14136 - Search for material around Chiron

Cycle: 23, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) CHIRON	WFC3/UVIS	1	03-Sep-2015 21:02:45.0	yes
02	(1) CHIRON	WFC3/UVIS	1	03-Sep-2015 21:02:48.0	yes
03	(1) CHIRON	WFC3/UVIS	1	03-Sep-2015 21:02:50.0	yes

3 Total Orbits Used

ABSTRACT

Chiron is an active Centaur object of radius ~110 km orbiting between Saturn and Uranus. Its size and orbital elements are similar to those of the largest Centaur known to date, Chariklo (radius~120 km). In 2013, a stellar occultation revealed the surprising presence of two narrow and dense rings around the latter body (Braga-Ribas F. et al., Nature, 2 April 2014), showing that rings are not an exclusivity of the giant planets and may be a more common feature than previously thought. A stellar occultation by Chiron observed in 2011 actually revealed the presence of sharp features that could be caused by a shell of material or cometary jets around Chiron (Ruprecht et al. 2015), a conclusion supported by the fact that Chiron (contrarily to Chariklo) does exhibit a cometary-like activity. Conversely, analyzing results from three stellar occultations (in 1993, 1994, 2011), Ortiz et al. (2015) show that the detections of secondary events could be explained by the presence of a dense and narrow rings orbiting at about 325 km from Chiron's center. Our goals here are to (1) Search for jets and faint material around Chiron (at more than 2,000 km from the central body), (2) search for faint satellites, (3) Constrain the presence of close-in ring structures, and (4) get multi-wavelength photometry to constrain the material composition. This would help us to assess how unique Chariklo's rings are, and to see whether the material surrounding both objects has something to do with a cometary activity.

OBSERVING DESCRIPTION

With a radius of about 110 km, Chiron subtends 17 mas on the sky, while the surrounding putative ring material span a diameter of about 750 km (or ~51 mas), see Fig 1 (at PDF attachment). Taking images with the CCD rows aligned with the ring longer axis, then rotating the telescope by 90 degrees and subtracting the resulting images will eliminate Chiron's contribution and may reveal jets well below the width reported by Ruprecht et al (2015), as illustrated in Fig. 1 (right panel).

The expected geometry of the putative rings at opposition (September 2016) corresponds to an opening angle B=50deg and position angle P=20deg (Fig. 1). With a radius 325 km and total width of 10 km the ring system apparent area should represent about 50% of that of Chiron, and also 50% of the flux, as they have similar geometric albedos (Fornasier et al. 2013, Ortiz et al. 2015). Using the same technique as above (90deg rotation), we can unveil the ring ansae and their position angle, see Fig 1 (middle panel), thus supporting the Ortiz et al.'s (2015) model.

The limiting magnitudes will get brighter inward of 2 arcsec from the central body.

Target acquisition strategies

The strategy to provide direct images of Chiron's surroundings is to choose a roll angle of HST and after a few days we plan to make another visit.

The time between each visit is dictated by HST for the camera to roll 90 degrees (the U3 angle). Using the same strategy as the first orbit, but with a 90 degrees roll difference on the camera, we can use Chiron to subtract itself out and remove the wings - caused by the surrounding material - of the PSF, letting us see diffuse coma material, possible rings, jets and/or any other elliptical material around the body and also to try to detect the motion of possible satellites. To confirm a possible detection of satellites or other features, a third visit after a few days is planned, having 0 or 180 degrees roll on the U3 angle (compared to the first orbit). For the three orbits, the same strategy of observation will be used (the only difference is the roll angle).

We will dither all exposures using optimal standard patterns based on the total number of exposures for each filter. Since we have a small (7 arcsec) region of interest, we will use the UVIS2-C512C-SUB aperture to permit getting more images per visit. The use of the F475X filter is to detect the rings in the visible, complementing the images on UV taken with the F300X filter. In particular, we want to confirm the water ice spectral slope below 5000 Angstrom, so the use of these two filters is needed. The broader F350LP filter is used for a deep search for additional rings or satellites. The available time in each visit will reach as faint as V=27, or down to a few km in size.

A satellite with orbital radius r_km has a period of T~10^(-4) r_km^(1.5) days, estimating Chiron's mass to ~10^(19) kg (icy body with radius 110 km). As we can detect and expect satellites up to ~30,000 km from the primary (see discussion above), T is at most 1.4 years. Thus, during one week, the satellite will move by at least 2,600 km, corresponding to at least ~5 pixels on WFC3.

Time distribution for each of the three orbits was checked to ensure that it fits in a single visibility window (see Table 1A in PDF attachment).

Visit

Proposal 14136, Visit 01 (01), implementation Fri Sep 04 01:02:52 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 220D TO 230 D

Comments: We are searching for objects within 2 arcsec away the central body (Chiron).

The "ring-broad-band" and "ring-UV" avoid saturation for accurate photometry and colors. The POS-TARG value use for all exposures is set to keep the target away from the bad column in the sub-array. The 2 point dither "pattern 1" is chosen for cosmic ray rejection and to move the target relative to any blemishes in the image. The exposure times in these color observations are set by our SNR requirements without saturation on Chiron.

"long-part 1" and "2" are longer exposures for looking for satellites. There is no dithering within these sets but there is a slight dither built in to the second part that mimics the two-point dither pattern while minimizing overhead from the dither operation. This pattern follows the successfull strategy used for Pluto during the search for faint satellites. The exposure times for these images are set to all be identical and to fill the orbit without excessive saturation from the central object.

Diagnostics

(broadband (01.001)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

(Surrounding-material-UV (01.002)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1), (2)

Solar System Targets

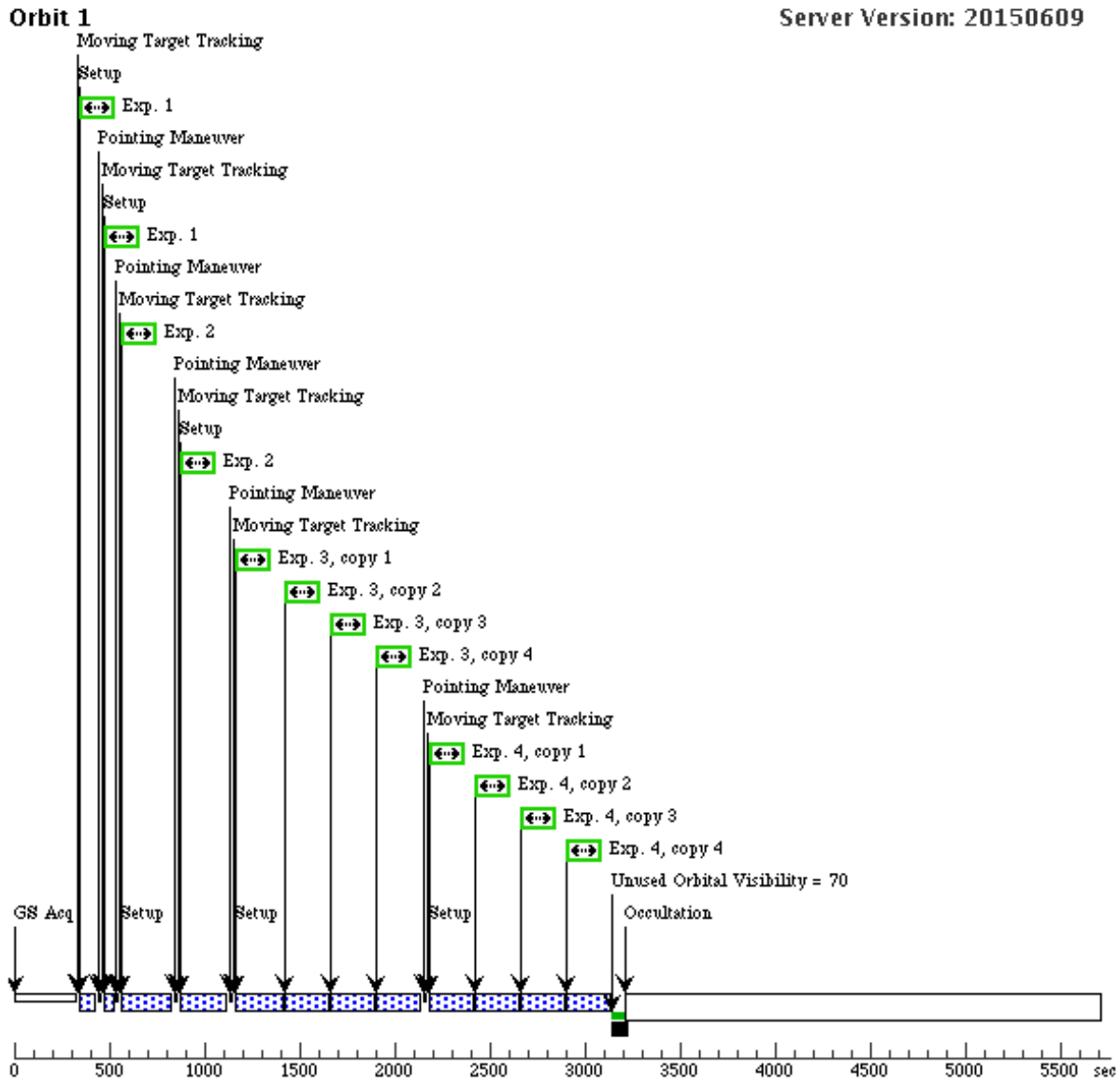
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	CHIRON	TYPE=ASTEROID,A=13.6383666493 2805,E=.3820988964285049,I=6.9383 62251723268,O=209.278046346615 ,W=339.3496505888005,M=134.5261 255528466 ,EQUINOX=J2000,EPOCH=09-DEC-2014:00:00:00,EpochTimeScale=TDB				EARTH

Proposal 14136 - Visit 01 (01) - Search for material around Chiron

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	broadband	(1) CHIRON	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F475X	CR-SPLIT=NO	POS TARG 3.0,0.; GS ACQ SCENARIO BASE1B3	Pattern 1, Exps 1-1 in Visit 01 (01) (1)	7 Secs (14 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2	Surrounding-material-UV	(1) CHIRON	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F300X	CR-SPLIT=NO	POS TARG 3.0,0.	Pattern 1, Exps 2-2 in Visit 01 (01) (1)	200 Secs (400 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
3	long-part 1	(1) CHIRON	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	CR-SPLIT=NO	POS TARG 3.0,0.		186 Secs X 4 (744 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]*	***[1]***
4	long-part 2	(1) CHIRON	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	CR-SPLIT=NO	POS TARG 3.14,0.14		186 Secs X 4 (744 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]*	***[1]***

Orbit Structure



Proposal 14136 - Visit 02 (02) - Search for material around Chiron

Visit

Proposal 14136, Visit 02 (02), implementation Fri Sep 04 01:02:52 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 75D TO 80D FROM 03

Comments: We are searching for objects within 2 arcsec away the central body (Chiron).
The design of this visit is identical to visit 1 and 3 except for a ideally 90 degree rotation needed. To adjust the requirements on visit planner, it was necessary to take visit 3 as reference for orient. Rotation is to isolate any non-circular surrounding material. A timing window is also needed for the sattelite search observations.
Visit 1 and 2 will comprise the discovery pair for initial orbit estimates and can not be either too close together or too far apart. The values we chose are a compromisee between the roll angle difference needed and the estimated motion of sattelites around Chiron.

The "ring-broad-band" and "ring-UV" avoid saturation for accurate photometry and colors. The POS-TARG value use for all exposures is set to keep the target away from the bad column in the sub-array.
The 2 point dither "pattern 1" is chosen for cosmic ray rejection and to move the target relative to any blemishes in the image. The exposure times in these color observations are set by our SNR requirements without saturation on Chiron.

"long-part 1" and "2" are longer exposures for looking for satellites. There is no dithering within these sets but there is a slight dither built in to the second part that mimics the two-point dither pattern while minimizing overhead from the dither operation. This pattern follows the successfull strategy used for Pluto during the search for faint satellites. The exposure times for these images are set to all be identical and to fill the orbit without excessive saturation from the central object.

Diagnostics

(broadband (02.001)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

(Surrounding-material-UV (02.002)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1), (2)

Solar System Targets

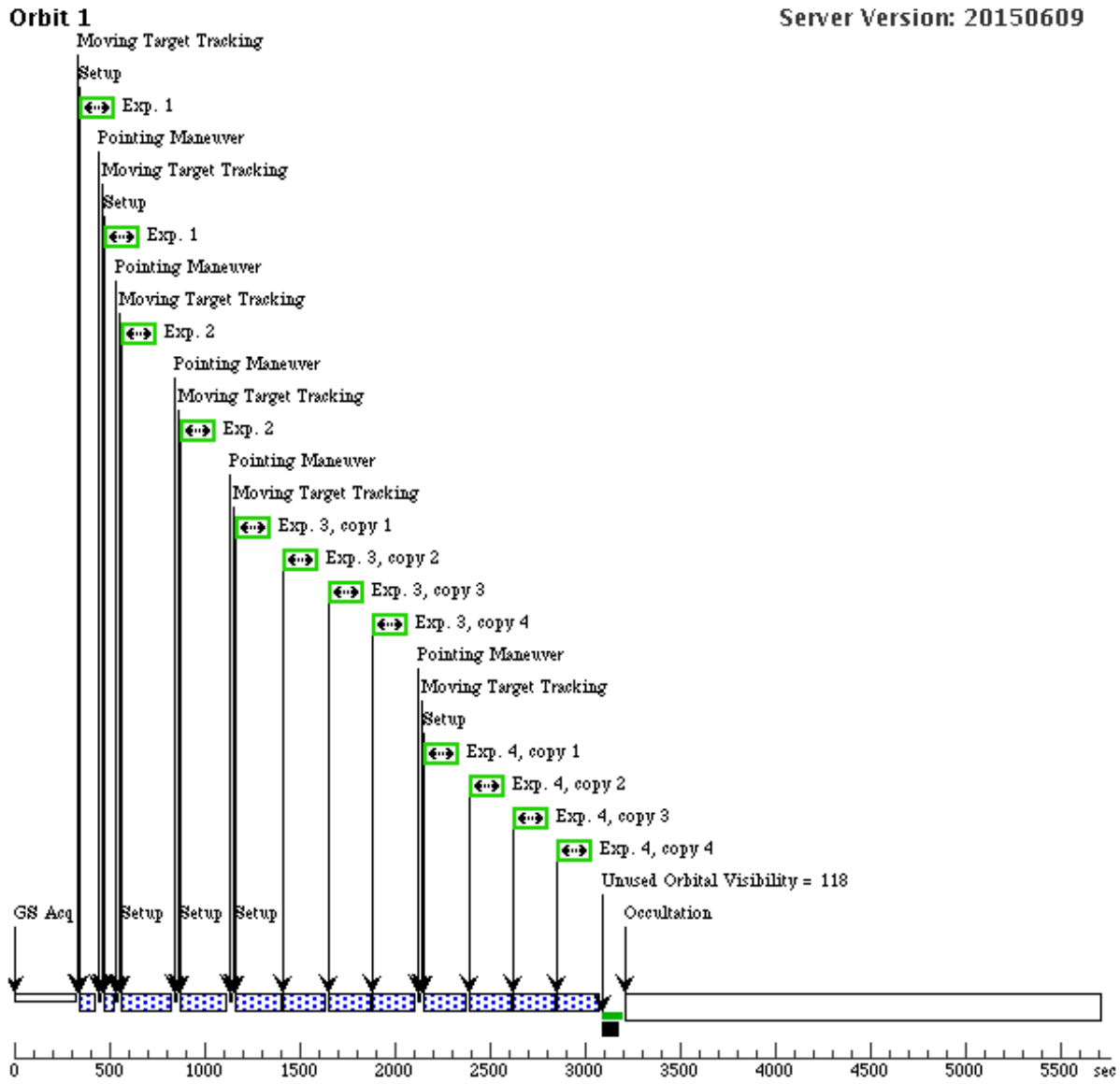
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	CHIRON	TYPE=ASTEROID,A=13.6383666493 2805,E=.3820988964285049,I=6.9383 62251723268,O=209.278046346615 ,W=339.3496505888005,M=134.5261 255528466 ,EQUINOX=J2000,EPOCH=09-DEC-2014:00:00:00,EpochTimeScale=TDB				EARTH

Proposal 14136 - Visit 02 (02) - Search for material around Chiron

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	broadband	(1) CHIRON	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F475X	CR-SPLIT=NO	POS TARG 3.0,0.; GS ACQ SCENARIO BASE1B3	Pattern 1, Exps 1-1 in Visit 02 (02) (1)	7 Secs (14 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2	Surrounding-material-UV	(1) CHIRON	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F300X	CR-SPLIT=NO	POS TARG 3.0,0.	Pattern 1, Exps 2-2 in Visit 02 (02) (1)	200 Secs (400 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
3	long-part 1	(1) CHIRON	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	CR-SPLIT=NO	POS TARG 3.0,0.		180 Secs X 4 (720 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]*	***[1]***
4	long-part 2	(1) CHIRON	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	CR-SPLIT=NO	POS TARG 3.14,0.14		180 Secs X 4 (720 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]*	***[1]***

Orbit Structure



Visit

Proposal 14136, Visit 03 (03), implementation Fri Sep 04 01:02:53 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 180D TO 180D FROM 01

Comments: We are searching for objects within 2 arcsec away the central body (Chiron).
The design of this visit is identical to visit 1 except for a 180 degree rotation needed
to isolate any non-circular material. The three visits provide two epoch of difference images that will contrain ring properties. The timing window is set to get confirmation of any new satellites at the earliest possible epoch consistent with the roll constraint.

The "ring-broad-band" and "ring-UV" avoid saturation for accurate photometry and colors. The POS-TARG value use for all exposures is set to keep the target away from the bad column in the sub-array. The 2 point dither "pattern 1" is chosen for cosmic ray rejection and to move the target relative to any blemishes in the image. The exposure times in these color observations are set by our SNR requirements without saturation on Chiron.

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Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
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Proposal 14136 - Visit 03 (03) - Search for material around Chiron

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	broadband	(1) CHIRON	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F475X	CR-SPLIT=NO	POS TARG 3.0,0.; GS ACQ SCENARIO BASE1B3	Pattern 1, Exps 1-1 in Visit 03 (03) (1)	7 Secs (14 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2	Surrounding-material-UV	(1) CHIRON	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F300X	CR-SPLIT=NO	POS TARG 3.0,0.	Pattern 1, Exps 2-2 in Visit 03 (03) (1)	200 Secs (400 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
3	long-part 1	(1) CHIRON	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	CR-SPLIT=NO	POS TARG 3.0,0.		186 Secs X 4 (744 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]*	***[1]***
4	long-part 2	(1) CHIRON	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	CR-SPLIT=NO	POS TARG 3.14,0.14		186 Secs X 4 (744 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]*	***[1]***

Orbit Structure