TEACHER NOTES – ASTRONOMY IN THE NEWS #18

THE LUCY MISSION LAUNCHES

Slide 2 – Background Science: Jupiter's Trojans

The majority of asteroids within the Solar System occur within the Asteroid Belt, a band of these objects that is found between Mars and Jupiter. However, there is a significant population of asteroids found in the orbit of Jupiter. There are two "swarms", one in front of Jupiter and one behind. These two swarms are found approximately 60 degrees away (around a circle) and are found in two of the Lagrangian points. These points are gravitationally stable points that are found in a two body system.

IMAGES:

1. (Left) GIF showing the orbits of Trojans with relation to the orbit of Jupiter. The Trojans are in two stable parts of the orbit, called Lagrangian points, where each planet (including Earth) would have them both in front and behind the orbit. They occur 60 degrees away from the planet.
2. (Right) Artist's impressions of the seven asteroids that Lucy will visit during its journey. 6 of them are within the Trojans whilst one, Donald Johanson, is within the main Asteroid Belt between Mars and Jupiter. Along with these 7 asteroids, Lucy will also visit the moon of Eurybates.

Slide 3: The Lucy Mission

The Lucy mission, named after the famous human fossil found in Africa which taught us a lot about human evolution, will visit 8 asteroid objects. 6 of these objects are asteroids within the Trojans, 4 in the leading swarm, 2 in the trailing swarm. 1 of the objects will be a moon of one of these asteroids with the leading swarm and the final object will be in the main Asteroid Belt between Mars and Jupiter. The first asteroid visit will occur in April 2025 (within the main Asteroid Belt), followed by orbiting the leading swarm between August 2027 and November 2028, and finally visiting the trailing swarm in March 2033.

One of the major questions relating to the Trojans are what they could reveal about the formation of the Solar System. One such model is something that explains the existence of Trojans. Objects that become Trojans are difficult to remove from their orbit, but on the flip side, it is difficult to put an object into a Trojan orbit. However, one way to do this is the Nice model. This model, which originated in France, describes how the orbits of the giant planets were once much closer to the Sun. The interaction of these planets eventually adjusted their orbits to the ones that we see today. However, as this occurred outer Solar System asteroids would be trapped in the Trojan orbits and Jupiter, as the largest planet, would trap the largest number. As a result, these Trojans should reflect the conditions that existed when the various giant planets formed.

The articles that this resource are built on can be found here:

https://www.bbc.co.uk/news/science-environment-58927969

https://www.theguardian.com/science/2021/oct/15/nasa-launch-lucy-mission-distant-asteroids

A more detailed description of the mission, from NASA, can be found here:

https://www.nasa.gov/mission_pages/lucy/overview/index

IMAGES:

1. (Top left) Artist's impression of Lucy orbiting one of the asteroids.
2. (Bottom left) Diagram displaying the journey to be taken by Lucy. The image is relative to the orbit of Jupiter. Lucy will first get some boosts from the gravity of Earth and then will head to the Trojans in front of Jupiter. On the way, it will encounter an Asteroid Belt object. Lucy will then travel back via Earth to the Trojans in the trailing swarm.
3. (Right) An animation of the Nice model. The green points are asteroids and comets that were initially beyond Neptune. The red, yellow, blue and purple lines are the orbits of Jupiter, Saturn, Neptune and Uranus, respectively. The orbit of Saturn crosses with the 2:1 resonance with Jupiter, and this interaction moves the planets outwards, and Jupiter inwards, and scatters the asteroids around the Solar System.

Slide 4 – Activity: What is Lucy's average speed?

Lucy will travel a phenomenal distance over the course of its 12 year mission, a total distance of 6.4 billion kilometres. Using this time and distance, can the students calculate the average speed in metres per second, which I believe comes to ~17,000 m/s or 16,912 m/s to be precise. They need to take particular care to convert 12 years into seconds and 6.4 billion kilometres into metres.

I also ask the students to compare this value to that for the speed of sound on Earth, 343 m/s. The students would find that it is 49 faster than this.

GCSE Specifications:

Specification	Knowledge Point
Pearson Edexcel Astronomy	11.1, 11.26, 12.1
Pearson Edexcel Physics	2.6, 2.12
Pearson Edexcel Combined Sciences	P2.6, P2.12
OCR Physics B	1.4.9, 4.2.1, 4.2.2
OCR Combined Sciences B	P4.2.1, P4.2.2
AQA Physics	4.5.6.1.2
AQA Combined: Trilogy	6.5.6.1.2

A-Level Physics Specifications:

Specification	Knowledge Point
Edexcel Physics	1
OCR Physics A	2.1.2(e)
OCR Physics B	2(b)
AQA Physics	3.1.1