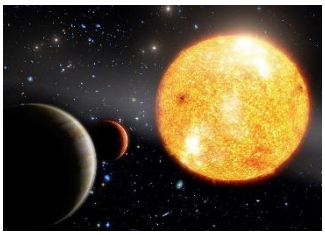
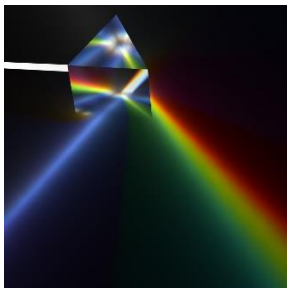
LOOKING FOR LIFE ON ALIEN WORLDS

For centuries, planets beyond our solar system—called exoplanets—existed only in theory and science fiction. It seemed nearly impossible to detect planets light-years away, since the relatively tiny worlds would appear billions of times fainter than their parent stars. From here on Earth the search would be like trying to see a firefly next to a high-power searchlight. It was not that long ago that it was widely thought that the only way we would find if other stars had planets was to go there and look. However, in the last two decades astronomers have successfully developed indirect detection methods, most of which rely on measuring the effects of orbiting planets on far-off stars.

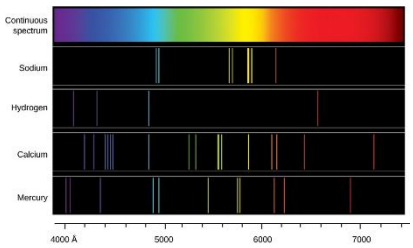


Today we have found thousands of planets out there, orbiting other stars. More than that, we can now even detect whether those planets have atmospheres, and soon possibly, if there is life.

The key tool in making these things possible was invented by Isaac Newton, when he passed sunlight through a prism, which separated out all the colours that make it up. His simple prism has been refined into an instrument known as the spectroscope, which, with the telescope, form a duo of tools that has done more than any others to revolutionize our view of the universe.



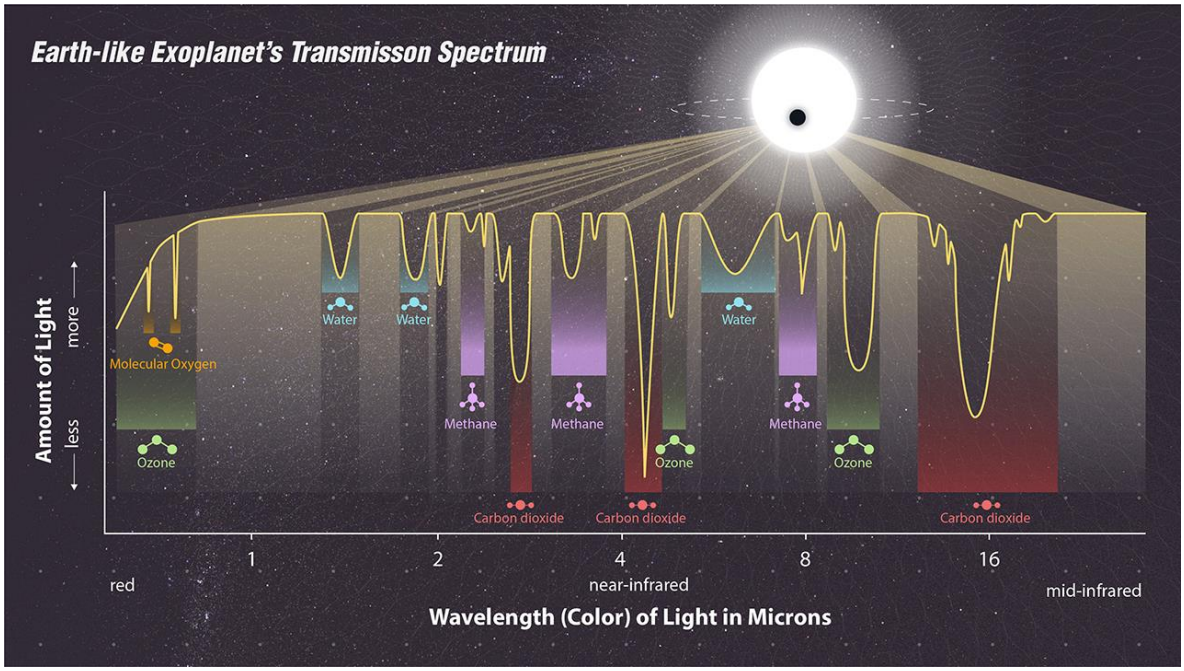
The output of a spectroscope is an image of the spectrum of the light entering it. If we pass sunlight into a spectroscope we see the light spread into a rainbow of colours, ranging from red to violet. However, it shows something Newton's basic prism did not. That spectrum is crossed by lots of dark lines. These are the signatures of elements in the solar atmosphere. Those elements resonated with certain wavelengths of light, and radiated it off in other directions, reducing the amount of light reaching us at those wavelengths, and giving us those dark lines. We can identify what elements made those dark lines, telling us the composition of the solar atmosphere.



The main method used to detect the presence of planets orbiting other stars is to search for the minute dimming of the starlight as a planet passes between us and the star. We now have satellite instruments that can monitor thousands of stars at a time, looking for those tiny dimmings. This has led to the identification of many thousands of these "exoplanets". However, thanks to the rapid improvements in astronomical technology and equally rapid fall in its prices, new exoplanets are being discovered by backyard astronomers. Amazingly, we can go further. We can detect whether an exoplanet has an atmosphere, and maybe what that atmosphere is made up of.

When an exoplanet with an atmosphere passes between us and its star, some of that starlight passes through that atmosphere, and in doing so picks up the signatures of what atoms and molecules are present in it. We can record spectrum of the star when we know no exoplanets

are passing through it, and then record the spectrum when there is an exoplanet in the way. Subtracting the spectrum of the star from the spectrum of the star plus planet should give us the signatures of the constituents of the exoplanet's atmosphere. We have an additional check. Stars are too hot for atoms to join together into molecules. Planets are cooler, so molecules can form and survive. For example, our planet's atmosphere contains molecules such as water and carbon dioxide, along with molecules comprising pairs of oxygen and nitrogen atoms. Some planets in our solar system have molecules of methane, ammonia and other things. If we see molecules, they are associated with the exoplanet.



We can go further. There are substances that should not exist together in any quantity. For example, here on Earth, with lots of carbon, iron and other materials eager to combine with it, there should not be much free oxygen. It is only there because plants are continually producing it in huge quantities. Therefore, if an exoplanet has oxygen, or other highly reactive elements such as chlorine in its atmosphere, there is a good chance that planet has some form of life. Perhaps fortunately for any inhabitants, the chances of having a closer look any time soon are pretty slim.

Jupiter lies low in the dawn glow, with Mars and then Saturn higher and further to the west. The Moon will reach First Quarter on the 13th.

Ken Tapping, 9th July, 2024

Ken Tapping is an astronomer with the National Research Council's Dominion Radio Astrophysical Observatory, Penticton, BC, V2A 6J9.