotation point.

```
arrow_tips = [3.3, 3.3, 3.3, 3.4, 3.5, 3.4, 3.3]
lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1,
  arrow_tip=arrow_tips, ax=ax)
```


N V
Si II
Si II
Si II
Si II
Si II
Si II
5
4
3
2
1
0
−1
−2
−3
1240
1245
1250
1255
1260
1265
1270


N V
Si II
Si II
Si II
Si II
Si II
Si II
5
4
3
2
1
0
−1
−2
−3
1240
1245
1250
1255
1260
1265
1270

CHAPTER 8

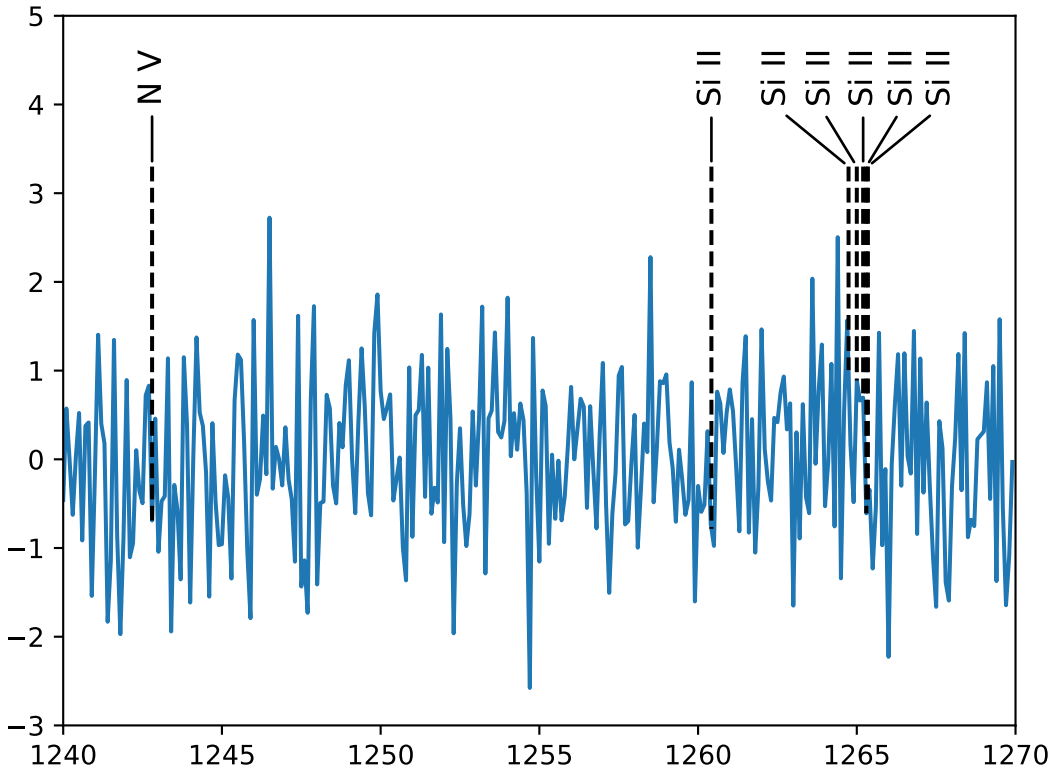
Custom y axis location for label boxes

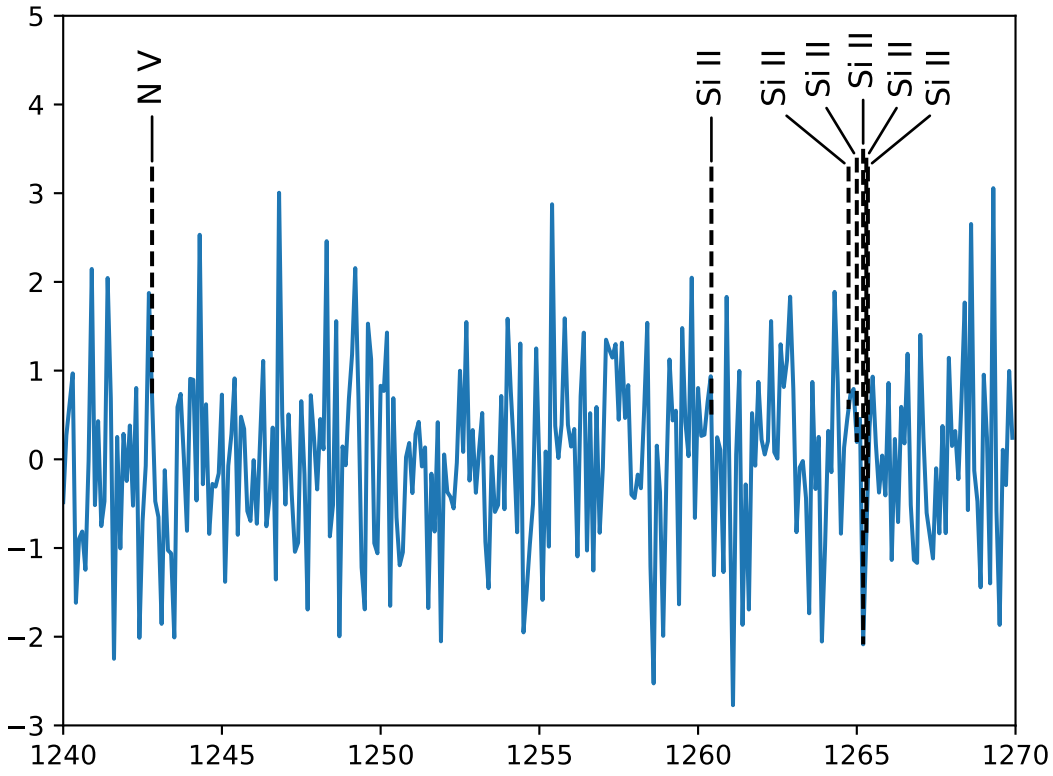
The label boxes can be given a custom y axis location. The value given is taken as the y coordinate of the center of a box, in data coordinates. When assigning custom Y locations, it is best to plot the data, set appropriate range for the Axes and then pass the Axes instance to *plot_line_ids()*.

```
lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1,
  arrow_tip=3.3, ax=ax, box_loc=4.3)
```

Each box can be assigned a separate Y box location.

```
arrow_tips = [3.3, 3.3, 3.3, 3.4, 3.5, 3.4, 3.3]
box_loc = [4.3, 4.3, 4.3, 4.4, 4.5, 4.4, 4.3]
lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1,
  arrow_tip=arrow_tips, box_loc=box_loc, ax=ax)
```


N V
Si II
Si II
Si II
Si II
Si II
Si II
5
4
3
2
1
0
−1
−2
−3
1240
1245
1250
1255
1260
1265
1270


N V
Si II
Si II
Si II
Si II
Si II
Si II
5
4
3
2
1
0
−1
−2
−3
1240
1245
1250
1255
1260
1265
1270

CHAPTER 9

Accessing a specific label

Each box has a property named *label*. These are identical to the input labels, except when there are duplicated. The duplicate texts are given a numeric suffix, based on the order in which the duplicates occur in the input. These are generated using the *unique_labels* function.

```
 line_label1
['N V', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II']
 lineid_plot.unique_labels(line_label1)
['N V',
 'Si II_num_1',
 'Si II_num_2',
 'Si II_num_3',
 'Si II_num_4',
 'Si II_num_5',
 'Si II_num_6']
```

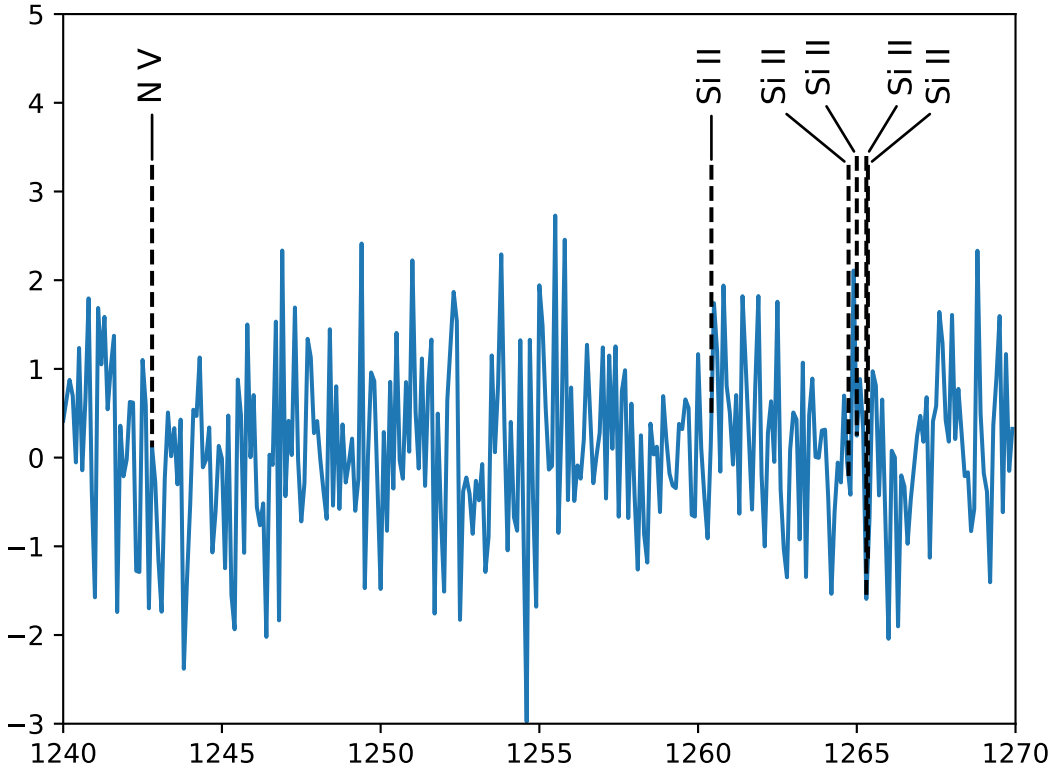
Each line extending from the annotation point to the flux level, is also assigned a label properties. The value is the above label property suffixed with "_line".

Matplotlib `Figure` and `Axes` instances have a method `findobj()` which can be used to find objects in it, that satisfy certain conditions. For example, all `Annotation` objects. It will accept a function, and any object that will cause this function to return True, will be returned by `findobj()`.

In the following one of the "Si II" boxes and line extending to the flux level are made invisible.

```
import numpy as np
from matplotlib import pyplot as plt
import matplotlib as mpl
import lineid_plot

wave = 1240 + np.arange(300) * 0.1
flux = np.random.normal(size=300)
line_wave = [1242.80, 1260.42, 1264.74, 1265.00, 1265.2, 1265.3, 1265.35]
line_flux = np.interp(line_wave, wave, flux)
line_label1 = ['N V', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II', 'Si II']
label1_sizes = np.array([12, 12, 12, 12, 12, 12, 12])
```

```
fig = plt.figure()
ax = fig.add_subplot(111)
ax.plot(wave, flux)
ax.axis([1240, 1270, -3, 5])

arrow_tips = [3.3, 3.3, 3.3, 3.4, 3.5, 3.4, 3.3]
box_loc = [4.3, 4.3, 4.3, 4.4, 4.5, 4.4, 4.3]
lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1,
  arrow_tip=arrow_tips, box_loc=box_loc, ax=ax)

a = ax.findobj(mpl.text.Annotation)
for i in a:
    if i.get_label() == "Si II_num_4":
       i.set_visible(False)

a = ax.findobj(mpl.lines.Line2D)
for i in a:
    if i.get_label() == "Si II_num_4_line":
       i.set_visible(False)

plt.show()
```



Adding a label to lines can cause problems when using `plt.legend()`: the legend will include the lines drawn from text box to spectrum location. There are two ways of overcoming this. First is to provide explicit

artists and texts to `plt.legend()`. Second is to tell `lineid_plot` not to add these labels by passing in `add_label_to_artists=False`. Of-course, if we use the second option then we can't use the above method for finding text and lines.

```
fig, ax = lineid_plot.plot_line_ids(
    wave, flux, line_wave, line_label1, max_iter=300, add_label_to_artists=False
)
```

CHAPTER 10

Customizing box location adjustment parameters

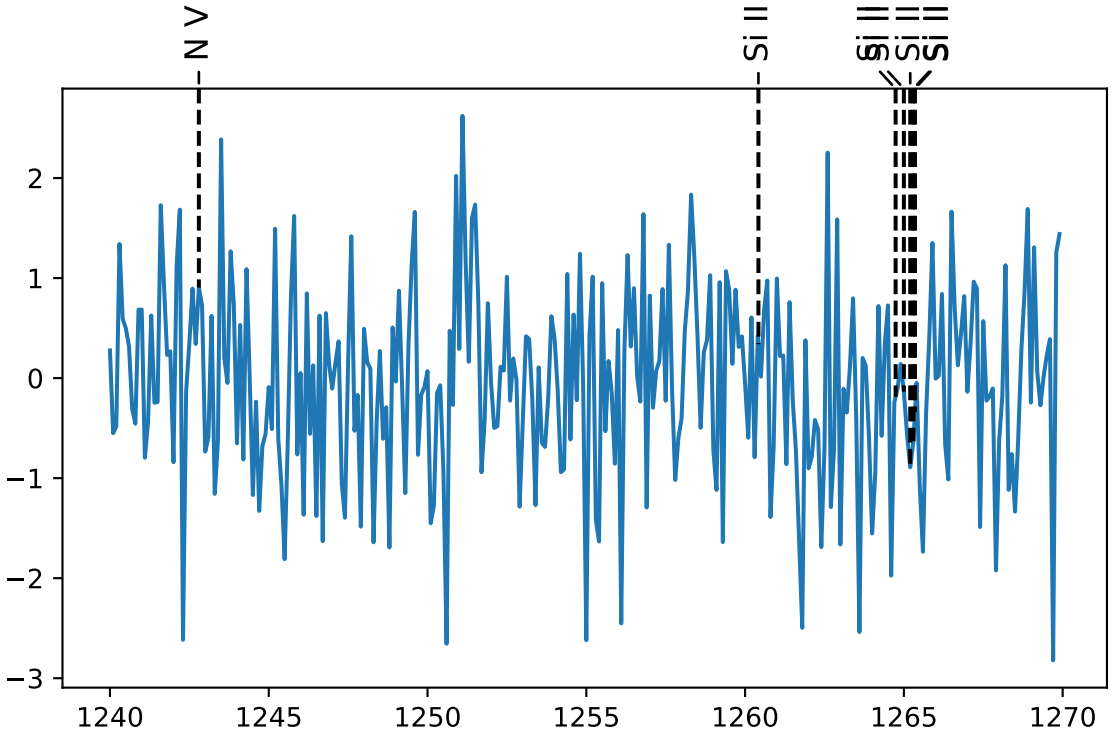
The parameter *max_iter* fixes the maximum number of adjustments to perform. Parameter *adjust_factor* sets the factor by which the current separation of the boxes must be increased or decreased. After *fd_p* percentage of *max_iter* the *adjust_factor* is reduced by a factor of *factor_decrement*. The defaults for all these should be enough in most situations.

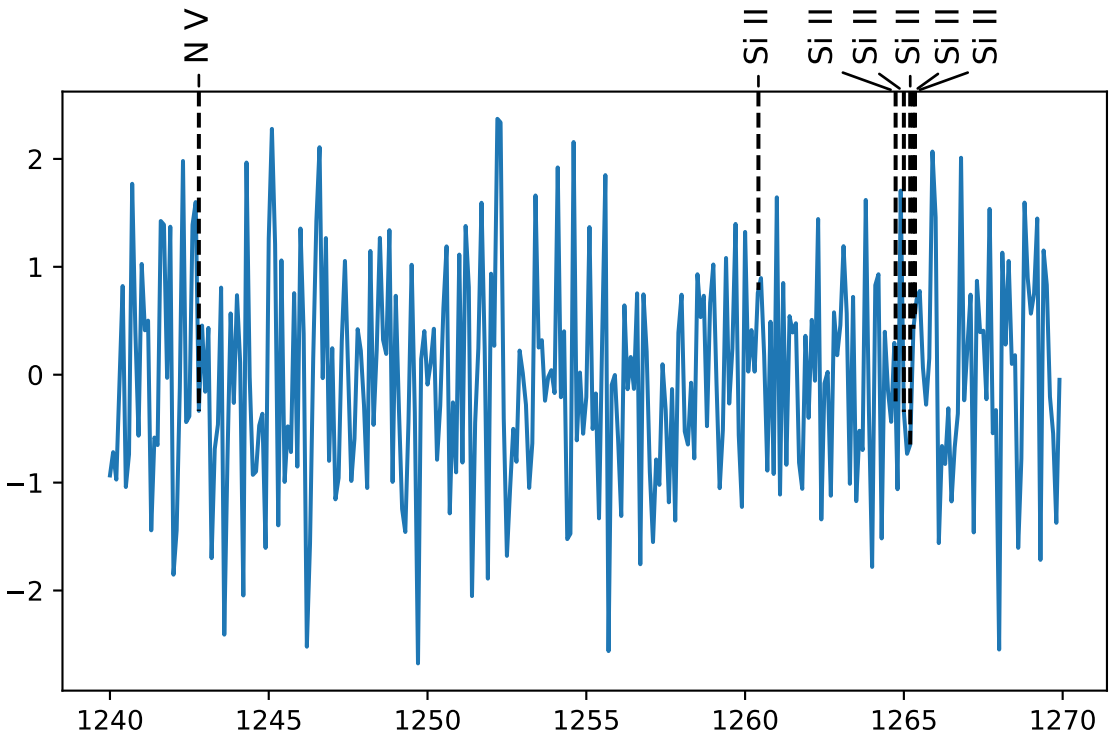
The example below shows, for the data used, a low value of *max_iter* doesn't separate the labels well enough.

```
lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1,
 max_iter=10)
```

Using a value of 300 works. Note that the default is 1000.

```
lineid_plot.plot_line_ids(wave, flux, line_wave, line_label1,
 max_iter=300)
```


N V
Si II
Si II
Si II
Si II
2
1
0
−1
−2
−3
1240
1245
1250
1255
1260
1265
1270


N V
Si II
Si II
Si II
Si II
Si II
Si II
2
1
0
−1
−2
1240
1245
1250
1255
1260
1265
1270