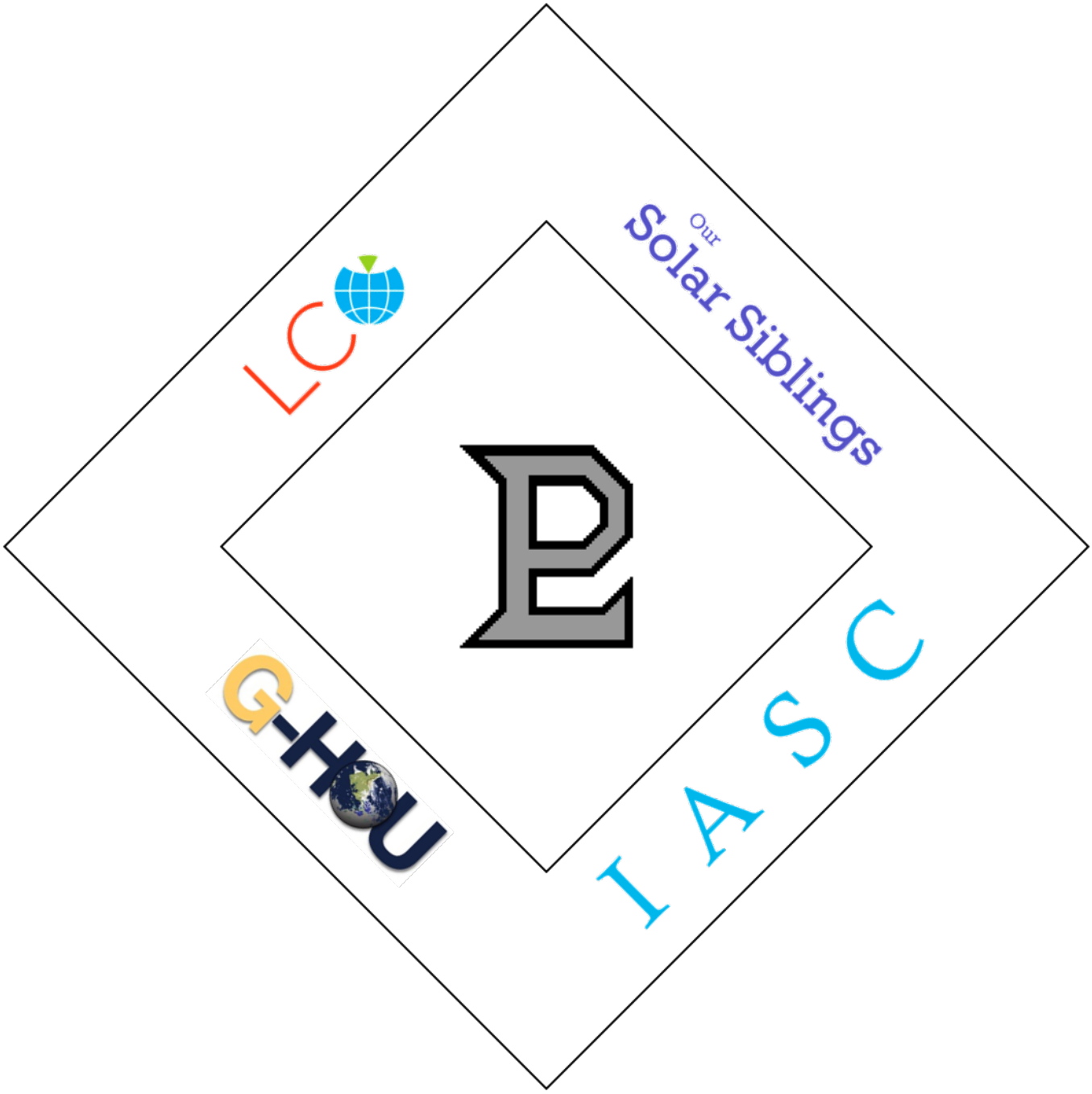
How to use the Orbit Calculator for Asteroid Observations



Orbit Calculator Instructions

Project Pluto supplies astronomical software, both commercial and freeware, to amateur and professional astronomers. The Find Orb orbit determination software can take a set of positional measurements of an asteroid, comet, or natural or artificial satellite, and determine its orbit.

1. In order to determine an orbit, you will need an MPC Report. These reports are generated by *Astrometrica*.

```
COD F51
OBS J. Bulger, T. Lowe, A. Schultz, M. Willman
MEA J.P. Miller, C. Davis, R. Valadez (HSU, USA)
TEL 1.8-m f/4.4 Ritchey-Chretien + CCD
ACK MPCReport file updated 2019.12.12 20:39:45
NET PPMXL
Image set: ps1-20191124_6_XY32_p00
     HSU5001  C2019 11 24.60059104 58 20.844+19 30 04.58          19.4 R      F51
     HSU5001  C2019 11 24.61341104 58 20.156+19 30 00.29          19.6 R      F51
     HSU5001  C2019 11 24.62620804 58 19.451+19 29 56.29          19.3 R      F51
     HSU5001  C2019 11 24.63905404 58 18.849+19 29 51.80          19.7 R      F51
----- end -----
```

2. Navigate to the Project Pluto Find Orb website at https://www.projectpluto.com/fo.htm

3. In the MPC Report, copy a minimum of two or a maximum of four measurement lines for the same object.

   NOTE: Using four lines will give you a more accurate orbit.

```
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MEA J.P. Miller, C. Davis, R. Valadez (HSU, USA)
TEL 1.8-m f/4.4 Ritchey-Chretien + CCD
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     HSU5001  C2019 11 24.62620804 58 19.451+19 29 56.29          19.3 R      F51
     HSU5001  C2019 11 24.63905404 58 18.849+19 29 51.80          19.7 R      F51
----- end -----
```
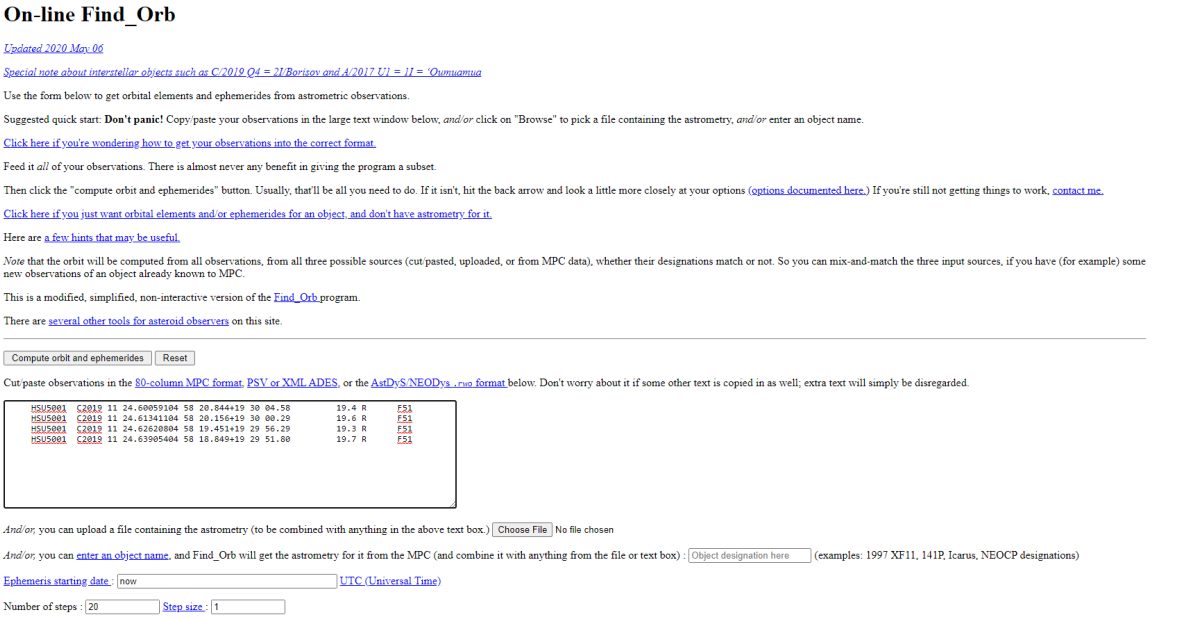

4. In the website, look for the window box that says, "Paste astrometry here, and/or upload it using the 'browse' button below".

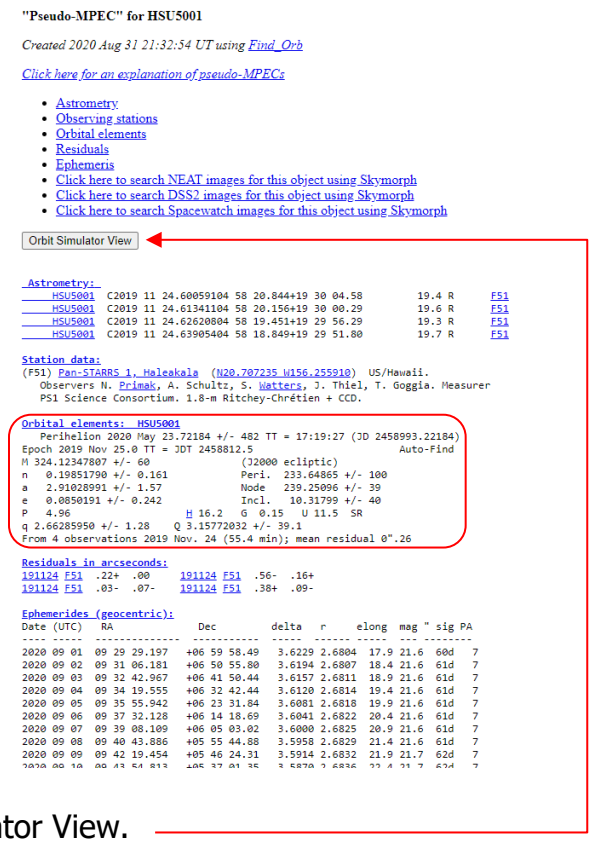
5. Paste the copied lines from the MPC Report.



Next, click on the Compute orbit and ephemerides Button.

6. A new webpage will load showing information such as:

   Semimajor Axis (a)
   Eccentricity (e)
   Perihelion or Perigee Distance (q)
   Aphelion or Apogee Distance (Q)
   Absolute Magnitude (H)



"Pseudo-MPEC" for HSU5001

Created 2020 Aug 31 21:32:54 UT using Find_Orb

Click here for an explanation of pseudo-MPECs

- Astrometry
- Observing stations
- Orbital elements
- Residuals
- Ephemeris
- Click here to search NEAT images for this object using Skymorph
- Click here to search DSS2 images for this object using Skymorph
- Click here to search Spacewatch images for this object using Skymorph

Orbit Simulator View

Astrometry:

```
     HSU5001  C2019 11 24.60059104 58 20.844+19 30 04.58         19.4 R      F51
     HSU5001  C2019 11 24.61341104 58 20.156+19 30 00.29         19.6 R      F51
     HSU5001  C2019 11 24.62620804 58 19.451+19 29 56.29         19.3 R      F51
     HSU5001  C2019 11 24.63905404 58 18.849+19 29 51.80         19.7 R      F51
```

Station data:

```
(F51) Pan-STARRS 1, Haleakala  (N20.707235 W156.255910)  US/Hawaii.
   Observers N. Primak, A. Schultz, S. Watters, J. Thiel, T. Goggia. Measurer
   PS1 Science Consortium. 1.8-m Ritchey-Chrétien + CCD.
```

Orbital elements: HSU5001

```
   Perihelion 2020 May 23.72184 +/- 482 TT = 17:19:27 (JD 2458993.22184)
Epoch 2019 Nov 25.0 TT = JDT 2458812.5                    Auto-Find
M 324.12347807 +/- 60              (J2000 ecliptic)
n   0.19851790 +/- 0.161           Peri.  233.64865 +/- 100
a   2.91028991 +/- 1.57            Node   239.25096 +/- 39
e   0.0850191 +/- 0.242            Incl.   10.31799 +/- 40
P   4.96                  H 16.2   G  0.15   U 11.5  SR
q 2.66285950 +/- 1.28    Q 3.15772032 +/- 39.1
From 4 observations 2019 Nov. 24 (55.4 min); mean residual 0".26
```

Residuals in arcseconds:

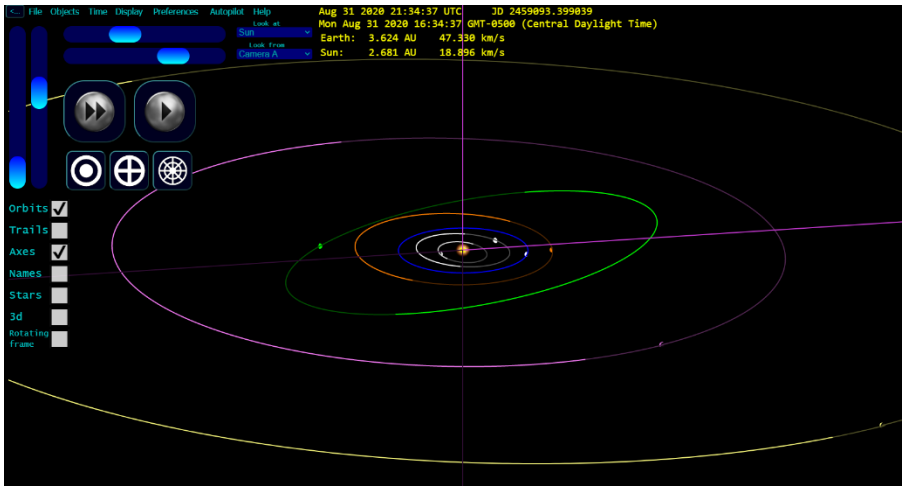
```
191124 F51  .22+  .00     191124 F51  .56-  .16+
191124 F51  .03-  .07-    191124 F51  .38+  .09-
```

Ephemerides (geocentric):

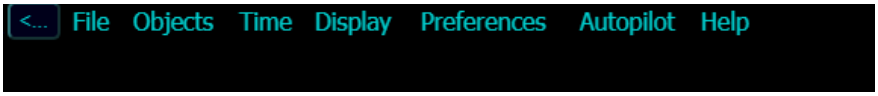
```
Date (UTC)    RA              Dec         delta   r      elong  mag " sig PA
---- -----  --------------  -----------  -----  ------ -----  --- --------
2020 09 01  09 29 29.197   +06 59 58.49   3.6229 2.6804  17.9 21.6  60d   7
2020 09 02  09 31 06.181   +06 50 55.80   3.6194 2.6807  18.4 21.6  61d   7
2020 09 03  09 32 42.967   +06 41 50.44   3.6157 2.6811  18.9 21.6  61d   7
2020 09 04  09 34 19.555   +06 32 42.44   3.6120 2.6814  19.4 21.6  61d   7
2020 09 05  09 35 55.942   +06 23 31.84   3.6081 2.6818  19.9 21.6  61d   7
2020 09 06  09 37 32.128   +06 14 18.69   3.6041 2.6822  20.4 21.6  61d   7
2020 09 07  09 39 08.109   +06 05 03.02   3.6000 2.6825  20.9 21.6  61d   7
2020 09 08  09 40 43.886   +05 55 44.88   3.5958 2.6829  21.4 21.6  61d   7
2020 09 09  09 42 19.454   +05 46 24.31   3.5914 2.6832  21.9 21.7  62d   7
2020 09 10  09 43 54.813   +05 37 01.35   3.5870 2.6836  22.4 21.7  62d   7
```

Next, click on Orbit Simulator View.

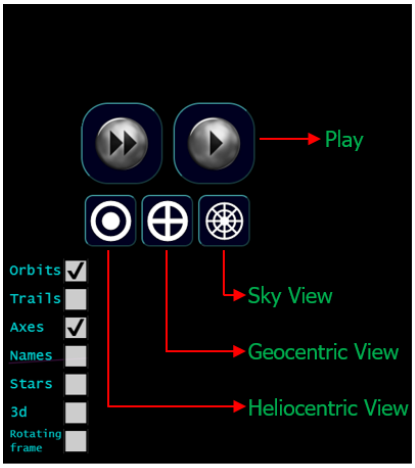
7. A new webpage will load showing an animation of the orbit.

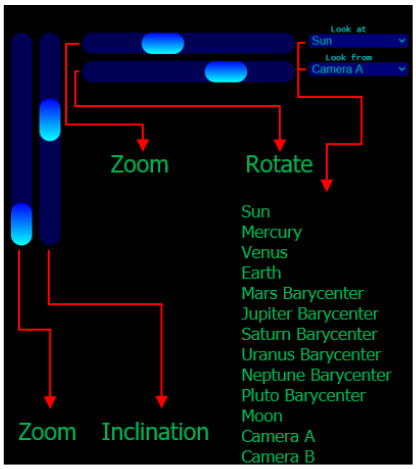


You can familiarize yourself with some of the menu options, buttons and sliders.

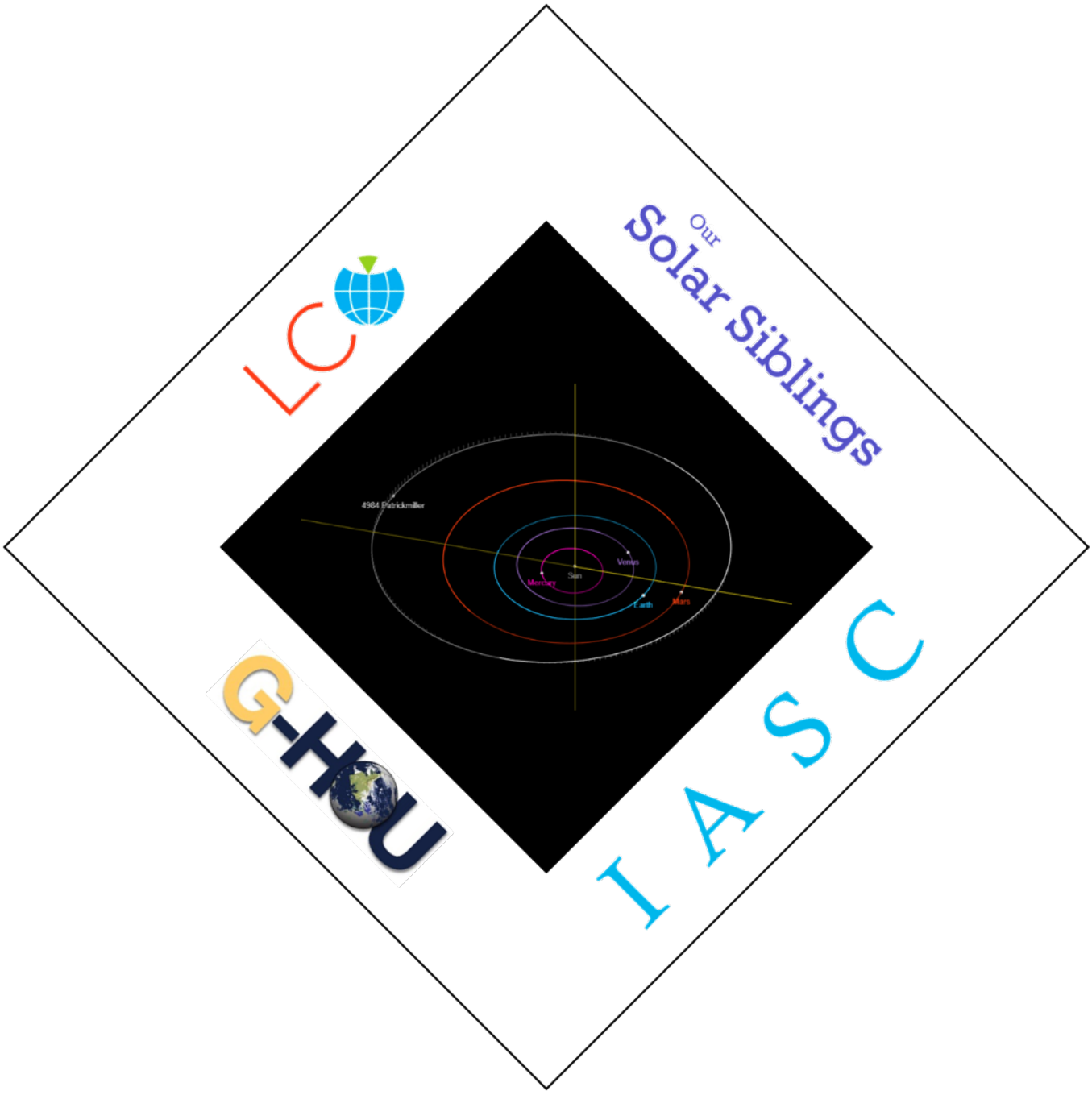


File	Objects	Time	Displays	Autopilot	Help
Save as	Create objects	Calendar date (Local)	Screens	Now	Description
Screen shots	Create object with clones	Calendar date (UTC)	Frame A	Single events	Quick help
Collision log	Import object	Julian day	Frame B	Per iteration	Manual
	Edit objects (vectors)	Time step	Rotating frame	Per graphic update	About
	Edit objects (elements)	Set time & date	Stereo		
	Vectors		Cities A		
	Delete objects		Cities B		
	Orbits		Camera A		
			Blank		
			Large play button		





Go Discover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Solar Siblings
4984 Patrickmiller
Sun
Mercury
Venus
Earth
Mars