Advanced radiation and remote sensing

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Exercise No. 3 – Line shape

You can reuse the python script from the first exercise as a starting point for this exercise. First, copy the python script from the first exercise into the directory of exercise no. 3:

```
$ cd ~/arts-lectures/exercises/03-line_shape/
$ cp ../01-rotational_spectra/absorption.ipynb line_shape.ipynb
$ cp ../01-rotational_spectra/absorption_module.py .
```

The "calculate_absxsec" function within your ipython notebook calculates absorption cross sections and uses several keyword arguments as inputs, among other lineshape and normalization, see also the function definition in "absorption_module.py" or the contextual help. Please use "VP" (Voigt-Function) as line shape and "VVH" (van Vleck-Huber) as normalization:

1. Choose an individual line of for example water vapor and perform calculations over a restricted frequency range for a number of different pressures. Keep the temperature constant.

   - How does the shape of the spectral lines change?

   By now we investigated absorption in terms of the absorption cross-section σ. Another widely used unit is the absorption coeffiction α. It takes the number concentration n of the absorber into account:

   $$\alpha = n \cdot \sigma \tag{1}$$

   - How does the absorption coefficient in the line centre change, if pressure is changed?

2. The full-width at half maximum (FWHM) is a measure of the line width. Typhon provides the function *typhon.spectroscopy.linewidth()* to calculate the FWHM for a given absorption spectrum.

   - Make a plot of this as a function of altitude (pressure) for a microwave line and an infrared absorption line.