16079 - Does the binary system LB-1 host a Black Hole?

Cycle: 27, 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) LS-V-+22-25 NONE WAVE	STIS STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	1	12-Mar-2020 11:00:37.0	yes
02	(1) LS-V-+22-25 CCDFLAT WAVE	STIS/CCD	1	12-Mar-2020 11:00:39.0	yes
03	(1) LS-V-+22-25	WFC3/IR	1	12-Mar-2020 11:00:42.0	yes

3 Total Orbits Used

ABSTRACT

It was recently proposed that the Galactic binary system LB-1 hosts an ~8+70 solar mass B-star+black hole (BH) wide binary that is X-ray quiet, strongly challenging the current paradigm for the formation of stellar mass black holes in metal rich environments. This claim was quickly disputed in two ways: The Balmer emission lines originally thought to arise from an accretion disk around the BH have been re-interpreted as a stationary circumbinary disk, hence it is only possible to estimate a minimum mass for the dark companion from the inferred mass of the B-type star. Secondly, detailed non-LTE analyses of the optical spectrum and spectral energy distribution of the B-type star now imply two scenarios for a significantly lower mass of the B-type 'primary': It is found to be either a main sequence B-type star of 3.2+/-2 solar masses or a stripped helium star of 1.1+/-0.5 solar masses, consistent with a 'secondary' mass between approximately 2 and 5 solar masses. The dark secondary could therefore still be a stellar mass BH, making it only the second X-ray quiet star+BH system known, or possibly even a massive neutron star. We propose obtaining an exquisite UV/optical/near-IR flux calibrated spectrum of the system that will provide the pivotal means of discriminating between these two scenarios by tightly constraining the mass and helium abundance of the primary.

OBSERVING DESCRIPTION

We follow the standard STIS and WFC3/IR flux calibration configurations, aiming for a s/n of at least 100--200, and a combined spectrum covering the FUV--near-IR with a spectral resolution of 500-1000 in the UV-optical, and 100-200 in the near-IR. For the predicted UV flux we adopt the parameters and extinction law from Simon-Diaz et al (their Appendix C). The source is non-variable and the extinction law is well enough determined to permit a reliable estimate of BOP concerns.

We require a total of 3 orbits/visits as follows:

VISIT O1: For a s/n of approximately 100 with STIS/MAMA using the 52x2 aperture and NUV G140L and FUV G230L configurations we require exposure times of at least 1000 and 800 seconds respectively. Exposure times are auto-adjusted to fill the orbit and improve s/n. We switch off the MAMA monthly offsets as this improves flux calibration to better than 3%, an objective of the proposal. Wavecals are explicitly added.

VISIT 02: For the STIS/CCD G430L and G750L detector/grating combinations exposure times are short, 20 seconds for s/n around 100 and we therefore repeat each x4 times (CRSPLIT=4) to match STIS calibration observations. We will use the 52x2 aperture, the E1 position for the G430L to mimimize CTE losses and the center position for G750L as per the standard calibration configurations. To complete this orbit we will add higher resolution G430M/3680 and G430M/3936 150/50 second exposures with the 52x0.1E1 aperture. These data will permit a very high fidelity view of the Balmer jump and the higher series members of the Balmer lines from Hepsilon onwards. In addition we note that the use of the 2 arcsec wide aperture in the low resolution observations will in effect provide imaging spectroscopy of the disk emission lines. Wavecals are explicitly added.

VISIT 03: With WFC3/IR we require use of the G102 and G141 grisms. We use an 8-point line dither pattern in Y of 10 pixels to improve the total s/n and reduce persistence effects. Using the 512 subarray, we can obtain 2 patterns per grism in a single orbit, for a total exposure time per grism of 102 seconds. A short exposure is added at the end of the sequence to define position of the source for the grism observations. We add short imaging exposures to check the Paschen Beta for extended emission. We use the 256 subarray to avoid saturation of the target.

Visit

Proposal 16079, LB1 MAMA SPEC (01) Thu Mar 12 15:00:43 GMT 2020

Diagnostic Status: Error

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, STIS, STIS/FUV-MAMA

Special Requirements: (none)

Diagnostics

(LB1 MAMA SPEC (01)) Error (Orbit Planner): ILLEGAL MSMOFF MODE EXPOSURE

(LB1 MAMA SPEC (01)) Error (Orbit Planner): ILLEGAL MSMOFF MODE EXPOSURE

(LB1 MAMA SPEC (01)) Error (Orbit Planner): ILLEGAL MSMOFF MODE EXPOSURE

(MSOFF ZERO (01.002)) Error (Form): Default Exposure Time not allowed for this exposure.

(MSOFF ZERO (01.002)) Error (Form): GRATING1 is not a valid selection

(MSOFF ZERO (01.002)) Error (Form): Illegal selection: STIS.

(MSOFF ZERO (01.002)) Error (Form): MSMOFF is not a valid selection.

(MSOFF ZERO (01.002)) Error (Form): SETOFFSET is not a valid selection

(MSOFF ZERO (01.002)) Error (Form): Target NONE is no longer a valid selection

(MSOFF ZERO (01.002)) Error (Form): This attribute is not allowed to have this value: Calibration_Target = NONE
It is an Available option and cannot normally be used in a GO proposal.

(MSOFF ZERO (01.002)) Error (Form): This attribute is not allowed to have this value: Config = STIS
It is a Restricted option and can only be used in an engineering proposal.

(MSOFF ZERO (01.002)) Error (Form): This attribute is not allowed to have this value: Mode = MSMOFF
It is a Restricted option and can only be used in an engineering proposal.

(MSOFF RESTORE (01.007)) Error (Form): Default Exposure Time not allowed for this exposure.

(MSOFF RESTORE (01.007)) Error (Form): GRATING1 is not a valid selection

(MSOFF RESTORE (01.007)) Error (Form): Illegal selection: STIS.

(MSOFF RESTORE (01.007)) Error (Form): MSMOFF is not a valid selection.

(MSOFF RESTORE (01.007)) Error (Form): SETOFFSET is not a valid selection

(MSOFF RESTORE (01.007)) Error (Form): Target NONE is no longer a valid selection

(MSOFF RESTORE (01.007)) Error (Form): This attribute is not allowed to have this value: Calibration_Target = NONE
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(MSOFF RESTORE (01.007)) Error (Form): This attribute is not allowed to have this value: Mode = MSMOFF
It is a Restricted option and can only be used in an engineering proposal.

Fixed Targets

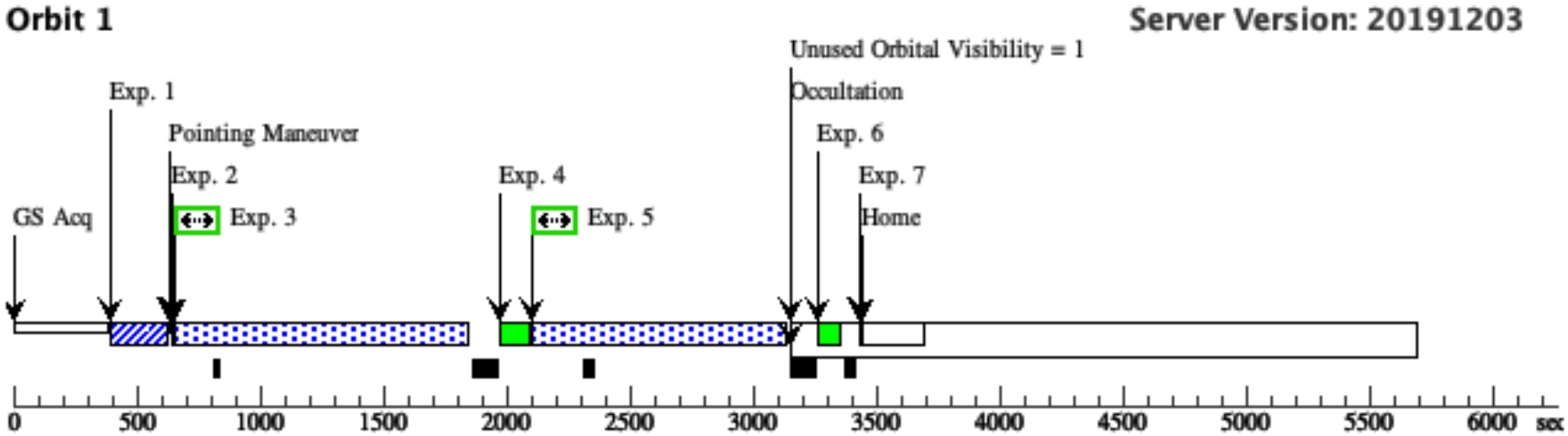
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	LS-V-+22-25	RA: 06 11 49.0762 (92.9544842d) Dec: +22 49 32.66 (22.82574d) Equinox: J2000	Proper Motion RA: -4.846175616301932E-6 sec of time/yr Proper Motion Dec: -0.00188900000092142145 arcsec/yr Epoch of Position: 2015.5	V=11.51+/-0.1	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[B6-B9.5 III-I]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	acq	(1) LS-V-+22-25	STIS/CCD, ACQ, F28X50LP	MIRROR				0.2 Secs (0.2 Secs) *[==>]*	*[1]*
2	MSOFF ZERO	NONE	STIS, MSMOFF		SETOFFSET=ZERO; GRATING1=ALL			*[==>]*	*[1]*
3	G140L (STIS.sp.1430903)	(1) LS-V-+22-25	STIS/FUV-MAMA, ACCUM, 52X2	G140L 1425 A	WAVECAL=NO			1000 Secs (1040 Secs) *[==>1040.0 Secs]*	*[1]*
4	G140L WAVE	WAVE	STIS/FUV-MAMA, ACCUM, 52X0.05	G140L 1425 A				*[==>]*	*[1]*
5	G230L (STIS.sp.1430898)	(1) LS-V-+22-25	STIS/NUV-MAMA, ACCUM, 52X2	G230L 2376 A	WAVECAL=NO			800 Secs (840 Secs) *[==>840.0 Secs]*	*[1]*
6	G230L WAVE	WAVE	STIS/NUV-MAMA, ACCUM, 31X0.05NDC	G230L 2376 A				*[==>]*	*[1]*
7	MSOFF RESTORE	NONE	STIS, MSMOFF		SETOFFSET=RESTORE; GRATING1=ALL			*[==>]*	*[1]*

Orbit Structure



Visit

Proposal 16079, LB1 CCD SPEC (02) Thu Mar 12 15:00:43 GMT 2020

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: (none)

Fixed Targets

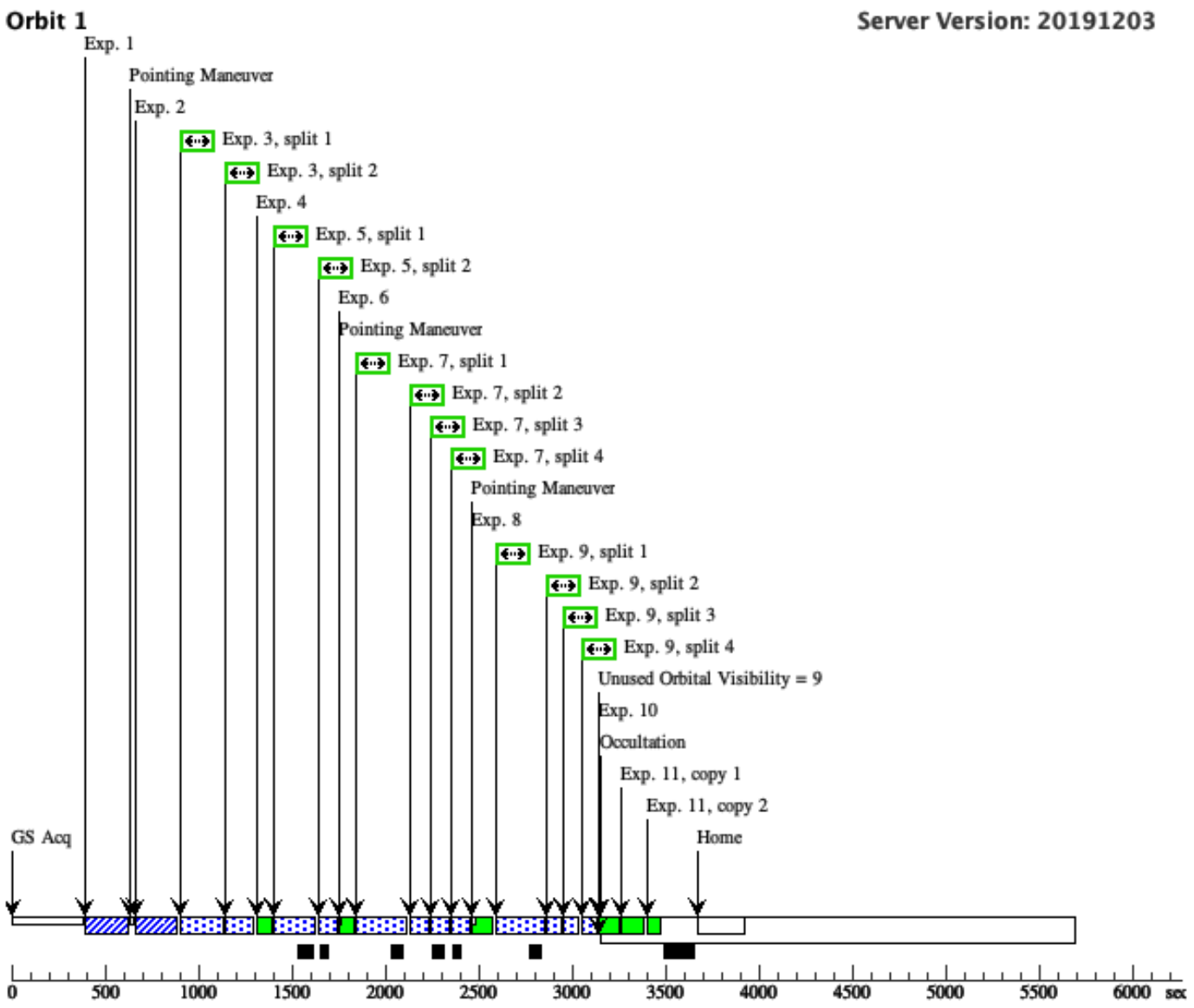
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	LS-V-+22-25	RA: 06 11 49.0762 (92.9544842d) Dec: +22 49 32.66 (22.82574d) Equinox: J2000	Proper Motion RA: -4.846175616301932E-6 sec of time/yr Proper Motion Dec: -0.00188900000092142145 arcsec/yr Epoch of Position: 2015.5	V=11.51+/-0.1	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[B6-B9.5 III-I]
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ	(1) LS-V-+22-25	STIS/CCD, ACQ, F28X50LP	MIRROR				0.5 Secs (0.5 Secs) *[==>]*	***[1]***
2	ACQ/PEAK	(1) LS-V-+22-25	STIS/CCD, ACQ/PEAK, 52X0.1E1	MIRROR				0.2 Secs (0.2 Secs) *[==>]*	***[1]***
3	G430M/3680	(1) LS-V-+22-25	STIS/CCD, ACCUM, 52X0.1E1	G430M 3680 A				150 Secs (242 Secs) *[==>121.0 Secs (Split 1)]* *[==>121.0 Secs (Split 2)]*	***[1]***
4	WAVECAL	WAVE	STIS/CCD, ACCUM, 52X0.2	G430M 3680 A	CR-SPLIT=NO			*[==>]*	***[1]***
5	G430M/3936	(1) LS-V-+22-25	STIS/CCD, ACCUM, 52X0.1E1	G430M 3936 A				50 Secs (142 Secs) *[==>71.0 Secs (Split 1)]* *[==>71.0 Secs (Split 2)]*	***[1]***
6	WAVECAL	WAVE	STIS/CCD, ACCUM, 52X0.2	G430M 3936 A				*[==>]*	***[1]***
7	G430L	(1) LS-V-+22-25	STIS/CCD, ACCUM, 52X2E1	G430L 4300 A	CR-SPLIT=4; WAVECAL=NO			80 Secs (264 Secs) *[==>66.0 Secs (Split 1)]* *[==>66.0 Secs (Split 2)]* *[==>66.0 Secs (Split 3)]* *[==>66.0 Secs (Split 4)]*	***[1]***
8	WAVECAL	WAVE	STIS/CCD, ACCUM, 52X0.2	G430L 4300 A	CR-SPLIT=NO			*[==>]*	***[1]***
9	G750L	(1) LS-V-+22-25	STIS/CCD, ACCUM, 52X2	G750L 7751 A	CR-SPLIT=4			20 Secs (204 Secs) *[==>51.0 Secs (Split 1)]* *[==>51.0 Secs (Split 2)]* *[==>51.0 Secs (Split 3)]* *[==>51.0 Secs (Split 4)]*	***[1]***
10	WAVECAL	WAVE	STIS/CCD, ACCUM, 52X0.2	G750L 7751 A	CR-SPLIT=NO			*[==>]*	***[1]***
11	FLAT	CCDFLAT	STIS/CCD, ACCUM, 52X2	G750L 7751 A				*[==>(Copy 1)]* *[==>(Copy 2)]*	***[1]***

Orbit Structure



Visit

Proposal 16079, LB1 WFC3/IR GRISM/IMAGE (03) Thu Mar 12 15:00:44 GMT 2020

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: ORIENT 210D TO 255 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-IR-DITHER-LINE Purpose=DITHER Number Of Points=8 Point Spacing=1.3 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=41.788 Angle Between Sides= Center Pattern=false		(1-3)
(2)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(4-5)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	LS-V-+22-25	RA: 06 11 49.0762 (92.9544842d) Dec: +22 49 32.66 (22.82574d) Equinox: J2000	Proper Motion RA: -4.846175616301932E-6 sec of time/yr Proper Motion Dec: -0.0018890000092142145 arcsec/yr Epoch of Position: 2015.5	V=11.51+/-0.1	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[B6-B9.5 III-I]
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	GRISM102	(1) LS-V-+22-25	WFC3/IR, MULTIACCUM, GRISM256	G102	NSAMP=15; SAMP-SEQ=RAPID		Pattern 1, Exps 1-3 in LB1 WFC3/IR GRISM/IMAGE (03) (1)	4.167225 Secs (33.338 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]* *[==>(Pattern 5)]* *[==>(Pattern 6)]* *[==>(Pattern 7)]* *[==>(Pattern 8)]*	***[1]***
2	GRISM141	(1) LS-V-+22-25	WFC3/IR, MULTIACCUM, GRISM256	G141	SAMP-SEQ=RAPID; NSAMP=15		Pattern 1, Exps 1-3 in LB1 WFC3/IR GRISM/IMAGE (03) (1)	4.167225 Secs (33.338 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]* *[==>(Pattern 5)]* *[==>(Pattern 6)]* *[==>(Pattern 7)]* *[==>(Pattern 8)]*	***[1]***
3	Direct image	(1) LS-V-+22-25	WFC3/IR, MULTIACCUM, GRISM256	F130N	SAMP-SEQ=RAPID; NSAMP=2		Pattern 1, Exps 1-3 in LB1 WFC3/IR GRISM/IMAGE (03) (1)	0.55563 Secs (4.445 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]* *[==>(Pattern 5)]* *[==>(Pattern 6)]* *[==>(Pattern 7)]* *[==>(Pattern 8)]*	***[1]***
4	F128N image	(1) LS-V-+22-25	WFC3/IR, MULTIACCUM, IRSUB256	F128N	NSAMP=15; SAMP-SEQ=RAPID		Pattern 2, Exps 4-5 in LB1 WFC3/IR GRISM/IMAGE (03) (2)	4.167225 Secs (16.669 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
5	F130N image	(1) LS-V-+22-25	WFC3/IR, MULTIACCUM, IRSUB256	F130N	NSAMP=15; SAMP-SEQ=RAPID		Pattern 2, Exps 4-5 in LB1 WFC3/IR GRISM/IMAGE (03) (2)	4.167225 Secs (16.669 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Orbit Structure