Advanced radiation and remote sensing

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 example file "absorption.arts".)

    Questions:
    *   Estimate the rotational constant *B* for HCl and for CO.
    *   Why is *B* larger for HCl than for CO?
    *   Do you have any idea why N_2O behaves like a diatomic molecule – and O_3 not?
    *   Calculate the reduced mass of the different molecules from the masses of the individual atoms. (For the diatomic molecules this is trivial. For N_2O, I think the appropriate mass can be found by careful thinking. Ignore O_3.)
    *   Calculate the bond length 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.
    *   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

    $$I = \mu r_0^2$$

    where μ is the reduced mass, defined as

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

    and r_0 is the distance between the two individual atom's centers of mass.