

Celestia Navigation

Key Stage 3

Topics covered: ICT, Solar System, exoplanets, orbits, Milky Way

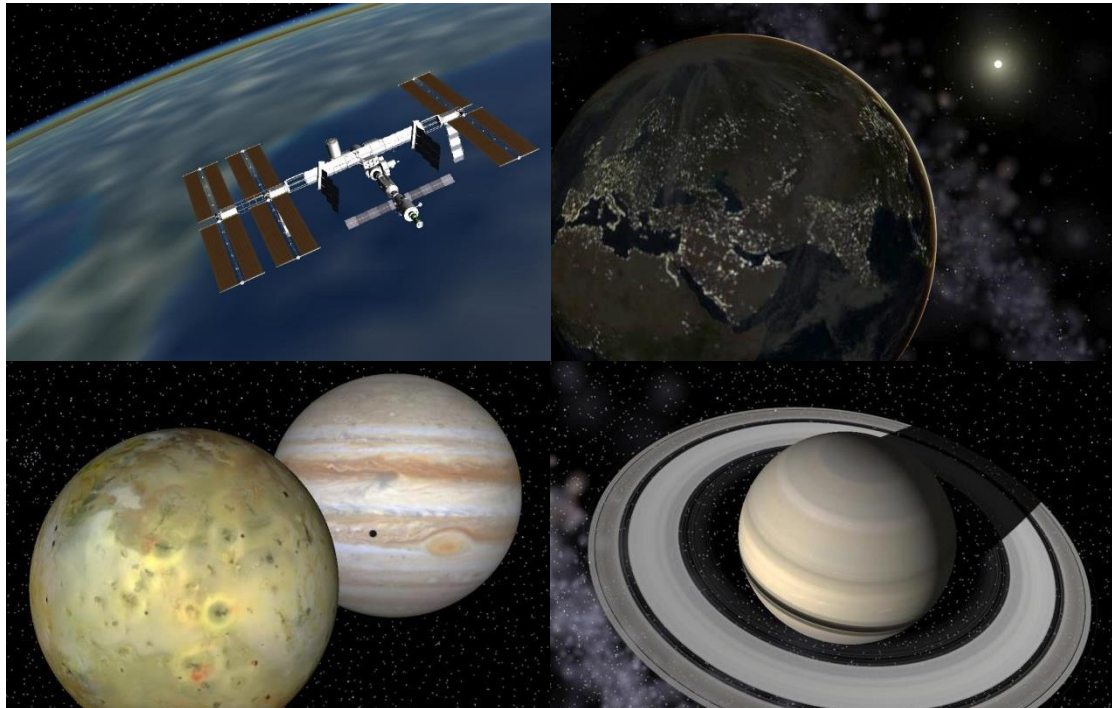
Teacher's Notes

Celestia is a spaceflight simulator that allows you to explore real astronomical data as you fly through space. The majority of content is related to our Solar System. This resource acts as a basic guide and explores the potential of the program with a sample KS3 activity included.

The program can be downloaded for free from:

<http://www.shatters.net/celestia/download.html>

Versions are available for Windows, Mac and Linux computers. The program comes preloaded with the planets, their moons, some galaxies, and star clusters.



Basic Tutorial:

Navigating the Solar System is a good place to start. Celestia always begins by flying to the Sun and then moving back to the Earth.

Let's go to the Sun:

- Press "**H**" to select Helios (the Sun)
- Press "**C**" to centre it in the screen
- Press "**G**" to go to it. Press "G" only once, as repeated pressing brings you closer to the target.
- To back away from a target, hold the "End" key or scroll your mouse wheel back.
- To move in closer to a target, hold "Home" or scroll your mouse wheel forward.

Here at the Sun you can also move around it by holding the Shift key and a direction arrow (left/ right) on your keyboard. You can also hold the right mouse button and move it around. You should be able to see some sunspots.



You may also notice that there is information in each corner of the screen (as seen above). If you do not have this, press "V" to bring it up. Pressing "V" again will bring up some extra information and again will clear all the text.

The only corner to look at in this basic tutorial is the top left. This displays some key facts about your target. These can be used as a part of a fun fact-finding mission using Celestia or for direct use in calculations.

Now you can **have a look at the Solar System** overall.

- Press "**P**" to display the names of all the planets
- Press "**O**" to display their orbits.
- Now you can **zoom away** from the Sun (**hold "End"**) until you see all the planets.
- Note that at a certain distance the inner planet orbits disappear to make room for the outer planet ones.
- To change your perspective (e.g. from side-on to top-down) hold the **Shift key and a direction arrow** (up/down).

Finally you can **visit each planet** and take a look around them.

- Press "**1**" to select the first planet from the Sun, Mercury.
- Press "**C**" to centre it in the screen,
- Press "**G**" to go to it.

Numbers "1" to "8" are the planets in our Solar System. All of the images that make up the planets in Celestia are from visiting spacecraft.

Velocity and Time Controls:

Spaceflight is difficult to control in Celestia so the tour method is recommended. However, watching the difference between 1 km per second and 1 light year per second can highlight the great distance involved in interstellar travel, for example.

Direction is controlled by the arrow keys and your "spacecraft" can be accelerated by holding the "a" key. The velocity is in the bottom left of the screen and changes units depending on how fast you are travelling.

To stop motion simply press "S". If students are flying through objects while trying to do a basic tour as described in the basic tutorial, they may be travelling at speed – "S" can be pressed to stop them travelling through targets.

A more useful feature in Celestia is the ability to speed up and slow down time.

The time is displayed in the top left corner of the screen (if not, press "V" until it comes up). It will start at your current computer time.

- Time can be accelerated in powers of 10 by pressing "L" repeatedly. This is useful for watching the planets orbit the Sun, for instance.
- Time can be paused using the spacebar or set back to real time rate by pressing "\".
- Time can be reversed by pressing "J".
- Time can also be reset to current computer time (at your current rate of time) by pressing "!".

Try all of these to get a feel for controlling the passage of time.

Much More:

There is much more to explore in this program, including displaying constellations, moon labels, leaving the Milky Way and looking back and lots more that this basic introduction does not include. A more comprehensive (yet technical) guide can be found here:

www.celestiamotherlode.net/catalog/documentation.html

At the end of this document is also a key chart that shows some of the other options available in Celestia and can expand the experience for students and teachers.

Sample KS3 Activity:

Catching Shadows on Jupiter

Students start off at planet Earth by default. Press "5" to select Jupiter and "G" to go there. The objective here is to identify shadows on Jupiter by speeding up the time rate and slowing it down when required, and then going on to identify what has created the shadow.

- Students can accelerate time with repeated pressing of "L".
- The time rate will appear in the bottom left hand corner. A time rate of 10000 is probably ideal.
- Students should have their finger over the "\" key, ready to slow down the time rate to real time when they see a shadow.

To identify what is making the shadow, students need to zoom away from Jupiter.




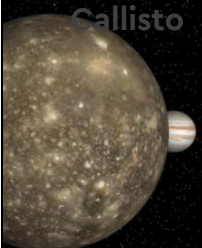
- By holding the "End" key very briefly, they should fly past one of the moons that can make discernable shadows on the clouds of Jupiter (Io/ Europa/ Ganymede).
- If they go too far, holding the "Home" key will fly back closer to Jupiter.
- Students can then click on the moon and press "G" to get travel to it. Here students can observe the surface and pick out details.
- Holding the shift key + a direction arrow left/ right moves the viewer around the moon to help reinforce ideas covered previously in Light & Shadow.

The images of the moons and Jupiter are taken from interplanetary spacecraft that have actually visited these worlds up close. Alternatively, if a mouse is available, the right button can be held to change the view.

Overleaf are helpful hints about the Galilean moons around Jupiter for teacher-student discussion. The following page is a simple answer sheet for students to fill in before a discussion of their findings.

Galilean Moons: Information for Teachers

These are the four largest moons around Jupiter (out of 67 confirmed). They were first identified by Galileo Galilei in 1610 and he would have seen them as small pin pricks of light near the bright body Jupiter through his early telescope. In Celestia only the first three moons make discernable shadows that students can identify.

Name	Orbital Period	Description	Diameter Compared to the Moon
	1.8 days	Io has over 400 active volcanoes maintained by the gravitational tug-of-war between Jupiter and its moons.	1.05
	3.6 days	Has an ice crust approximately 100 km thick with a possible liquid water ocean underneath. Possibility of life here?	0.89
	7.2 days	The largest moon in the Solar System, bigger in diameter than Mercury. Mainly composed of silicate rock and ice.	1.52
	16.7 days	Callisto is not affected as much gravitationally compared to its fellow Galilean moons. The surface is a mixture of rock and ice and it is heavily cratered.	1.39

Activity: Catching Shadows on Jupiter

Let's fly to Jupiter...

Press "5" on your keyboard **and "G"** to travel to the biggest planet in the Solar System!

When you reach your destination, **speed up time ("L") and then slow it down ("\\") when you see a shadow.**

Fly away from Jupiter slightly (briefly hold "End" key) to see which moon is making the shadow. Identify the moon by clicking on it, and press "G" to fly closer to it.

What sort of features/ colours/ patterns can you see on the surface of this moon?

Can you identify three moons that make shadows on Jupiter? Which one of the three casts its shadow most often?

Use the table below to fill in these answers.

Name	Features	Most frequent shadows (Tick one only)
		<input type="checkbox"/>
		<input type="checkbox"/>
		<input type="checkbox"/>

Why do you think that moon casts its shadow most frequently?

Celestia Key Chart

v 1.6.0



★ Frequently used keys.

Time

- ★ Spacebar Pause/Resume the flow of time and scripts (toggle)
- ★ J Reverse/Forward time (toggle)
- ★ \ Set time rate: 1x forward (norm), cancels faster/slower x factors
- ★ L Change time rate: 10x faster
- ★ K Change time rate: 10x slower
- ★ Shift+L Change time rate: 2x faster
- ★ Shift+K Change time rate: 2x slower
- ! Set time to current system date and time
- ? Display light-travel delay between observer / selected object
- (hyphen) Subtract light-travel delay from current simulation time

Labels

- E Toggle Galaxie labels
- Shift+E Toggle Globular labels
- B Toggle Star labels
- P Toggle Planet labels
- Shift+P Toggle Dwarf Planet labels
- M Toggle Moon labels
- Shift+M Toggle Minor Moon labels
- W Toggle Asteroid labels
- Shift+W Toggle Comet labels
- = Toggle Spacecraft labels
- & Toggle Constellation labels
- Toggle Location labels
- Toggle Markers (placed on objects)
- Ctrl+K Toggle Mark selected object
- Ctrl+P Toggle cycle the Info text verbosity (None / Terse / Verbose)
- V

Other

- Ctrl+C Copy location URL to clipboard (Cel:// URL)
- F10 Capture Image to file (screenshot)
- Shift+F10 Capture Movie to file (video)
- F11 While In Movie Capture: Start / Pause capture
- F12 Write In Movie Capture: Stop capture
- ~ Toggle debug console (use Up/Down arrow keys to scroll list)
- @ Toggle display of "frames per second" (FPS) being rendered
- D Edit Mode toggle (to assist in the placement of objects)
- ★ Enter Run demo script (/celestia/demo.cel)
- ★ Toggle Name entry Mode (use Tab / Shift+Tab to highlight an item)

The author: Sergey Leonov, e-mail: lesov@sun.fm

Navigation

- ★ 1 - 9 Select planet around the nearest star
- 0 (zero) Select parent star of current planet or system
- ★ H Select Sol (Home system)
- ★ C Center on selected object
- G Goto selected object
- F Follow selected object
- T Track selected object
- Y Sync Orbit selected object at a rate synced to its rotation
- : Lock on selected object
- ;" Chase selected object
- Shift+C Center/orbit--center the selected object without changing the position of the reference object
- Ctrl+G goto surface of selected object
- Ctrl+F Toggle Alt-azimuth mode
- Home Move closer to object
- End Move further away from object
- * Look back
- Backspace Select parent of current object or clear the selection
- Esc Cancel motion or script

Options.

- U Toggle Galaxie rendering
- Shift+U Toggle Globular rendering
- ^ Toggle Nebulae rendering
- % Toggle Star color table rendering
- I Toggle Cloud textures
- / Toggle Constellation diagrams
- ;/ Show an Earth-based equatorial coordinate sphere
- o Orbits (toggle ALL selected orbits)
- { Decrease Ambient Light
- } Increase Ambient Light
- (Decrease Galaxy Light gain
-) Increase Galaxy Light Gain
- [If Automag OFF: Decrease limiting magnitude (fewer stars)
-] If Automag ON : Decrease limiting magnitude at 45 deg FOV
- 1 If Automag OFF: Increase limiting magnitude (more stars)
- 1 If Automag ON : Increase limiting magnitude at 45 deg FOV
- Ctrl+Y Toggle Auto Magnitude (auto adaptation of star visibility to FOV)
- ^ Narrow Field Of View
- ^ Widen Field Of View
- Ctrl+V Cycle among supported OpenGL render paths

Spaceflight

- Z Decrease velocity
- A Increase velocity
- Q Reverse direction
- X Set movement direction toward center of screen
- F2 Set velocity to 1 km/second
- F3 Set velocity to 1,000 km/second
- F4 Set velocity to speed of light (1 c)
- F5 Set velocity to 10x the speed of light (10 c)
- F6 Set velocity to 1 AU/second
- F7 Set velocity to 1 light year/second
- F1 Stop motion
- S Stop motion

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