Modelling the Solar System

Welcome!
The webinar will start in a few minutes.

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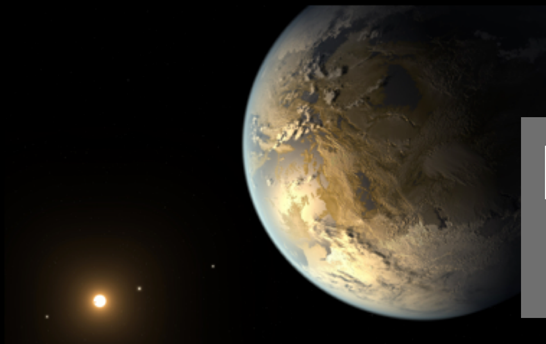

Is Pluto a Planet or Not?

- *October 24, 2018*

Workshop for Teachers – Level 2

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Contact:

nannau@observatoryhill.org

OR VISIT:

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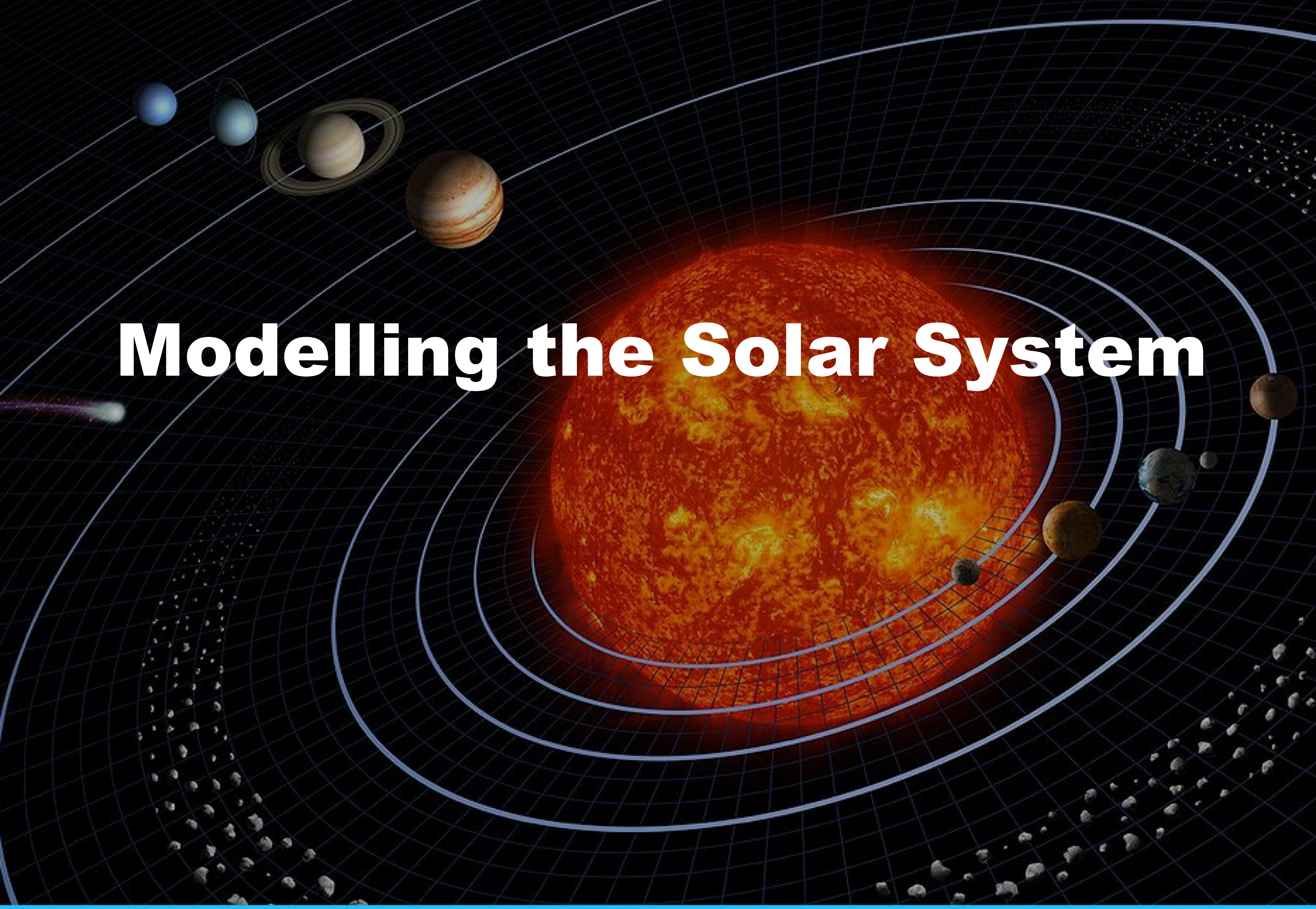
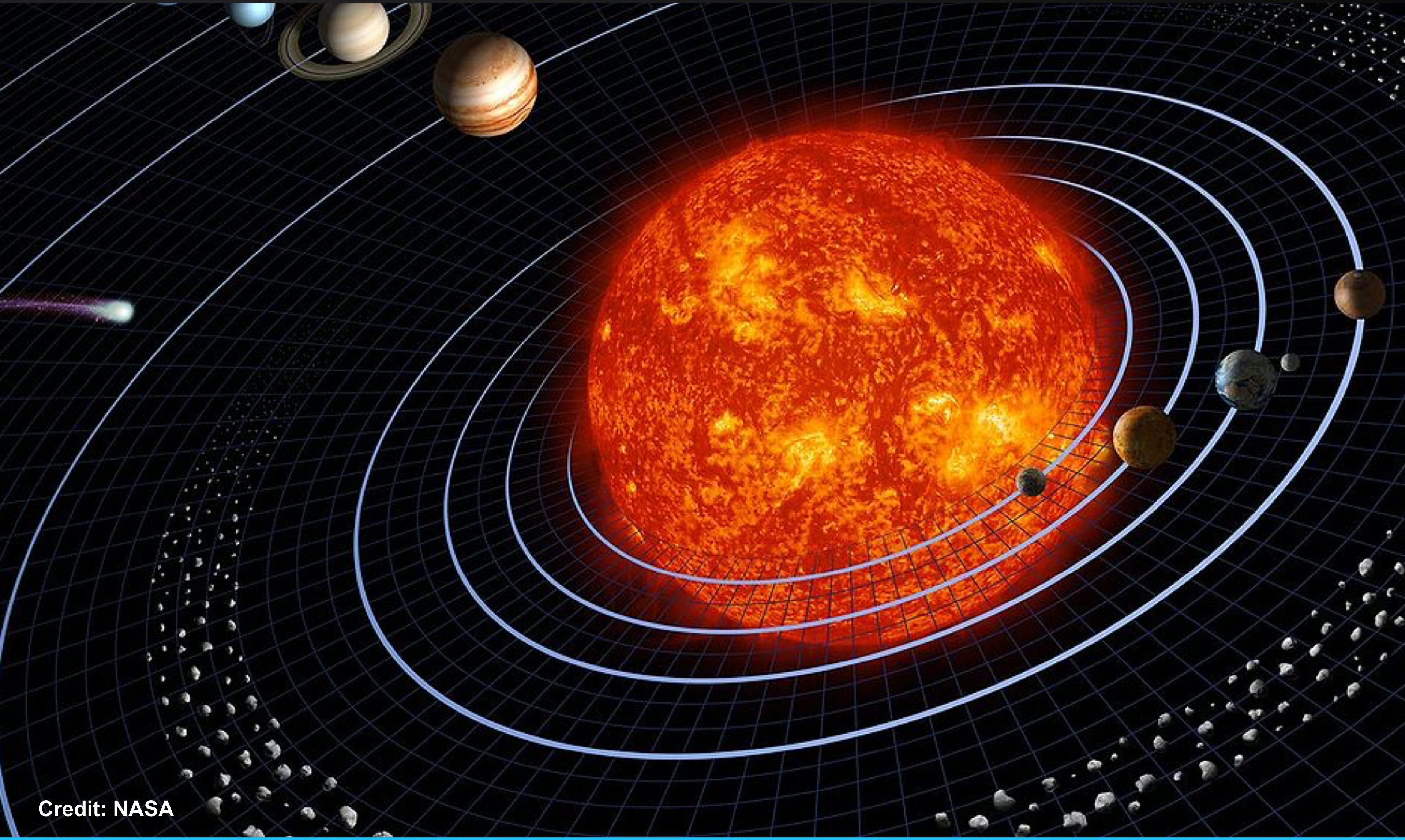


Modelling the Solar System

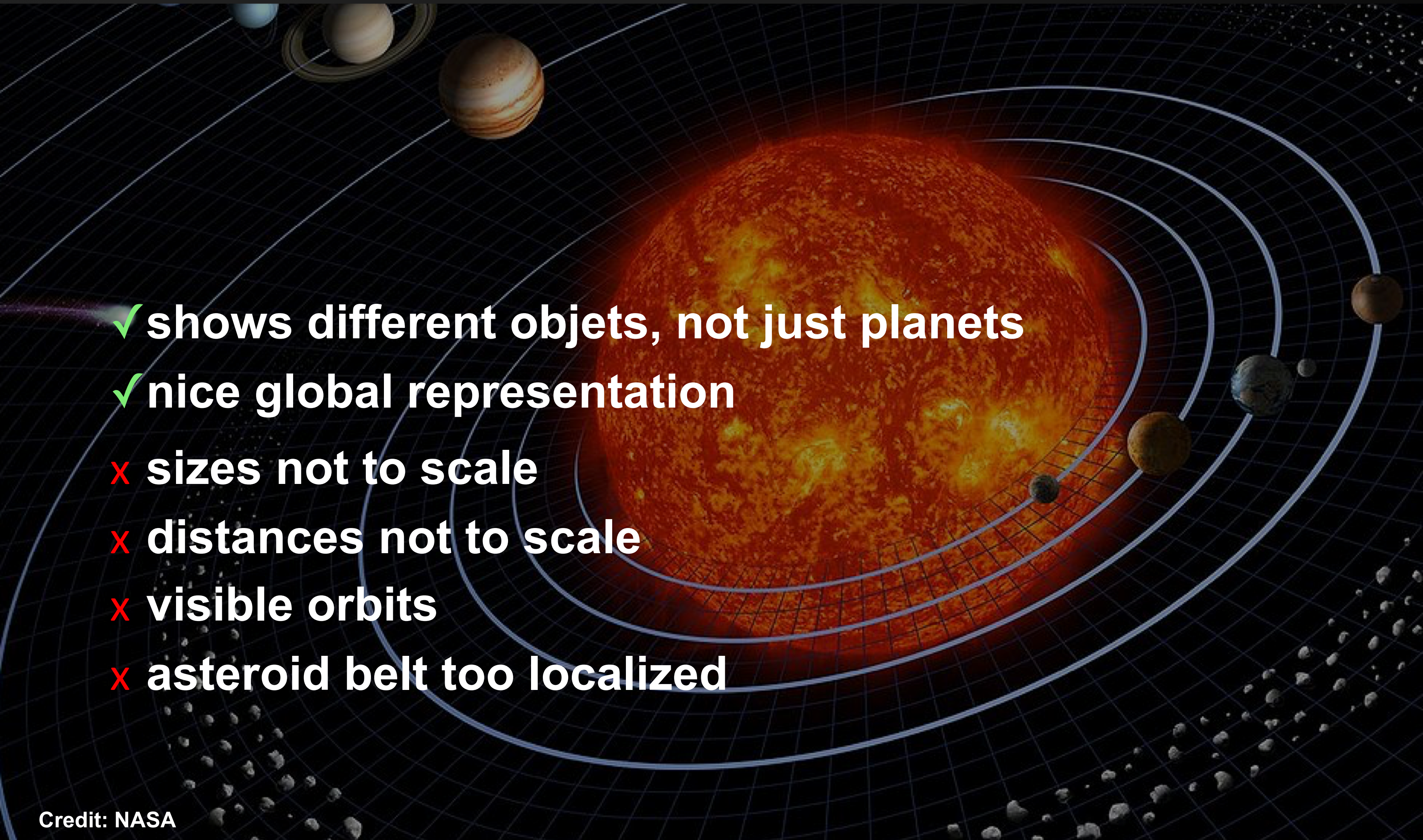
It’s impossible to represent the solar system to scale on a sheet of paper or a slide!

Representation of the Solar System



Credit: NASA

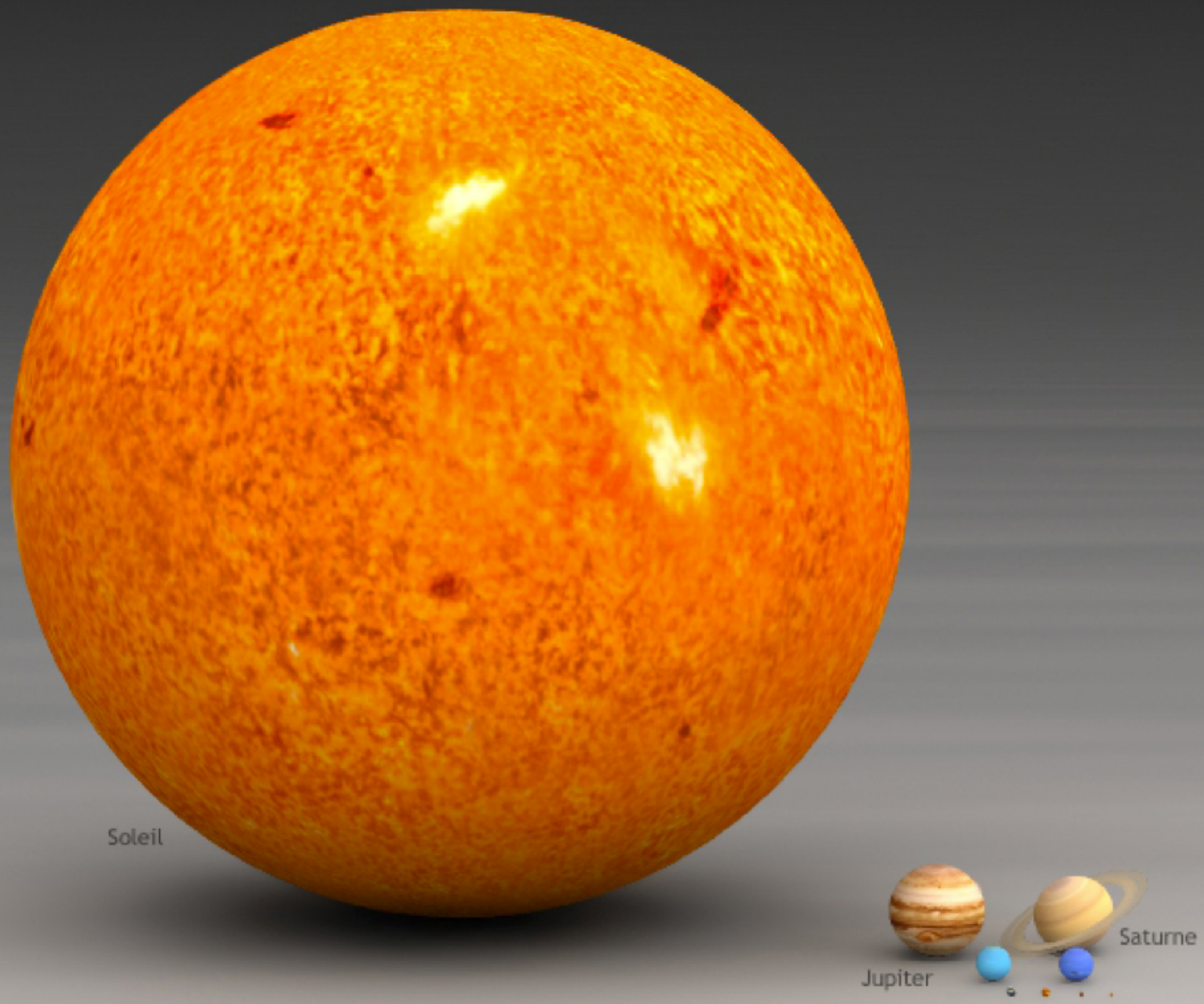
Representation of the Solar System



- ✓ shows different objets, not just planets
- ✓ nice global representation
- x sizes not to scale
- x distances not to scale
- x visible orbits
- x asteroid belt too localized

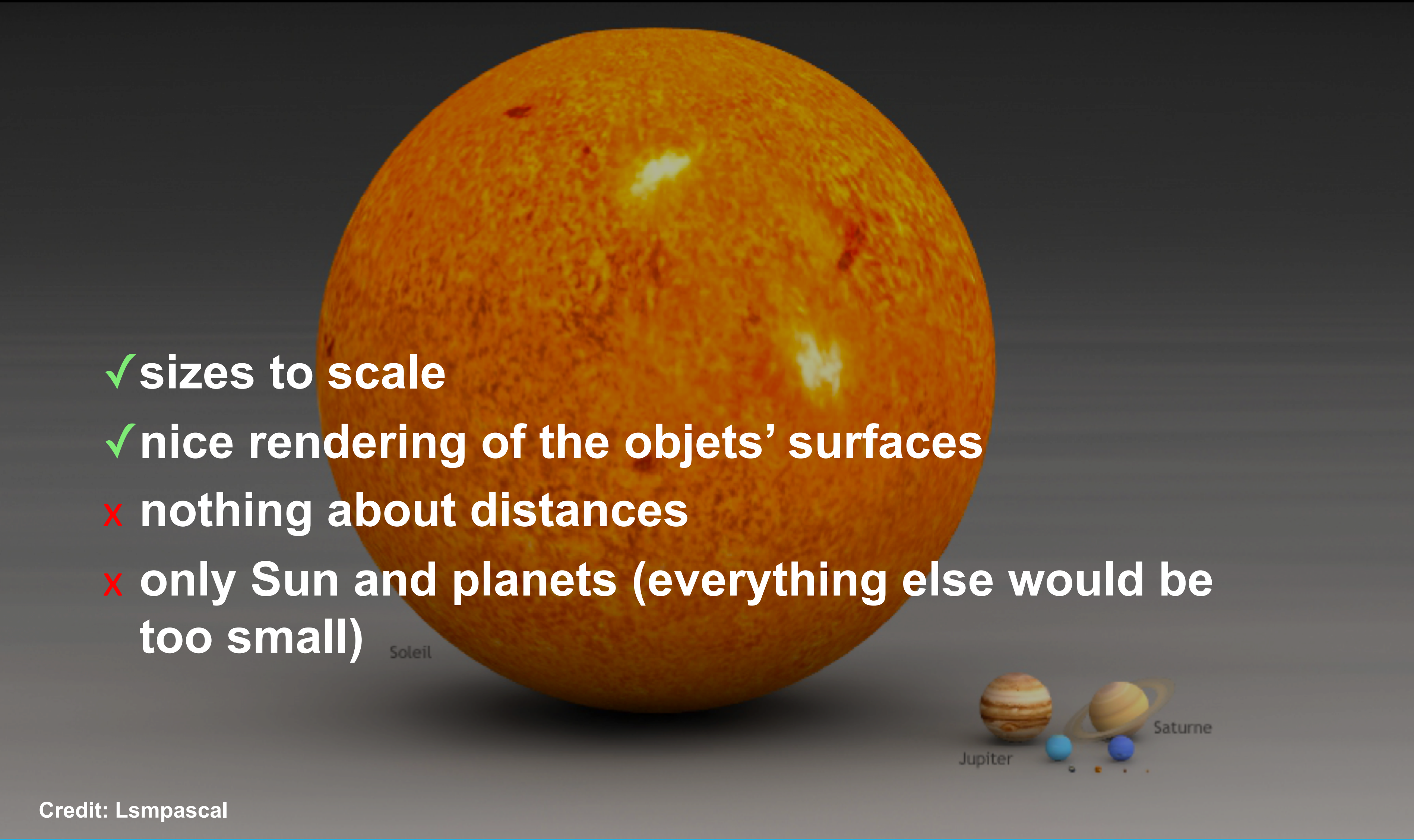
Credit: NASA

Representation of the Solar System



Credit: Lsmpascal

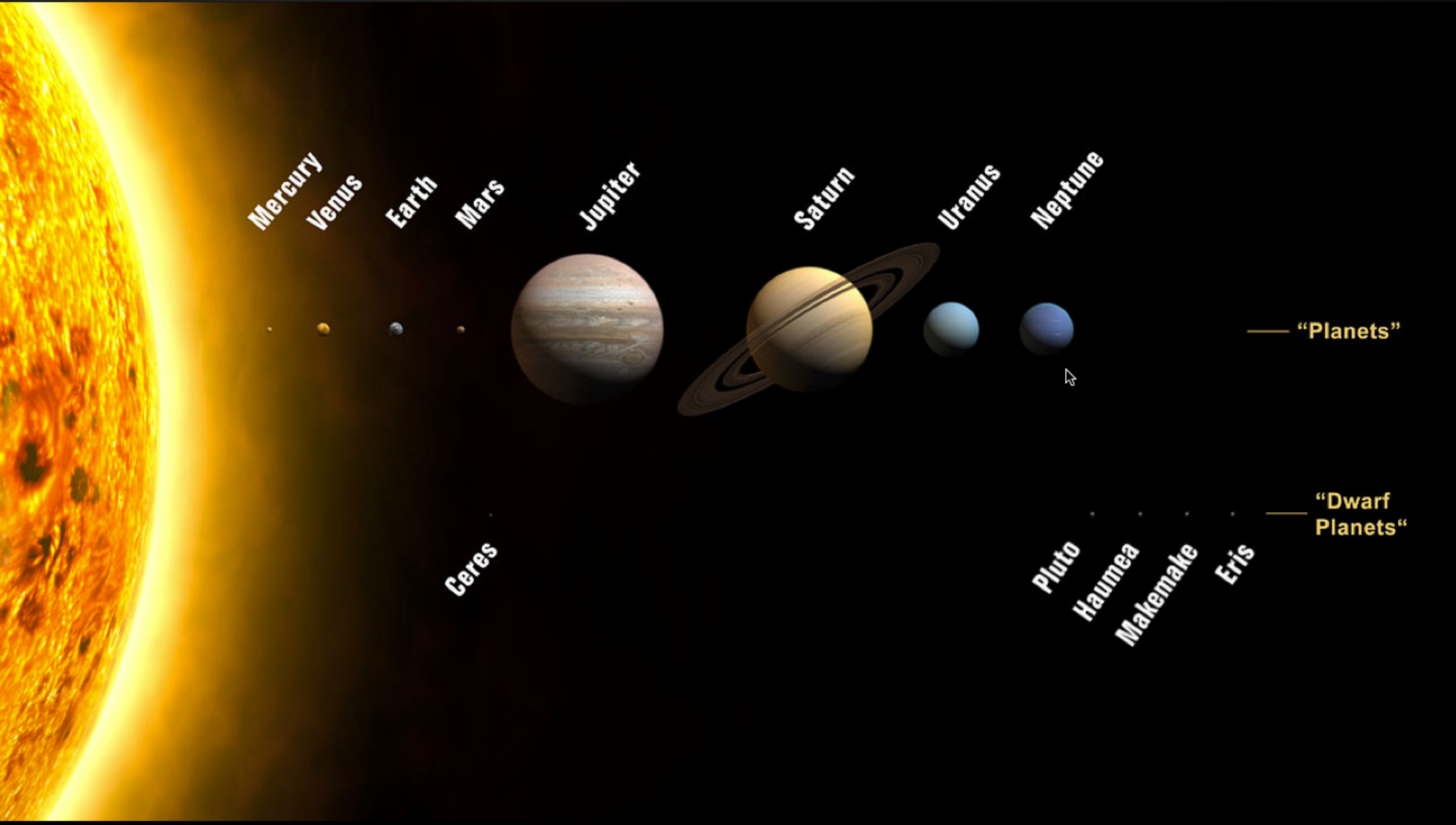
Representation of the Solar System



- ✓ sizes to scale
- ✓ nice rendering of the objets' surfaces
- x nothing about distances
- x only Sun and planets (everything else would be too small)

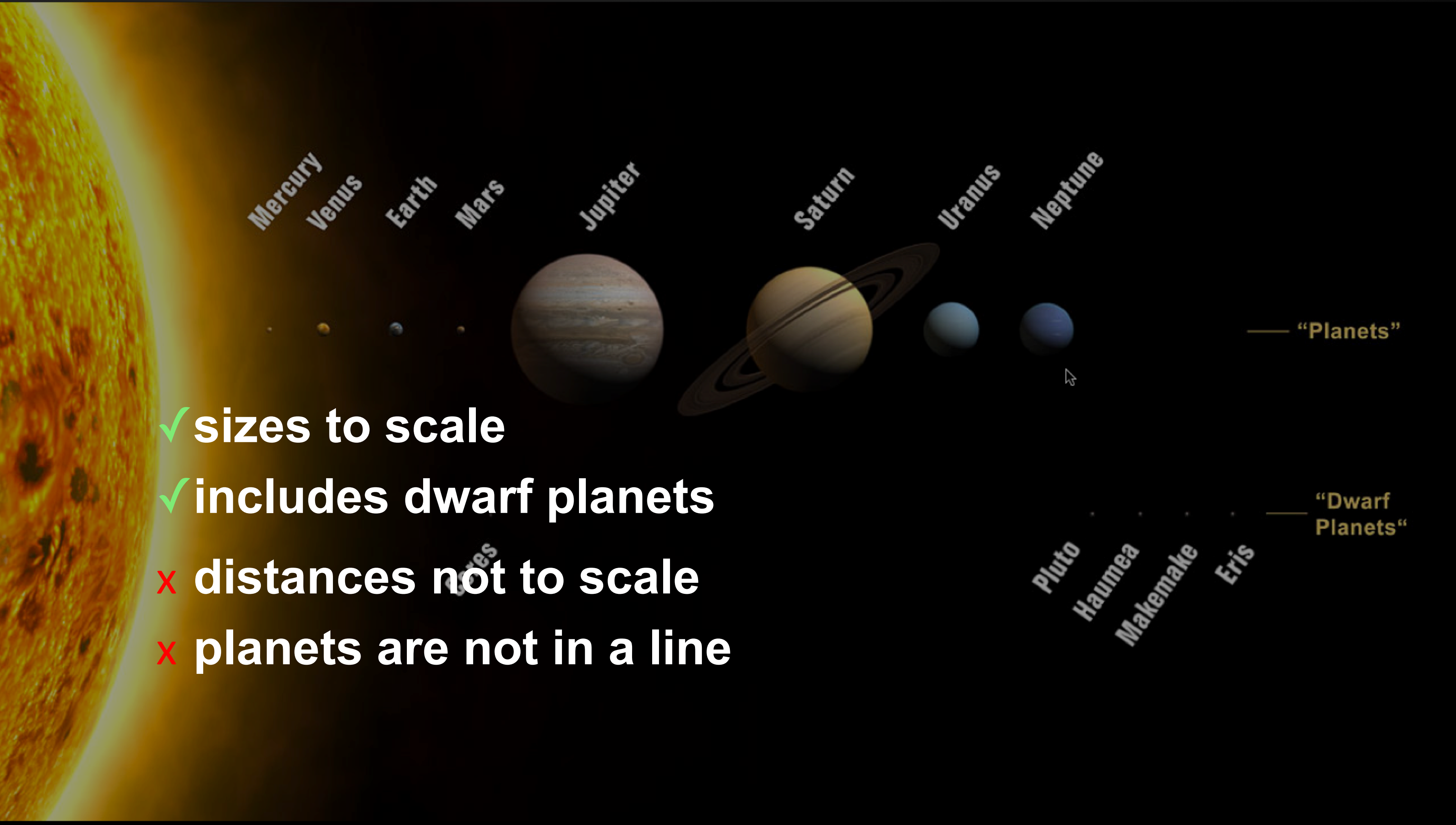
Credit: Lsmpascal

Representation of the Solar System



Credit: NASA

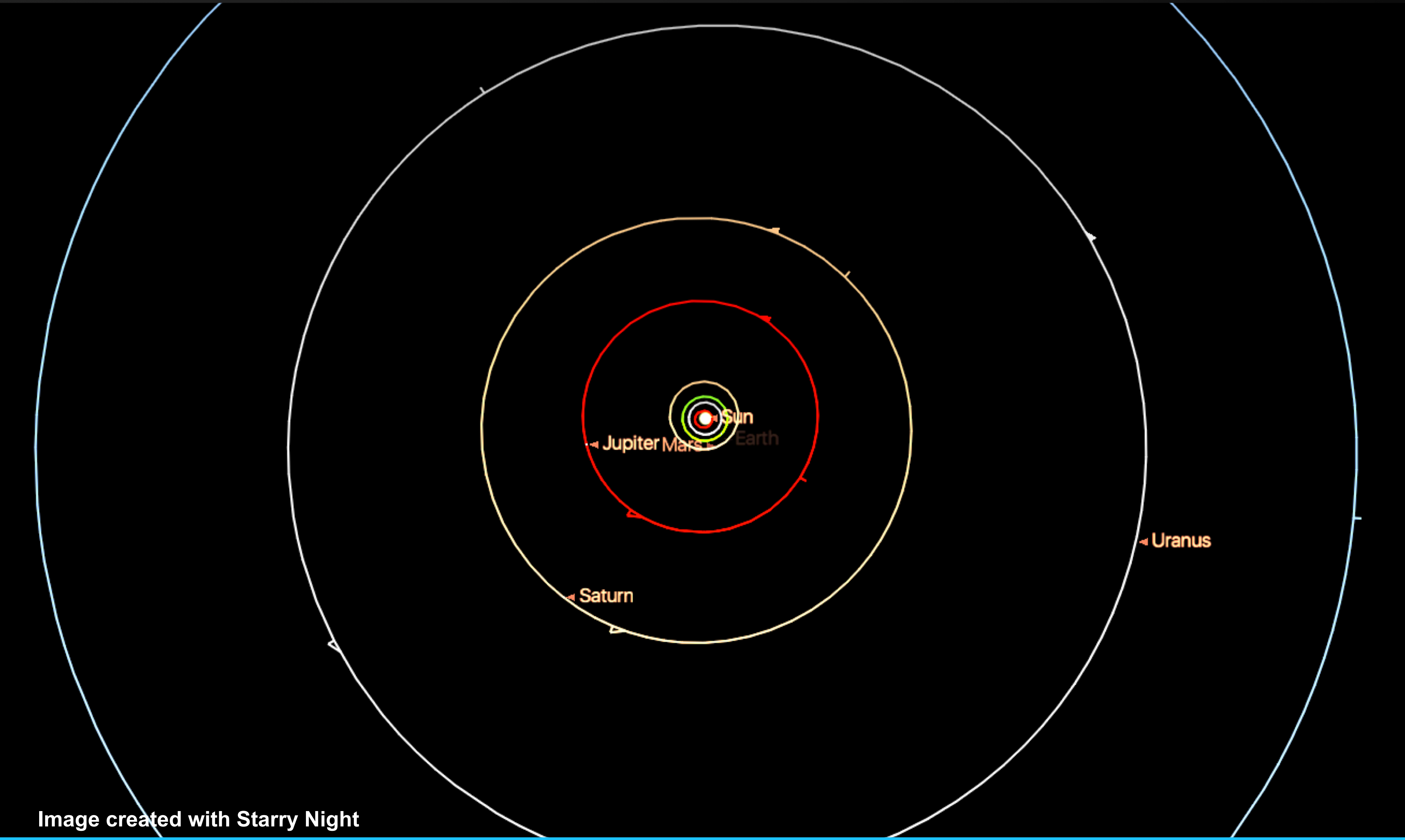
Representation of the Solar System



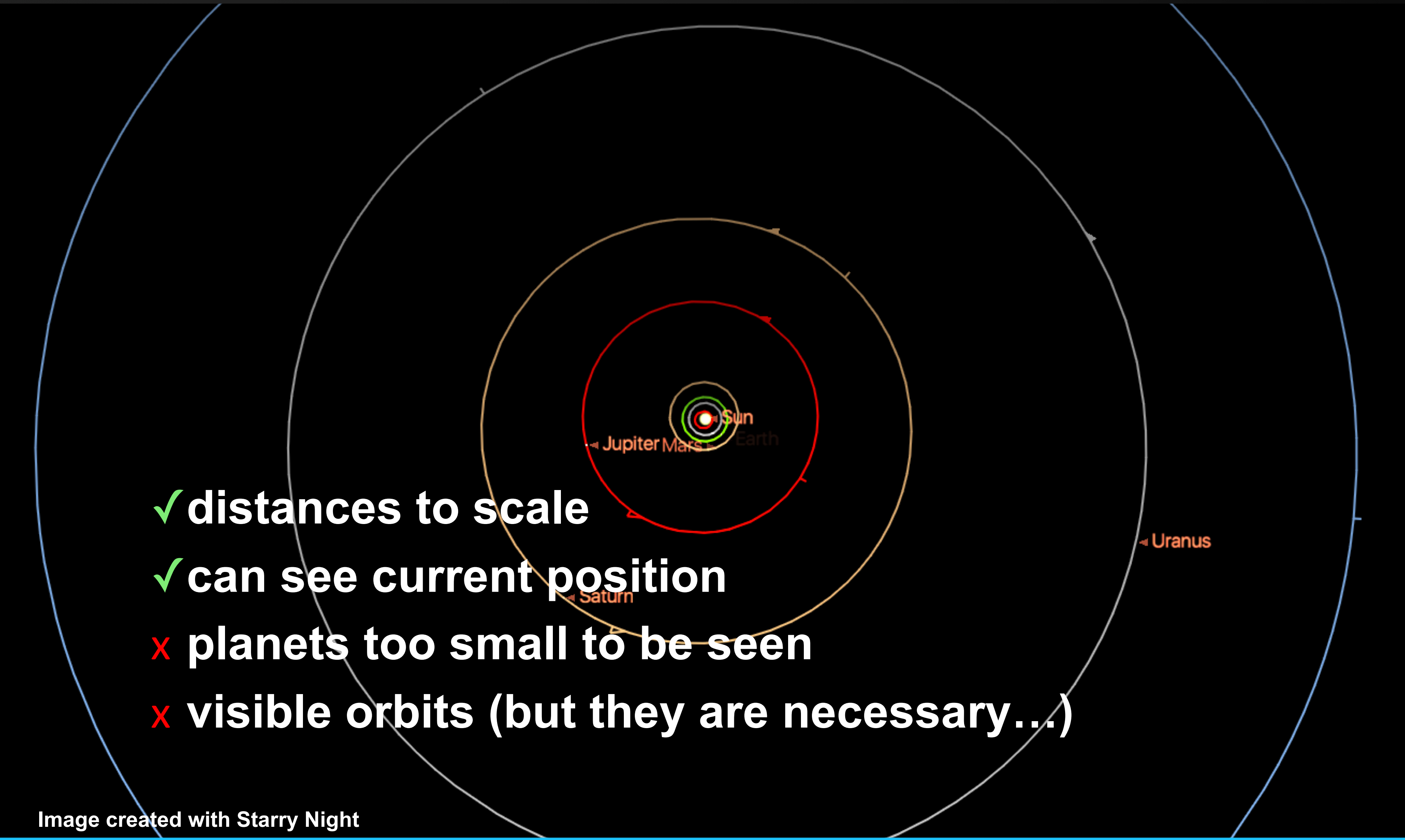
- ✓ sizes to scale
- ✓ includes dwarf planets
- x distances not to scale
- x planets are not in a line

Credit: NASA

Representation of the Solar System



Representation of the Solar System



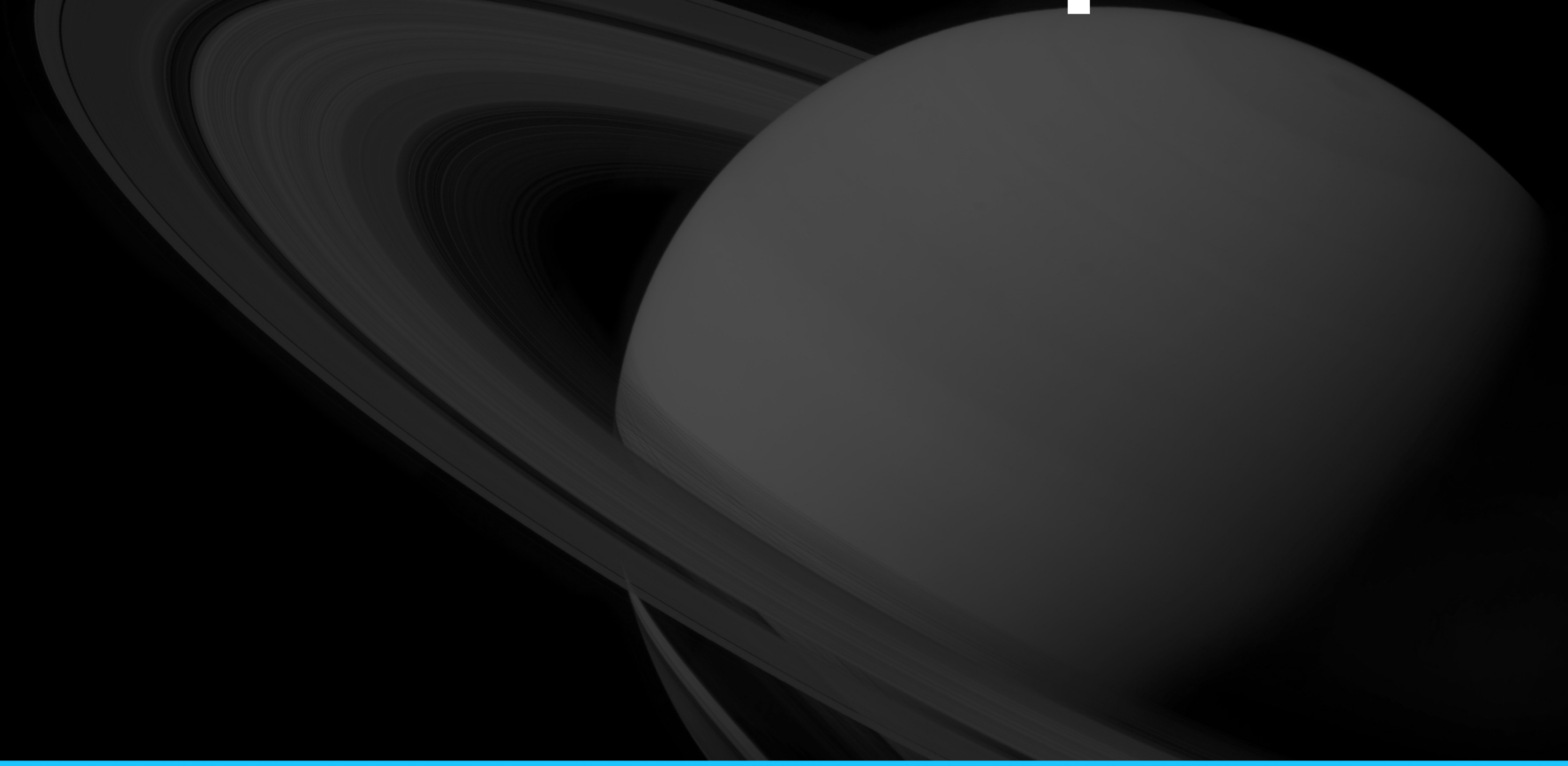
- ✓ distances to scale
- ✓ can see current position
- x planets too small to be seen
- x visible orbits (but they are necessary…)

Image created with Starry Night

What should we do?

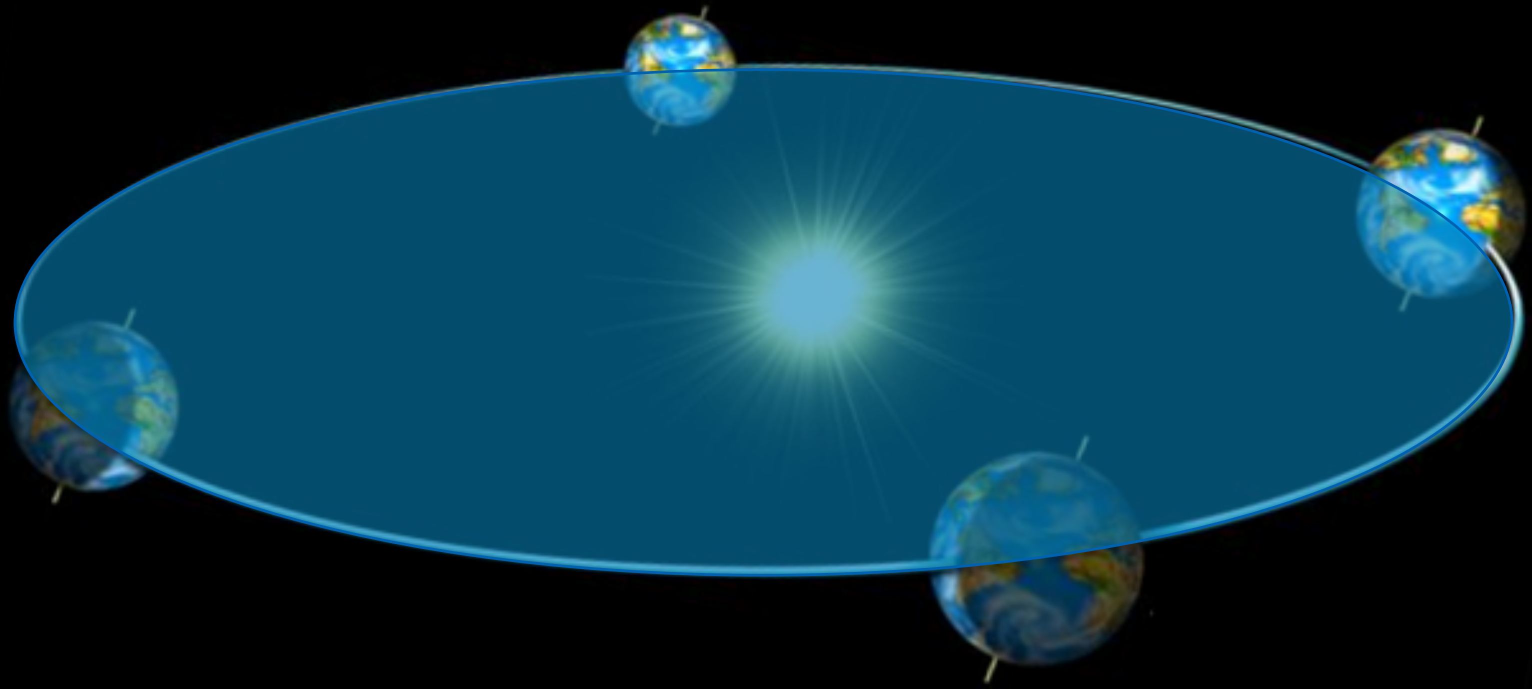
Create models!

A few basic concepts...



Ecliptic

The plane formed by the orbit of the Earth around the Sun is called the ecliptic.



Credit: FAAQ/Montreal Planetarium

Image not to scale

Ecliptic

The orbits of the other planets are also on the ecliptic, within a few degrees.

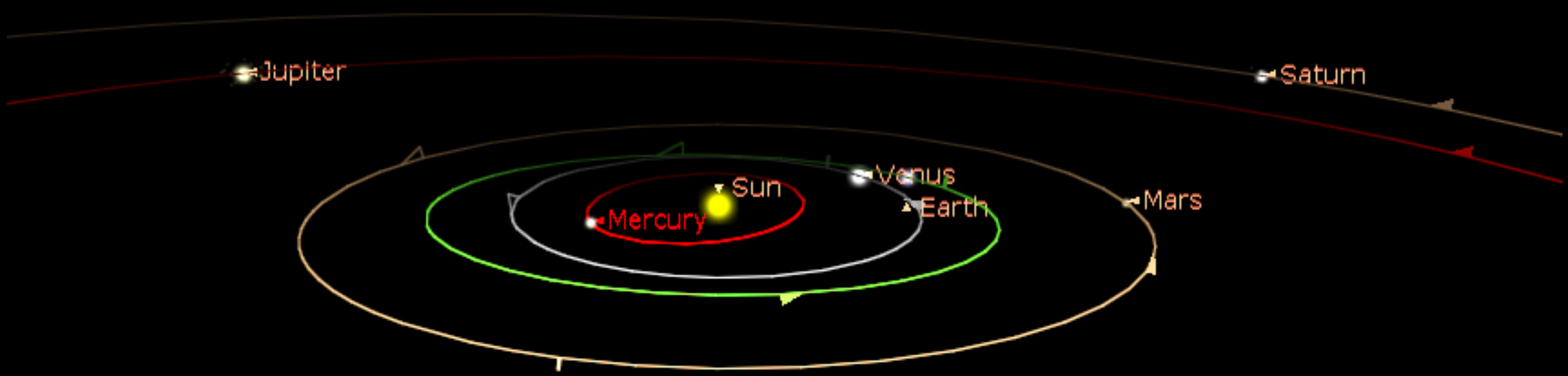


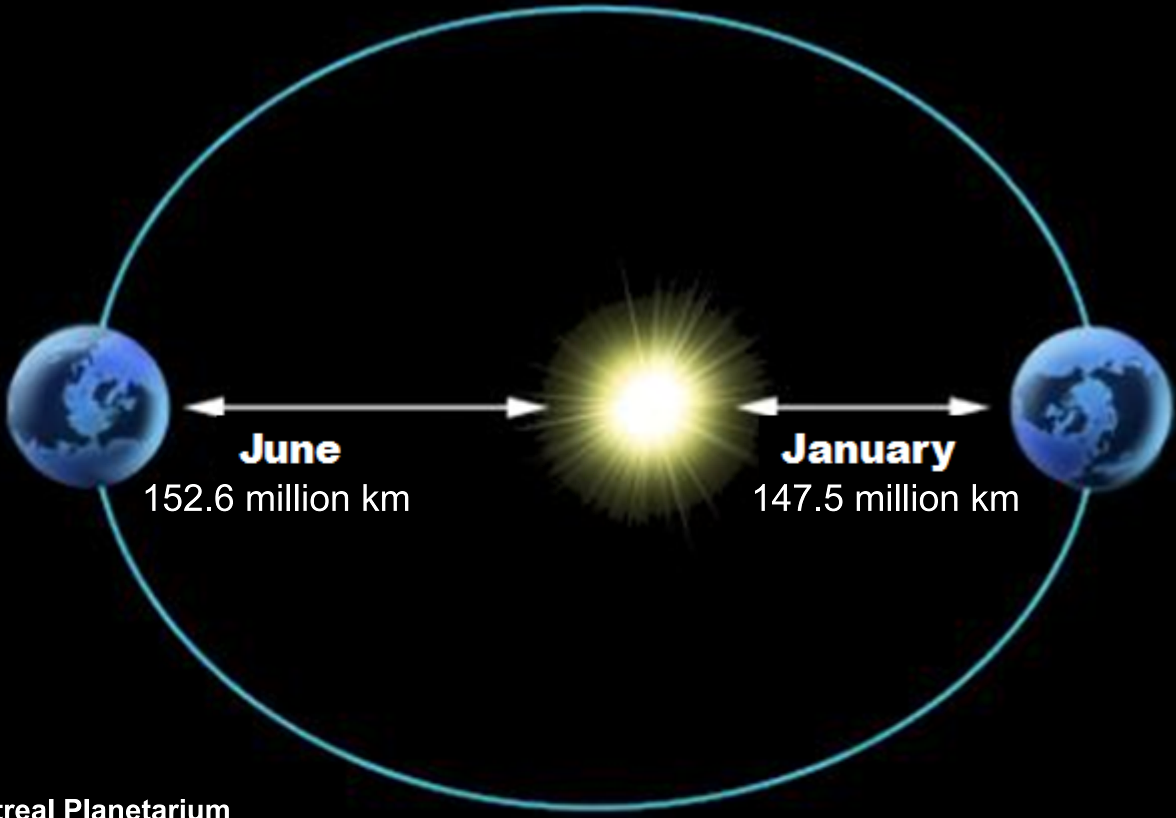
Image created with Starry Night

Astronomical Unit

1 astronomical unit (au) =

= average Earth-Sun distance

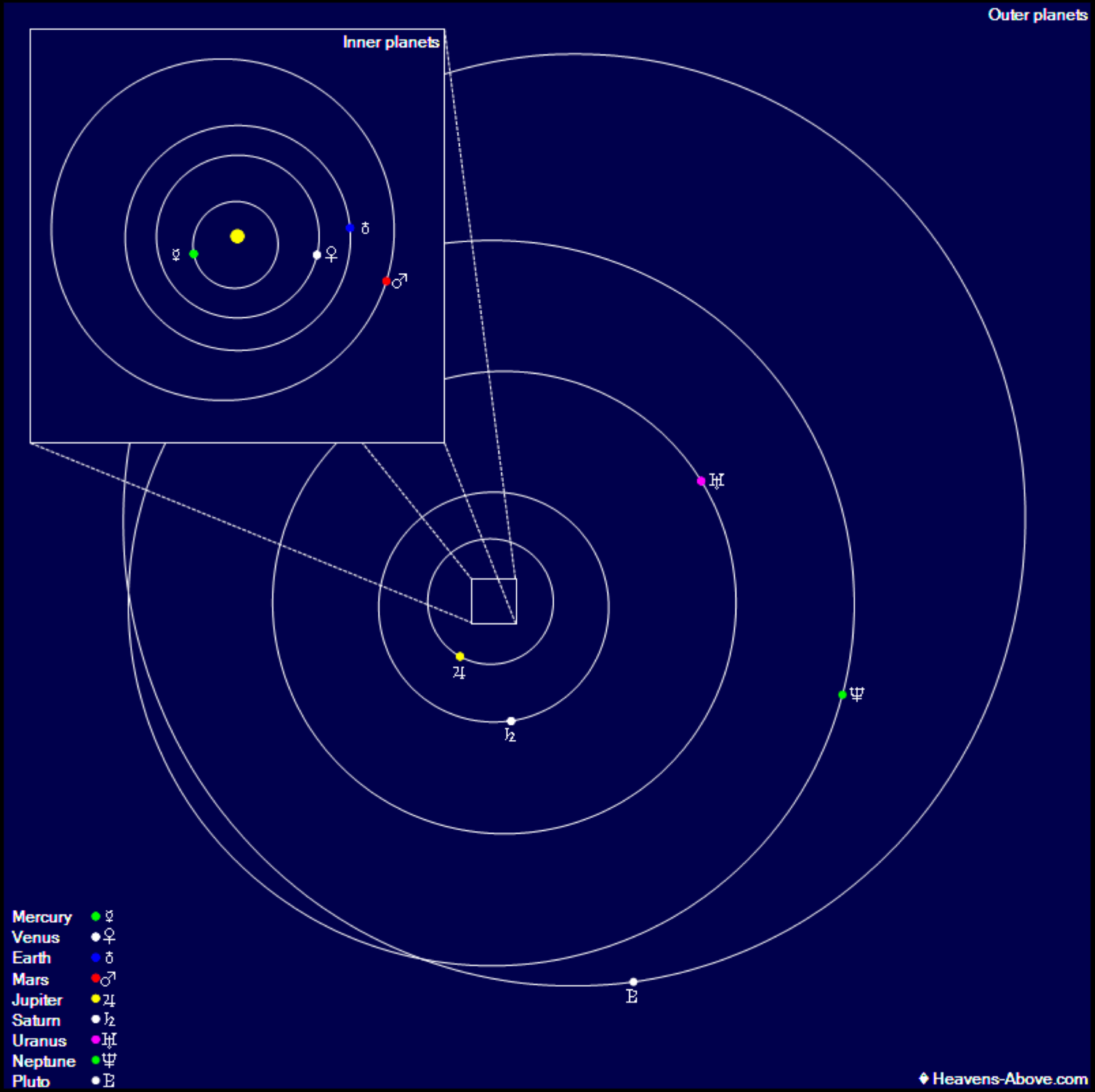
= 149.6 million km



Credit: FAAQ/Montreal Planetarium

Image not to scale

Orbits of the Planets



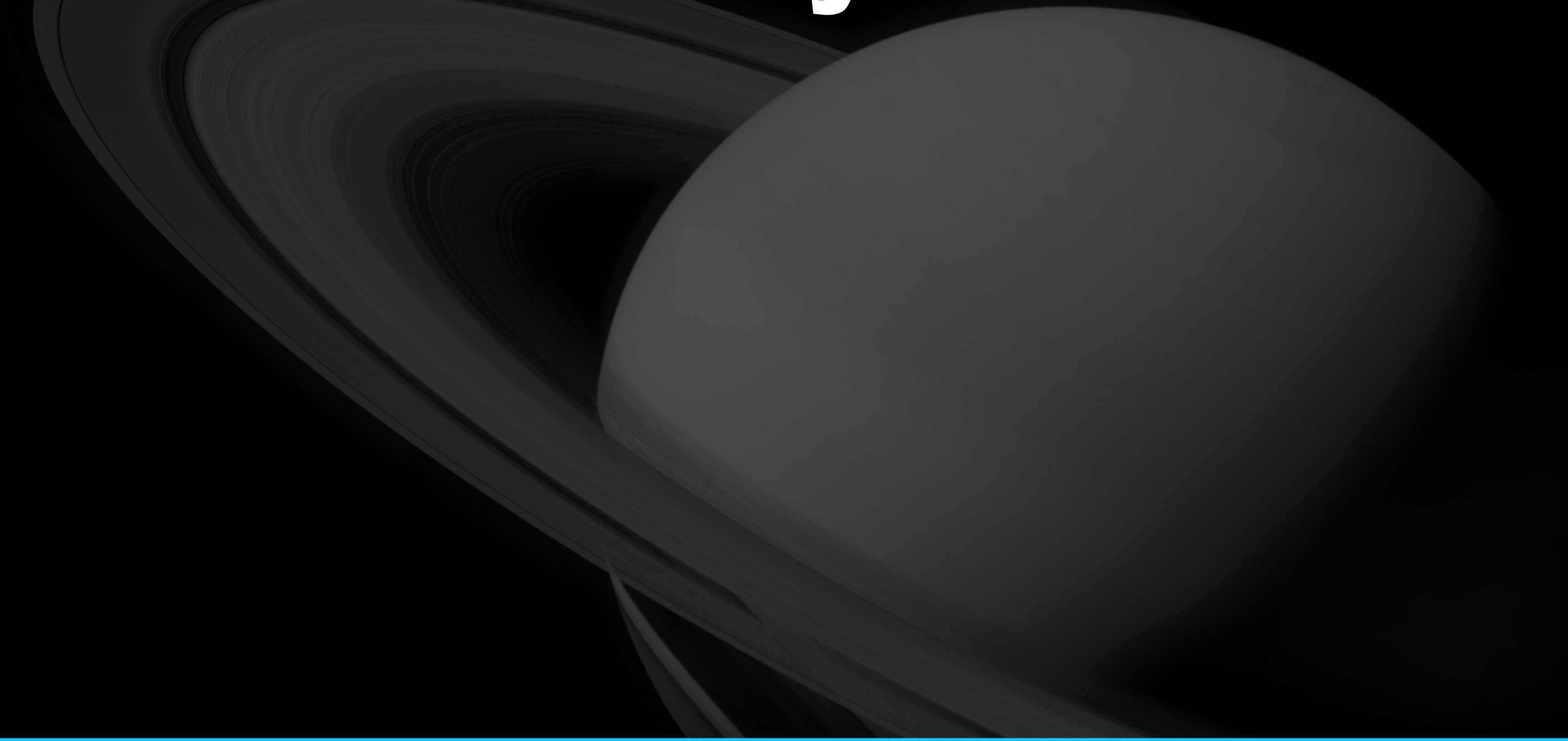
The orbits are not circles, but almost. They are ellipses with the Sun at one focus.

Size of the Solar System

Object	Diameter (km)	Distance from Sun (km)	Distance from Sun (au)
Sun	1 392 530	---	---
Mercury	4879	57 900 000	0.4
Venus	12 104	108 200 000	0.7
Earth	12 756	149 600 000	1.0
Mars	6792	227 900 000	1.5
Ceres (asteroid belt)	952	414 000 000	2.8
Jupiter	142 984	778 600 000	5.2
Saturn	120 536	1 433 500 000	9.6
Uranus	51 118	2 872 500 000	19.2
Neptune	49 528	4 495 100 000	30.1
Pluto (Kuiper belt)	2390	5 906 400 000	39.5

Activity ideas

Pocket Solar System



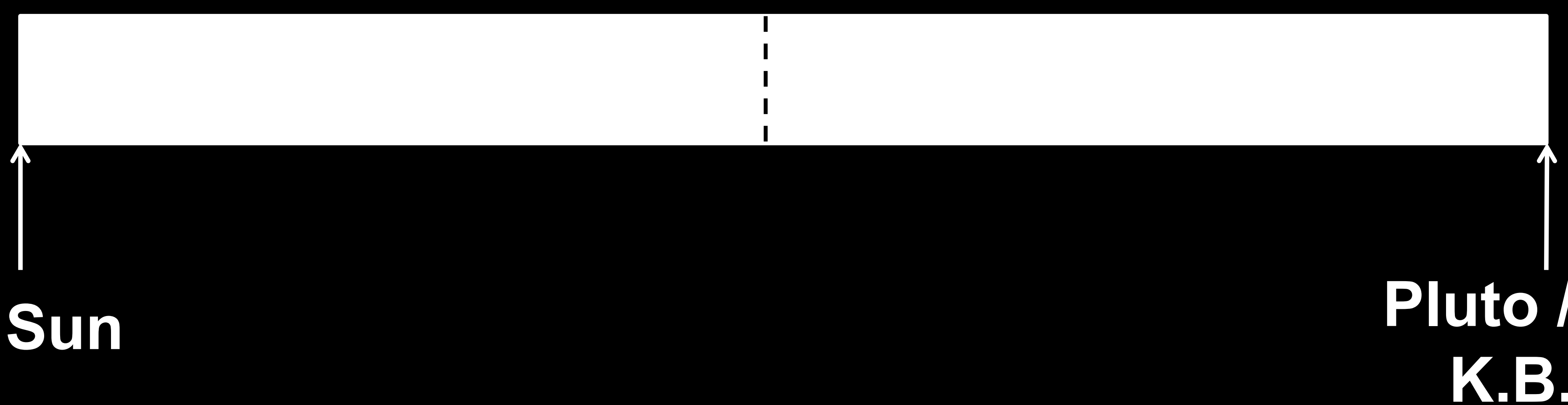
Pocket Solar System

Simple and surprising activity to learn about the distances in the solar system.

Adapted from « Pocket Solar System » from the *Astronomical Society of the Pacific*/Night Sky Network:
http://nightsky.jpl.nasa.gov/download-view.cfm?Doc_ID=392

Cut out a piece of paper tape – about 1m long.

Write “Sun” at one end and “Pluto – Kuiper Belt” at the other end.



Sun

Mercury

Venus

Earth

Mars

Ceres (asteroid belt)

Jupiter

Saturn

Uranus

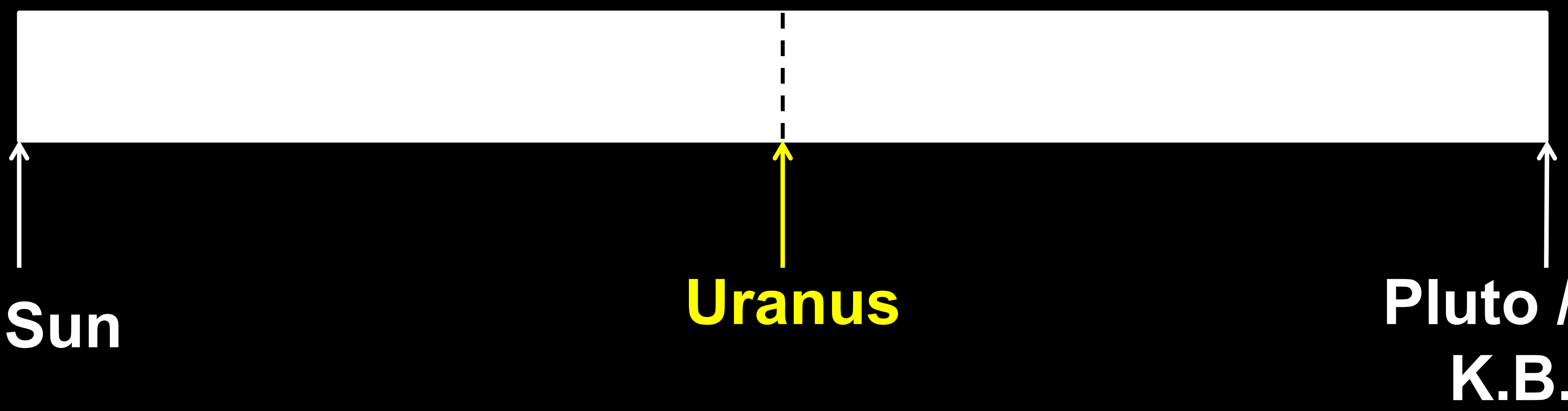
Neptune

Pluto (Kuiper belt)

We now need to place all these objects between the Sun and Pluto.

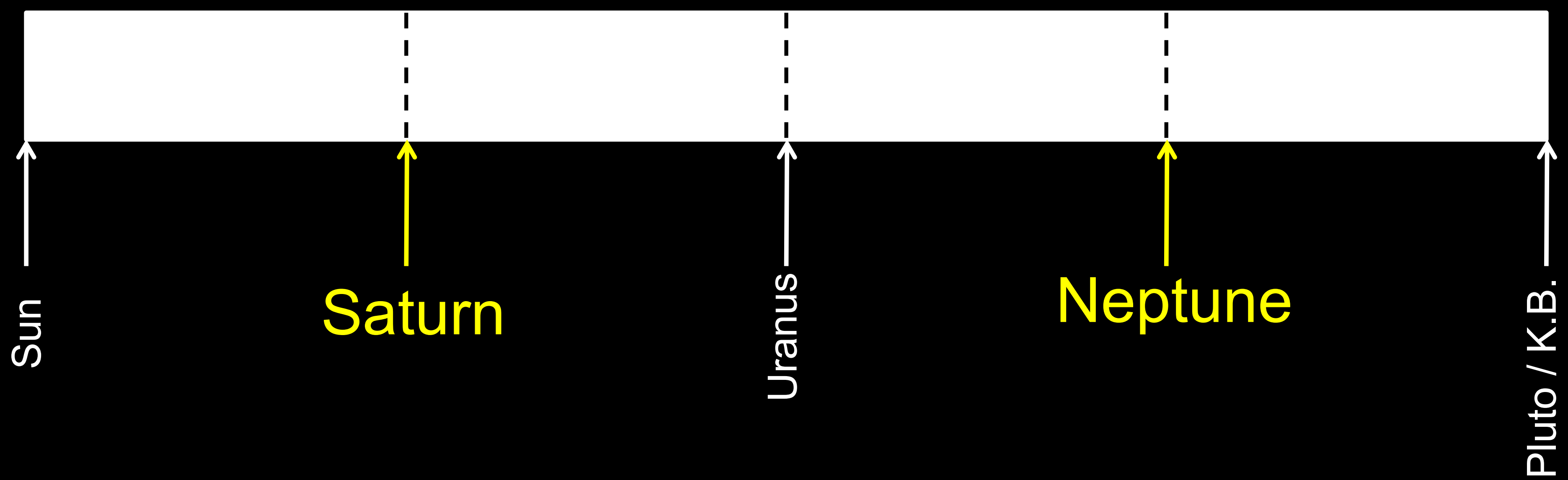
You can ask your students to predict where they go, either on the other side of the paper or with another colour. We’ll then make the real model.

Which object would be in the middle of the tape?

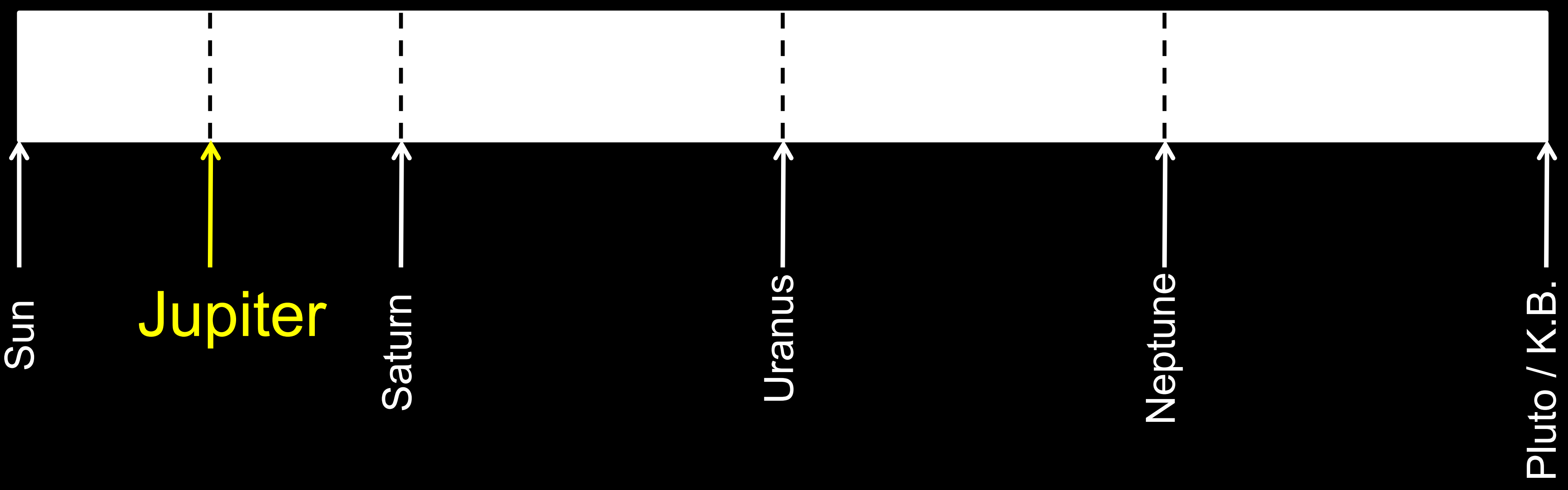


Which object is halfway between Uranus and Pluto?

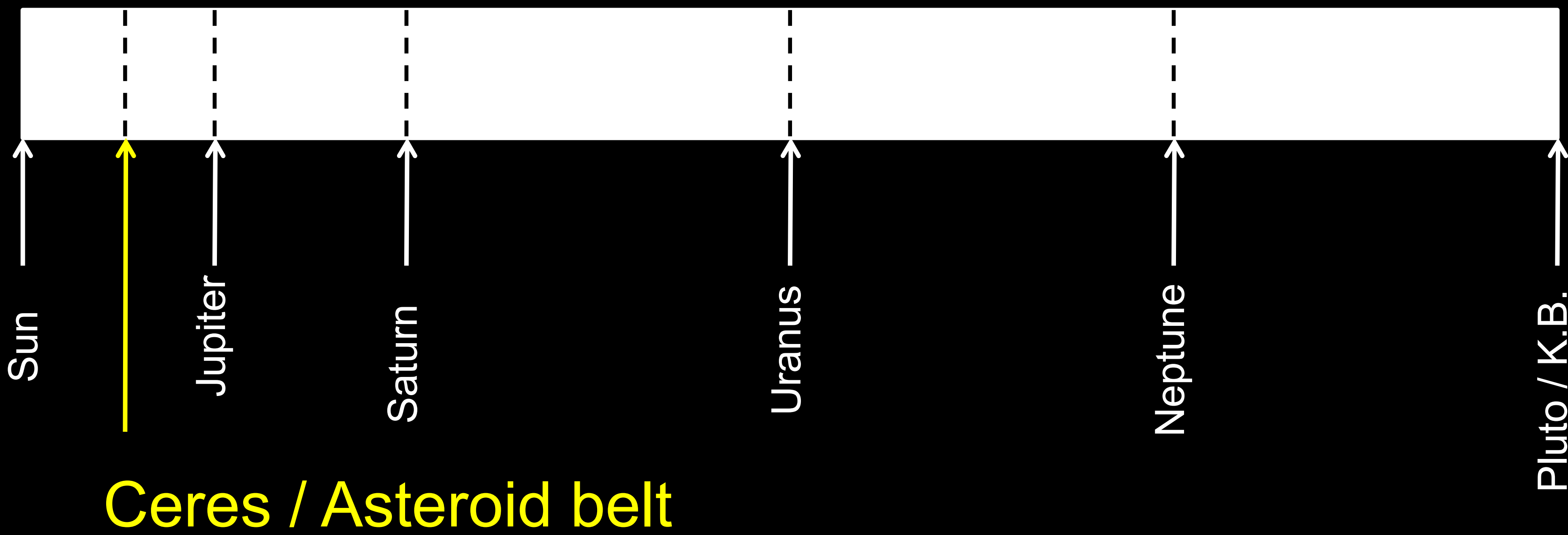
Which object is halfway between the Sun and Uranus?



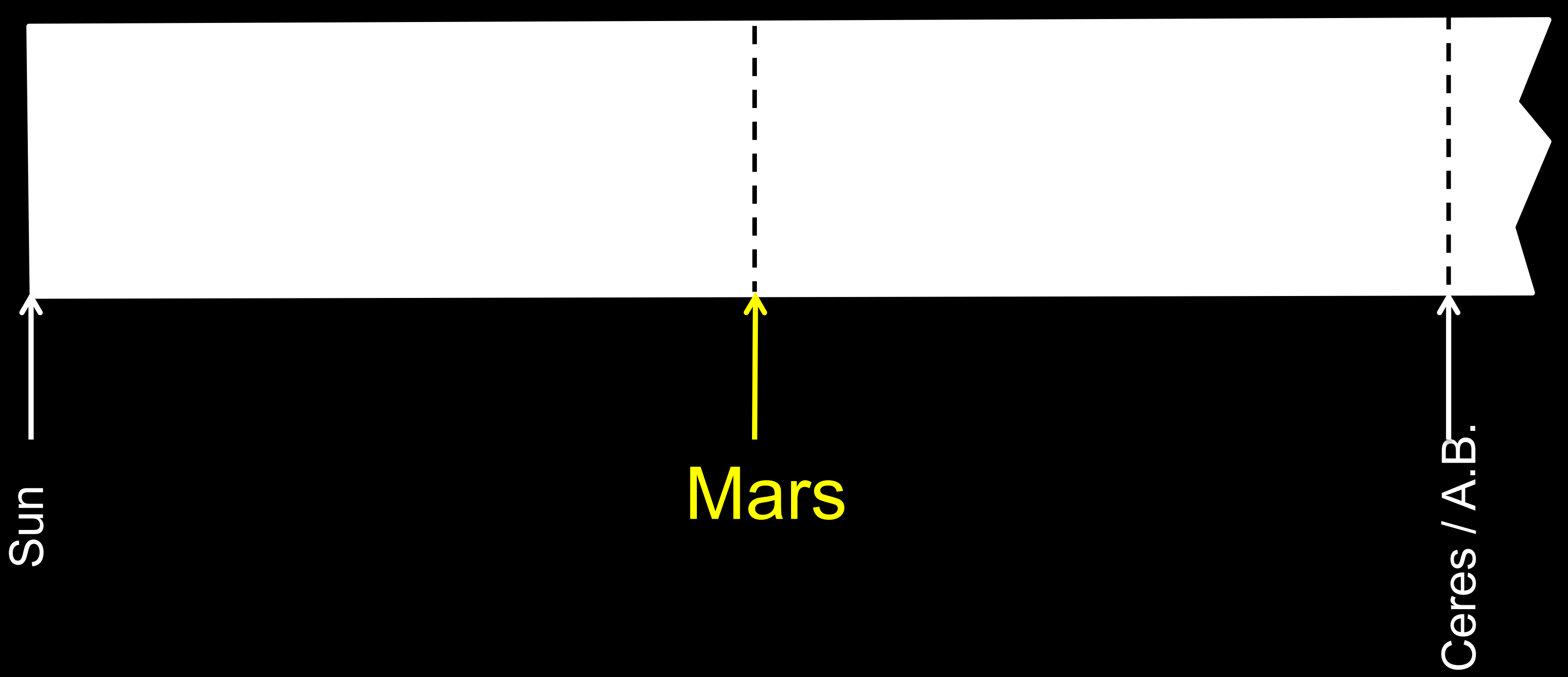
Which object is halfway between the Sun and Saturn?



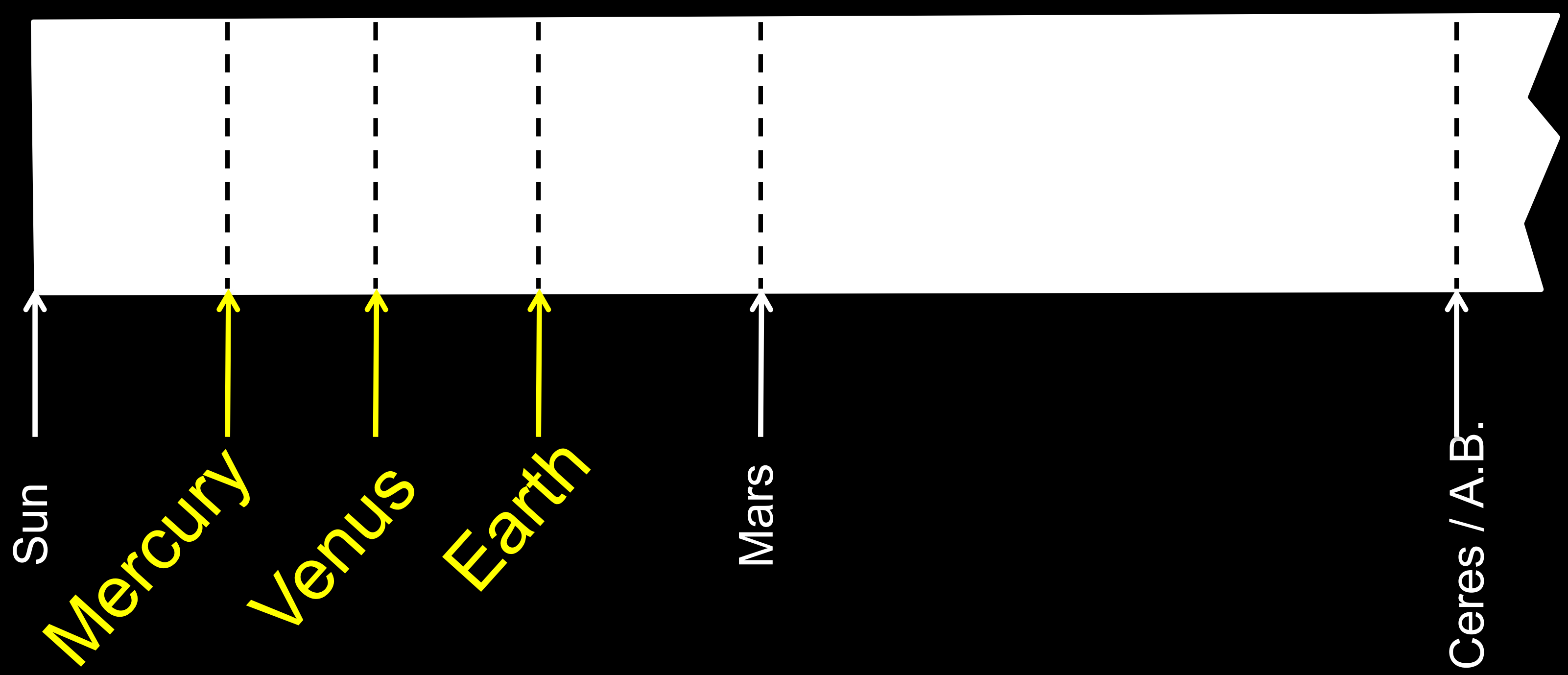
Which object is halfway between the Sun and Jupiter?



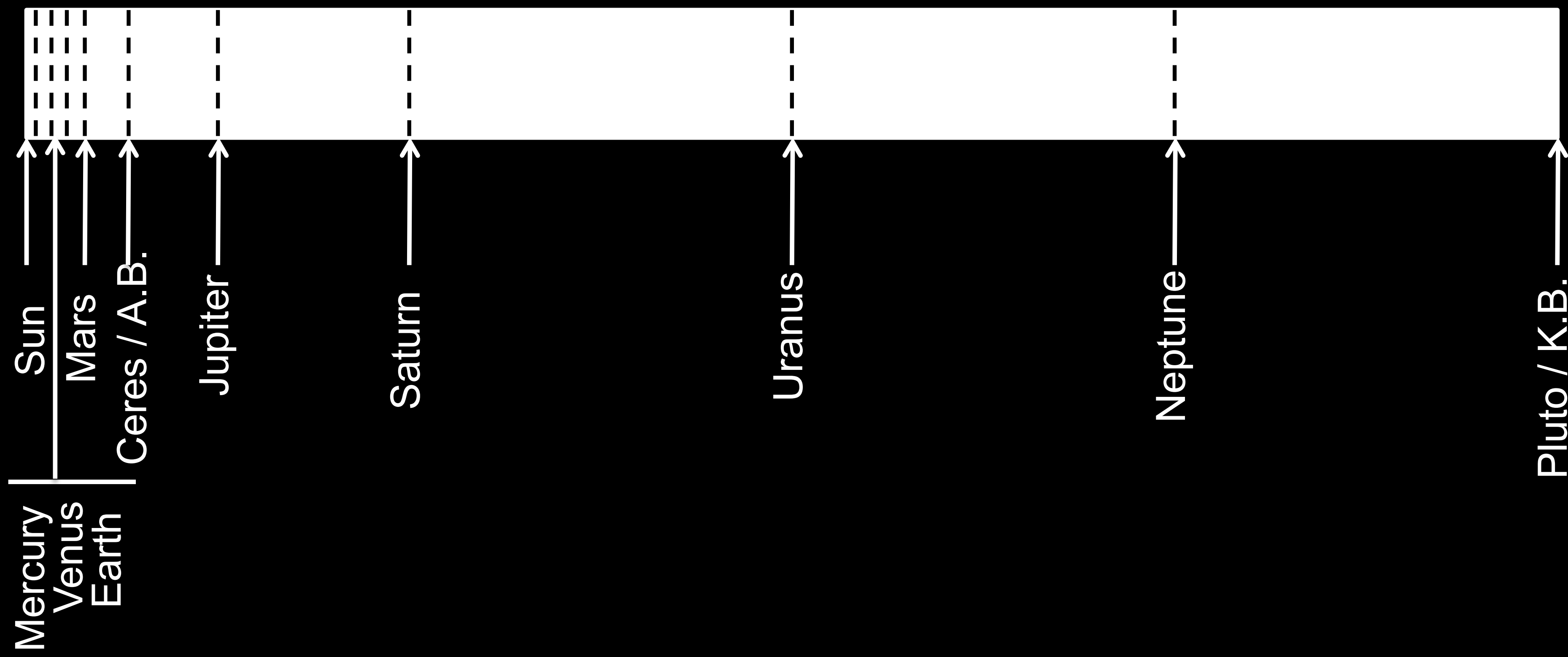
Which object is halfway between the Sun and Ceres?



Finally, we draw three lines between the Sun and Mars for Mercury, Venus and the Earth.



Now look at the entire solar system. Any surprise?!?



	Real distance (au)	Approximate distance (au)
Mercury	0,39	0,4
Venus	0,72	0,7
Earth	1	1
Mars	1,52	1,5
Ceres	2,77	2,8
Jupiter	5,20	5
Saturn	9,54	10
Uranus	19,19	20
Neptune	30,06	30
Pluto	39,44	40

Pocket Solar System

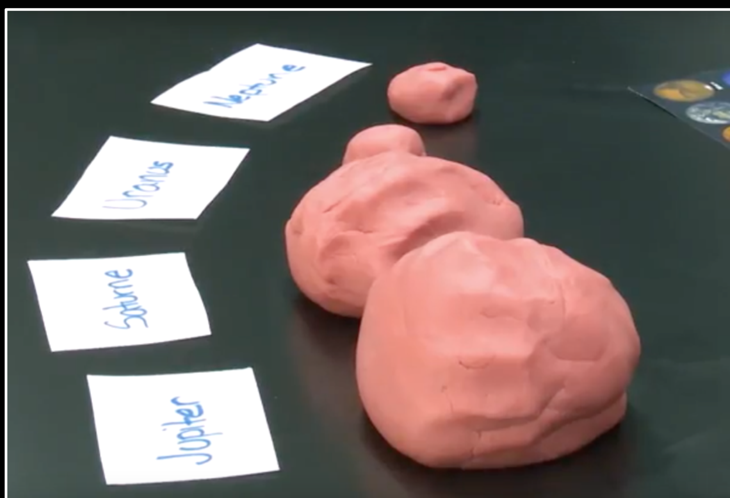
- ✓ very simple, short and efficient
- ✓ shows distances to scale

- x shows objects in a straight line
- x no information about sizes of the objects
- x may be too abstract for some people (tip: draw planets instead of writing names…)

Planets in Playdough

Planets in Playdough

Models the volumes of the planets to scale.



Worlds in Comparison

By Dennis Schatz (*Pacific Science Center*)

390 Ashton Avenue, San Francisco, CA 94112 ~~~ www.astrosociety.org/afgu

What's This About?

This activity demonstrates the different sizes of the nine planets in our solar system. Follow the steps outlined below to see the relative size (volume) of each planet. Start with a big 3-pound ball of playdough, which represents the volume of all the planets combined.

1. Divide the Entire Ball of Playdough into 10 Equal Parts

You may find it easiest to start by rolling the ball into one big hot dog shape.

- Combine 6 parts together, roll them into a ball, and put the ball into the Jupiter box.
- Similarly combine 3 parts and put them into the Saturn box.

2. Cut the Remaining Part Into 10 Equal Parts

- Take 5 parts and combine them with the ball in the Saturn box.
- Combine 2 parts to put into the Neptune box.
- Put 2 parts into the Uranus box.

3. Cut the Remaining Part Into 4 Equal Parts

- Take 3 parts and combine them with the ball in the Saturn box.

4. Cut the Remaining Part Into 10 Equal Parts

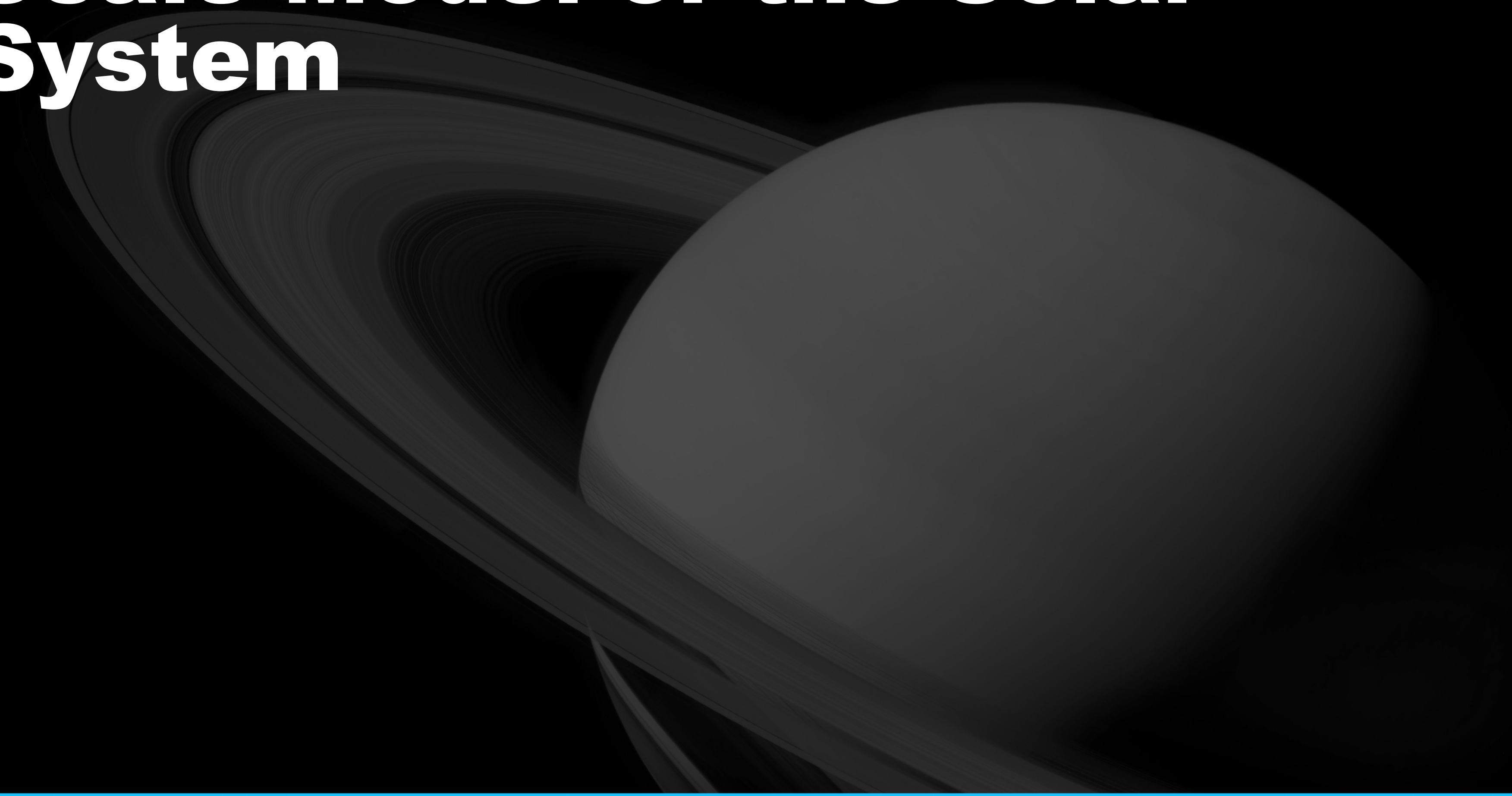
Info:
http://astronomy.sdsu.edu/projectastro/resources/WorldsInComparison.pdf

Planets in Playdough

- ✓ excellent activity to model sizes (volume, not just diameter)
- ✓ very surprising!

- x needs a lot of playdough
- x impossible to do perfectly (but that's part of the challenge!)
- x nothing about distances
- x planets only – the other objects would be too small

Scale Model of the Solar System



Scale Model of the Solar System

Recreates the main objects in the solar system using the right scale for both size AND distance.

You can find everyday items to represent the planets and put them at the right distance from your Sun (get ready for a long walk!)

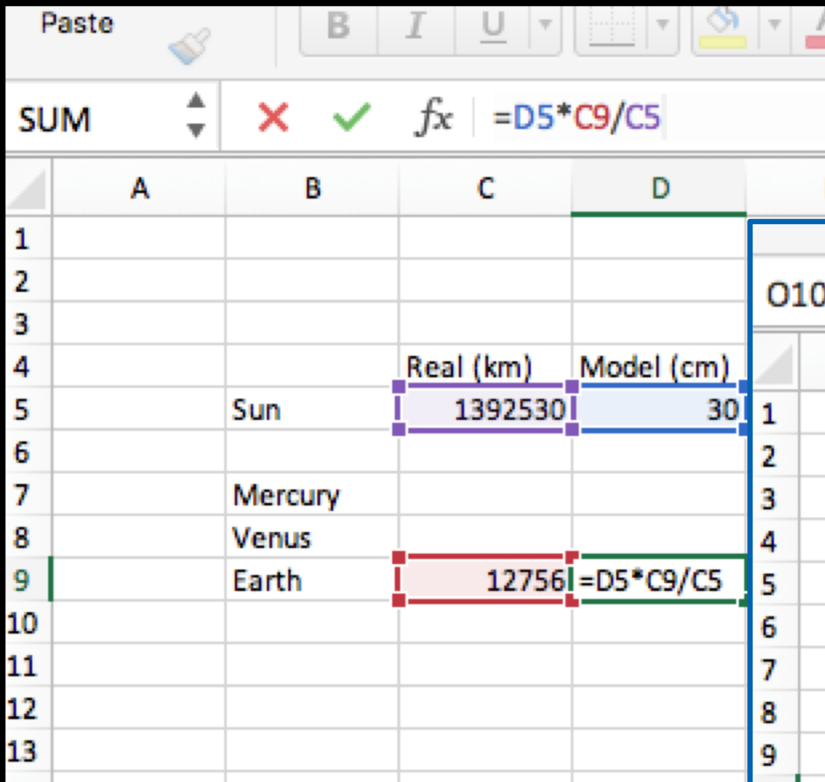
Calculate your Model

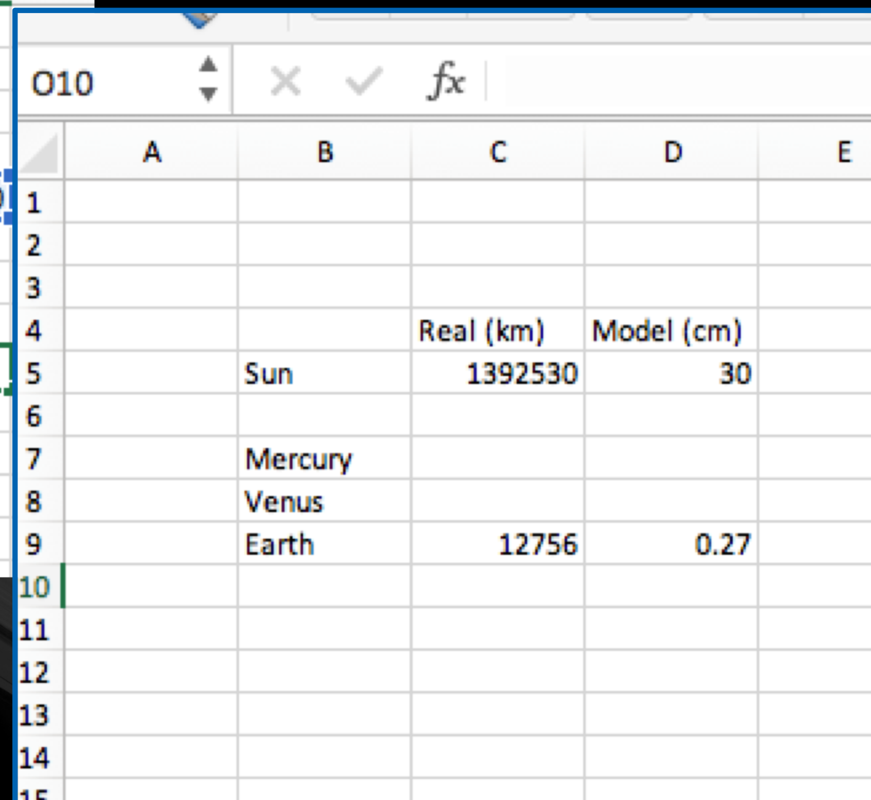
If you want the Sun to be 30 cm in diameter, how big should Earth be?

$$\frac{30\ cm}{1392530\ km} = \frac{x}{12756\ km}$$

$$x = \frac{30\ cm\ \times 12756\ km}{1392530\ km} = 0.27\ \mathrm{cm} = 2.7\ \mathrm{mm}$$

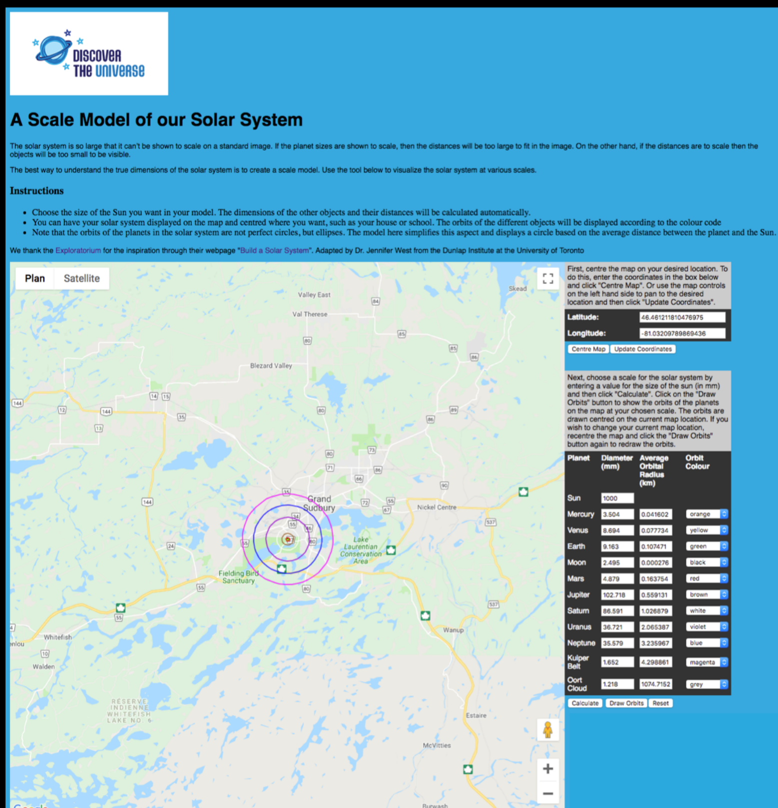
Calculate your Model in Excel





Scale Model of the Solar System

http://www.discovertheuniverse.ca/solarsystem.html

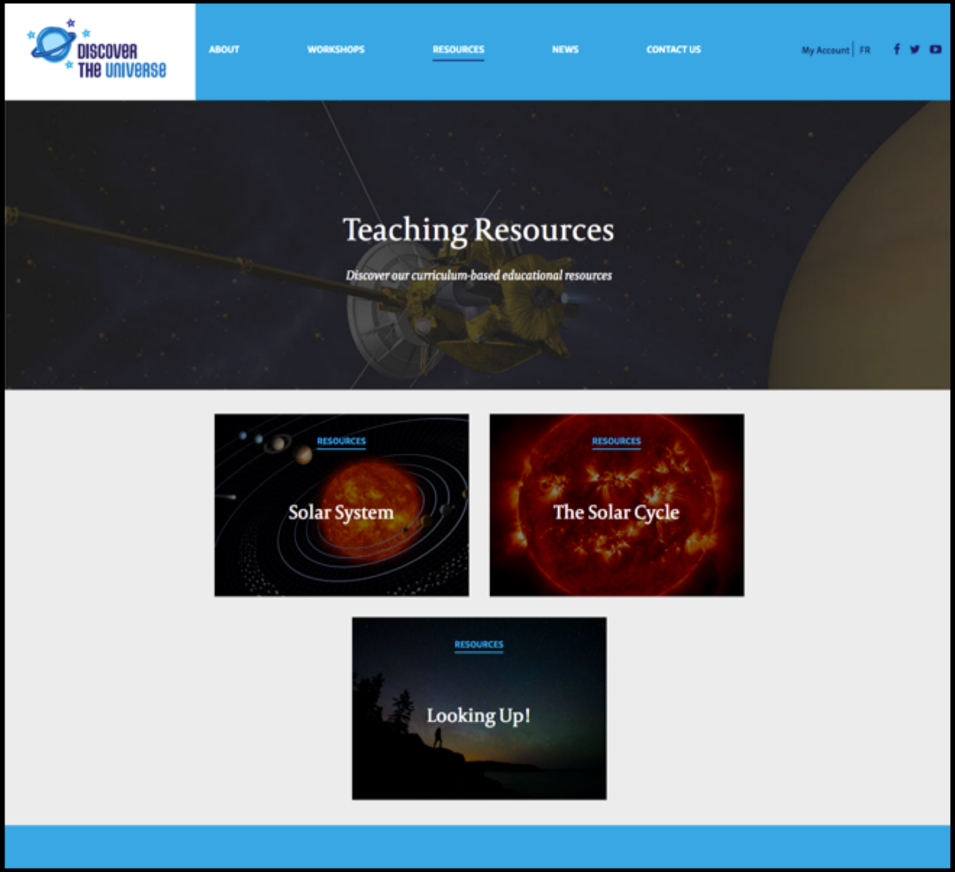


Enter the size of the Sun you want for your model. Everything else is calculated automatically.

Show the scale solar system on the map, centred where you want.

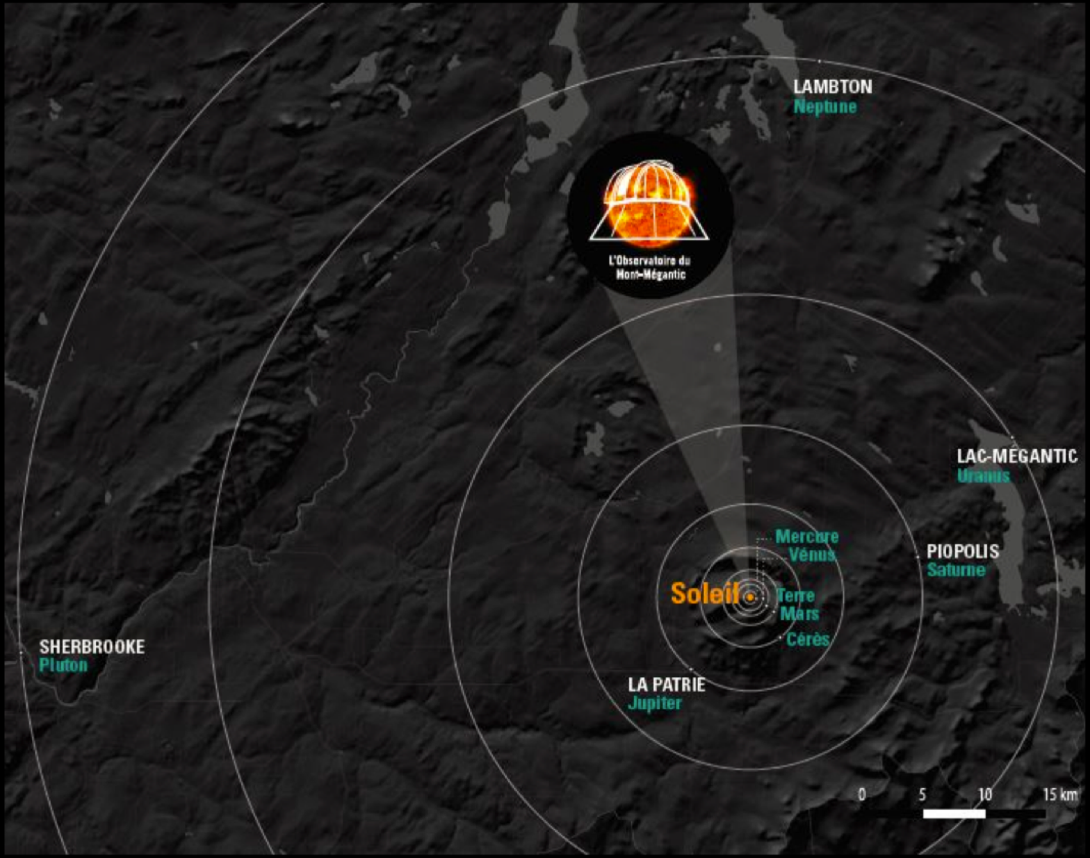
Scale Model of the Solar System

Also available in our Resources section.



Scale Model of the Solar System - Example

Giant scale model based on the Observatory of Mont Megantic, near Sherbooke, QC.



Scale Model of the Solar System - Example

Uranus, in Lac-Mégantic

Info : http://www.astrolab-parc-national-mont-megantic.org/en/giant.solar.system.htm

Scale Model of the Solar System - Example

Excellent video– Solar system to scale in the Nevada desert: https://youtu.be/zR3Igc3Rhfg

Scale Model of the Solar System

- ✓ models distances AND sizes
- ✓ gives an excellent idea of the true scale of the solar system

- x needs many items and long distance
- x might be difficult to have a general overview
- x might give the impression that planest are all in a line
- x very difficult to model the smaller objects


Sphero Solar System by X-Chem Outreach Program

Sphero Solar System

Activity developed by X-Chem Outreach and Actua

★ includes robotics, coding, and math to calculate orbital periods and speeds to scale

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SCIENCE LITERACY WEEK

CSA ASC

Sphero Solar System

What you'll need:

- ★4-5 Sphero SPRK+ or Sphero Mini
- ★4-5 tablets to control each Sphero
- ★large surface (up to Mars: radius of 1.6 m; up to Jupiter: radius of 5.3 m)

Sphero Solar System

We know:

- ★distances to each planet (1au becomes 1m in the model);
- ★orbital speeds in km/s of each planet.

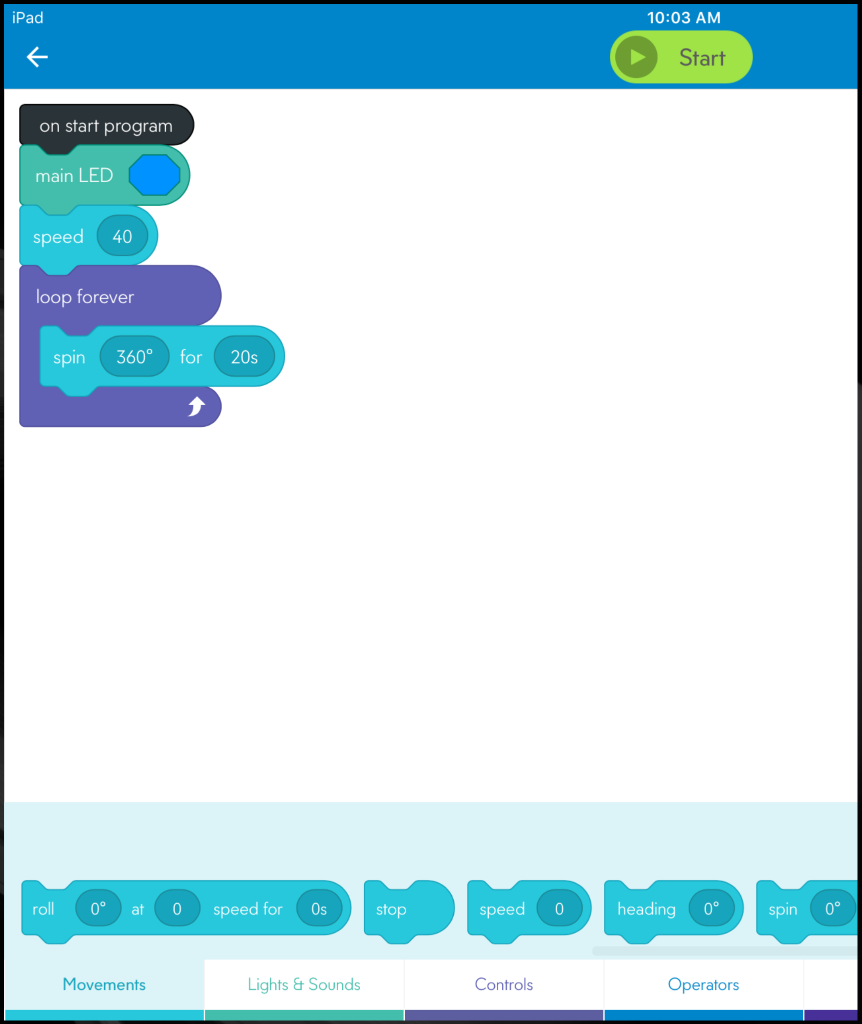
Need to calculate:

- ★speeds in Sphero unit (or use calculated values in activity description);
- ★orbital periods, using the speeds and circumferences (or use values in activity description).

Sphero Solar System

Coding in blocks using the app Sphero Edu:

And we get 4 or 5 planets orbiting the Sun at different speeds and with different colours!



Sphero Solar System

Detailed description:
https://actua.ca/en/activities/sphero-solar-system-by-x-chem-outreach-program

Sphero Solar System

- ✓ multidisciplinary activity: astronomy, robotics, coding and math
- ✓ models distances and motion to scale

- x needs equipment
- x sizes of planets not to scale
- x system becomes unstable after a few orbits

Modelling the Solar System

No model is perfect but they are better than still images.

Don't hesitate to discuss limitations of the models with your students.

Questions?

Thank you!