Advanced radiation and remote sensing

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Exercise No. 1 – Calculation of absorption coefficients

1. Calculate the absorption cross sections in the microwave spectral range for the following molecules:

   - HCl
   - ClO
   - CO
   - N_2O
   - O_3

   Unless otherwise specified use the parameter setting as given in the Jupyter (IPython) notebook "absorption.ipynb".
   Questions and tasks:

   (a) Estimate the rotational constant B (in GHz) for HCl and for CO.

   (b) Why is B larger for HCl than for CO?

   (c) Do you have any idea why N_2O behaves like a diatomic molecule – and O_3 not?

   (d) Calculate the reduced mass (in atomic mass units u) of the different molecules from the masses of the individual atoms. (For the diatomic molecules this is trivial. For N_2O, The appropriate mass can be found by careful thinking. Ignore O_3.)

   (e) Calculate the bond length (in pm) of the various molecules (except O_3) from the reduced mass and the rotational constant. Verify your result with Google. Again N_2O needs some extra thinking.

   (f) Play with different temperatures. How does the rotational spectrum change? Can you explain the changes?

2. Investigate some other molecules!

3. Show for a diatomic molecule that the moment of inertia is given by

$$I = \mu r_0^2 \tag{1}$$

   where μ is the reduced mass, defined as

$$\mu = \frac{m_1 m_2}{m_1 + m_2} \tag{2}$$