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Bringing Nobel Prize Physics in the Classroom

Hunting Exoplanets

DCU ELLINOGERMANIKI AGOGI NUCLIO EGO EUROPEAN GRAVITATIONAL OBSERVATORY IASA Paris Centre for Cosmological Physics Co-funded by the Erasmus+ Programme of the European Union léargas

Vivienne Daly, Ireland
vcdaly@gmail.com

Kleanthi Vasilakou, Greece
k.leri.v@hotmail.com

Athanasios Karakostas, Greece
athanasios.karakostas@gmail.com

Background information for teachers

Overview of this lesson pack:

Name of the activity	Discovering Alien Planets using Light Sensing equipment
Topics introduced	Exoplanets, Luminosity, Graphing
Curriculum Connection	**IRELAND**: **Science**:- Working scientifically, Designing and making, Light, Forces. **Geography**:- Earth, Solar system,Planet Earth in space, including abstract concepts. **History-** Working as an historian, Stories of people from a wide range of human experience, including scientific and technological fields. **Visual Arts-** Drawing, Paint and colour. **ICT** integration.Using apps- PhyPhox , Google Science Journal , Spark Video , Comic Life Camera **Mathematics**:- 3D shapes, 2D shapes, **GREECE**: Geography: Earth as a celestial body, Solar System, Planet orbits (Ages 11-12) ICT: Problem solving using Spreadsheets (Ages 11-12) ICT: Implement research plans using computers (Ages 6-12) Maths: The concept of time (the duration of year in different exoplanets)Ages(10-12) History: Discovering of Space, discovering of exoplanets(Ages 11-12) Greek Language:Related Vocabulary, definitions (Ages 6-12) English Language: Related Vocabulary, definitions (Ages 6-12) Visual Arts: Development of awareness about line, shape, form, colour, pattern, rhythm, and space. Gross-curricular integration to support the understanding of concepts.(Ages 6-12)
Reference Demonstrator	Discovering Alien Worlds http://www.frontiers-project.eu/demonstrators/discoveringalien/
Age of students	6-12

Overview of this lesson pack:

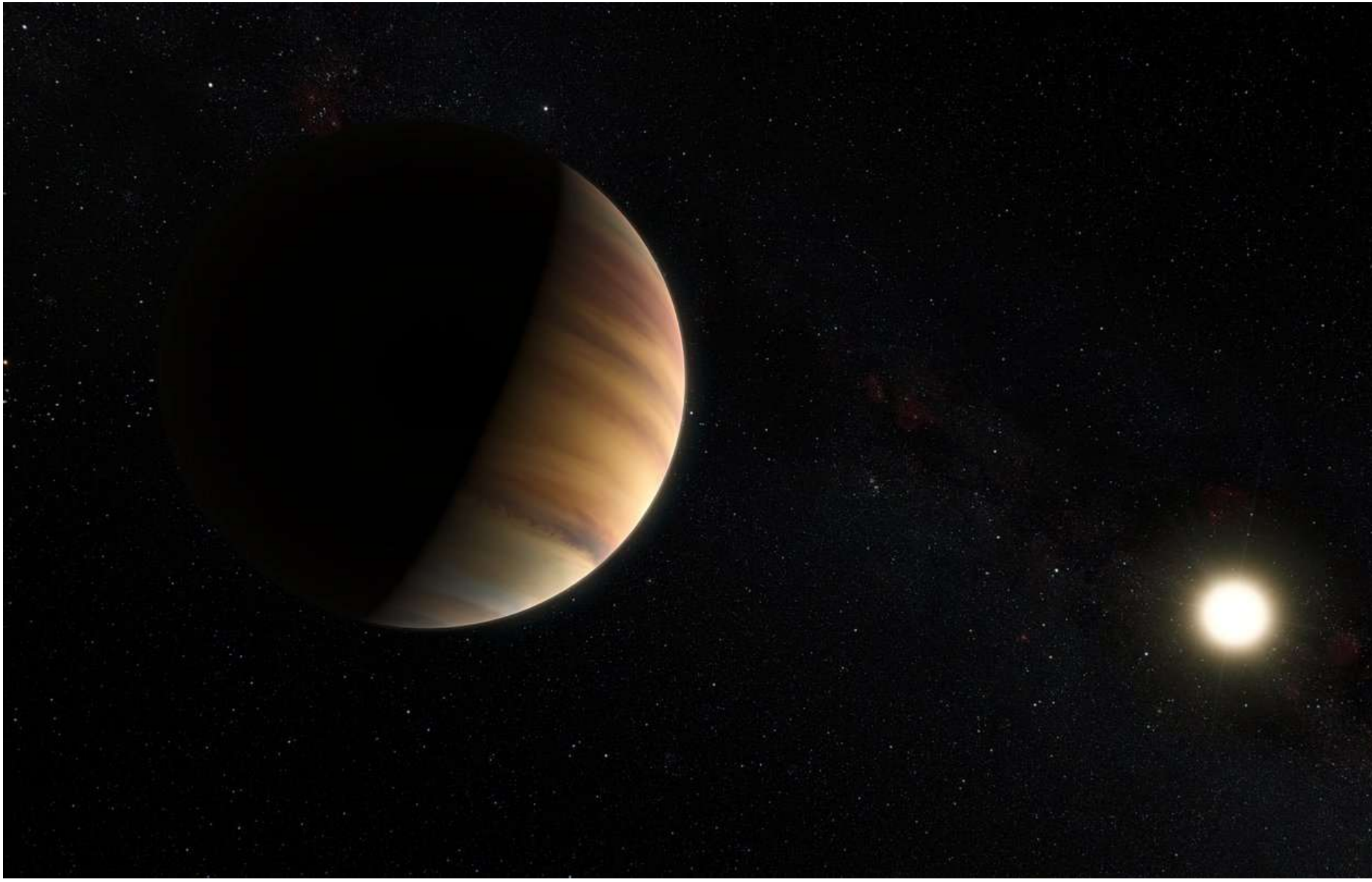
Type of activity	Construction of simple lab apparatus using a shoebox, experimental procedure via light sensing software to obtain data, graphing of the data obtained in a spreadsheet
Description of activity	Teacher activities: ● Prepare presentation, gather material/equipment needed ● Present material, explain light curve ● Supervise construction of lab apparatus to perform experiment ● Guide students to perform the experiment using a smartphone/tablet, extract data to excel spreadsheet for the students to graph ● Supervise graph generation, discuss results Student activities: ● Watch presentation and related videos ● Construct experiment apparatus using shoebox or table lamp in a dark room ● Graph results, discuss ● create artwork related to exoplanets
Equipment requirements	-Mobile device with camera (smartphone or tablet), PC for processingand presenting the results, light sensor app such as Google Science Journal or PhyPhox. iSwiff light graphing software -Easily obtained material to construct lab apparatus (a shoebox, scissors etc) PC/laptop with internet connection and a projector for presentation and related videos projection -Optional, IKEA table lamp that may be suitable for the experiment in a dark room 
Prior knowledge for students	Basic Astronomy knowledge of a star and planet system, Graphs in Excel, LibreOffice Calc or similar software (Ages 11-12)

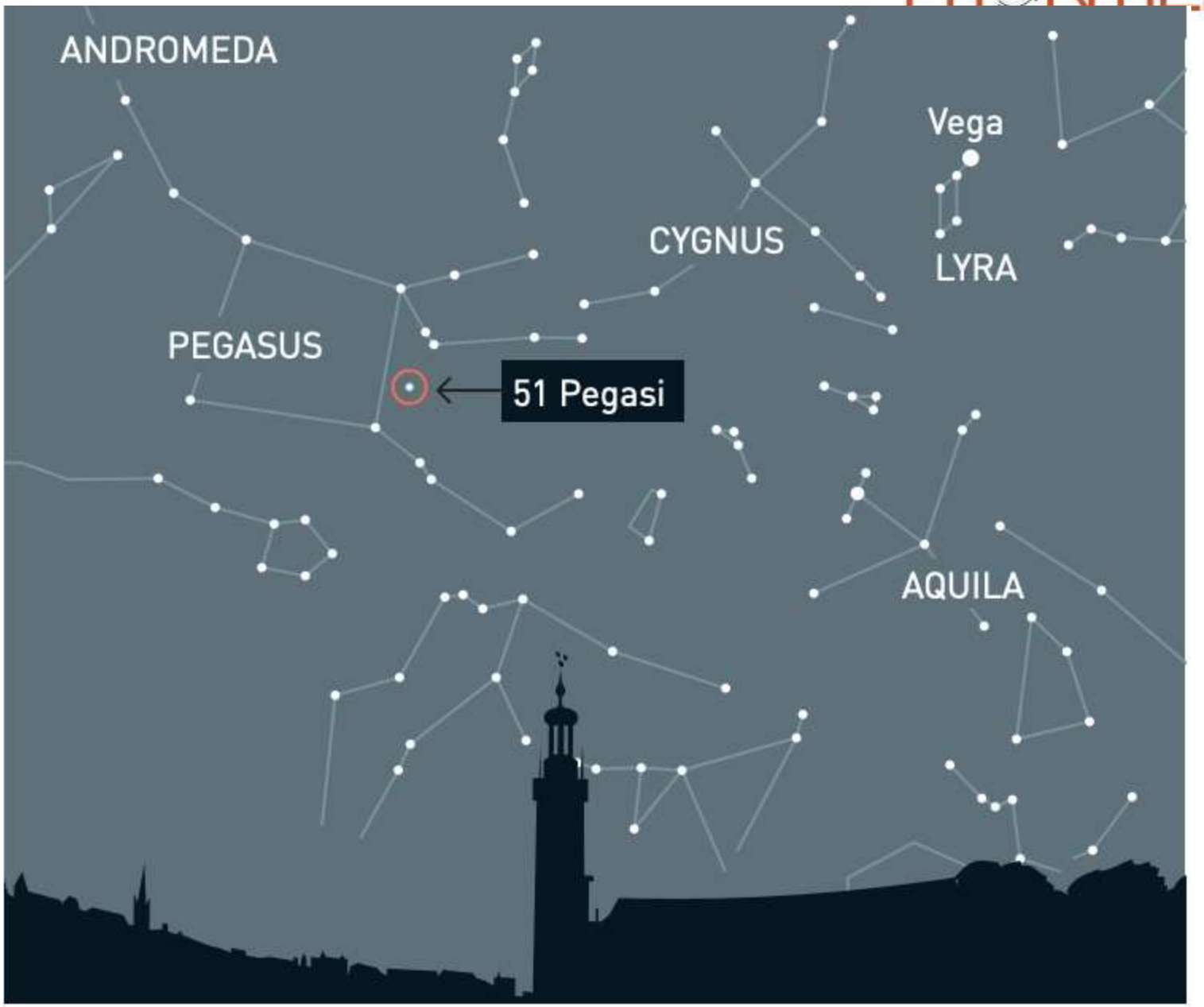
Background and overview of the discovering alien worlds demonstrator:

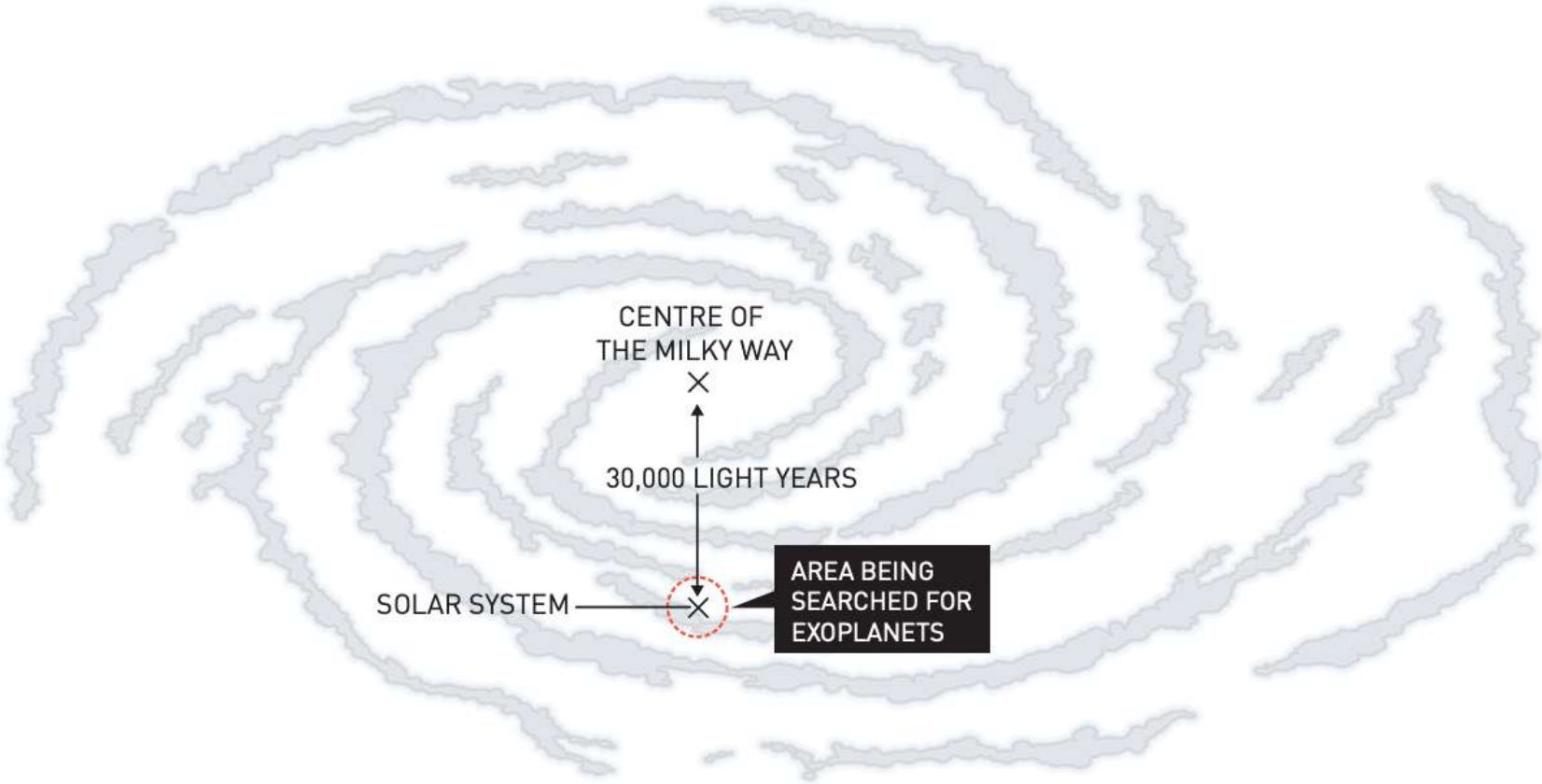
This demonstrator introduces the concept of an exoplanet and how they have been discovered in our universe. Students are introduced to the transit method of exoplanet detection. Experimentally obtained images using apparatus constructed in class will be used to simulate changes in the starlight that might result due to the motion of an orbiting exoplanet. Light Sensing apps will be used to perform photometry and to allow the students to graph the data and analyse the graphs. Students can present their work to the class and discuss findings.

Presentation for students

Teacher guidelines can be found in the notes attached to each slide



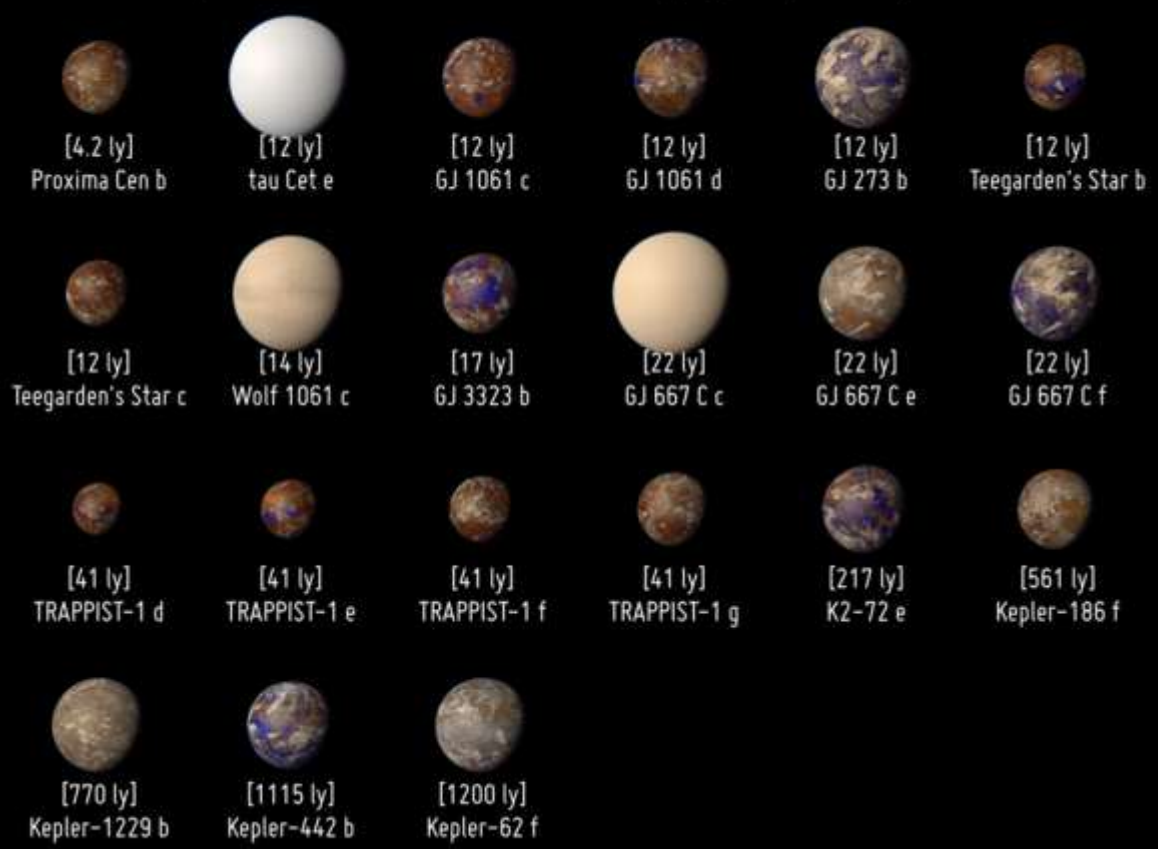

ANDROMEDA
Vega
CYGNUS
LYRA
PEGASUS
51 Pegasi
AQUILA



Potentially Habitable Exoplanets

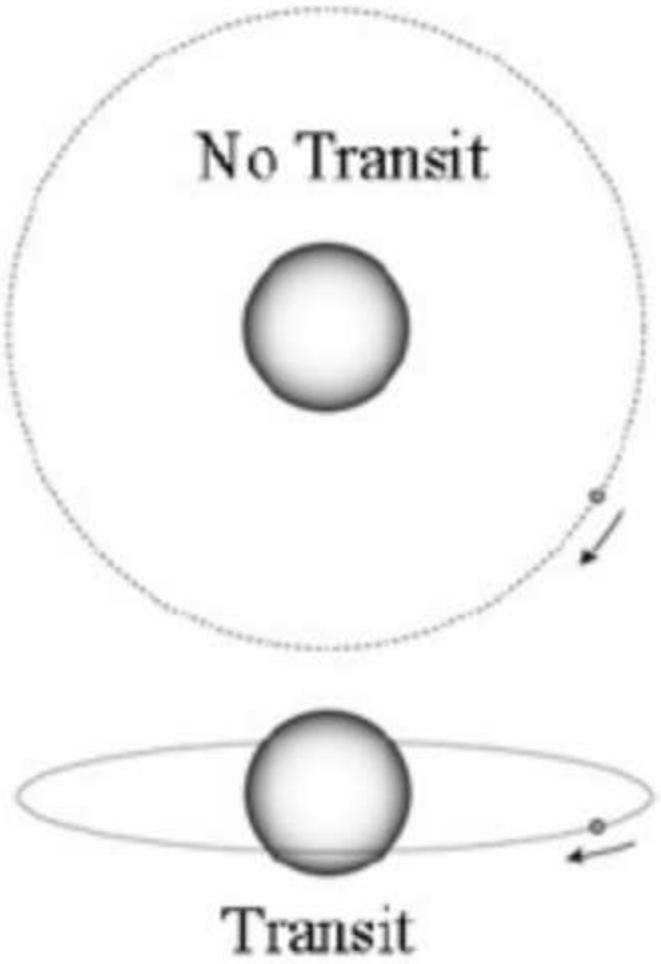
PHL

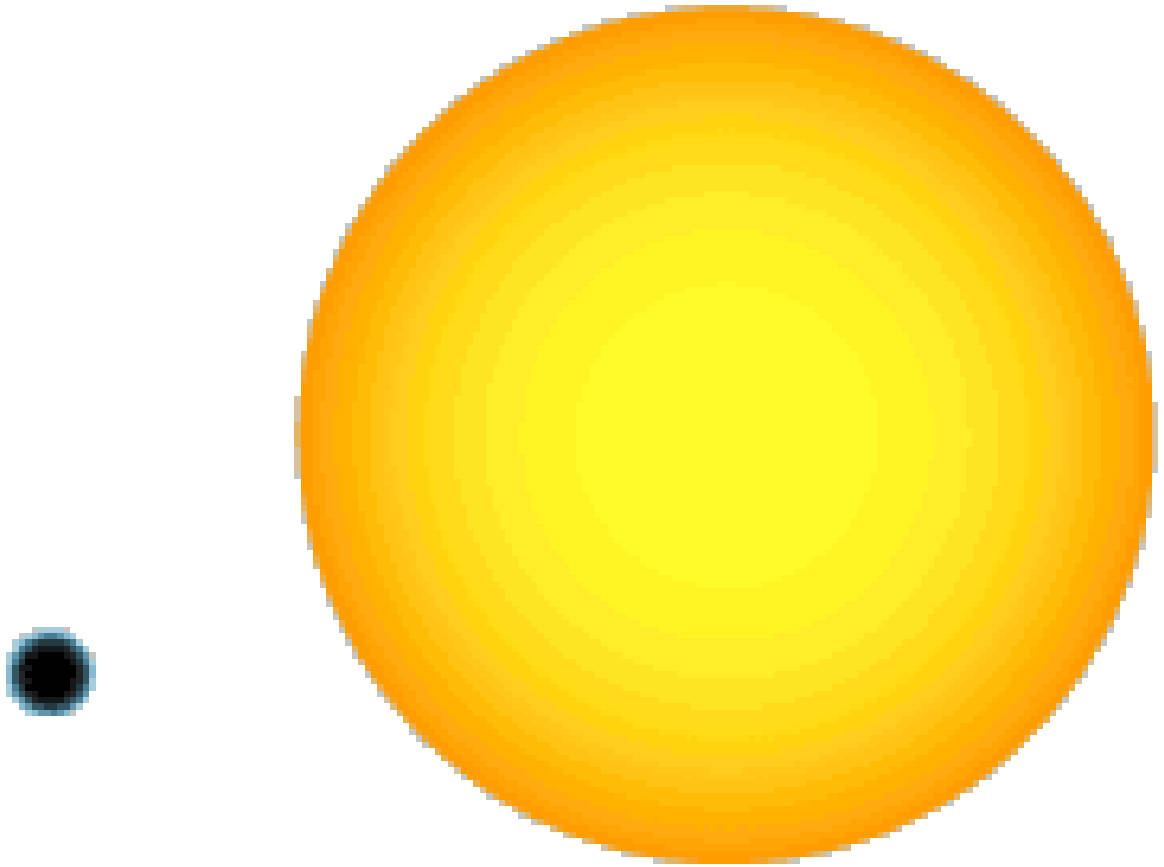
Ranked by Distance from Earth (light years)



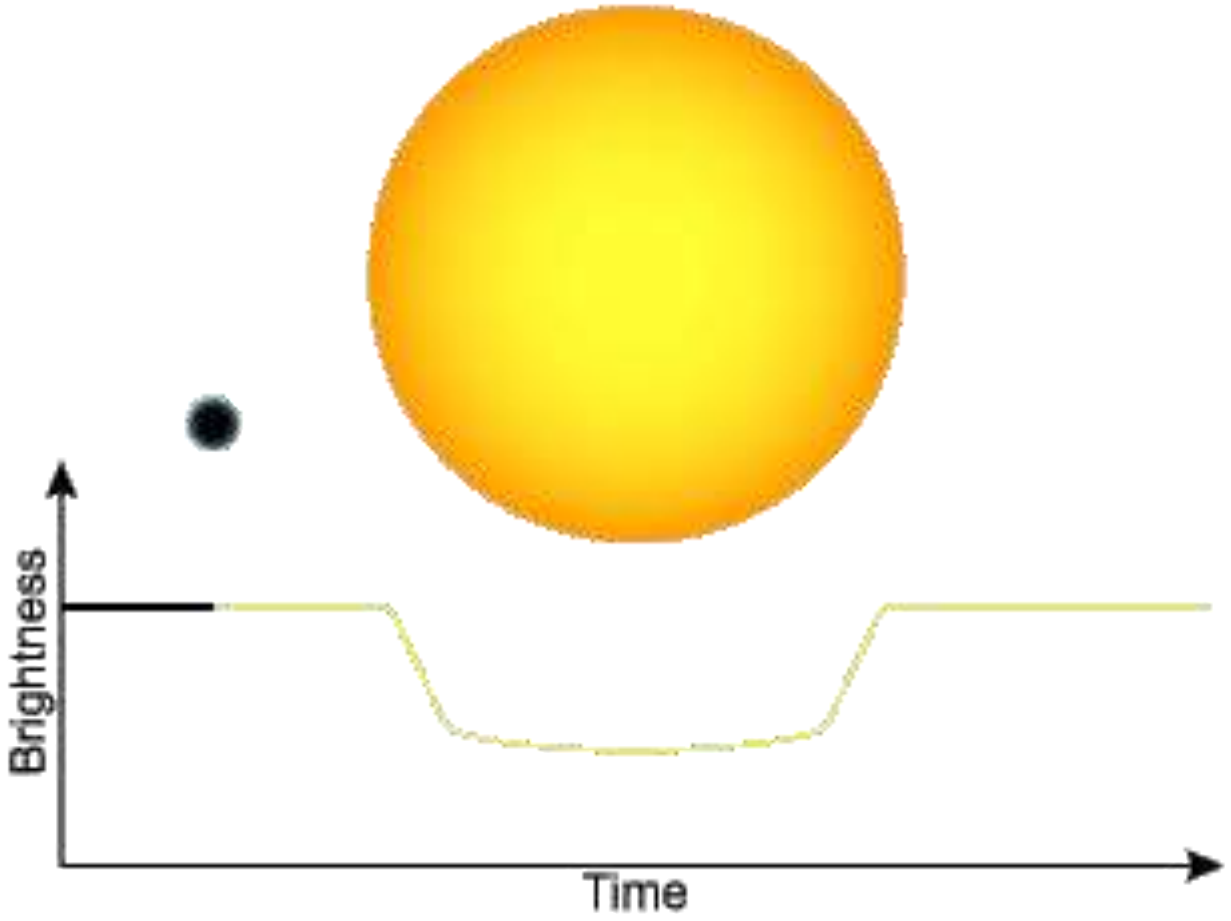
Artistic representations. Earth, Mars, Jupiter, and Neptune for scale. Distance from Earth is between brackets.

CREDIT: PHL @ UPR Arecibo (phl.upr.edu) Sep 4, 2019


No Transit
Transit



Light Curve of a Star During Planetary Transit



Experimental procedure

FADO

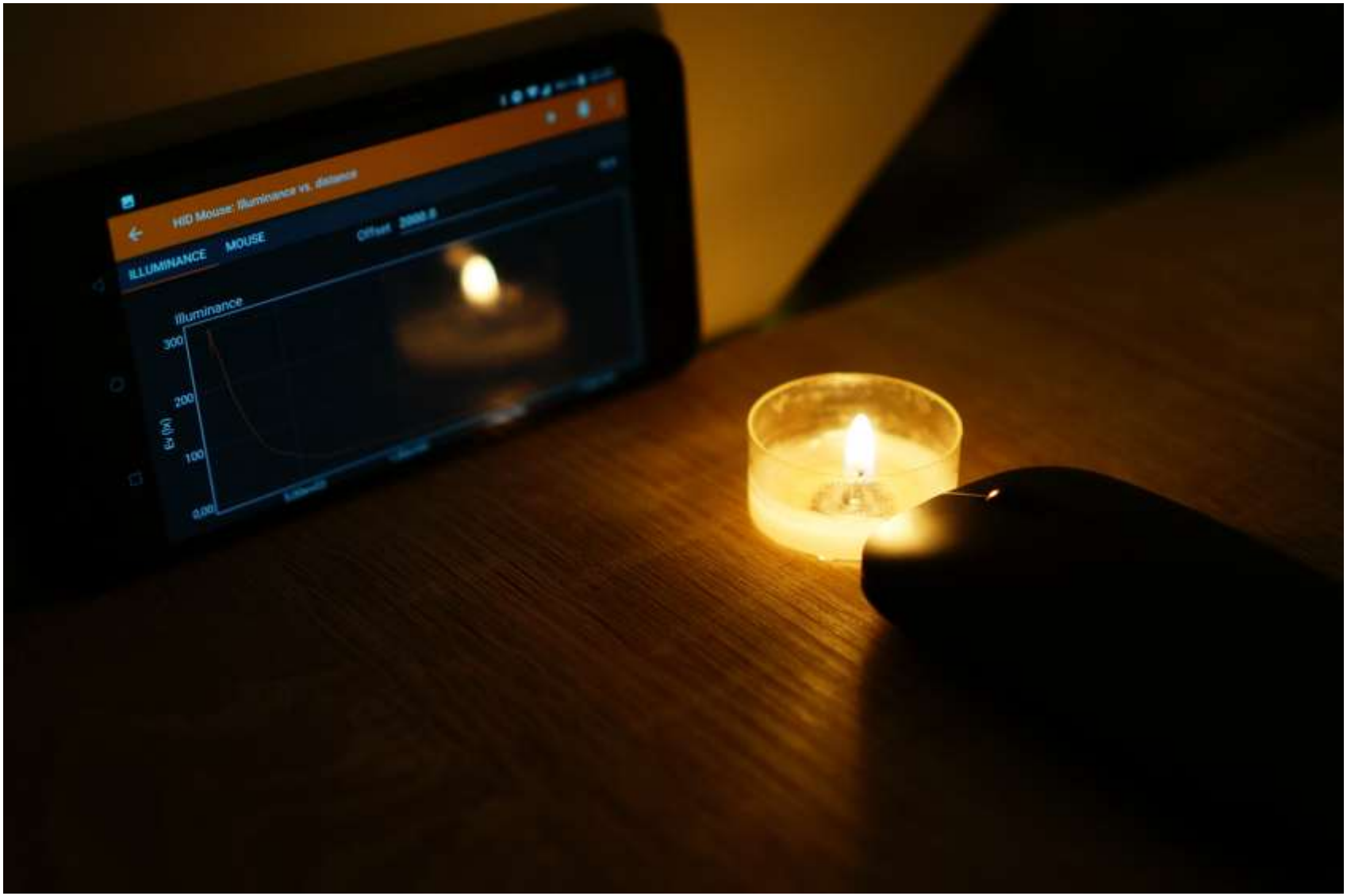
Table lamp, 17 cm

€8 A++

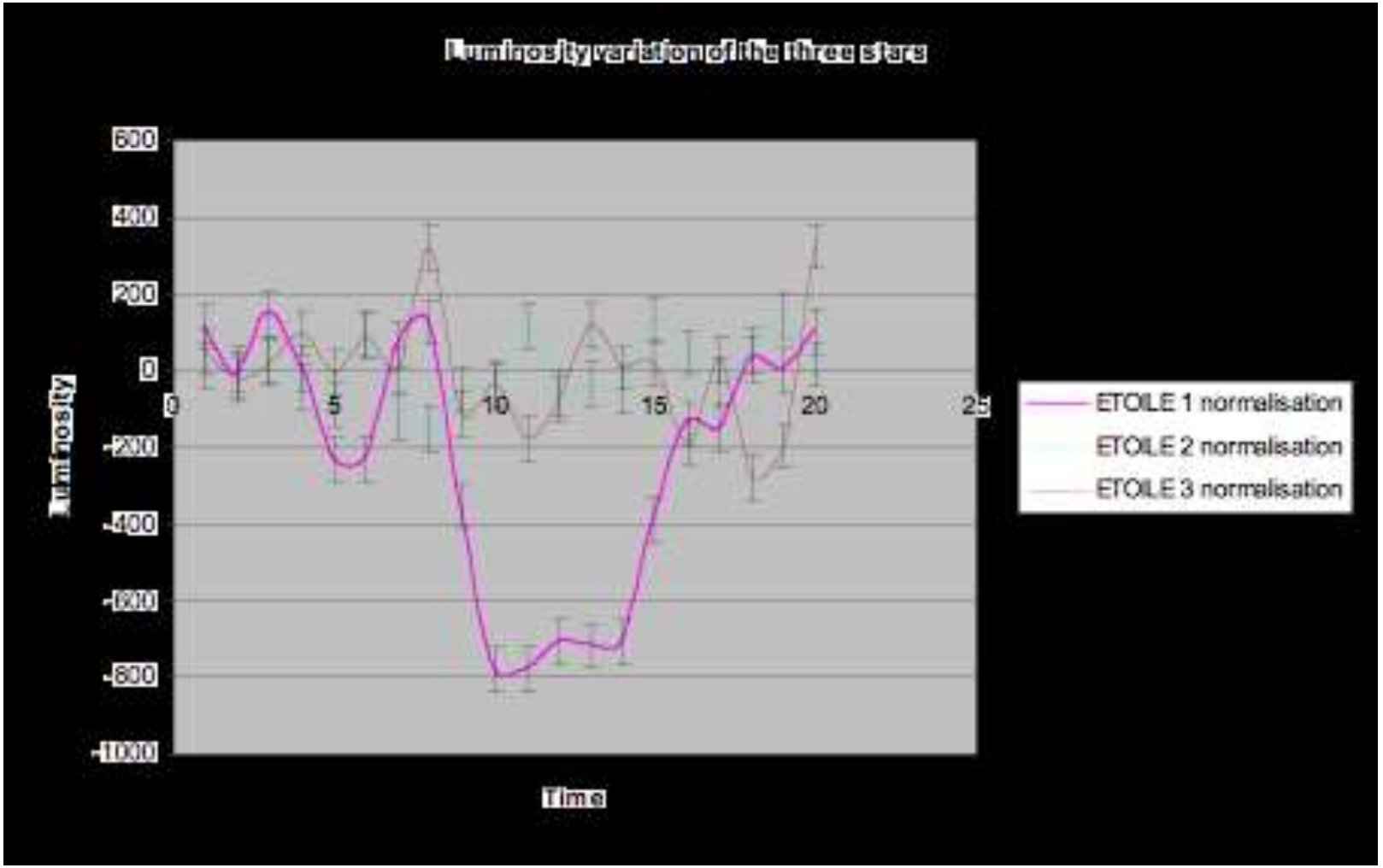
FADO

Table lamp, 25 cm

€15 A++

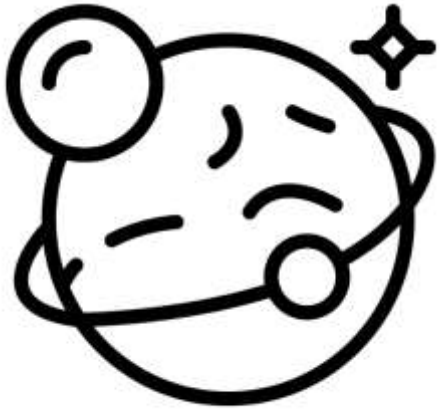

HID Mouse: Illuminance vs. distance
ILLUMINANCE
MOUSE
Offset
Illuminance
300
200
100
0.00

Graphing our Data


Luminosity variation of the three stars
600
400
200
0
-200
-400
-600
-800
-1000
0
5
10
15
20
25
Luminosity
Time
ETOILE 1 normalisation
ETOILE 2 normalisation
ETOILE 3 normalisation

Well done!

You are now an Exoplanet Hunter!



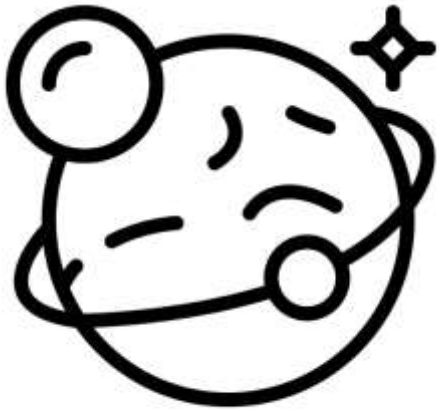
Created by Prettycons
from Noun Project

We're Going On An Exoplanet Hunt!

Learning Goals

Children will be enabled to :-

- Understand that there are planets outside our solar system, called exoplanets.
- Understand that astrophysicists can find out about these planets using different methods
- Know that one of these methods is called the transit method.
- Understand that this method causes the light of the star to dim, and this can be observed



Created by Prettycons
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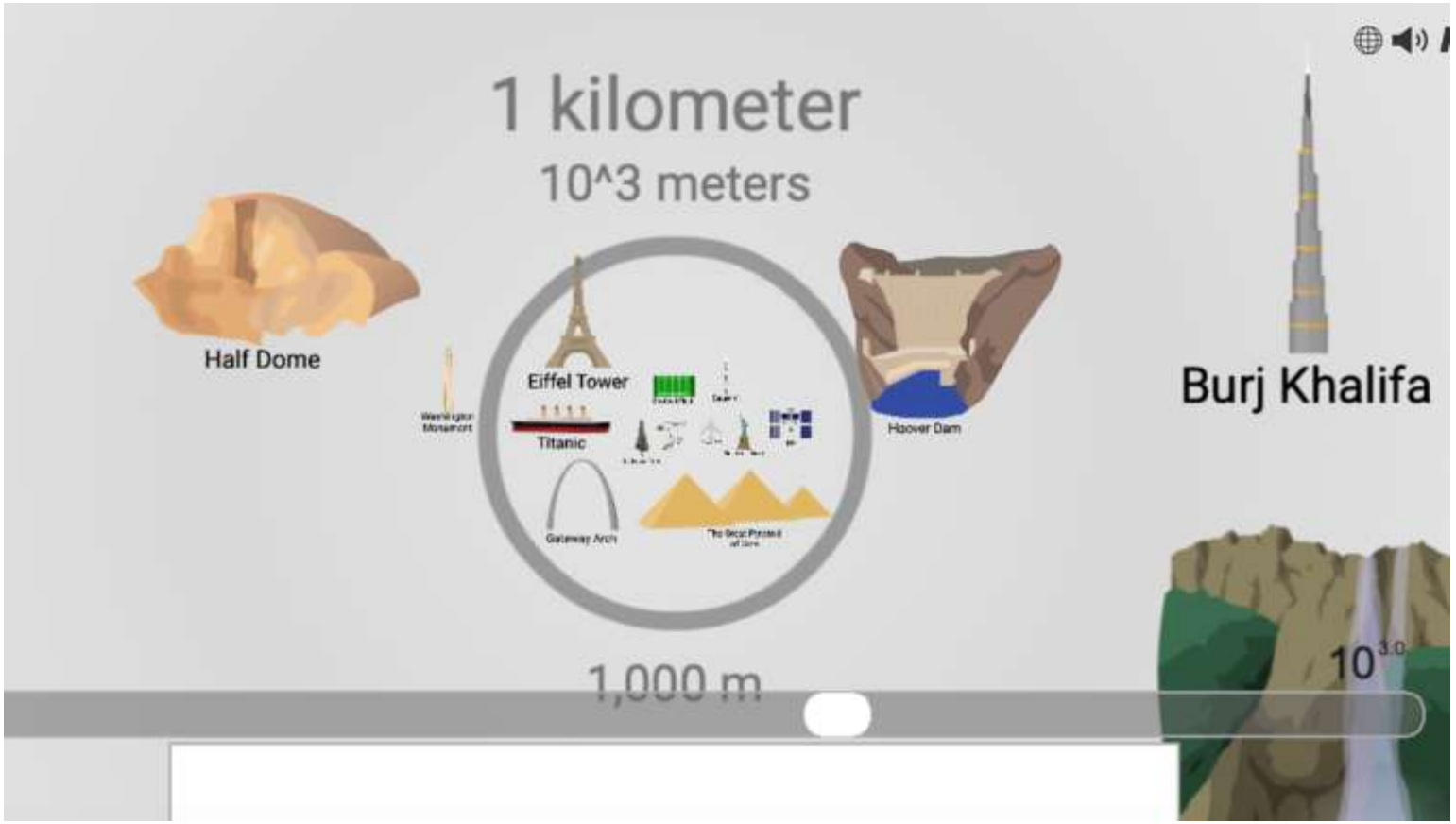
Exoplanets, ages 6-9

Introducing the transit method

Earth compared to The Sun and planets

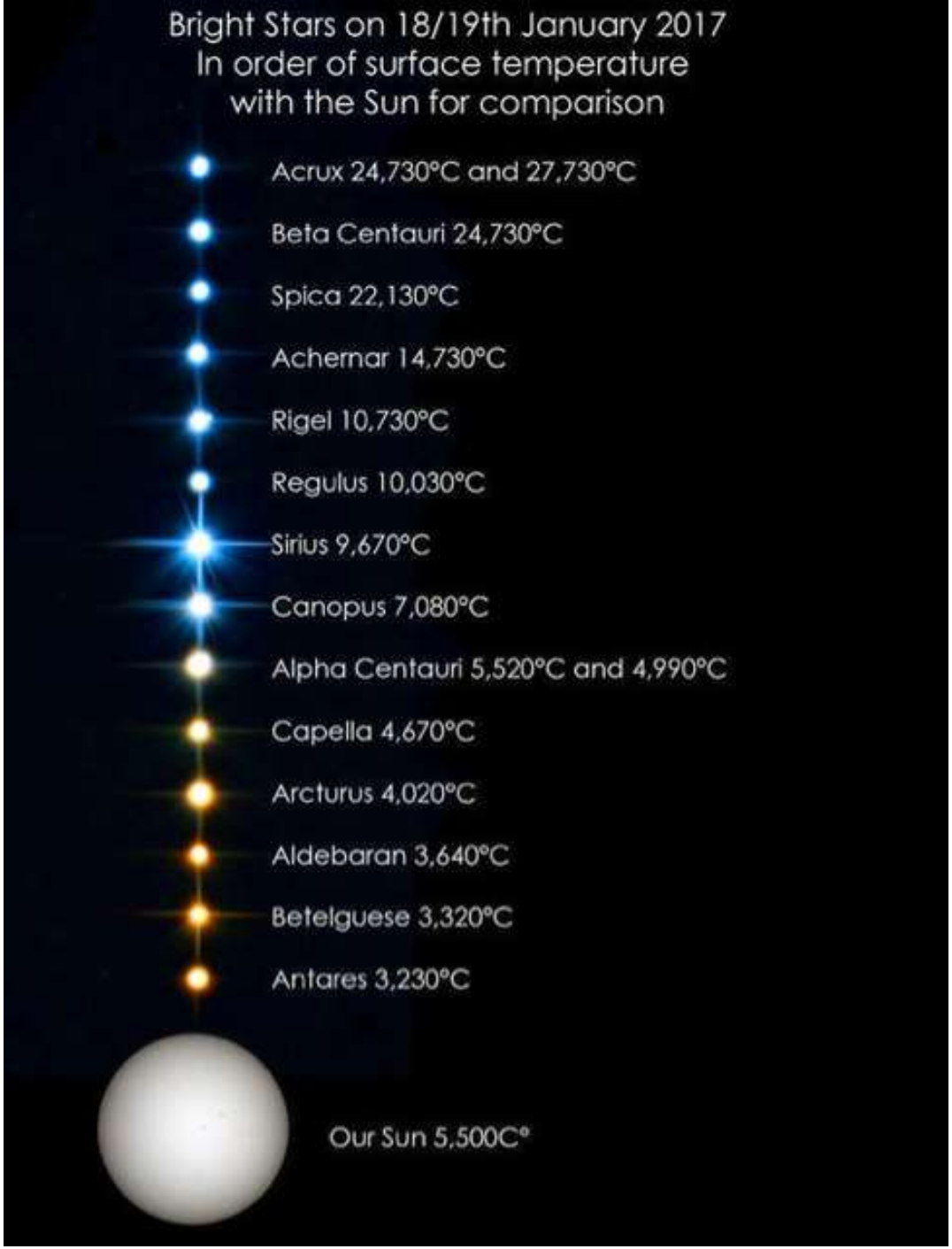
Looking at the scale of the universe



https://htwins.net/scale2/

Introducing Exoplanets

Imagining Exoplanets



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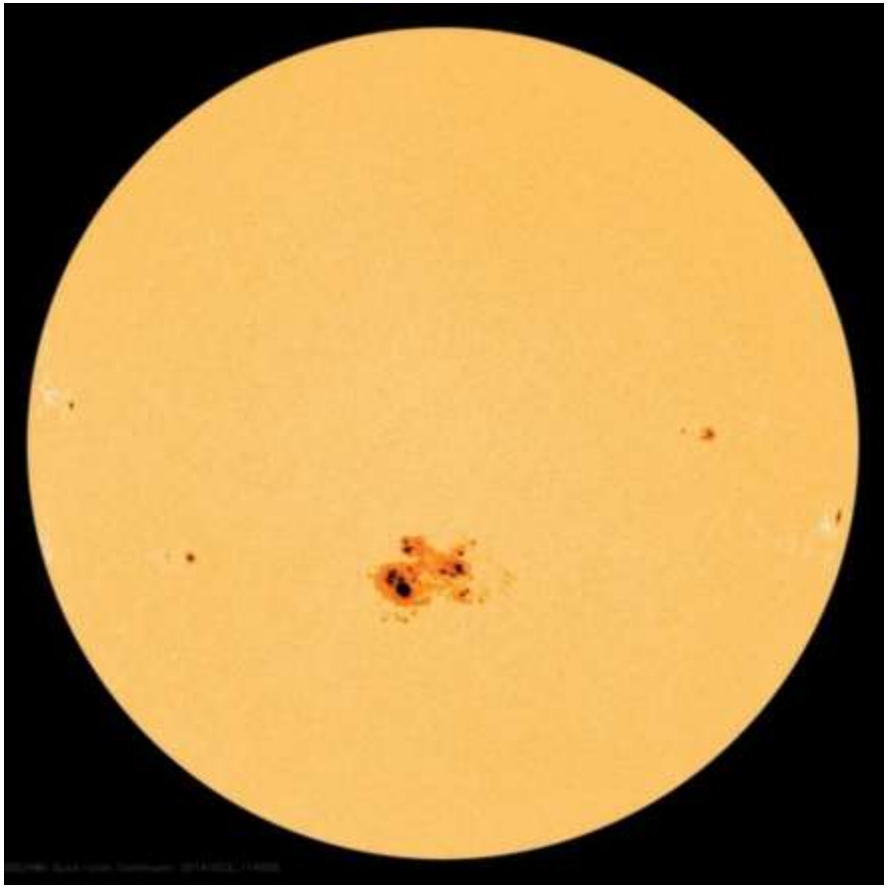
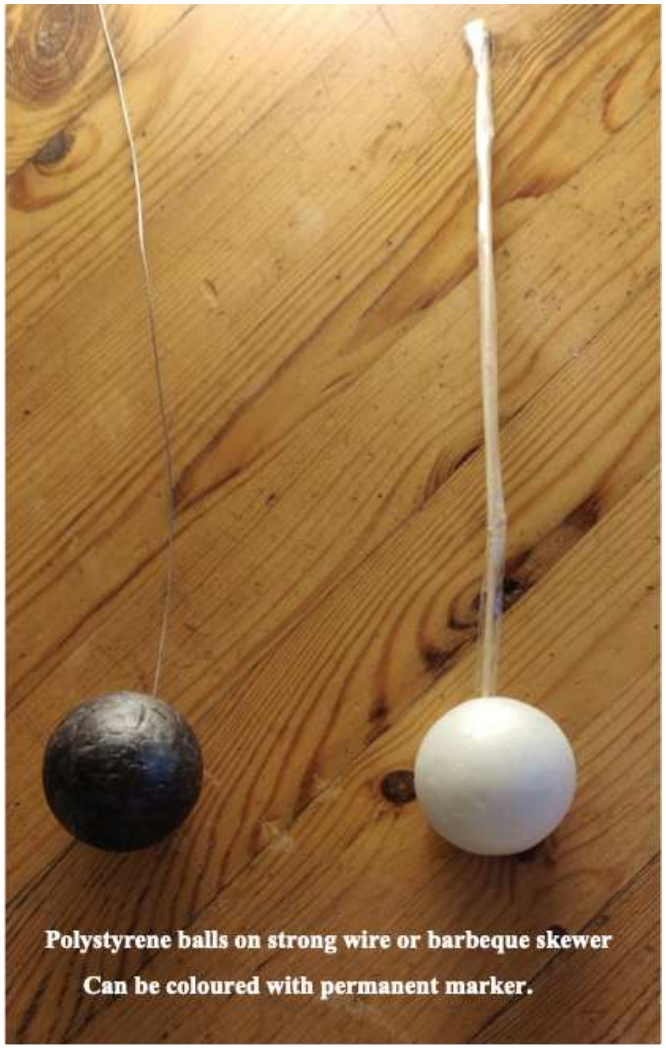
‘It’s full of stars!’

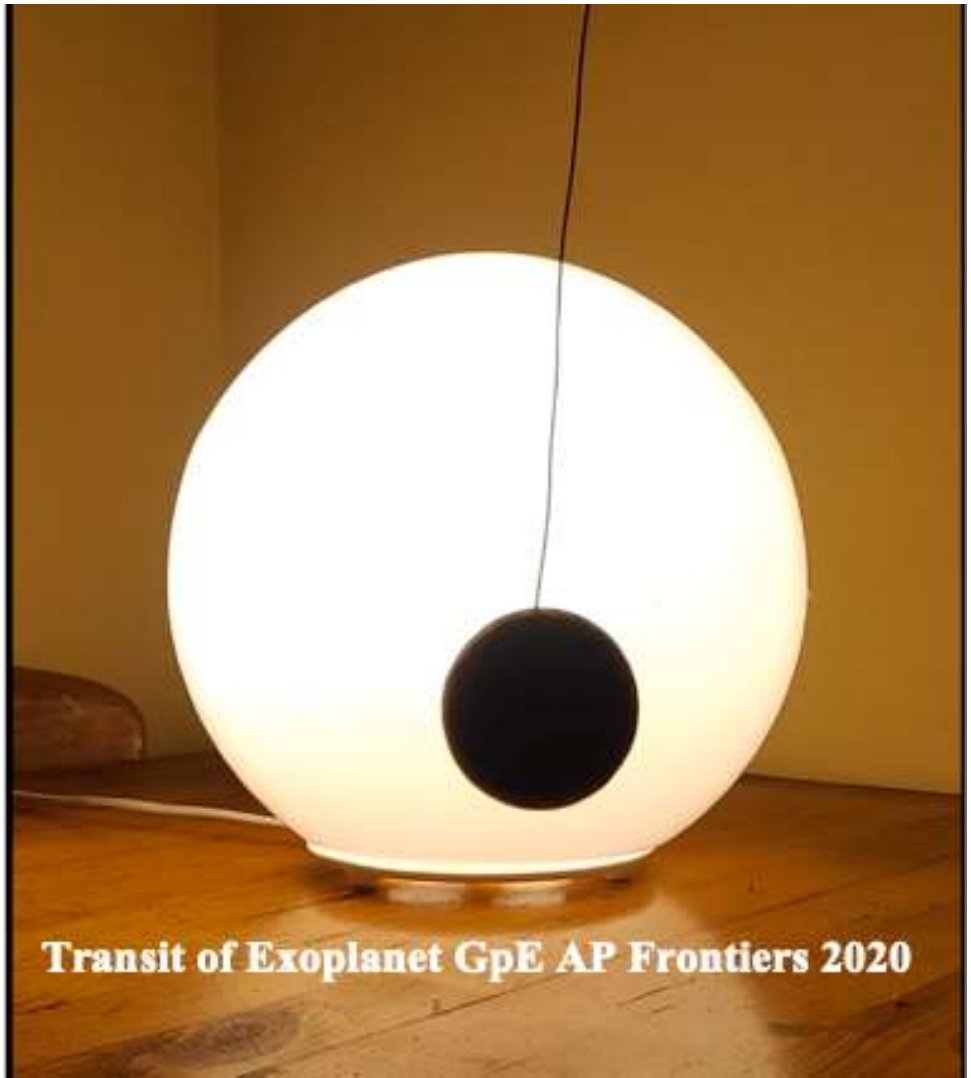
Created by ibrandify
from Noun Project

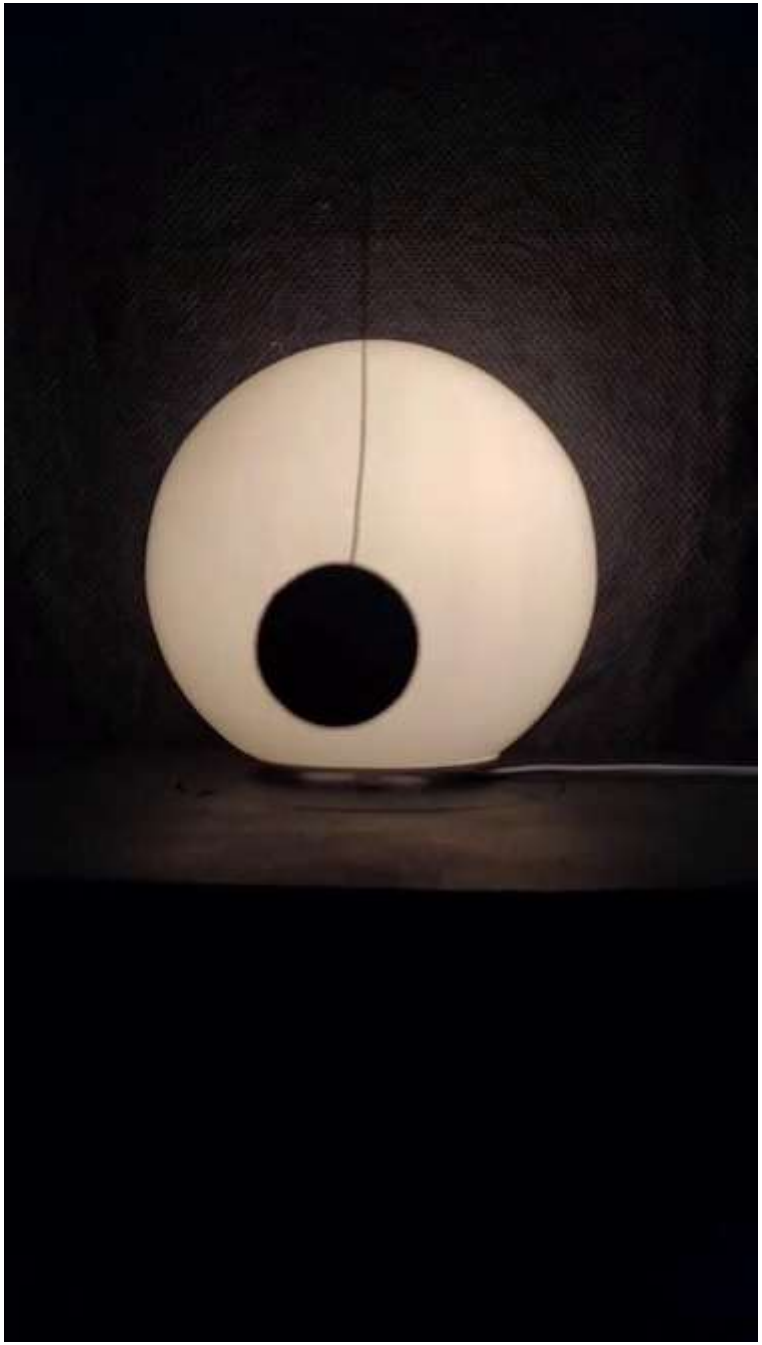


The Sun

Hands-on activity







Video of ‘Transit’

Using ICT to record activities.

Discovering Exoplanets

Susan Jocelyn Bell is an Irish astrophysicist who discovered pulsar stars.

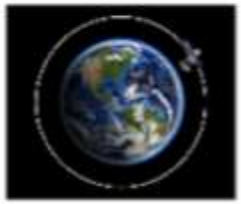
Although she was the first to observe the pulsars, Bell was not one of the recipients of the Nobel Prize.

She was awarded a special prize for physics in 2018, but used the prize money to set up a fund to help women and minority group students to become physics researchers.

In 1992 scientists studying the pulsar star noticed changes in the signals. This information led to the discovery of the first exoplanet by Mayor and Queloz in 1995, using radial velocity, for which they won the Nobel Prize.

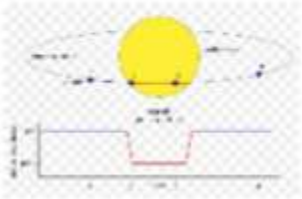
PLANET HUNTING WORDS

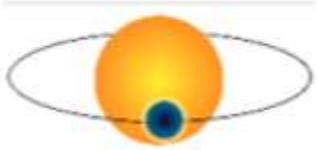
Can you match the word with the correct picture?



Dim Discover Exoplanet Transit method Bright

Orbit Solar System Transit Star Illuminance





Appendix: Links to videos and related material

Paxi exopalnets- (What exoplanets are?)
https://www.esa.int/kids/en/Multimedia/Paxi_animations/English/Exoplanets

Cheops telescope ESA- older classes https://bit.ly/32uImwe

History of discovering exoplanets

https://astronomy.com/news/2019/10/how-the-first-exoplanets-were-discovered

https://en.wikipedia.org/wiki/List_of_proper_names_of_exoplanets

Radial Velocity Method- wobble method- https://www.youtube.com/watch?v=YOS3LrTtpZg

Nobel prize winners for discovery of first exoplanet 51 Pegasi b https://go.nasa.gov/2B9OHSt

NASA – older children, radial velocity method
https://www.jpl.nasa.gov/video/details.php?id=1606

How artists imagine other planets- Explore the galaxy

https://exoplanets.nasa.gov/alien-worlds/exoplanet-travel-bureau/

NASA Exoplanet site- English and Spanish https://exoplanets.nasa.gov/

PhyPhox and Google Science Journal:

https://phyphox.org/

https://sciencejournal.withgoogle.com/