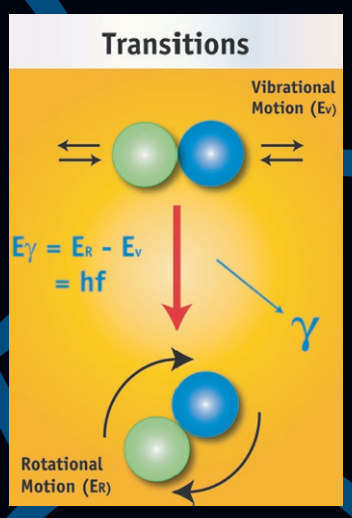
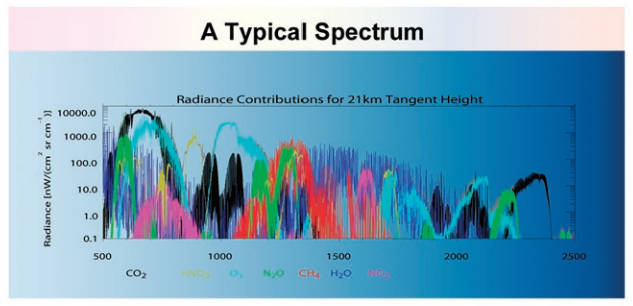
# PROBING ATMOSPHERES

A molecule can store energy in different ways. Two examples are rotational energy due to a molecule's rotation about its centre of mass and vibrational energy due to the atoms within it oscillating about their equilibrium positions. When a molecule changes between two energy states, it emits a photon of energy
$E = hf$ where E is the difference in energy between the two states, h is Planck's constant and f is the frequency of the outgoing photon.




A molecule will absorb photons with a unique spectrum of energy. The spectra of typical molecules in the Earth's atmosphere are shown on the right.

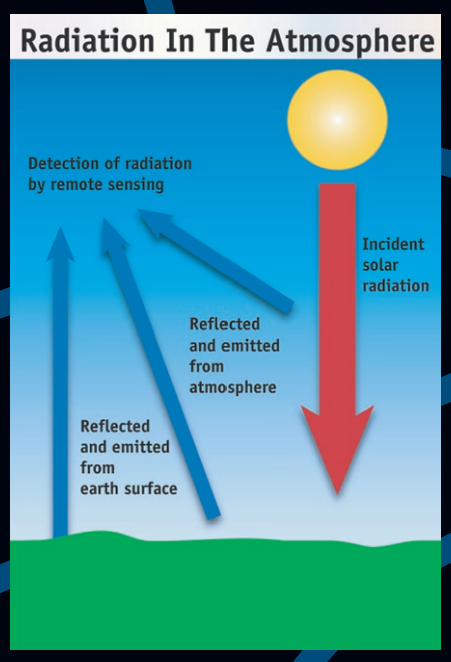
The temperature and chemical composition of the different molecules can be deduced from the position, amplitude and spacing of the lines.

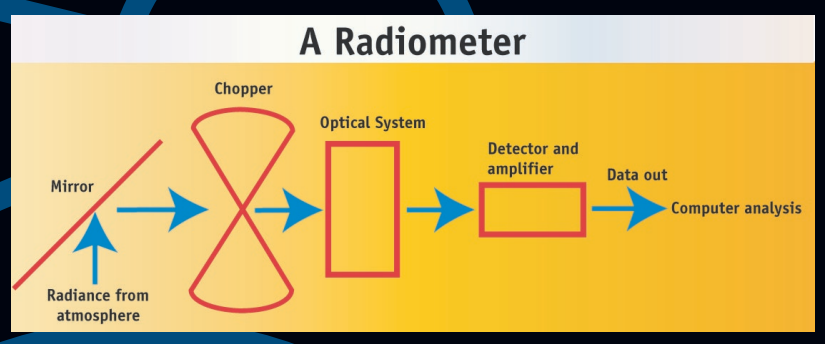



device. Photons from the atmosphere being studied are focused by the optical apparatus on to a detector. The signal is then amplified and the data can be analysed to produce a spectrum similar to the one above. These devices are mounted on satellites and used to probe the atmospheres of the Earth and other planets. The chopper discriminates between thermal radiation from the planet and from the instrument, and also reduces noise and drift.

It is useful to think of the atmosphere as a group of molecules transferring between different rotational and vibrational energy states. The photon energies produced by these transitions are in the infrared part of the electromagnetic spectrum. By studying the infrared spectrum produced by the atmosphere we can deduce much about its gaseous composition and other properties such as temperature. This technique is known as infrared remote sensing.

Oxford scientists are currently working on an infrared instrument called the Troposheric Emission Spectrometer (TES).
This sounds the atmosphere of the Earth to determine atmospheric temperature and composition, as well as mapping cloud positions.




Courtesy NASA

Using exactly the same techniques, it is possible to study the atmospheres of other planets. For example, Oxford scientists are currently involved in the Cassini-Huygens mission which includes CIRS (the Composite Infrared Spectrometer) used to analyse the atmospheric structure and composition of Jupiter, Saturn and Titan.

Courtesy NASA/JPL - Caltech

If you want to know more about Physics at Oxford see the web:
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'One important object of this original spectroscopic investigat ion.... namely to discover whether the same chemical elements as those of our earth are present throughout the universe, was most satisfactorily settled in the affirmative'
Sir William Huggins (1909)

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