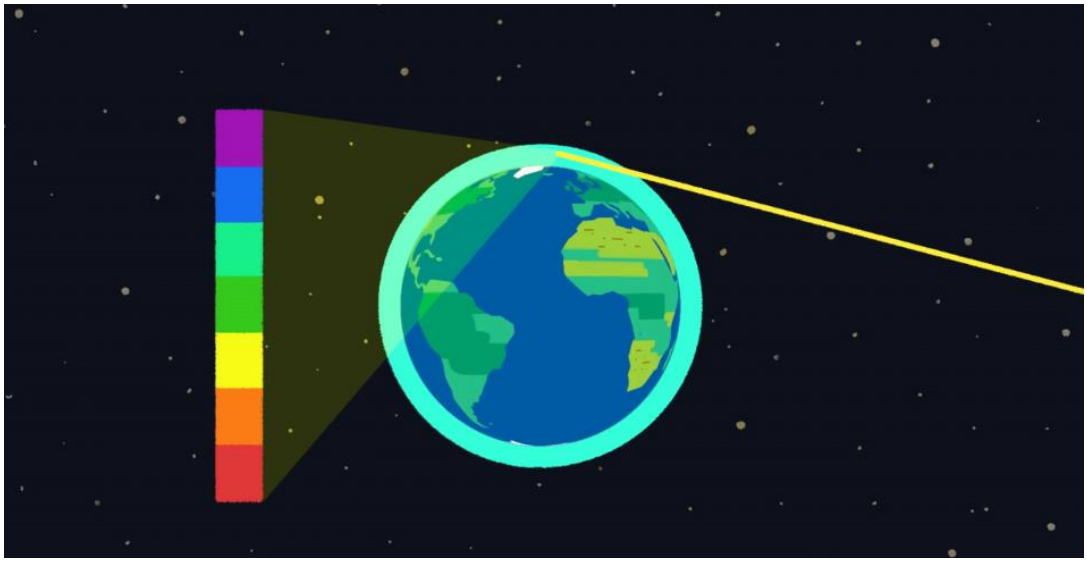
ROYAL OBSERVATORY GREENWICH

Searching for life on extrasolar planets

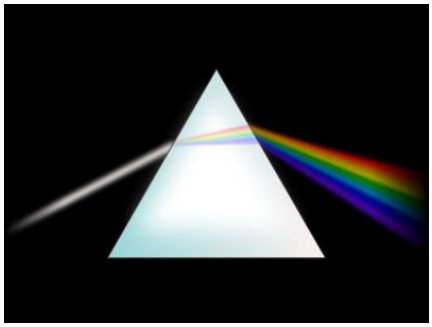
Key Stage 4

Topics covered: Extrasolar planets, light, spectra, gases

Watch the video "Are there aliens?" https://vimeo.com/122515138



To search for life on other planets scientists must look at the atmospheres of these planets. They analyse the spectrum of light from these atmospheres. A prism splits light into its constituent colours – this is a spectrum (figure 1).



If a specific colour (wavelength) is missing then this means it has been absorbed by molecules in the planet's atmosphere. Different molecules absorb different wavelengths, they each have their own spectral fingerprint which allows them to be identified.

Figure 1

The spectrum of Earth's atmosphere shows absorption bands (dips) at certain wavelengths (x-axis) as seen in figure 2. The different gases in our atmosphere absorb specific wavelengths, particularly in the infrared (thermal) part of the electromagnetic spectrum.

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1. Write down the names of the six gases present in the spectrum of our atmosphere (figure 2).

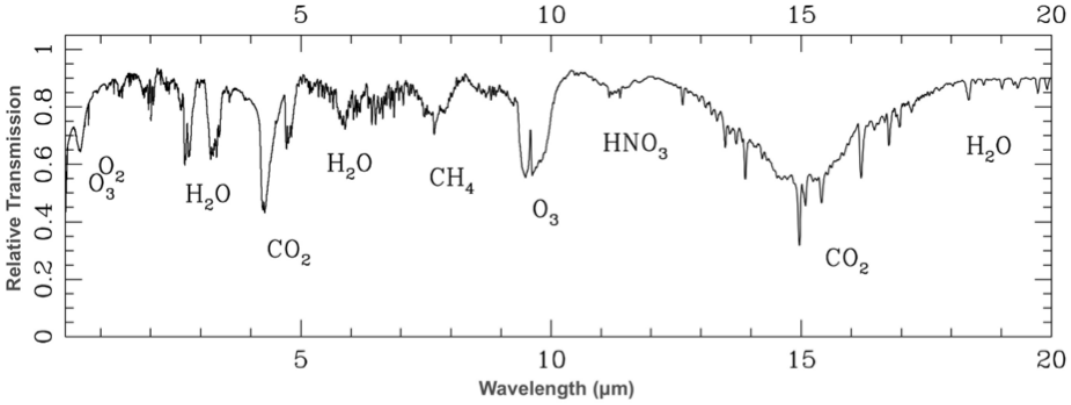
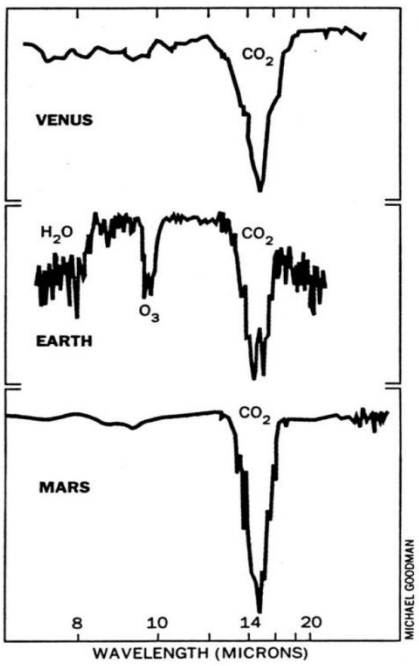


Figure 2
Credit: Kaltenegger, L. and Traub, W. (2009) Transits of Earth-like planets. Astrophysical Journal.



Gases such as CH_4, N_2O and NH_4 are produced on Earth primarily by bacteria.

O_3 is produced higher up in Earth's atmosphere. O_2 is split into two oxygen atoms by ultraviolet light, the atoms then recombine to form O_3. O_3 is very important as it blocks most high energy (shorter wavelength) ultraviolet radiation from the Sun - this can damage cells if it reaches the surface.

Infrared light from a planet provides information about the surface temperature. This then allows scientists to determine if there is liquid water present, a pre-requisite for life.

Figure 3
Credit: Des Marais, D.J., et al (2002) Remote sensing of planetary properties and biosignatures on extrasolar terrestrial planets. Astrobiology.

2. Look at the atmospheric spectra of Venus, Earth and Mars in figure 3. How do they compare? How do they differ? What can you conclude from this?

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Another signature of life is a feature in the spectrum of the planet called the vegetation red edge. This can be seen in figure 6 – there is a sharp increase in reflectivity (y-axis) at **0.7 microns** (x-axis). This is due to the behaviour of the pigment found in plants on Earth. They absorb red light, but reflect infrared light of wavelength longer than 0.7 microns.

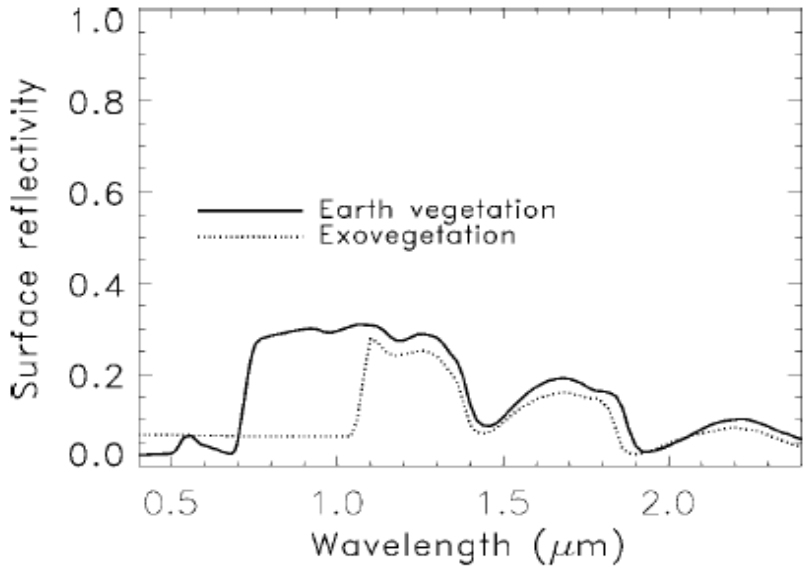

Figure 6
Credit: Tinetti, G., Rashby, S., and Yung, Y.L., (2006) Detectability of red-edge–shifted vegetation on terrestrial planets orbiting M stars. Astrophysical Journal.

3. What is the name of the pigment found in plants used for photosynthesis?

4. If the spectrum of an extrasolar planet showed a red edge at 0.7 microns, what would that tell you about the planet?

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Searching for life on extrasolar planets: ANSWERS

Key Stage 4

1. O_3 = ozone; O_2 = oxygen; H_2O = water vapour; CO_2 = carbon dioxide; CH_4 = methane; HNO_3 = nitric acid
2. All 3 have CO_2 in their atmospheres, however Earth also has water vapour and ozone. Earth has the biosignatures of life.
3. Chlorophyll
4. It has vegetation (plants, trees).