**Calculating optical depth from absorption coefficient**

1. **Between 691.5 cm−1 and 692.5 cm−1, the HITRAN 2016 database contains the following parameters for lines of the relevant gases with line strengths above 10−21 cm/molecule:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23 | 2 | 691.558689 | 1.144E-21 | 8.111E-01 | 0.1213 | 1.053 | 43.1975 | 0.75 |
| 43 | 1 | 691.627250 | 1.066E-21 | 5.078E-02 | 0.1000 | 0.200 | 205.8231 | 0.75 |
| 11 | 1 | 691.767164 | 4.587E-21 | 1.024E+01 | 0.0976 | 0.396 | 1022.9201 | 0.72 |
| 2 | 1 | 691.972420 | 9.101E-20 | 9.153E-01 | 0.0687 | 0.090 | 362.7883 | 0.75 |
| 3 | 1 | 692.034820 | 1.140E-21 | 9.259E-02 | 0.0746 | 0.103 | 191.7092 | 0.78 |
| 43 | 1 | 692.125070 | 1.132E-21 | 5.151E-02 | 0.1000 | 0.200 | 184.4532 | 0.75 |
| 2 | 1 | 692.129005 | 4.052E-21 | 9.650E-01 | 0.0688 | 0.091 | 1007.1335 | 0.75 |
| 11 | 1 | 692.312700 | 1.013E-20 | 1.153E+01 | 0.0931 | 0.302 | 1026.6435 | 0.72 |
| 26 | 1 | 692.318440 | 1.708E-20 | 3.312E+00 | 0.0787 | 0.147 | 912.6394 | 0.75 |
| 2 | 1 | 692.400097 | 3.727E-21 | 9.665E-01 | 0.0687 | 0.090 | 1031.1292 | 0.75 |
| 3 | 1 | 692.468700 | 1.212E-21 | 9.278E-02 | 0.0755 | 0.103 | 158.1653 | 0.78 |

**Compute the optical depth at a wavenumber of 691.97242** **cm−1 for a 1 km thick layer at a pressure of and temperature of . The volume mixing ratios of the radiatively active gases are = 3.70 × 10−4.**

* 1. **The number of air molecules per cm2 in this layer is:**

Where is Avogadro constant and is ideal gas constant.

* 1. **Calculate the absorption coefficient.**

The monochromatic absorption coefficient from the program is

* 1. **Calculate the optical depth of the layer.**

The optical depth of the layer at this wavenumber is the absorber amount of CO2 times the absorption coefficient:

The number of air molecules per cm2 in this layer is