Manual for pgf-spectra 2.0.0

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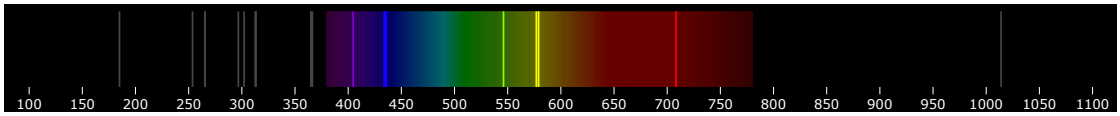


\pgfspectra[element=Hg,axis,axis step=50,begin=100,end=1100,back=visible40,gamma=.6,line width=.5pt]

Abstract

The purpose of this package is to draw the spectrum of elements in a simple way. It's based on the package *pst-spectra*, but with some extra options. It relays on the pgf/TikZ to draw the desired spectrum, continuous or discrete. As in *pst-spectra* there are data available for the spectra of 98 elements and their ions. It also allows the user to draw a spectrum with their own personal data.

In this version the previous data was extended to include lines from Extreme UV to Near IR ($10\,nm \leq \lambda \leq 4000\,nm$). *See section The lines data below for more information.*

There is now the possibility to redshift the lines of spectra, entering directly the redshift value or by entering the velocity and the angle to compute the redshift value (Doppler Redshift).

Contents

Installation and usage

pgf-spectra is placed under the terms of the LaTeX Project Public License, version 1.3 or later (http://www.latex-project.org/lppl.txt). pgf-spectra loads and only requires the package tikz.

You need to put the style file (pgf-spectra.sty) in a location where pdflatex can find them. According to the TDS conventions this may be a subdirectory named tex/latex/pgfspectra/ or tex/latex/misc/ in your (site specific) installation tree (insert your appropriate directory delimiter instead of /, if needed).

If you are using pdflatex, just can simply include the style file without any option via the \usepackage command: \usepackage{pgf-spectra}

For more detailed information see section The lines data.

What's new

- The package can now be loaded with one of the following options:
  - \usepackage[NIST]{pgf-spectra} (**default**)
  - \usepackage[LSE]{pgf-spectra}
- Range of spectral window from $10\,nm$ to $4000\,nm$ (previous version from $380\,nm$ to $780\,nm$).
- Added the lines data outside the visible range for the 98 elements.
- No more dependency on the package ifthen (code rewrote with the \ifx TeX primitive).
- Setting/disabling global options to draw the spectra's with the new commands:
  - \pgfspectraStyle[options]
  - \pgfspectraStyleReset
- New keys:
  - axis ticks
  - backIRUV (only for emission spectrum)
  - IRcolor (for emission lines and for background in absorption spectrum)
  - UVcolor (for emission lines and for background in absorption spectrum)
  - redshift
  - show redshift value

- The issues with the zooming of the pdf viewer sometimes introducing blank lines in the spectra have been fixed:

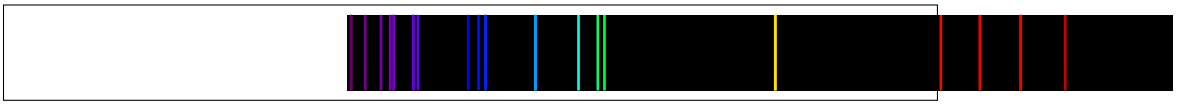
  

  The rendition should now be working for every zoom (I hope!):

  Many thanks to *Daniel García*'s suggestion to solve this problem!

- Fixed the problem when putting the spectra inside any horizontal TEX box, like `\makebox`, `\mbox` or `\hbox`.
  For instance, the code \makebox[\textwidth][c]\pgfspectra[element=He]:
  - had as a result in the previous version (version 1.0):

  - and will result in current version (2.0.0) at:

The lines data

There are two data sets availbale for drawing the spectra: one based in the previous version, whose data was initially obtained from the package pst-spectra and the other obtained from NIST.

In both cases are included the lines for 98 elements, from hydrogen ($Z = 1$) to einsteinium ($Z = 99$), except for francium ($Z = 87$). For each element there are lines between $10\,nm$ and $4000\,nm$ (obtained from the referred pages at February 2021).

1 Data based on pst-spectra

This set was obtained from http://cdsarc.u-strasbg.fr/viz-bin/Cat?VI/16

According to the information on the page the listed lines are based on "Line Spectra of the Elements", Joseph Reader and Charles H. Corliss CRC Handbook of Chemistry and Physics. This book refers that «The table contains the outstanding spectral lines of neutral (I) and singly ionized (II) atoms of the elements from hydrogen through plutonium ($Z = 1 - 94$); selected strong lines from doubly ionized (III), triply ionized (IV), and quadruply ionized (V) atoms are also included.»

Note: pst-spectra documentation refers "*Line Spectra of the Elements from the Astronomical Data Center of NASA*" as the source material, but I'm assuming the original source is "*Line Spectra of the Elements", Joseph Reader and Charles H. Corliss CRC Handbook of Chemistry and Physics*, obtained from http://cdsarc.u-strasbg.fr/viz-bin/Cat?VI/16.

To use this data set load the package `pgf-spectra` with the option `LSE` (acronym to Line Spectra of the Elements):

```
\usepackage[LSE]{pgf-spectra}
```

Number of lines provided: 46065 (see file pgf-spectraDataLSE.pdf)

2 Data based on NIST

This set was obtained from
https://physics.nist.gov/PhysRefData/Handbook/Tables/findinglist.htm

According to the information on the page the listed lines «includes data for the neutral and singly-ionized atoms».

Note: **This set is loaded by default**. Because the data to search is slightly smaller (only neutral and singly-ionized atoms) the time consumption when building the spectra could be a bit lower.

To use this data set load the package `pgf-spectra` without options:

```
\usepackage{pgf-spectra}
```

Number of lines provided: 11980 (see file pgf-spectraDataNIST.pdf);

The commands

There are now for commands available:

- \pgfspectra or \pgfspectra[options list]
- \wlcolor{wavelength}
- \pgfspectraStyle[options]
- and \pgfspectraStyleReset

► Utilization of \pgfspectra

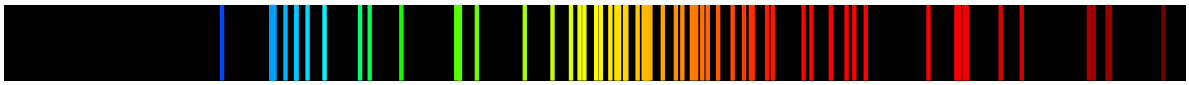
This command is used without options to draw the visible continuous spectrum:

```
\pgfspectra
```

When using options a continuous or discrete spectra in the visible region can be drawn, for instance:

```
\pgfspectra[width=.5\textwidth,height=1.5cm]
```

```
\pgfspectra[width=\textwidth,element=Ne]
```

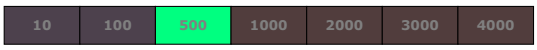


► Utilization of \wlcolor{wavelength}

A command to convert a wavelength from 380 to 780 nanometers (or other value in the range $10\,nm \leq \lambda \leq 4000\,nm$) to the respective color available as 'wlcolor':

```
\tikz{\foreach \x in {380,400,...,780}{
          \wlcolor{\x}
          \draw[fill=wlcolor] (.03*\x,0) rectangle ++(.6,.5)
                  node[midway,font=\tiny\bfseries,text=black!50] {\x};}
}
```

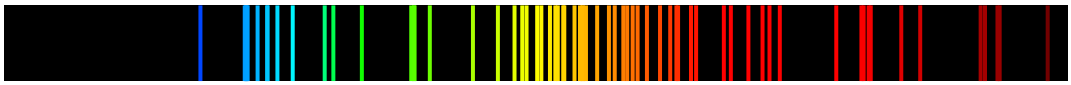

```
\tikz{\foreach \x/\y in {10/0,100/1,500/2,1000/3,2000/4,3000/5,4000/6}{
          \wlcolor{\x}
          \draw[fill=wlcolor] (\y,0) rectangle ++(1,.5)
                  node[midway,font=\tiny\bfseries,text=black!50] {\x};}
}
```



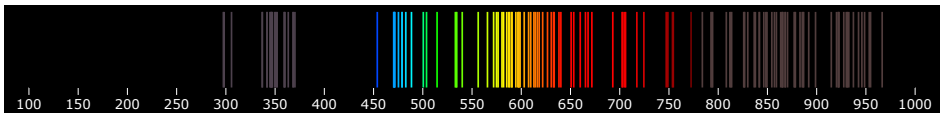
► Utilization of \pgfspectraStyle[options]

Use this command to set the global style of all the subsequent drawn spectra:

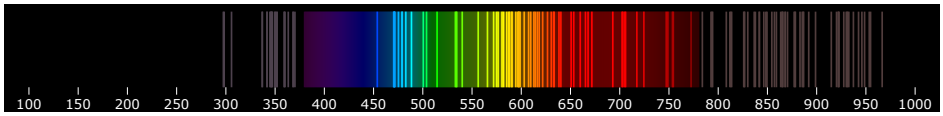
```
\pgfspectra[element=Ne]                                    (before defining the global style)
```



```
\pgfspectraStyle[width=.75\textwidth,axis,begin=100,end=1000,axis step=50]
\pgfspectra[element=Ne]                                    (after defining the global style)
```

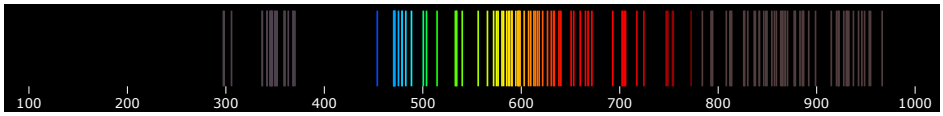



```
\pgfspectra[element=Ne,back=visible40,gamma=.6]            (adding other options)
```



Note you can locally override the settings defined in the global style:

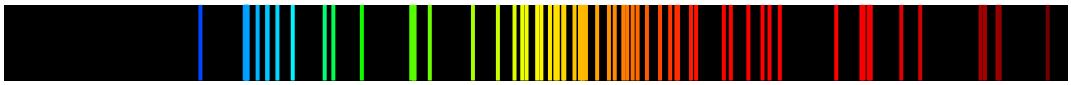
```
\pgfspectra[element=Ne,axis step=100]                      (overriding a global option)
```



► Utilization of \pgfspectraStyleReset

Used to reset all the options of the spectra to their default values:

```
\pgfspectraStyleReset
\pgfspectra[element=Ne]
```



The options

For the commands \pgfspectra and \pgfspectraStyle there are a set of options available to draw the spectrum as described below.

> The list of options is of the form 'key' or 'key=value' separated by commas.

width default: *0.9\textwidth*

Sets the width of the spectrum.

```
\pgfspectra[width=10cm]
```

height default: *1cm*

Sets the height of the spectrum.

```
\pgfspectra[height=40pt]
```

element default: *NONE*

A single chemical symbol of an element or a list of chemical symbols.

```
\pgfspectra[element=H]
```

```
\pgfspectra[element={H,He}]
```

charge default: *0*

The charge of the *particle* to draw the spectrum. Use 'all' to get all available lines for the element, i.e, for the atom and all the positive ions that exists in the database.

```
\pgfspectra[element=He]
```

```
\pgfspectra[element=He,charge=1]
```

```
\pgfspectra[element=He,charge=2]
```

Element “He” with charge “2” have no lines to display.

```
\pgfspectra[element=He,charge=all]
```

Imin default: *0*

The minimum intensity of the lines to put in the spectrum. Value from 0 to 1.

```
\pgfspectra[element=He,Imin=.5]
```

```
\pgfspectra[element=He,Imin=.05]
```

relative intensity default: *false*

Draws the lines respecting the intensity of the observed spectrum.

```
\pgfspectra[element=He,relative intensity]
```

relative intensity threshold default: *0.25*

Sets the minimum intensity for the lines in the spectrum when using relative intensities. When set to 0.25 a line with real intensity 0 will have a spectral intensity of 0.25 and a line with intensity equal to the max intensity observed in that spectrum will have an intensity in the computed spectrum of 1, assuming of course an overall intensity in the range between 0 and 1.

```
\pgfspectra[element=He,relative intensity,relative intensity threshold=0]
```

```
\pgfspectra[element=He,relative intensity,relative intensity threshold=.25]
```

```
\pgfspectra[element=He,relative intensity,relative intensity threshold=.5]
```

```
\pgfspectra[element=He,relative intensity,relative intensity threshold=.75]
```

```
\pgfspectra[element=He,relative intensity,relative intensity threshold=1]
```

In fact setting the relative intensity threshold to 1 is equivalent to the spectrum without relative intensities:

```
\pgfspectra[element=He]
```

line intensity default: *100*

Draws all the lines with the specified intensity between 0 and 100 (as a percentage of the maximum intensity).

```
\pgfspectra[element=He,line intensity=0]
```

```
\pgfspectra[element=He,line intensity=50]
```

```
\pgfspectra[element=He,line intensity=100]
```

```
\pgfspectra[element=He]
```

gamma default: *0.8*

Gamma color correction: any positive value.

```
\pgfspectra[gamma=.1]
```

```
\pgfspectra[gamma=.8]
```

```
\pgfspectra[gamma=1]
```

```
\pgfspectra[gamma=2]
```

```
\pgfspectra[gamma=5]
```

```
\pgfspectra[gamma=10]
```

brightness default: *1*

Brightness color correction as in the CMYK color model. Value between 0 and 1. Zero stands for black and one for the maximum bright. *This option only works for the continuous component of the spectra, to change the "brightness" of spectral lines use the option 'line intensity'.*

```
\pgfspectra[brightness=.1]
```

```
\pgfspectra[brightness=.5]
```

```
\pgfspectra[brightness=1]
```

back default: *black*

Sets the background color of the spectrum. Only useful when there are spectral lines. Some shorthand are defined to put the visible region in the background: 'visible5', 'visible10', 'visible15', . . . , 'visible100'.

Note: this labels combined with the 'brightness' option makes it possible to achieve other values on the background, since the visible amount (5%,10%,. . .) is multiplied by the value of brightness.

```
\pgfspectra[element=He,back=white]
```

```
\pgfspectra[element=He,back=black!50]
```

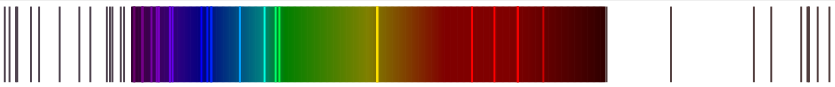
```
\pgfspectra[element=He,back=visible50]
```

```
\pgfspectra[element=He,back=visible50,brightness=.26]
```

backIRUV default: *black*

Sets the background color, *only for the emission spectrum*, outside the visible region ($10nm \leq \lambda < 380nm$ and $780nm < \lambda \leq 4000nm$) *(new in v2.0.0)*

```
\pgfspectra[element=He,back=visible50,begin=100,end=1000,backIRUV=white]
```

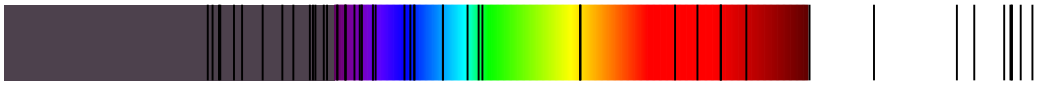


IRcolor default: *rgb(0.3157,0.2373,0.2373)*

Sets the color for emission lines and for background in absorption spectrum in the IR region ($780nm < \lambda \leq 4000nm$) *(new in v2.0.0)*

```
\pgfspectra[element=He,back=visible50,begin=100,end=1000,IRcolor=white]
```

```
\pgfspectra[element=He,back=visible50,begin=100,end=1000,IRcolor=white,
absorption]
```

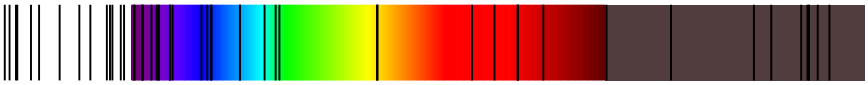


UVcolor default: *rgb(0.3,0.2568,0.3)*

Sets the color for emission lines and for background in absorption spectrum in the UV region ($10nm \leq \lambda < 380nm$) *(new in v2.0.0)*

```
\pgfspectra[element=He,back=visible50,begin=100,end=1000,UVcolor=white]
```

```
\pgfspectra[element=He,back=visible50,begin=100,end=1000,UVcolor=white,
absorption]
```



lines default: *{}*

A comma separated list of wavelengths in the interval $[10; 4000]\,nm$.

(Interval updated in v2.0.0)

```
\pgfspectra[lines={400,500,550,700}]
```

```
\pgfspectra[lines={200,205,400,500,550,700,850,950,980},begin=100,end=1000]
```

line width default: *1pt*

The width of each individual line in the spectrum.

```
\pgfspectra[line width=2pt]
```

```
\pgfspectra[line width=2pt,element=He]
```

begin default: *380*

The starting wavelength in nanometers of the spectrum ($10 \leq \lambda \leq 4000$).

(Interval updated in v2.0.0)

```
\pgfspectra[begin=500]
```

end default: *740*

The finishing wavelength in nanometers of the spectrum ($10 \leq \lambda \leq 4000$).

(Interval updated in v2.0.0)

```
\pgfspectra[end=500]
```

Remark: *it's obviously possible to set 'begin' and 'end' at the same time and if desired change the order of the wavelengths.*

```
\pgfspectra[begin=500,end=700]
```

```
\pgfspectra[begin=700,end=500]
```

```
\pgfspectra[begin=780,end=380]
```

```
\pgfspectra[begin=780,end=380,element=He]
```

absorption default: *false*

Draws the absorption spectrum instead of the emission one.

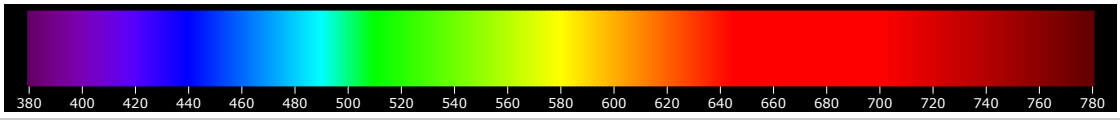
```
\pgfspectra[element=H,absorption]
```

```
\pgfspectra[element={H,He},absorption]
```

axis default: *false*

Draws a nanometric axis below the spectrum.

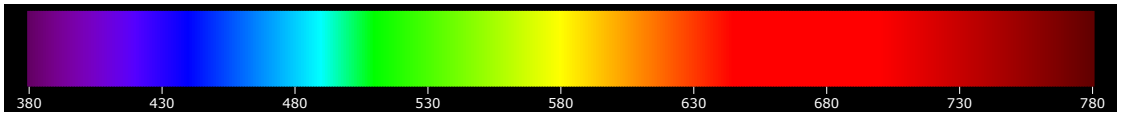
```
\pgfspectra[axis]
```



axis step default: *20*

The increment to use in the axis scale.

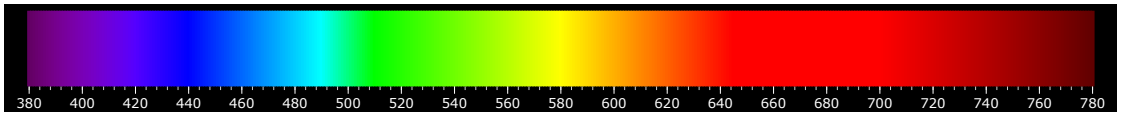
```
\pgfspectra[axis,axis step=50]
```



axis ticks default: *0*

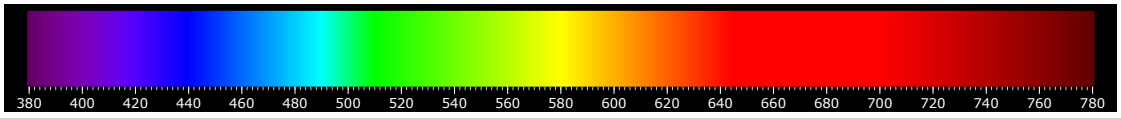
The number of minor ticks between two consecutive ticks in the axis. *(new in v2.0.0)*

```
\pgfspectra[axis,axis ticks=4]
```



Keep in mind, if you desire to divide two consecutive ticks into 10 equal parts set 'axis ticks=9':

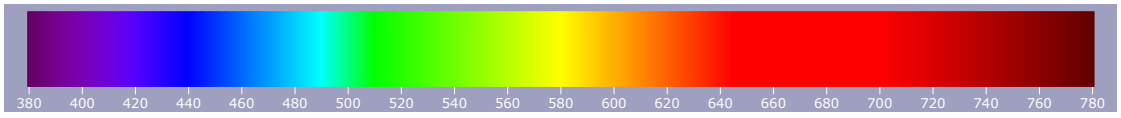
```
\pgfspectra[axis,axis ticks=9]
```



axis color default: *black*

The color of the axis.

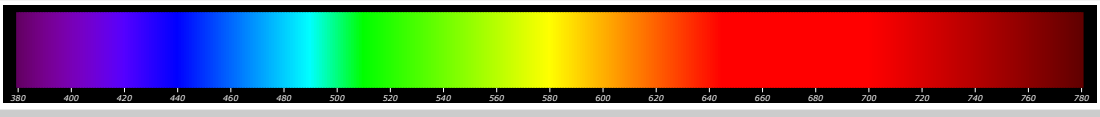
```
\pgfspectra[axis,axis color=red!50!green!50!blue!50]
```



axis font default: *\tiny*

The font specs to use in the axis.

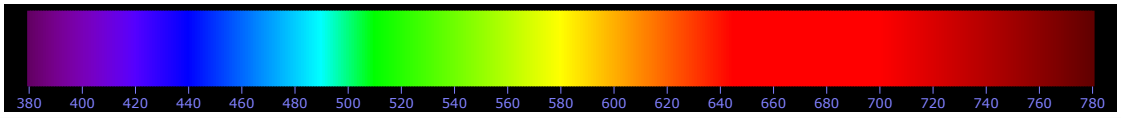
```
\pgfspectra[axis,axis font=\fontsize{3}{3}\itshape\selectfont]
```



axis font color default: *white*

The color of the font used in the axis.

```
\pgfspectra[axis,axis font color=blue!50!white]
```



label default: *false*

Puts a label for the spectrum.

```
\pgfspectra[label]
```

```
\pgfspectra[label,element=He]
```

label position default: *west*

Sets the position of the label according to:

north west north north east
west *spectrum* east
south west south south east

```
\pgfspectra[label,label position=east,element=He]
```

label font default: *\bfseries\small*

The font specs for the label.

```
\pgfspectra[label,label font=\footnotesize\itshape,element=He]
```

label font color default: *black*

The color of the font used in the label.

```
\pgfspectra[label,label font color=blue!50!white,element=He]
```

label before text default: *{}*

Inserts text before the value stored in the label: if chemical symbols were provided, the label has them stored, otherwise it is empty.

```
\pgfspectra[label,label before text=text\ ,element=He]
```

Remark: *The \␣ is to insert a space between the text entered by user and the text stored in label.*

label after text default: {}

Inserts text after the value stored in the label: if chemical symbols were provided, the label has them stored, otherwise it is empty.

```
\pgfspectra[label,label after text=\ text,element=He]
```

redshift default: {}

Redshift (or blueshift) the spectral lines:
The redshift value (z) is *defined* as $1+z = \lambda_{obs}/\lambda_E$ which leaves the observed wavelength to $\lambda_{obs} = (1+z)\lambda_E$, given the emitted wavelength of the source (λ_E).

- **Use 'redshift=<numeric value>'** to directly enter the redshift value

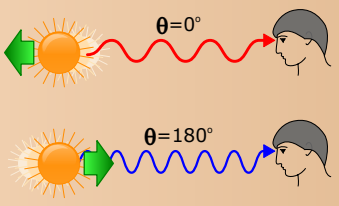
  or

- **use 'redshift={D=<numeric value 1>/<numeric value 2>}'** to compute the Relativistic Doppler redshift with $\overline{v}$ = <numeric value 1> and θ = <numeric value 2>^{o}.

  The Relativistic Doppler redshift ($1+z$) is calculated accordingly:

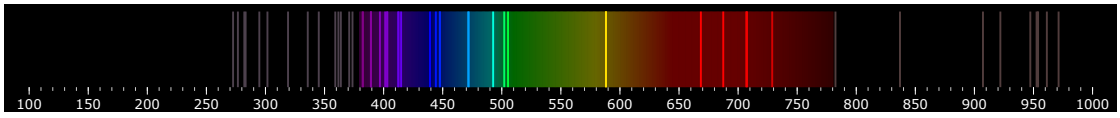
$$1+z = \frac{1+\overline{v}\cos\theta}{\sqrt{1-\overline{v}^2}} \qquad \overline{v} = \frac{v}{c}$$

  where $\overline{v}$ is the *normalized velocity* (in units of the speed of light in vacuum, c) of the emitter and θ is the angle between the direction of relative motion and the direction of emission in the observer's frame (zero angle is directly away from the observer).
  So, if the source of light is moving away from an observer, then redshift occurs ($z > 0$), but, if the source moves towards the observer, then blueshift occurs ($z < 0$).

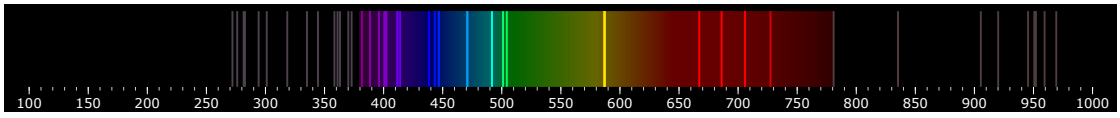


(new in v2.0.0)

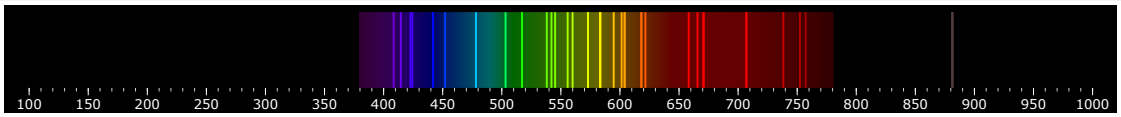
```
\pgfspectra[element=He,back=visible40,gamma=.6,axis,axis step=50,axis
ticks=4,begin=100,end=1000,redshift={D=.001/0}]
```



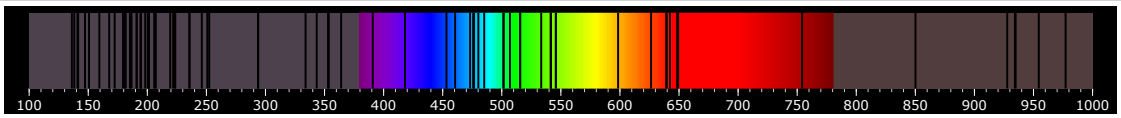

```
\pgfspectra[element=He,back=visible40,gamma=.6,axis,axis step=50,axis
ticks=4,begin=100,end=1000,redshift={D=.001/180}]
```



```
\pgfspectra[element=He,back=visible40,gamma=.6,axis,axis step=50,axis ticks=4,begin=100,end=1000,redshift=.5]
```



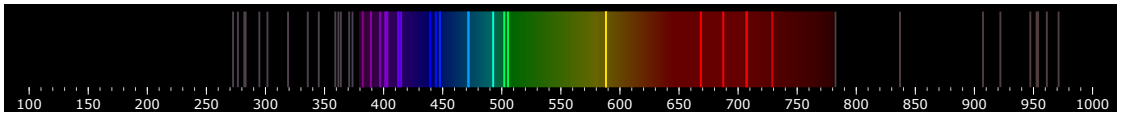

```
\pgfspectra[element=He,absorption,gamma=.6,axis,axis step=50,axis ticks=4,begin=100,end=1000,redshift=-.5]
```



show redshift value default: *false*

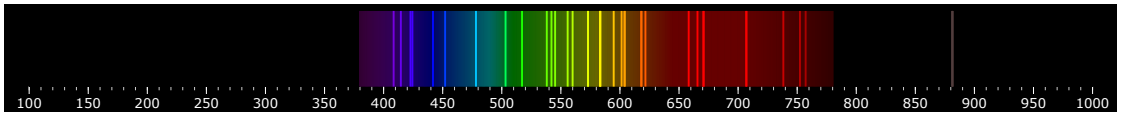
Writes the value of the redshift (left below the spectrum). *(new in v2.0.0)*

```
\pgfspectra[element=He,back=visible40,gamma=.6,axis,axis step=50,axis ticks=4,begin=100,end=1000,redshift={D=.001/0},show redshift value]
```



Relativistic Doppler redshift z=0.001 (v=.001c ; θ=0°)

```
\pgfspectra[element=He,back=visible40,gamma=.6,axis,axis step=50,axis ticks=4,begin=100,end=1000,redshift=.5,show redshift value]
```



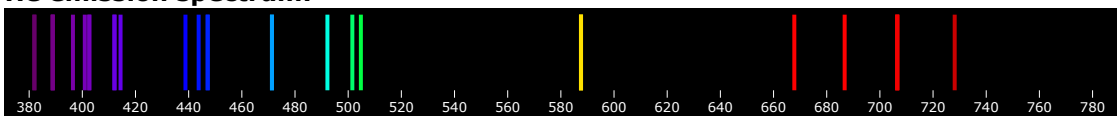
redshift z=.5

Examples

Here are some examples for drawing some *eventually useful* spectra:

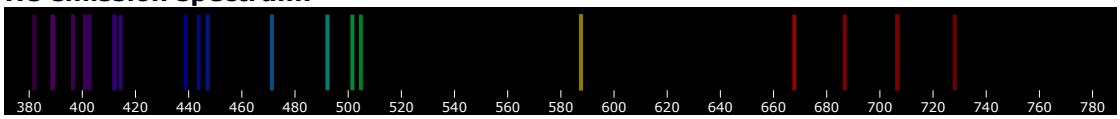
```
\pgfspectra[element=He,axis,label,label position=north west,
label after text=\ emission spectrum:]
```

He emission spectrum:




```
\pgfspectra[element=He,axis,label,label position=north west,label after text=
\ emission spectrum:,relative intensity,relative intensity threshold=.5]
```

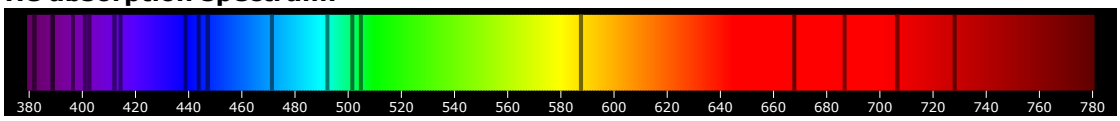
He emission spectrum:




```
\pgfspectra[element=He,charge=all,line intensity=50,Imin=.05]
```

```
\pgfspectra[element=He,absorption,axis,label,label position=north west,label after
text=\ absorption spectrum:,relative intensity,relative intensity threshold=.5]
```

He absorption spectrum:




```
\pgfspectra[element=He,charge=all,absorption,line intensity=50]
```

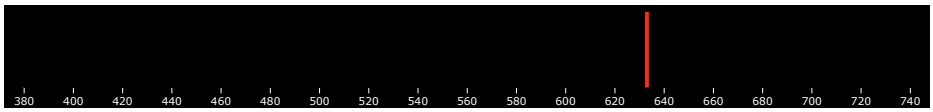
```
\pgfspectra[element=He,charge=all,relative intensity,back=visible75,gamma=2]
```

When the lines are manually inserted it's possible to use 'label before text' only with personalized text. In the next three examples 'label before text' is used to make labels for a multiple choice problem, omitting evidently the type of luminous font.

✓ Laser He-Ne

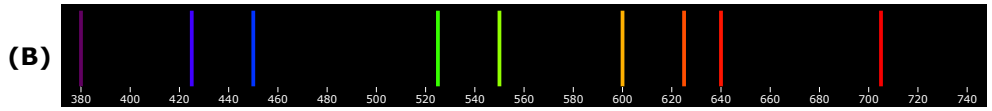
```
\pgfspectra[begin=380,end=740,lines={633},line
width=1.25pt,width=.75\linewidth,label,axis,label before text=(A),axis
font=\fontsize{4pt}{6pt}\selectfont]
```

(A)



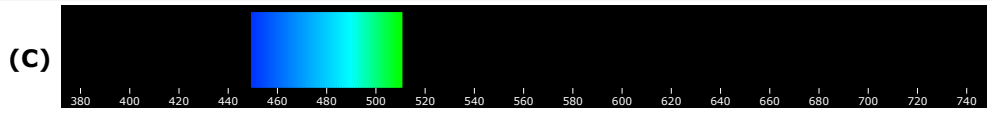
✓ Fluorescent lamp

```
\pgfspectra[begin=380,end=740,lines={380,425,450,525,550,600,625,640,705},
line width=1.25pt,width=.75\linewidth,label,axis,label before text=(B),axis
font=\fontsize{4pt}{6pt}\selectfont]
```



✓ Blue LED

```
\pgfspectra[begin=380,end=740,lines={450,451,452,453,454,455,456,457,458,459,
460,461,462,463,464,465,466,467,468,469,470,471,472,473,474,475,476,477,478,
479,480,481,482,483,484,485,486,487,488,489,490,491,492,493,494,495,496,497,
498,499,500,501,502,503,504,505,506,507,508,509,510},line width=1.25pt,
width=.75\linewidth,label,axis,label before text=(C),axis
font=\fontsize{4pt}{6pt}\selectfont]
```



✓ Sun like spectrum

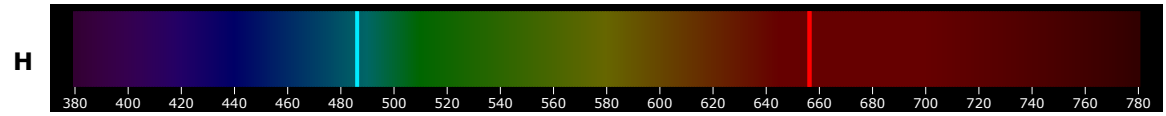
```
\pgfspectra[element={H,Fe,Mg,Na},absorption,line intensity=40,Imin=.05]
```

✓ Sirius like spectrum

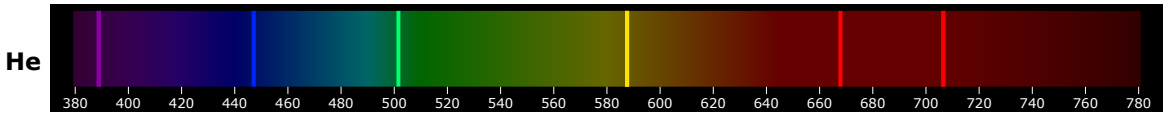
```
\pgfspectra[element={H,He},absorption,line intensity=40,Imin=.05]
```

✓ "Classical" emission spectra of elements:

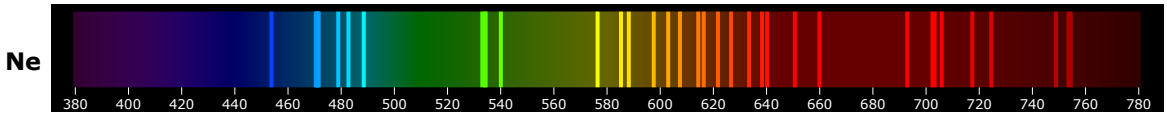
```
\pgfspectra[element=H,back=visible40,gamma=.6,label,axis,Imin=.05]
```




```
\pgfspectra[element=He,back=visible40,gamma=.6,label,axis,Imin=.05]
```



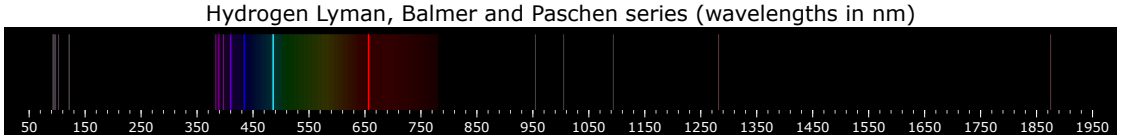

```
\pgfspectra[element=Ne,back=visible40,gamma=.6,label,axis,Imin=.05]
```



✓ Series of hydrogen:

```
\pgfspectra[element=H,line width=.5pt,begin=50,end=1950,axis,axis
step=100,axis ticks=4,back=visible40,gamma=.6,brightness=.5,label,label
position=north,label font=\footnotesize,label after text={ydrogen Lyman, Balmer
and Paschen series (wavelengths in nm)}]
```

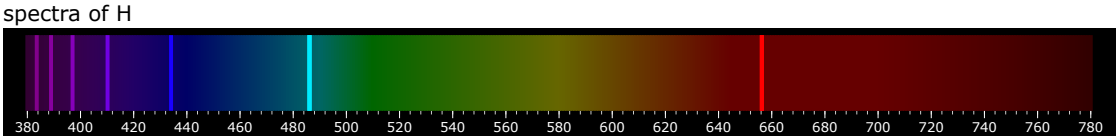
Hydrogen Lyman, Balmer and Paschen series (wavelengths in nm)



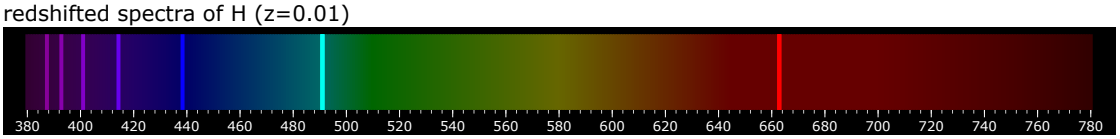
✓ Redshifted & Blueshifted lines of hydrogen using the \foreach statement:

```
\pgfspectraStyle[axis,axis ticks=4,back=visible40,gamma=.6,line width=.5pt]
\pgfspectra[element=H,label,label position=north west,label
font=\footnotesize,label before text={spectra of\ }]
\foreach \SQ/\z/\shift in {H/0.01/redshifted,H/-0.01/blueshifted}{
        \pgfspectra[element=\SQ,label,label position=north west,label
        font=\footnotesize,label before text={\shift\ spectra of\ },label after
        text={\ (z=\z)},redshift=\z]
}
\foreach \SQ/\z/\shift in {H/{D=0.01/0}/redshifted,H/{D=0.01/180}/blueshifted}{
        \pgfspectra[element=\SQ,label,label position=north west,label
        font=\footnotesize,label before text={\shift\ spectra of\ },redshift=\z,show
        redshift value]
}
```

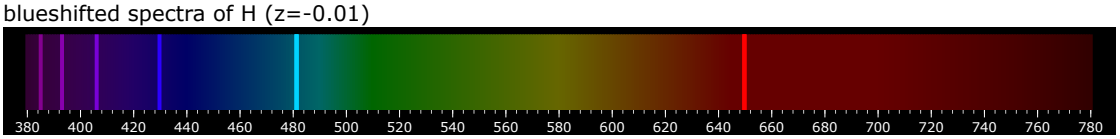
spectra of H



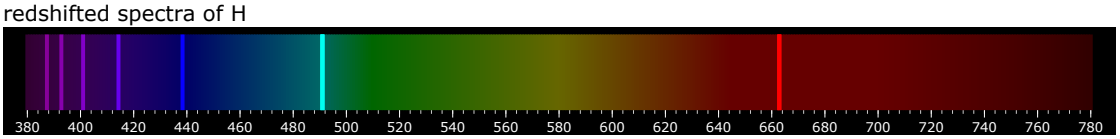
redshifted spectra of H (z=0.01)



blueshifted spectra of H (z=-0.01)

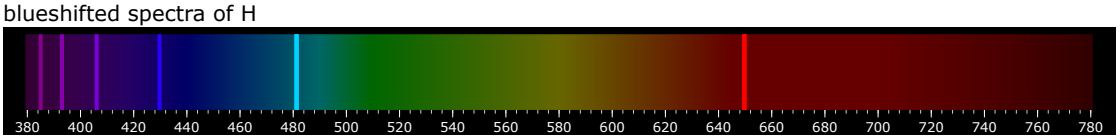


redshifted spectra of H



Relativistic Doppler redshift z=0.01 (v=0.01c ; $\theta = 0^{\circ}$)

blueshifted spectra of H



Relativistic Doppler redshift z=-0.01 (v=0.01c ; $\theta = 180^{\circ}$)

Recommendations and known issues

The code could be a bit slow, so if there are many spectra to draw, the time consumption to get them could be high. In that case it's preferable to compile individual spectrum via the *preview* package, for later inclusion with `\includegraphics{<filename>.pdf}`:

```
% <filename>.tex
\documentclass{article}
\usepackage{pgf-spectra}
\usepackage[active,tightpage]{preview}
\PreviewEnvironment{tikzpicture}
\setlength\PreviewBorder{1pt}%
%%%%%%%%%%%%%%%%%%
\begin{document}
\pgfspectra[element=H,width=15cm]
\end{document}
```

Hint for TEX *'limits'*:

If tex capacity exceeded when running...
«! TeX capacity exceeded, sorry [main memory size=2000001].»
just make a \newpage at the point of origin of the message (ejecting the page releases the TEX memory!)

The code

```
% Hugo Gomes @ 15/04/2016 (v1.0)
% Hugo Gomes @ 15/03/2021 (v2.0.0)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\NeedsTeXFormat{LaTeX2e}%
\ProvidesPackage{pgf-spectra}[15/03/2021 pgf-spectra v2.0.0]%
\RequirePackage{tikz}%
\DeclareOption{LSE}{\input{./spectra.data.LSE.tex}}%
\DeclareOption{NIST}{\input{./spectra.data.NIST.tex}}%
\ExecuteOptions{NIST}%
\ProcessOptions\relax%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\definecolor{wlIRcolor}{rgb}{.3157,.2373,.2373}% NEW
\definecolor{wlUVcolor}{rgb}{.3,.2568,.3}% NEW
%
\newif\ifwl@absorption%
\newif\ifcur@elem@exist%
\newif\ifwl@drawaxis%
\newif\ifwl@axislabel%
\newif\ifwl@intensity%
\newif\ifwl@redshift% NEW
\newif\ifwl@RSvalue% NEW
% defining PGF keys
\pgfkeys{/wl/.cd,%
element/.get=\wl@element,%
element/.store in=\wl@element,%
element/.default=NONE,%
width/.get=\wl@width,%
width/.store in=\wl@width,%
width/.default={0.9\textwidth},%
height/.get=\wl@height,%
height/.store in=\wl@height,%
height/.default=1cm,%
back/.get=\wl@back,%
back/.store in=\wl@back,%
back/.default=black,%
```

```
backIRUV/.get=\wl@backnotvisible,% NEW
backIRUV/.store in=\wl@backnotvisible,% NEW
backIRUV/.default=black,% NEW
IRcolor/.get=\wl@IRcolor,% NEW
IRcolor/.store in=\wl@IRcolor,% NEW
IRcolor/.default=wlIRcolor,% NEW
UVcolor/.get=\wl@UVcolor,% NEW
UVcolor/.store in=\wl@UVcolor,% NEW
UVcolor/.default=wlUVcolor,% NEW
charge/.get=\wl@charge,%
charge/.store in=\wl@charge,%
charge/.default=0,%
Imin/.get=\wl@intmin,%
Imin/.store in=\wl@intmin,%
Imin/.default=0,%
lines/.get=\wl@lines,%
lines/.store in=\wl@lines,%
lines/.default={},%
line width/.get=\wl@linewidth,%
line width/.store in=\wl@linewidth,%
line width/.default=1pt,%
begin/.get=\wl@begin,%
begin/.store in=\wl@begin,%
begin/.default=380,%
end/.get=\wl@end,%
end/.store in=\wl@end,%
end/.default=780,%
axis step/.get=\wl@axisstep,%
axis step/.store in=\wl@axisstep,%
axis step/.default=20,%
axis ticks/.get=\wl@axisticks,% NEW
axis ticks/.store in=\wl@axisticks,% NEW
axis ticks/.default=0,% NEW
axis color/.get=\wl@axiscolor,%
axis color/.store in=\wl@axiscolor,%
axis color/.default=black,%
axis font/.get=\wl@axisfont,%
axis font/.store in=\wl@axisfont,%
axis font/.default={\tiny},%
axis font color/.get=\wl@axisfontcolor,%
axis font color/.store in=\wl@axisfontcolor,%
axis font color/.default=white,%
label position/.get=\wl@labelposition,%
label position/.store in=\wl@labelposition,%
label position/.default={west},%
label before text/.get=\wl@labelbtext,%
label before text/.store in=\wl@labelbtext,%
label before text/.default={},%
label after text/.get=\wl@labelatext,%
label after text/.store in=\wl@labelatext,%
label after text/.default={},%
label font/.get=\wl@labelfont,%
label font/.store in=\wl@labelfont,%
label font/.default={\bfseries\small},%
label font color/.get=\wl@labelfontcolor,%
label font color/.store in=\wl@labelfontcolor,%
label font color/.default=black,%
gamma/.get=\wl@gamma,%
gamma/.store in=\wl@gamma,%
gamma/.default=0.8,%
brightness/.get=\wl@brightness,%
brightness/.store in=\wl@brightness,%
brightness/.default=1,%
line intensity/.get=\wl@lineint,%
line intensity/.store in=\wl@lineint,%
line intensity/.default=100,%
relative intensity threshold/.get=\wl@relintthresh,%
relative intensity threshold/.store in=\wl@relintthresh,%
relative intensity threshold/.default=0.25,%
absorption/.is if=wl@absorption,%
```

```
106 axis/.is if=wl@drawaxis,%
107 label/.is if=wl@axislabel,%
108 relative intensity/.is if=wl@intensity,%
109 redshift/.get=\wl@redshift,% NEW
110 redshift/.store in=\wl@redshift,% NEW
111 redshift/.default={},% NEW
112 show redshift value/.is if=wl@RSvalue% NEW
113 }%
114 % setting keys with default values
115 \pgfkeys{/wl/.cd,element,width,height,back,backIRUV,IRcolor,UVcolor,charge,Imin,lines,
      line width,begin,end,% NEW -> backIRUV,IRcolor,UVcolor
116 axis color,axis font,axis font color,axis step,axis ticks,label position,label before
      text,label after text,label font,label font color,gamma,brightness,line intensity,%
117 relative intensity threshold,absorption=false,axis=false,label=false,relative intensity
      =false,redshift,show redshift value=false}% NEW -> redshift, show redshift value
118 % strings for \ifx tests
119 \def\wlN@NE{NONE}%
120 \def\wl@ll{all}%
121 \def\wl@visible{visible}%
122 \def\wl@visible@list{visible,visible5,visible10,visible15,visible20,visible25,visible
      30,visible35,visible40,visible45,visible50,visible55,visible60,visible65,visible70,
      visible75,visible80,visible85,visible90,visible95,visible100}%
123 \def\wl@label@position@list{west,north west,north,north east,east,south east,south,
      south west}%
124 \def\wl@redshift@D{D}% NEW
125 %%%% COMMANDS
      ------------------------------------------------------------------------------>
126 % commands ##################################################
127 \newif\ifpgfspectra@StyleIsDef\pgfspectra@StyleIsDeffalse% NEW
128 % \pgfspectraStyle[options]% NEW
129 \def\pgfspectraStyle[#1]{\pgfspectraStyleReset\pgfspectra@StyleIsDeftrue\relax\tikzset
      {/wl/.cd,#1}%
130 \def\pgfspectra@DoStyle{\tikzset{/wl/.cd,#1}}% applies storing user style for future
      use
131 }% NEW
132 % \pgfspectraStyleReset% NEW
133 \def\pgfspectraStyleReset{\pgfspectra@StyleIsDeffalse\tikzset{/wl/.cd,%
134 element=NONE,width=0.9\textwidth,height=1cm,back=black,backIRUV=black,IRcolor=wlIRcolor
      ,UVcolor=wlUVcolor,%
135 charge=0,Imin=0,lines={},line width=1pt,begin=380,end=780,axis color=black,axis font=\
      tiny,axis font color=white,axis step=20,axis ticks=0,label position=west,%
136 label before text={},label after text={},label font=\bfseries\small,label font color=
      black,gamma=0.8,brightness=1,line intensity=100,%
137 relative intensity threshold=0.25,absorption=false,axis=false,label=false,relative
      intensity=false,redshift={},show redshift value=false}}% NEW
138 % ---------------- The main command to draw the spectra
      ----------------------------------------
139 % \pgfspectra[options]
140 \def\pgfspectra{\@ifnextchar[\wl@pgfspectra@withoptions{\wl@pgfspectra@nooptions}}%
141 \def\wl@pgfspectra@nooptions{\wl@pgfspectra@continuous(0.9\textwidth,1cm)}%
142 % ##########################################################
143 \def\wl@pgfspectra@continuous(#1,#2){\ignorespaces%
144 \begin{tikzpicture}%
145 \pgfmathparse{#1/400}\edef\xscale{\pgfmathresult}
146 \pgfmathparse{1.4*\xscale+.09*\linewidth/\wl@width}\edef\wl@linewidth{\pgfmathresult}%
      NEW {\xscale} -> {1.4*\xscale+.09*\linewidth/\wl@width}
147 \foreach \x in {380,...,780}%
148         {%
149         \wlcolor{\x}%
150         \pgfmathparse{(\x-380)*\xscale}\edef\wl@currentx{\pgfmathresult pt}%
151         \draw[wl@temp,line width=\wl@linewidth] (\wl@currentx,0) -- ++(0,#2);%
152         }%
153 \end{tikzpicture}%
154 }%
155 % ##########################################################
156 \def\wl@pgfspectra@withoptions[#1]{\ignorespaces%
157 % setting default values or user style
158 \ifpgfspectra@StyleIsDef\pgfspectraStyleReset\pgfspectra@DoStyle\
      pgfspectra@StyleIsDeftrue\relax\else\pgfspectraStyleReset\relax\fi% NEW
159 % process options (key values)
```

```
\pgfkeys{/wl/.cd,#1}%
% axis height
\setbox0=\hbox{\wl@axisfont\selectfont380}\edef\@wl@axis@height{\the\ht0}%
% process visible background (visible+opacity)
\wl@counta=0%
\wl@countb=-1%
\@for\@myarg:=\wl@visible@list\do{%
            \ifx\wl@back\@myarg\wl@countb=\wl@counta\fi%
            \advance\wl@counta by1%
            }%
\ifnum\wl@countb=-1\edef\@visible@opacity{1}\else% NEW
\ifnum\wl@countb=0\let\wl@back\wl@visible\edef\@visible@opacity{.5}\else%
\ifnum\wl@countb>0\let\wl@back\wl@visible\pgfmathparse{.05*\wl@countb}\edef\
  @visible@opacity{\pgfmathresult}\fi\fi\fi%
%back color: |wl@back|| debug
%
  ------------------------------------------------------------------------------------------------------------------------

% check limits... % NEW
\ifnum\wl@end<10\relax\def\wldez{10}\let\wl@end\wldez\fi%
\ifnum\wl@end>4000\relax\def\wlquatromil{4000}\let\wl@end\wlquatromil\fi%
\ifnum\wl@begin<10\relax\def\wldez{10}\let\wl@begin\wldez\fi%
\ifnum\wl@begin>4000\relax\def\wlquatromil{4000}\let\wl@begin\wlquatromil\fi%
%
  ------------------------------------------------------------------------------------------------------------------------

% verifying redshift key
\ifx\wl@redshift\@empty\relax%
\wl@redshiftfalse%
\else%
\wl@processredshiftkey\wl@redshift\relax%
\fi%
%
  ------------------------------------------------------------------------------------------------------------------------

% if no element provided draws continuous spectrum with options or user list of lines
\ifx\wl@element\wlN@NE%no element by the user
    \ifx\wl@elt@chemsym\undefined\else\let\wl@elt@chemsym\undefined\fi%
    \ifx\wl@lines\@empty%no lines by the user => continuous spectrum
    % draws the continuous spectrum width options (default or by the user)
    \begin{tikzpicture}%
        \pgfkeys{/wl/.cd,#1}% NEW
        \pgfmathparse{\wl@width/(abs(\wl@end-\wl@begin))}\edef\xscale{\pgfmathresult}%
        \ifwl@drawaxis%draws the axis
        \wl@utils@draw@axis%
        \fi%|ifwl@drawaxis
        \ifwl@axislabel%put the label
        \wl@utils@put@label%
        \fi%|ifwl@axislabel
        \let\wl@back\wl@visible%
        \let\wl@background@UVcolor\wl@backnotvisible\let\wl@background@IRcolor\
          wl@backnotvisible\relax%
        \wl@utils@drawbackground{\@visible@opacity*\wl@brightness}%
    \end{tikzpicture}%
    \let\wl@list@@\@empty%
    \else% lines by the user
    \edef\wl@list@@{\wl@lines}%
    \let\wl@background@UVcolor\wl@backnotvisible\let\wl@background@IRcolor\
      wl@backnotvisible\relax%
    \fi%|wl@lines|@empty
\else%|wl@element|wlN@NE
    % else get element(s) data
    \wl@countc=0%
    \wl@countd=1%
    \@for\@myarg:=\wl@element\do{\advance\wl@countc by1}%count number of elements
    \wl@addt@list{}{}%
    \@for\@myarg:=\wl@element\do{%
            \cur@elem@existtrue%
            \def\wl@elt@chemsym{NOT FOUND!}%
            \def\@search@result@err{NOT FOUND!}%
```

```
221             \wl@elt@data{\@myarg}\relax%
222             % check if element provided exists
223             \ifx\@search@result@err\wl@elt@chemsym Element\ ``\@myarg'' with charge ``\
                  wl@charge'' not found!\cur@elem@existfalse\else%
224             % if exists, set the wavelength's list
225             \wl@set@element@list{\wl@elt@elemdata}{\wl@elt@Imax}%
226             \fi%|@search@result@err|wl@elt@chemsym
227             \ifcur@elem@exist\ifnum\wl@countd<\wl@countc\wl@addt@list{\wl@list@@}{,}\fi
                  \fi%
228             \advance\wl@countd by1%
229             }%end do
230 \fi%|wl@element|wlN@NE
231 % check if there are lines to draw and make the spectrum
232     \ifx\wl@list@@\@empty\ifx\wl@element\wlN@NE\else Element\ ``\wl@element'' with
          charge ``\wl@charge'' have no lines to display.\fi\else%
233       \ifwl@absorption%absortion spectrum
234       \begin{tikzpicture}%
235               \pgfkeys{/wl/.cd,#1}% NEW
236               \pgfmathparse{\wl@width/(abs(\wl@end-\wl@begin))}\edef\xscale{\
                    pgfmathresult}%
237               \ifwl@drawaxis%draws the axis
238               \wl@utils@draw@axis%
239               \fi%|ifwl@drawaxis
240               \ifwl@axislabel%put the label
241               \wl@utils@put@label%
242               \fi%|ifwl@axislabel
243               \let\wl@back\wl@visible%
244               \let\wl@background@UVcolor\wl@UVcolor\let\wl@background@IRcolor\
                    wl@IRcolor\relax%
245               \wl@utils@drawbackground{\wl@brightness}%
246               % draws the lines
247               \wl@utils@drawabsorptionlines%
248       \end{tikzpicture}%
249       \else%emission spectrum
250       % draws the spectrum
251       \ifx\wl@back\wl@visible%visible background
252       \begin{tikzpicture}%
253               \pgfkeys{/wl/.cd,#1}% NEW
254               \pgfmathparse{\wl@width/(abs(\wl@end-\wl@begin))}\edef\xscale{\
                    pgfmathresult}%
255               \ifwl@drawaxis%draws the axis
256               \wl@utils@draw@axis%
257               \fi%|ifwl@drawaxis
258               \ifwl@axislabel%put the label
259               \wl@utils@put@label%
260               \fi%|ifwl@axislabel
261               \let\wl@background@UVcolor\wl@backnotvisible\let\wl@background@IRcolor\
                    wl@backnotvisible\relax%
262               \wl@utils@drawbackground{\@visible@opacity*\wl@brightness}%
263               \wl@utils@drawemissionlines% emission lines
264       \end{tikzpicture}%
265       \else%without visible background
266       \begin{tikzpicture}%
267               \pgfkeys{/wl/.cd,#1}% NEW
268               \pgfmathparse{\wl@width/(abs(\wl@end-\wl@begin))}\edef\xscale{\
                    pgfmathresult}%
269               \ifwl@drawaxis%draws the axis
270               \wl@utils@draw@axis%
271               \fi%|ifwl@drawaxis
272               \ifwl@axislabel%put the label
273               \wl@utils@put@label%
274               \fi%|ifwl@axislabel
275               \let\wl@background@UVcolor\wl@backnotvisible\let\wl@background@IRcolor\
                    wl@backnotvisible\relax%
276               \wl@utils@drawbackground{0}% dummy argument
277               \wl@utils@drawemissionlines% emission lines
278       \end{tikzpicture}%
279       \fi%|wl@back|@visible
280       \fi%|ifwl@absorption
281     \fi% |wl@list@@|@empty
```

```
}%
% ############################################################
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% get individual line data from one element of the array data
\def\wl@get@line@info[#1 #2 #3]{%
\def\@currentline@wl{#1}% return
\def\@currentline@int{#2}% return
\def\@currentline@charge{#3}% return
}%
% ##########################################################################
% ################### |wl@set@element@list ####################################
% ##########################################################################
%
% |wl@set@element@list{|wl@elt@elemdata}{|wl@elt@Imax}
% RETURN: |wl@list@@ -> (wl1,wl2,...)
%            or if relative intensity true (between 0 and 1)
%                 |wl@list@@ -> (wl1/int1,wl2/int2,...)
%
\newif\ifwl@first% for first ocurrence of Imin
\def\wl@set@element@list#1#2{\ignorespaces% |wl@elt@Imax
\wl@firsttrue%
\wl@counta=0%
\wl@countb=1%
\pgfmathparse{int(\wl@intmin*100)}\edef\@wl@intmin{\pgfmathresult}%intensity percentage
\ifnum\@wl@intmin=0% include all intensities
\ifx\wl@ll\wl@charge%ALL lines
\@for\@myarg:=#1\do{\advance\wl@counta by1}%count all entries
        \ifwl@intensity%
        \@for\@myarg:=#1%
        \do{%
        \expandafter\wl@get@line@info\@myarg%
        \pgfmathparse{\wl@relintthresh+(1-\wl@relintthresh)*\@currentline@int/#2}\edef\
          wl@intensity@to@list{\pgfmathresult}%
        \ifnum\wl@countb<\wl@counta\wl@addt@list{\wl@list@@}{\@currentline@wl/\
          wl@intensity@to@list,}\else%
        \wl@addt@list{\wl@list@@}{\@currentline@wl/\wl@intensity@to@list}\fi%
        \advance\wl@countb by1%
        }%END do
        \else%
        \@for\@myarg:=#1%
        \do{%
        \expandafter\wl@get@line@info\@myarg%
        \ifnum\wl@countb<\wl@counta\wl@addt@list{\wl@list@@}{\@currentline@wl,}\else%
        \wl@addt@list{\wl@list@@}{\@currentline@wl}\fi%
        \advance\wl@countb by1%
        }%END do
        \fi%
\else% lines for one specific charge
\@for\@myarg:=#1\do{\expandafter\wl@get@line@info\@myarg\ifx\@currentline@charge\
  wl@charge\advance\wl@counta by 1\fi}%count only if is the desired charge
        \ifwl@intensity%
        \@for\@myarg:=#1%
        \do{%
        \expandafter\wl@get@line@info\@myarg%
        \pgfmathparse{\wl@relintthresh+(1-\wl@relintthresh)*\@currentline@int/#2}\edef\
          wl@intensity@to@list{\pgfmathresult}%
        \ifx\@currentline@charge\wl@charge%add to list if is the desired charge
            \ifnum\wl@countb<\wl@counta\wl@addt@list{\wl@list@@}{\@currentline@wl/\
              wl@intensity@to@list,}\else%
            \wl@addt@list{\wl@list@@}{\@currentline@wl/\wl@intensity@to@list}\fi%
        \advance\wl@countb by 1%
        \fi%
        }%END do
        \else%
        \@for\@myarg:=#1%
        \do{%
        \expandafter\wl@get@line@info\@myarg%
        \ifx\@currentline@charge\wl@charge%add to list if is the desired charge
            \ifnum\wl@countb<\wl@counta\wl@addt@list{\wl@list@@}{\@currentline@wl,}\
              else%
```

```
346             \wl@addt@list{\wl@list@@}{\@currentline@wl}\fi%
347         \advance\wl@countb by 1%
348         \fi%
349         }%END do
350         \fi%
351 \fi%
352 \else%|wl@intmin>0 & |wl@intmin<1
353 \ifnum\@wl@intmin>100\else%
354 \pgfmathparse{\wl@intmin*#2}\edef\wl@actual@int{\pgfmathresult}%
355 \ifx\wl@ll\wl@charge%ALL lines
356 \@for\@myarg:=#1\do{\advance\wl@counta by 1}%count all entries
357         \ifwl@intensity%
358         \@for\@myarg:=#1%
359         \do{%
360         \expandafter\wl@get@line@info\@myarg%
361         \pgfmathparse{notless(\@currentline@int,\wl@actual@int)}\relax\edef\
            wl@int@result{\pgfmathresult}%
362         \ifnum\wl@int@result=1%
363             \pgfmathparse{\wl@relintthresh+(1-\wl@relintthresh)*\@currentline@int/#2}\
              edef\wl@intensity@to@list{\pgfmathresult}%
364             \ifwl@first\wl@addt@list{\wl@list@@}{\@currentline@wl/\wl@intensity@to@list
              }\else%
365             \wl@addt@list{\wl@list@@}{,\@currentline@wl/\wl@intensity@to@list}\fi%
366             \ifwl@first\wl@firstfalse\fi%
367         \fi%
368         \advance\wl@countb by 1%
369         }%END do
370         \else%
371         \@for\@myarg:=#1%
372         \do{%
373         \expandafter\wl@get@line@info\@myarg%
374         \pgfmathparse{notless(\@currentline@int,\wl@actual@int)}\relax\edef\
            wl@int@result{\pgfmathresult}%
375         \ifnum\wl@int@result=1%
376             \ifwl@first\wl@addt@list{\wl@list@@}{\@currentline@wl}\else%
377             \wl@addt@list{\wl@list@@}{,\@currentline@wl}\fi%
378             \ifwl@first\wl@firstfalse\fi%
379         \fi%
380         \advance\wl@countb by 1%
381         }%END do
382         \fi%
383 \else% lines for one specific charge
384 \@for\@myarg:=#1\do{\expandafter\wl@get@line@info\@myarg\ifx\@currentline@charge\
      wl@charge\advance\wl@counta by 1\fi}%count only if is the desired charge
385         \ifwl@intensity%
386         \@for\@myarg:=#1%
387         \do{%
388         \expandafter\wl@get@line@info\@myarg%
389         \ifx\@currentline@charge\wl@charge%add to list if is the desired charge
390             \pgfmathparse{notless(\@currentline@int,\wl@actual@int)}\edef\wl@int@result
                {\pgfmathresult}%
391             \ifnum\wl@int@result=1%
392             \pgfmathparse{\wl@relintthresh+(1-\wl@relintthresh)*\@currentline@int/#2}\
                edef\wl@intensity@to@list{\pgfmathresult}%
393             \ifwl@first\wl@addt@list{\wl@list@@}{\@currentline@wl/\wl@intensity@to@list
                }\else%
394             \wl@addt@list{\wl@list@@}{,\@currentline@wl/\wl@intensity@to@list}\fi%
395             \ifwl@first\wl@firstfalse\fi%
396         \fi%
397         \advance\wl@countb by 1%
398         \fi%
399         }%END do
400         \else%
401         \@for\@myarg:=#1%
402         \do{%
403         \expandafter\wl@get@line@info\@myarg%
404         \ifx\@currentline@charge\wl@charge%add to list if is the desired charge
405             \pgfmathparse{notless(\@currentline@int,\wl@actual@int)}\edef\wl@int@result
                {\pgfmathresult}%
406             \ifnum\wl@int@result=1%
```

```
407             \ifwl@first\wl@addt@list{\wl@list@@}{\@currentline@wl}\else%
408             \wl@addt@list{\wl@list@@}{,\@currentline@wl}\fi%
409             \ifwl@first\wl@firstfalse\fi%
410         \fi%
411         \advance\wl@countb by 1%
412         \fi%
413         }%END do
414         \fi%
415 \fi%
416 \fi%
417 \fi%
418 }%
419 % add to list
420 \def\wl@addt@list#1#2{\edef\wl@list@@{#1#2}}%
421 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
422 % internal utils
423 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
424 \def\wl@utils@draw@axis{\ignorespaces%
425                 \ifnum\wl@begin>\wl@end%
426                 % New xshift={-2.5*\@wl@axis@height} to hold bigger numbers, e.g. 2500
427                 \draw[draw=none,fill=\wl@axiscolor] ([xshift={2.5*\@wl@axis@height}]0,\
                      wl@height+2.5pt) rectangle ([xshift={-2.5*\@wl@axis@height}]-\
                      wl@width,-2.5*\@wl@axis@height);%
428                       % minor ticks -> NEW
429                       \ifnum\wl@axisticks>0\relax%
430                       \pgfmathparse{\wl@end+\wl@axisstep/(\wl@axisticks+1)}\
                            pgfmathparse{int(\pgfmathresult)}
431                       \edef\@axis@list{\wl@end,\pgfmathresult,...,\wl@begin}
432                       \foreach \x in \@axis@list%
433                       {%
434                       \pgfmathparse{(\wl@end-\x)*\xscale}\edef\wl@currentx{\
                            pgfmathresult pt}%
435                       \draw[\wl@axisfontcolor!80!transparent,line width=.25pt] (\
                            wl@currentx,-.375*\@wl@axis@height) -- ++(0,.375*\
                            @wl@axis@height);
436                       }%
437                       \fi%
438                 \pgfmathparse{\wl@end+\wl@axisstep}\pgfmathparse{int(\pgfmathresult)}
439                 \edef\@axis@list{\wl@end,\pgfmathresult,...,\wl@begin}
440                 \foreach \x in \@axis@list%
441                 {%
442                 \pgfmathparse{(\wl@end-\x)*\xscale}\edef\wl@currentx{\pgfmathresult pt}
                      %
443                 \draw[\wl@axisfontcolor,line width=.25pt] (\wl@currentx,-.75*\
                      @wl@axis@height) -- ++(0,.75*\@wl@axis@height);
444                 \node[\wl@axisfontcolor,font=\wl@axisfont,above,inner sep=0pt] at (\
                      wl@currentx,-2.25*\@wl@axis@height) {\x};
445                 }%
446                 \else%
447                 \draw[draw=none,fill=\wl@axiscolor] ([xshift={-2.5*\@wl@axis@height
                      }]0,\wl@height+2.5pt) rectangle ([xshift={2.5*\@wl@axis@height}]\
                      wl@width,-2.5*\@wl@axis@height);%
448                       % minor ticks -> NEW
449                       \ifnum\wl@axisticks>0\relax%
450                       \pgfmathparse{\wl@begin+\wl@axisstep/(\wl@axisticks+1)}\
                            pgfmathparse{int(\pgfmathresult)}
451                       \edef\@axis@list{\wl@begin,\pgfmathresult,...,\wl@end}
452                       \foreach \x in \@axis@list%
453                       {%
454                       \pgfmathparse{(\x-\wl@begin)*\xscale}\edef\wl@currentx{\
                            pgfmathresult pt}%
455                       \draw[\wl@axisfontcolor!80!transparent,line width=.25pt] (\
                            wl@currentx,-.375*\@wl@axis@height) -- ++(0,.375*\
                            @wl@axis@height);
456                       }%
457                       \fi%
458                 \pgfmathparse{\wl@begin+\wl@axisstep}\pgfmathparse{int(\pgfmathresult)}
459                 \edef\@axis@list{\wl@begin,\pgfmathresult,...,\wl@end}
460                 \foreach \x in \@axis@list%
461                 {%
```

```
462                 \pgfmathparse{(\x-\wl@begin)*\xscale}\edef\wl@currentx{\pgfmathresult
                      pt}%
463                 \draw[\wl@axisfontcolor,line width=.25pt] (\wl@currentx,-.75*\
                      @wl@axis@height) -- ++(0,.75*\@wl@axis@height);
464                 \node[\wl@axisfontcolor,font=\wl@axisfont,above,inner sep=0pt] at (\
                      wl@currentx,-2.25*\@wl@axis@height) {\x};
465                 }%
466                 \fi%
467 }%
468 \def\wl@utils@put@label{\ignorespaces%
469                 \ifx\wl@elt@chemsym\undefined\def\wl@elt@chemsym{}\fi%
470                 \wl@get@label@position%
471                 \ifnum\wl@begin>\wl@end%
472                         \ifcase\wl@label@position%
473                         %west
474                             \ifwl@drawaxis%|ifwl@axislabel%
475                             \node[\wl@labelfontcolor,font=\wl@labelfont,left,minimum
                                  width=2em,align=right] at (-2.5*\@wl@axis@height-\
                                  wl@width,0.5*\wl@height-1.25*\@wl@axis@height) {\
                                  wl@labelbtext\wl@elt@chemsym\wl@labelatext};%
476                             \else%
477                             \node[\wl@labelfontcolor,font=\wl@labelfont,left,minimum
                                  width=2em,align=right] at (-\wl@width,0.5*\wl@height) {\
                                  wl@labelbtext\wl@elt@chemsym\wl@labelatext};%
478                             \fi%
479                         \or%north west
480                             \ifwl@drawaxis%
481                             \node[\wl@labelfontcolor,font=\wl@labelfont,above right,
                                  inner xsep=0pt] at (-2.5*\@wl@axis@height-\wl@width,\
                                  wl@height) {\wl@labelbtext\wl@elt@chemsym\wl@labelatext};
                                  %
482                             \else%
483                             \node[\wl@labelfontcolor,font=\wl@labelfont,above right,
                                  inner xsep=0pt] at (-\wl@width,\wl@height) {\
                                  wl@labelbtext\wl@elt@chemsym\wl@labelatext};%
484                             \fi%
485                         \or%north
486                         \node[\wl@labelfontcolor,font=\wl@labelfont,above] at (-0.5*\
                              wl@width,\wl@height) {\wl@labelbtext\wl@elt@chemsym\
                              wl@labelatext};%
487                         \or%north east
488                         \ifwl@drawaxis%
489                         \node[\wl@labelfontcolor,font=\wl@labelfont,above left,inner
                              xsep=0pt] at (2.5*\@wl@axis@height,\wl@height) {\
                              wl@labelbtext\wl@elt@chemsym\wl@labelatext};%
490                         \else%
491                         \node[\wl@labelfontcolor,font=\wl@labelfont,above left,inner
                              xsep=0pt] at (0,\wl@height) {\wl@labelbtext\wl@elt@chemsym\
                              wl@labelatext};%
492                         \fi
493                         \or%east
494                             \ifwl@drawaxis%
495                             \node[\wl@labelfontcolor,font=\wl@labelfont,right] at
                                  (2.5*\@wl@axis@height,0.5*\wl@height-1.25*\
                                  @wl@axis@height) {\wl@labelbtext\wl@elt@chemsym\
                                  wl@labelatext};%
496                             \else%
497                             \node[\wl@labelfontcolor,font=\wl@labelfont,right] at
                                  (0,0.5*\wl@height) {\wl@labelbtext\wl@elt@chemsym\
                                  wl@labelatext};%
498                             \fi%
499                         \or%south east
500                             \ifwl@drawaxis%
501                             \node[\wl@labelfontcolor,font=\wl@labelfont,below left,
                                  inner xsep=0pt] at (2.5*\@wl@axis@height,-2.5*\
                                  @wl@axis@height) {\wl@labelbtext\wl@elt@chemsym\
                                  wl@labelatext};%
502                             \else%
503                             \node[\wl@labelfontcolor,font=\wl@labelfont,below left,
                                  inner xsep=0pt] at (0,0) {\wl@labelbtext\wl@elt@chemsym\
```

```
                wl@labelatext};%
504             \fi%
505         \or%south
506             \ifwl@drawaxis%
507             \node[\wl@labelfontcolor,font=\wl@labelfont,below] at
                  (-0.5*\wl@width,-2.5*\@wl@axis@height) {\wl@labelbtext\
                  wl@elt@chemsym\wl@labelatext};%
508             \else%
509             \node[\wl@labelfontcolor,font=\wl@labelfont,below] at
                  (-0.5*\wl@width,0) {\wl@labelbtext\wl@elt@chemsym\
                  wl@labelatext};%
510             \fi%
511         \or%south west
512             \ifwl@drawaxis%
513             \node[\wl@labelfontcolor,font=\wl@labelfont,below right,
                  inner xsep=0pt] at (-2.5*\@wl@axis@height-\wl@width
                  ,-2.5*\@wl@axis@height) {\wl@labelbtext\wl@elt@chemsym\
                  wl@labelatext};%
514             \else%
515             \node[\wl@labelfontcolor,font=\wl@labelfont,below right,
                  inner xsep=0pt] at (-\wl@width,0) {\wl@labelbtext\
                  wl@elt@chemsym\wl@labelatext};%
516             \fi%
517         \fi%
518     \else%
519         \ifcase\wl@label@position%
520         %west
521             \ifwl@drawaxis%
522             \node[\wl@labelfontcolor,font=\wl@labelfont,left,minimum
                  width=2em,align=right] at (-2.5*\@wl@axis@height,0.5*\
                  wl@height-1.25*\@wl@axis@height) {\wl@labelbtext\
                  wl@elt@chemsym\wl@labelatext};%
523             \else%
524             \node[\wl@labelfontcolor,font=\wl@labelfont,left,minimum
                  width=2em,align=right] at (0,0.5*\wl@height) {\
                  wl@labelbtext\wl@elt@chemsym\wl@labelatext};%
525             \fi%
526         \or%north west
527             \ifwl@drawaxis%
528             \node[\wl@labelfontcolor,font=\wl@labelfont,above right,
                  inner xsep=0pt] at (-2.5*\@wl@axis@height,\wl@height) {\
                  wl@labelbtext\wl@elt@chemsym\wl@labelatext};%
529             \else%
530             \node[\wl@labelfontcolor,font=\wl@labelfont,above right,
                  inner xsep=0pt] at (0,\wl@height) {\wl@labelbtext\
                  wl@elt@chemsym\wl@labelatext};%
531             \fi%
532         \or%north
533         \node[\wl@labelfontcolor,font=\wl@labelfont,above] at (0.5*\
              wl@width,\wl@height) {\wl@labelbtext\wl@elt@chemsym\
              wl@labelatext};%
534         \or%north east
535         \ifwl@drawaxis%
536             \node[\wl@labelfontcolor,font=\wl@labelfont,above left,
                  inner xsep=0pt] at (\wl@width+2.5*\@wl@axis@height,\
                  wl@height) {\wl@labelbtext\wl@elt@chemsym\wl@labelatext};
                  %
537             \else%
538             \node[\wl@labelfontcolor,font=\wl@labelfont,above left,
                  inner xsep=0pt] at (\wl@width,\wl@height) {\wl@labelbtext
                  \wl@elt@chemsym\wl@labelatext};%
539             \fi%
540         \or%east
541             \ifwl@drawaxis%
542             \node[\wl@labelfontcolor,font=\wl@labelfont,right] at ([
                  xshift={2.5*\@wl@axis@height}]\wl@width,0.5*\wl@height
                  -1.25*\@wl@axis@height) {\wl@labelbtext\wl@elt@chemsym\
                  wl@labelatext};%
543             \else%
```

```
544                                 \node[\wl@labelfontcolor,font=\wl@labelfont,right] at (\
                                      wl@width,0.5*\wl@height) {\wl@labelbtext\wl@elt@chemsym\
                                      wl@labelatext};%
545                                 \fi%
546                             \or%south east
547                                 \ifwl@drawaxis%
548                                 \node[\wl@labelfontcolor,font=\wl@labelfont,below left,
                                      inner xsep=0pt] at (\wl@width+2.5*\@wl@axis@height,-2.5*\
                                      @wl@axis@height) {\wl@labelbtext\wl@elt@chemsym\
                                      wl@labelatext};%
549                                 \else%
550                                 \node[\wl@labelfontcolor,font=\wl@labelfont,below left,
                                      inner xsep=0pt] at (\wl@width,0) {\wl@labelbtext\
                                      wl@elt@chemsym\wl@labelatext};%
551                                 \fi%
552                             \or%south
553                                 \ifwl@drawaxis%
554                                 \node[\wl@labelfontcolor,font=\wl@labelfont,below] at
                                      (0.5*\wl@width,-2.5*\@wl@axis@height) {\wl@labelbtext\
                                      wl@elt@chemsym\wl@labelatext};%
555                                 \else%
556                                 \node[\wl@labelfontcolor,font=\wl@labelfont,below] at
                                      (0.5*\wl@width,0) {\wl@labelbtext\wl@elt@chemsym\
                                      wl@labelatext};%
557                                 \fi%
558                             \or%south west
559                                 \ifwl@drawaxis%
560                                 \node[\wl@labelfontcolor,font=\wl@labelfont,below right,
                                      inner xsep=0pt] at (-2.5*\@wl@axis@height,-2.5*\
                                      @wl@axis@height) {\wl@labelbtext\wl@elt@chemsym\
                                      wl@labelatext};%
561                                 \else%
562                                 \node[\wl@labelfontcolor,font=\wl@labelfont,below right,
                                      inner xsep=0pt] at (0,0) {\wl@labelbtext\wl@elt@chemsym\
                                      wl@labelatext};%
563                                 \fi%
564                             \fi%
565                 \fi%
566 }%
567 \def\wl@utils@drawbackground#1{\ignorespaces% NEW - in this version draws from UV, VIS
      to IV -> replaces |wl@utils@visiblespectrum#1
568 % reprocess visible background (only visible) -> needed because of the override in keys
569     \wl@counta=0%
570     \wl@countb=-1%
571     \@for\@myarg:=\wl@visible@list\do{%
572             \ifx\wl@back\@myarg\wl@countb=\wl@counta\fi%
573             \advance\wl@counta by1%
574             }%
575         \ifnum\wl@countb>-1\let\wl@back\wl@visible\fi%
576                 \pgfmathparse{int(#1*100)}\edef\wl@bright{\pgfmathresult}%
577                 \pgfmathparse{1.4*\xscale+.09*\linewidth/\wl@width}\edef\wl@linewidth{\
                      pgfmathresult}% NEW {|xscale} -> {1.4*|xscale+.09*|linewidth/|
                      wl@width}
578                 \ifnum\wl@begin>\wl@end% 0
579                     \ifnum\wl@end<380\relax% 1
580                         \pgfmathparse{(\wl@end-380)*\xscale}\edef\wl@pointA{\
                              pgfmathresult pt}%
581                         \ifnum\wl@begin>780\relax% 2
582                             \pgfmathparse{(\wl@end-780)*\xscale}\edef\wl@pointB{\
                                  pgfmathresult pt}%
583                             \draw[draw=none,fill=\wl@background@UVcolor] (0,0)
                                  rectangle (\wl@pointA,\wl@height);%
584                             \draw[draw=none,fill=\wl@background@IRcolor] (\wl@pointB,0)
                                   rectangle (-\wl@width,\wl@height);%
585                              \ifx\wl@back\wl@visible% 3 visible background
586                                  \foreach \x in {780,...,380}{%
587                                  \wlcolor{\x}%
588                                  \colorlet{wlcolor}{wl@temp!\wl@bright!black}%
589                                  \pgfmathparse{\wl@pointB+(780-\x)*\xscale}\edef\
                                       wl@currentx{\pgfmathresult pt}%
```

```
590                                     \draw[wl@color,line width=\wl@linewidth] (\
                                          wl@currentx,0) -- ++(0,\wl@height);}%
591                                 \else% 3
592                                     \draw[draw=none,fill=\wl@back] (\wl@pointA,0)
                                          rectangle (\wl@pointB,\wl@height);%
593                                 \fi% 3
594                             \else% 2
595                                 \pgfmathparse{(\wl@end-\wl@begin)*\xscale}\edef\wl@pointB{\
                                      pgfmathresult pt}%
596                                 \draw[draw=none,fill=\wl@background@UVcolor] (0,0)
                                      rectangle (\wl@pointA,\wl@height);%
597                                   \ifx\wl@back\wl@visible% 3 visible background
598                                     \foreach \x in {\wl@begin,...,380}{%
599                                     \wlcolor{\x}%
600                                     \colorlet{wlcolor}{wl@temp!\wl@bright!black}%
601                                     \pgfmathparse{\wl@pointB+(\wl@begin-\x)*\xscale}\
                                          edef\wl@currentx{\pgfmathresult pt}%
602                                     \draw[wlcolor,line width=\wl@linewidth] (\
                                          wl@currentx,0) -- ++(0,\wl@height);}%
603                                 \else% 3
604                                     \draw[draw=none,fill=\wl@back] (\wl@pointA,0)
                                          rectangle (\wl@pointB,\wl@height);%
605                                 \fi% 3
606                             \fi% 2
607                         \else% 1
608                             \ifnum\wl@begin>780\relax% 2
609                                 \pgfmathparse{(\wl@end-780)*\xscale}\edef\wl@pointB{\
                                      pgfmathresult pt}%
610                                 \draw[draw=none,fill=\wl@background@IRcolor] (\wl@pointB,0)
                                      rectangle (-\wl@width,\wl@height);%
611                                   \ifx\wl@back\wl@visible% 3 visible background
612                                     \foreach \x in {780,...,\wl@end}{%
613                                     \wlcolor{\x}%
614                                     \colorlet{wlcolor}{wl@temp!\wl@bright!black}%
615                                     \pgfmathparse{\wl@pointB+(780-\x)*\xscale}\edef\
                                          wl@currentx{\pgfmathresult pt}%
616                                     \draw[wlcolor,line width=\wl@linewidth] (\
                                          wl@currentx,0) -- ++(0,\wl@height);}%
617                                 \else% 3
618                                     \draw[draw=none,fill=\wl@back] (0,0) rectangle (\
                                          wl@pointB,\wl@height);%
619                                 \fi% 3
620                             \else% 2
621                                 \pgfmathparse{(\wl@end-\wl@begin)*\xscale}\edef\wl@pointB{\
                                      pgfmathresult pt}%
622                                   \ifx\wl@back\wl@visible% 3 visible background
623                                     \foreach \x in {\wl@begin,...,\wl@end}{%
624                                     \wlcolor{\x}%
625                                     \colorlet{wlcolor}{wl@temp!\wl@bright!black}%
626                                     \pgfmathparse{\wl@pointB+(\wl@begin-\x)*\xscale}\
                                          edef\wl@currentx{\pgfmathresult pt}%
627                                     \draw[wlcolor,line width=\wl@linewidth] (\
                                          wl@currentx,0) -- ++(0,\wl@height);}%
628                                 \else% 3
629                                     \draw[draw=none,fill=\wl@back] (0,0) rectangle (\
                                          wl@pointB,\wl@height);%
630                                 \fi% 3
631                             \fi% 2
632                         \fi% 1
633                     \else% 0
634                         \ifnum\wl@begin<380\relax% 1
635                             \pgfmathparse{(380-\wl@begin)*\xscale}\edef\wl@pointA{\
                                  pgfmathresult pt}%
636                             \ifnum\wl@end>780\relax% 2
637                                 \pgfmathparse{(780-\wl@begin)*\xscale}\edef\wl@pointB{\
                                      pgfmathresult pt}%
638                                 \draw[draw=none,fill=\wl@background@UVcolor] (0,0)
                                      rectangle (\wl@pointA,\wl@height);%
639                                 \draw[draw=none,fill=\wl@background@IRcolor] (\wl@pointB,0)
                                      rectangle (\wl@width,\wl@height);%
```

```
                                \ifx\wl@back\wl@visible% 3 visible background
                                    \foreach \x in {380,...,780}{%
                                    \wlcolor{\x}%
                                    \colorlet{wlcolor}{wl@temp!\wl@bright!black}%
                                    \pgfmathparse{\wl@pointB-(780-\x)*\xscale}\edef\
                                      wl@currentx{\pgfmathresult pt}%
                                    \draw[wlcolor,line width=\wl@linewidth] (\
                                      wl@currentx,0) -- ++(0,\wl@height);}%
                                \else% 3
                                    \draw[draw=none,fill=\wl@back] (\wl@pointA,0)
                                      rectangle (\wl@pointB,\wl@height);%
                                \fi% 3
                            \else% 2
                                \pgfmathparse{(\wl@end-\wl@begin)*\xscale}\edef\wl@pointB{\
                                  pgfmathresult pt}%
                                \draw[draw=none,fill=\wl@background@UVcolor] (0,0)
                                  rectangle (\wl@pointA,\wl@height);%
                                  \ifx\wl@back\wl@visible% 3 visible background
                                    \foreach \x in {\wl@end,...,380}{%
                                    \wlcolor{\x}%
                                    \colorlet{wlcolor}{wl@temp!\wl@bright!black}%
                                    \pgfmathparse{\wl@pointB-(\wl@end-\x)*\xscale}\edef
                                      \wl@currentx{\pgfmathresult pt}%
                                    \draw[wlcolor,line width=\wl@linewidth] (\
                                      wl@currentx,0) -- ++(0,\wl@height);}%
                                  \else% 3
                                    \draw[draw=none,fill=\wl@back] (\wl@pointA,0)
                                      rectangle (\wl@pointB,\wl@height);%
                                  \fi% 3
                            \fi% 2
                        \else% 1
                            \ifnum\wl@end>780\relax% 2
                                \pgfmathparse{(780-\wl@begin)*\xscale}\edef\wl@pointB{\
                                  pgfmathresult pt}%
                                \draw[draw=none,fill=\wl@background@IRcolor] (\wl@pointB,0)
                                   rectangle (\wl@width,\wl@height);%
                                    \ifx\wl@back\wl@visible% 3 visible background
                                    \foreach \x in {\wl@begin,...,780}{%
                                    \wlcolor{\x}%
                                    \colorlet{wlcolor}{wl@temp!\wl@bright!black}%
                                    \pgfmathparse{(\x-\wl@begin)*\xscale}\edef\
                                      wl@currentx{\pgfmathresult pt}%
                                    \draw[wlcolor,line width=\wl@linewidth] (\
                                      wl@currentx,0) -- ++(0,\wl@height);}%
                                  \else% 3
                                    \draw[draw=none,fill=\wl@back] (0,0) rectangle (\
                                      wl@pointB,\wl@height);%
                                  \fi% 3
                            \else% 2
                                \pgfmathparse{(\wl@end-\wl@begin)*\xscale}\edef\wl@pointB{\
                                  pgfmathresult pt}%
                                    \ifx\wl@back\wl@visible% 3 visible background
                                    \foreach \x in {\wl@begin,...,\wl@end}{%
                                    \wlcolor{\x}%
                                    \colorlet{wlcolor}{wl@temp!\wl@bright!black}%
                                    \pgfmathparse{\x-\wl@begin)*\xscale}\edef\
                                      wl@currentx{\pgfmathresult pt}%
                                    \draw[wlcolor,line width=\wl@linewidth] (\
                                      wl@currentx,0) -- ++(0,\wl@height);}%
                                  \else% 3
                                    \draw[draw=none,fill=\wl@back] (0,0) rectangle (\
                                      wl@pointB,\wl@height);%
                                  \fi% 3
                            \fi% 2
                        \fi% 1
                    \fi%0
}%
\def\wl@utils@drawabsorptionlines{\ignorespaces%
                    \ifnum\wl@begin>\wl@end%
                        \ifwl@intensity%
```

```
693                     \ifwl@redshift\wl@utils@redshift\fi% NEW
694                     \foreach \x/\y in \wl@list@@%
695                     {%
696                     \pgfmathparse{notless(\x,\wl@end)}\edef\wl@x@nl{\pgfmathresult}
                          %
697                     \pgfmathparse{notgreater(\x,\wl@begin)}\edef\wl@x@ng{\
                          pgfmathresult}%
698                     \pgfmathparse{and(\wl@x@nl,\wl@x@ng)}\edef\wl@plot@point{\
                          pgfmathresult}%
699                     \ifnum\wl@plot@point=1%
700                     \pgfmathparse{(\wl@end-\x)*\xscale}\edef\wl@currentx{\
                          pgfmathresult pt}%
701                     \pgfmathparse{int(\y*100)}\edef\wl@black{\pgfmathresult}%
702                     \wlcolor{\x}%
703                     \colorlet{wlcolor}{black!\wl@black!wl@temp}%
704                     \draw[wlcolor,line width=\wl@linewidth] (\wl@currentx,0) --
                          ++(0,\wl@height);%
705                     \fi%
706                     }%
707                 \else%
708                     \ifwl@redshift\wl@utils@redshift\fi% NEW
709                     \foreach \x in \wl@list@@%
710                     {%
711                     \pgfmathparse{notless(\x,\wl@end)}\edef\wl@x@nl{\pgfmathresult}
                          %
712                     \pgfmathparse{notgreater(\x,\wl@begin)}\edef\wl@x@ng{\
                          pgfmathresult}%
713                     \pgfmathparse{and(\wl@x@nl,\wl@x@ng)}\edef\wl@plot@point{\
                          pgfmathresult}%
714                     \ifnum\wl@plot@point=1%
715                     \pgfmathparse{(\wl@end-\x)*\xscale}\edef\wl@currentx{\
                          pgfmathresult pt}%
716                     \wlcolor{\x}%
717                     \colorlet{wlcolor}{black!\wl@lineint!wl@temp}%
718                     \draw[wlcolor,line width=\wl@linewidth] (\wl@currentx,0) --
                          ++(0,\wl@height);%
719                     \fi%
720                     }%
721                 \fi%
722             \else%
723                 \ifwl@intensity%
724                     \ifwl@redshift\wl@utils@redshift\fi% NEW
725                     \foreach \x/\y in \wl@list@@%
726                     {%
727                     \pgfmathparse{notless(\x,\wl@begin)}\edef\wl@x@nl{\
                          pgfmathresult}%
728                     \pgfmathparse{notgreater(\x,\wl@end)}\edef\wl@x@ng{\
                          pgfmathresult}%
729                     \pgfmathparse{and(\wl@x@nl,\wl@x@ng)}\edef\wl@plot@point{\
                          pgfmathresult}%
730                     \ifnum\wl@plot@point=1%
731                     \pgfmathparse{(\x-\wl@begin)*\xscale}\edef\wl@currentx{\
                          pgfmathresult pt}%
732                     \pgfmathparse{int(\y*100)}\edef\wl@black{\pgfmathresult}%
733                     \wlcolor{\x}%
734                     \colorlet{wlcolor}{black!\wl@black!wl@temp}%
735                     \draw[wlcolor,line width=\wl@linewidth] (\wl@currentx,0) --
                          ++(0,\wl@height);%
736                     \fi%
737                     }%
738                 \else%
739                     \ifwl@redshift\wl@utils@redshift\fi% NEW
740                     \foreach \x in \wl@list@@%
741                     {%
742                     \pgfmathparse{notless(\x,\wl@begin)}\edef\wl@x@nl{\
                          pgfmathresult}%
743                     \pgfmathparse{notgreater(\x,\wl@end)}\edef\wl@x@ng{\
                          pgfmathresult}%
744                     \pgfmathparse{and(\wl@x@nl,\wl@x@ng)}\edef\wl@plot@point{\
                          pgfmathresult}%
```

```
                        \ifnum\wl@plot@point=1%
                        \pgfmathparse{(\x-\wl@begin)*\xscale}\edef\wl@currentx{\
                          pgfmathresult pt}%
                        \wlcolor{\x}%
                        \colorlet{wlcolor}{black!\wl@lineint!wl@temp}%
                        \draw[wlcolor,line width=\wl@linewidth] (\wl@currentx,0) --
                          ++(0,\wl@height);%
                        \fi%
                        }%
                    \fi%
                \fi%
\ifwl@RSvalue% NEW
\ifnum\wl@begin>\wl@end%
\ifwl@drawaxis\pgfmathparse{-\wl@width-2.5*\@wl@axis@height}\edef\wl@redshiftinfo@x{\
  pgfmathresult pt}%
\else\pgfmathparse{-\wl@width}\edef\wl@redshiftinfo@x{\pgfmathresult pt}\fi%
\else%
\ifwl@drawaxis\pgfmathparse{-2.5*\@wl@axis@height}\edef\wl@redshiftinfo@x{\
  pgfmathresult pt}%
\else\edef\wl@redshiftinfo@x{0pt}\fi%
\fi%
\ifwl@drawaxis\pgfmathparse{-.75*\@wl@axis@height-1.3*\ht0-2pt}\edef\wl@redshiftinfo@y
  {\pgfmathresult pt}\else\edef\wl@redshiftinfo@y{0pt}\fi%
\node[below right,inner xsep=0pt,font=\wl@axisfont] at (\wl@redshiftinfo@x,\
  wl@redshiftinfo@y) {\wl@redshiftinfo};%
\fi% NEW
}%
\def\wl@utils@drawemissionlines{\ignorespaces%
                \ifnum\wl@begin>\wl@end%
                \ifwl@intensity%
                    \ifwl@redshift\wl@utils@redshift\fi% NEW
                        \foreach \x/\y in \wl@list@@%
                        {%
                        \wlcolor{\x}%
                        \pgfmathparse{notless(\x,\wl@end)}\edef\wl@x@nl{\pgfmathresult}
                          %
                        \pgfmathparse{notgreater(\x,\wl@begin)}\edef\wl@x@ng{\
                          pgfmathresult}%
                        \pgfmathparse{and(\wl@x@nl,\wl@x@ng)}\edef\wl@plot@point{\
                          pgfmathresult}%
                        \ifnum\wl@plot@point=1%
                        \pgfmathparse{(\wl@end-\x)*\xscale}\edef\wl@currentx{\
                          pgfmathresult pt}%
                        \pgfmathparse{int(\y*100)}\edef\wl@black{\pgfmathresult}%
                        \colorlet{wlcolor}{wl@temp!\wl@black!black}%
                        \draw[wlcolor,line width=\wl@linewidth] (\wl@currentx,0) --
                          ++(0,\wl@height);%
                        \fi%
                        }%
                \else%
                    \ifwl@redshift\wl@utils@redshift\fi% NEW
                        \foreach \x in \wl@list@@%
                        {%
                        \wlcolor{\x}%
                        \pgfmathparse{notless(\x,\wl@end)}\edef\wl@x@nl{\pgfmathresult}
                          %
                        \pgfmathparse{notgreater(\x,\wl@begin)}\edef\wl@x@ng{\
                          pgfmathresult}%
                        \pgfmathparse{and(\wl@x@nl,\wl@x@ng)}\edef\wl@plot@point{\
                          pgfmathresult}%
                        \ifnum\wl@plot@point=1%
                        \pgfmathparse{(\wl@end-\x)*\xscale}\edef\wl@currentx{\
                          pgfmathresult pt}%
                        \colorlet{wlcolor}{wl@temp!\wl@lineint!black}%
                        \draw[wlcolor,line width=\wl@linewidth] (\wl@currentx,0) --
                          ++(0,\wl@height);%
                        \fi%
                        }%
                \fi%
                \else%
```

```
                \ifwl@intensity%
                    \ifwl@redshift\wl@utils@redshift\fi% NEW
                        \foreach \x/\y in \wl@list@@%
                        {%
                        \wlcolor{\x}%
                        \pgfmathparse{notless(\x,\wl@begin)}\edef\wl@x@nl{\
                          pgfmathresult}%
                        \pgfmathparse{notgreater(\x,\wl@end)}\edef\wl@x@ng{\
                          pgfmathresult}%
                        \pgfmathparse{and(\wl@x@nl,\wl@x@ng)}\edef\wl@plot@point{\
                          pgfmathresult}%
                        \ifnum\wl@plot@point=1%
                        \pgfmathparse{(\x-\wl@begin)*\xscale}\edef\wl@currentx{\
                          pgfmathresult pt}%
                        \pgfmathparse{int(\y*100)}\edef\wl@black{\pgfmathresult}%
                        \colorlet{wlcolor}{wl@temp!\wl@black!black}%
                        \draw[wlcolor,line width=\wl@linewidth] (\wl@currentx,0) --
                          ++(0,\wl@height);%
                        \fi%
                        }%
                \else%
                    \ifwl@redshift\wl@utils@redshift\fi% NEW
                        \foreach \x in \wl@list@@%
                        {%
                        \wlcolor{\x}%
                        \pgfmathparse{notless(\x,\wl@begin)}\edef\wl@x@nl{\
                          pgfmathresult}%
                        \pgfmathparse{notgreater(\x,\wl@end)}\edef\wl@x@ng{\
                          pgfmathresult}%
                        \pgfmathparse{and(\wl@x@nl,\wl@x@ng)}\edef\wl@plot@point{\
                          pgfmathresult}%
                        \ifnum\wl@plot@point=1%
                        \pgfmathparse{(\x-\wl@begin)*\xscale}\edef\wl@currentx{\
                          pgfmathresult pt}%
                        \colorlet{wlcolor}{wl@temp!\wl@lineint!black}%
                        \draw[wlcolor,line width=\wl@linewidth] (\wl@currentx,0) --
                          ++(0,\wl@height);%
                        \fi%
                        }%
                \fi%
                \fi%
\ifwl@RSvalue% NEW
\ifnum\wl@begin>\wl@end%
\ifwl@drawaxis\pgfmathparse{-\wl@width-2.5*\@wl@axis@height}\edef\wl@redshiftinfo@x{\
  pgfmathresult pt}%
\else\pgfmathparse{-\wl@width}\edef\wl@redshiftinfo@x{\pgfmathresult pt}\fi%
\else%
\ifwl@drawaxis\pgfmathparse{-2.5*\@wl@axis@height}\edef\wl@redshiftinfo@x{\
  pgfmathresult pt}%
\else\edef\wl@redshiftinfo@x{0pt}\fi%
\fi%
\ifwl@drawaxis\pgfmathparse{-.75*\@wl@axis@height-1.3*\ht0-2pt}\edef\wl@redshiftinfo@y
  {\pgfmathresult pt}\else\edef\wl@redshiftinfo@y{0pt}\fi%
\node[below right,inner xsep=0pt,font=\wl@axisfont] at (\wl@redshiftinfo@x,\
  wl@redshiftinfo@y) {\wl@redshiftinfo};%
\fi% NEW
}%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% return: integer with position (e.g. '0' for west, ... )
\def\wl@get@label@position{\ignorespaces%
\wl@countc=0%
\@for\@mylabel:=\wl@label@position@list%
            \do{%
            \ifx\@mylabel\wl@labelposition\edef\wl@label@position{\the\wl@countc}\fi%
            \advance\wl@countc by1%
            }%
}%
% NEW ----------------------
% redshift: lambda(obs)=lambda(emit)*{(1+v/c*cos(theta))/sqrt(1-v^2/c^2)} --->
  Relativistic Doppler
```

```
% vbar-> v/c -> normalized velocity of the source (e.g. '0.9' for v=0.9c )
% theta ->angle between the direction of relative motion of the source and the
  direction of emission in the observer's frame (zero angle is directly away from the
  observer)
\def\wl@processredshiftkey#1{\ignorespaces%
\wl@redshiftfalse%
\edef\wl@redshiftkey@expand{#1}% to expand a value passed by a macro (not necessary if
  the user provided a number...)
\expandafter\wl@redshiftkey@firstchar\wl@redshiftkey@expand\relax%
\ifcat1\wl@@RedShift\relax%
\pgfmathparse{1+#1}\relax%
\edef\wl@UMMAISZ{\pgfmathresult}\wl@redshifttrue%
\edef\wl@redshiftinfo{redshift z=#1}%
\else%
\edef\wl@redshiftkey@expand{#1}%
\expandafter\wl@process@redshift\wl@redshiftkey@expand\relax%
\fi%
}%
\def\wl@redshiftkey@firstchar#1#2\relax{\edef\wl@@RedShift{#1}}%
\def\wl@process@redshift#1=#2/#3\relax{%
\edef\wl@redshifttest{#1}%
\ifx\wl@redshifttest\wl@redshift@D\relax%
\pgfmathparse{(1+#2*cos(#3))/sqrt(1-#2*#2)}%
\edef\wl@UMMAISZ{\pgfmathresult}\wl@redshifttrue%
\pgfmathparse{#2*cos(#3))/sqrt(1-#2*#2)}%
\edef\wl@redshiftinfo{Relativistic Doppler redshift z=\pgfmathresult\ (\mbox{v\hskip.1
  ex=\hskip.1ex#2\hskip.1exc\hskip.5ex;\hskip.5ex\ensuremath{\theta}\hskip.1ex=\hskip.1
  ex#3\ensuremath{^\circ}})}%
\fi%
}%
% \wl@utils@redshift
  ------------------------------------------------------------------------
% returns the wllist with the shift computed
\def\wl@utils@redshift{\ignorespaces%
    \let\wt@backlist@@\wl@list@@\relax%
    \let\wl@list@@\@empty\relax%
    \wl@firsttrue\relax%
    \ifwl@intensity% list (lambda/intensity)
        \foreach \x/\y in \wt@backlist@@{%
            \pgfmathparse{\x*\wl@UMMAISZ}\edef\@currentline@wl{\pgfmathresult}%
            \ifwl@first\global\wl@addt@list{\wl@list@@}{\@currentline@wl/\y}\else%
                \global\wl@addt@list{\wl@list@@}{,\@currentline@wl/\y}\fi%
            \ifwl@first\global\wl@firstfalse\fi%
        }%
    \else% list (lambda)
        \foreach \x in \wt@backlist@@{%
            \pgfmathparse{\x*\wl@UMMAISZ}\edef\@currentline@wl{\pgfmathresult}%
            \ifwl@first\global\wl@addt@list{}{\@currentline@wl}\else%
                \global\wl@addt@list{\wl@list@@}{,\@currentline@wl}\fi%
            \ifwl@first\global\wl@firstfalse\fi%
        }%
    \fi%
}%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%
% nm2rgb convert nanometer wavelength to rgb
% (380 <= Lambda <= 780 ) -> r,g,b on stack
%
% BASED on FORTRAN Code
% RGB VALUES FOR VISIBLE WAVELENGTHS by Dan Bruton (astro@tamu.edu)
% This program can be found at
% http://www.physics.sfasu.edu/astro/color.html
% and was last updated on February 20, 1996.
% The spectrum is generated using approximate RGB values for visible
% wavelengths between 380 nm and 780 nm.
% The red, green and blue values (RGB) are
% assumed to vary linearly with wavelength (for GAMMA=1).
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
\newdimen\wl%wavelength
\newdimen\wl@i%intensity
\newdimen\@wl@gamma%gamma
\newdimen\wlc@lorr%red (0. - 1)
\newdimen\wlc@lorg%green (0. - 1)
\newdimen\wlc@lorb%blue (0. - 1) % wavelength to rgb values
\newcount\wl@counta% tmp counter
\newcount\wl@countb% tmp counter
\newcount\wl@countc% tmp counter
\newcount\wl@countd% tmp counter
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% \wlcolor{wavelength}
\def\wlcolor#1{\ignorespaces%
\wl=#1pt%
\@wl@gamma=\wl@gamma pt%
% compute the rgb components
\ifdim\wl<10pt\relax\PackageWarning{pgf-spectra}{(#1nm) wavelength out of range ignored. The wavelength must be graeter or equal to 10nm (EUV)...}\else% NEW
\ifdim\wl<379.99999pt\relax\else%% NEW
\ifdim\wl<440pt\wlc@lorr=440pt\advance\wlc@lorr by-\wl\divide\wlc@lorr by60\wlc@lorg=0pt\wlc@lorb=1pt\else%
\ifdim\wl<490pt\wlc@lorr=0pt\wlc@lorg=\wl\advance\wlc@lorg by-440pt\divide\wlc@lorg by50\wlc@lorb=1pt\else%
\ifdim\wl<510pt\wlc@lorr=0pt\wlc@lorg=1pt\wlc@lorb=510pt\advance\wlc@lorb by-\wl\divide\wlc@lorb by20\else%
\ifdim\wl<580pt\wlc@lorr=\wl\advance\wlc@lorr by-510pt\divide\wlc@lorr by70\wlc@lorg=1pt\wlc@lorb=0pt\else%
\ifdim\wl<645pt\wlc@lorr=1pt\wlc@lorg=645pt\advance\wlc@lorg by-\wl\divide\wlc@lorg by65\wlc@lorb=0pt\else%
\ifdim\wl<780.00001pt\wlc@lorr=1pt\wlc@lorg=0pt\wlc@lorb=0pt\else%
\ifdim\wl>4000pt\relax\PackageWarning{pgf-spectra}{invalid wavelength (#1nm). The wavelength must be lesser or equal to 4000nm (NIR)...}% NEW
\relax%
\fi\fi\fi\fi\fi\fi\fi\fi\fi%
% intensity correction at vision limits
\ifdim\wl>700pt\ifdim\wl<780.00001pt\wl@i=780pt\advance\wl@i by-\wl\divide\wl@i by80\multiply\wl@i by7\advance\wl@i by3pt\divide\wl@i by10\fi\else%  NEW
\ifdim\wl<420pt\ifdim\wl>379.99999pt\wl@i=\wl\advance\wl@i by-380pt\divide\wl@i by40\multiply\wl@i by7\advance\wl@i by3pt\divide\wl@i by10\fi\else%
\wl@i=1pt%
\fi\fi%
%apply intensity at vision limits correction and  gamma
\ifdim\wl<380pt\colorlet{wl@temp}{\wl@UVcolor}\else\ifdim\wl>780pt\colorlet{wl@temp}{\wl@IRcolor}\else% NEW
\pgfmathparse{\wlc@lorr*\wl@i^\@wl@gamma}\edef\wl@red{\pgfmathresult}%
\pgfmathparse{\wlc@lorg*\wl@i^\@wl@gamma}\edef\wl@green{\pgfmathresult}%
\pgfmathparse{\wlc@lorb*\wl@i^\@wl@gamma}\edef\wl@blue{\pgfmathresult}%
\definecolor{wl@temp}{rgb}{\wl@red,\wl@green,\wl@blue}%
\fi\fi% NEW
\colorlet{wlcolor}{wl@temp}
}%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\def\wl@elt@search#1#2#3#4{\ignorespaces%
% #1 Chemical Symbol, entered by USER
% #2 Chemical Symbol to compare to, e.g. Na
% #3 Emission Lines Data (or error message)
% #4 Imax
\edef\wl@CS@user{#1}\edef\wl@CS@comp{#2}\relax% New
\ifx\wl@CS@user\wl@CS@comp\relax% New -> was \iftthenelse{...
\def\wl@elt@chemsym{#2}%  set chemical symbol
\def\wl@elt@elemdata{#3}%  set element lines data
\def\wl@elt@Imax{#4}%  set element Imax
\fi%
}%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\endinput
```