TEACHER NOTES – ASTRONOMY IN THE NEWS #21
RADIO-DETECTED EXOPLANETS

Slide 2 – Background Science: Stellar Flares

The Sun, our star, is a good laboratory for us to study a star close by and test our understanding of stellar astrophysics. The difference with studying our star, compared to others, is that we are within the heliosphere of the Sun. The heliosphere is the outermost layer of the Sun, and defines the end of the cavity blown out by the Sun in the interstellar medium. Using the Voyager 2 probe, the heliosphere appears to have a radius of 129.2 AU, or 1.87 $\times 10^{13}$ m.

However, an advantage of being within the heliosphere, we can detect and characterise stellar flares, and their impact on Earth and other planets. A solar wind is charged particles, as a plasma, released from the upper levels of the Sun. These charged particles are electrons and protons, with some alpha particles. These flares contain a great deal of energy, and as such could pose a threat to our technology on Earth! However, in an astrophysical setting, the charged particles interact with the magnetic field of a planet, or its magnetosphere. The magnetosphere deflects the particles away, via the Lorentz Force. If there is no magnetosphere associated with a planet, the atmospheres are stripped way by the stellar wind.

IMAGES:

1. (Left) Multiwavelength image of a solar flare taken by the Solar Dynamics Observatory, a satellite that is tasked with studying the Sun and how the Earth and Sun interact with each other. The wavelengths shown, from left to right, are 1600, 304, 171, 335, 94, and 131 Å which corresponds to 160, 30.4, 17.1, 33.5, 9.4 and 13.1 nm. These wavelengths are all in the ultraviolet.
2. (Right) A cartoon depicting the interaction between the Sun's solar flares and solar wind with the Earth's magnetic field. As the solar wind interacts with the Earth's magnetosphere, causing a bow shock (the purple region between the Sun and Earth). The magnetosphere deflects some charged particles (the highest and lowest bands past the Earth), with plasma sheets the other bands past Earth. There is also the Van Allen radiation belt, which is the blue bubble around Earth. This is where some of the charged particles are trapped in the radiation belt, within the magnetic field. Occasionally these make their way to Earth via the aurora.

Slide 3: Radio-Detected Exoplanets

The usual methods of detecting exoplanets, as we have discussed in bulletins #16 and #20, usually require the transiting of a planet in front of a host star, obscuring the light we receive from the star. However, this article presents a potentially new method for detecting exoplanets, with potential confirmation.

The method uses a radio telescope to detect M-dwarf stars, the most common stars in the Milky Way. Although these stars are much less massive than the Sun, they are more magnetically active. By observing a sample of these stars, they were found to have coherent radio emission, which is a signature of the coronal ejections of a star. However, a series of quiescent stars, with no signatures of coronal ejections have shown this emission. As a result, the authors predict that these are a detection of the magnetic fields of the stars and planets interacting, producing this radio emission.

The 19 M dwarfs detected in radio emission were followed up with optical observations. These optical observations, over a period of time, show that the majority of the stars show stellar flares, ruling out star-planet magnetic interactions. However, the inactivity of 4 stars strengthens the case that they are planet-star interactions.

To strengthen the cases even further, simultaneous radio and optical observations are required.

The article that this resource is built off can be found here:

https://www.theguardian.com/science/2021/oct/12/i-think-theres-life-out-there-powerful-radio-antenna-used-for-first-time-to-find-exoplanets

Free, permanent versions of the research papers can be found here:

https://arxiv.org/abs/2110.03713 (Radio observations)

https://arxiv.org/abs/2110.04759 (Optical observations)

IMAGES:

1. (Top left) Radio observation of one candidate star-planet interaction, GJ 1151. This image shows the brightness in the background image, with the red circle showing the position of a star detected with the Gaia satellite.
2. (Top right) Radio light curve for the same candidate. It shows the increasing and decreasing of the radio brightness over the observed time period. This is proposed to highlight the star-planet interaction.
3. (Bottom) Optical light curve of the star, with no flares detected over the observed time. The lack of optical flares indicates that any radio-brightness increases may be from the proposed interaction, as opposed to the stellar flares.

Slide 4 – Activity: What is the Solar cycle?

This activity involves looking at the graph shown on the slide of the number of sunspots over time. The more sunspots, the more activity. The students should estimate the length of the Solar cycle, i.e. the time between either the peaks or dips.

The estimated Solar cycle is 11 years.

GCSE Specifications:

Specification	Knowledge Point
Pearson Edexcel Astronomy	10.8, 10.10, 10.12

A-Level Physics Specifications:

Specification	Knowledge Point
Pearson Edexcel Physics	122
OCR Physics A	6.3.2(a)
AQA Physics	3.7.5.2