



14263 - Hubble imaging of a newly discovered active asteroid

Cycle: 23, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
Dr. David Jewitt (PI) (Contact)	University of California - Los Angeles	jewitt@ucla.edu
Dr. Harold A. Weaver (CoI) (Contact)	The Johns Hopkins University Applied Physics Laboratory	hal.weaver@jhuapl.edu
Max Mutchler (CoI) (Contact)	Space Telescope Science Institute	mutchler@stsci.edu
Dr. Jessica Agarwal (CoI) (ESA Member)	Max Planck Institute for Solar System Research	je.agarwal@gmail.com
Dr. Stephen M. Larson (CoI)	University of Arizona	slarson@lpl.arizona.edu
Dr. Jing Li (CoI)	University of California - Los Angeles	jli@igpp.ucla.edu

VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) 324P-LA-SAGRA	WFC3/UVIS	1	12-Sep-2015 21:11:05.0	yes
02	(1) 324P-LA-SAGRA	WFC3/UVIS	1	12-Sep-2015 21:11:07.0	yes

2 Total Orbits Used

ABSTRACT

Active asteroids (also called main-belt comets or MBCs) have the orbital characteristics of asteroids but also show transient, comet-like activity caused by mass-loss. Examples of mass-loss likely caused by sublimation, impact, and rotational effects have been established, while numerous additional processes are capable of launching material from asteroids. We propose two orbits of non-disruptive, target-of-opportunity observations of any newly discovered active asteroid in Cycle 23 in order to constrain the process driving the mass loss.

OBSERVING DESCRIPTION

We request two single-orbit HST visits to image a newly-discovered MBC. The basic objective is to characterize the early-time morphology and establish the initial rates of change in the appearance, so that the need for additional HST observations and their optimum cadence can be realistically determined. In some cases the initial observations alone may be enough to determine whether the morphology is more consistent with sublimation or another origin. In others (as with 313P), the ToO orbits motivate follow-up through the DDT program.

Our basic observing strategy is to take multiple long exposures using WFC3 and a wide bandpass filter (F350LP) for maximum sensitivity. If the nucleus is bright, we will also include some shorter exposures, possibly with a filter having a narrower bandpass (e.g., F621M). Asteroid Scheila, with its ultra-bright nucleus $V=13.7$, represents an end-member case. We used an exposure time of 4 s with the F621M filter to obtain S/N of 200 on the nucleus itself in search of structure at 100 km scales. We used long exposures through the F606W filter to provide a deep search for debris. The F350LP filter provides an 1.6x higher count rate for a target with a solar-type spectrum, so we used that filter for cycle 22 and plan to use it in cycle 23. If the target requires two different exposure times (Scheila did, but other MBCs did not), we plan to use the M1K1C-SUB aperture for the short exposures (only the region around the nucleus is important in this case, and using the subarray prevents the loss of observing efficiency associated with CCD memory dumps) and the full UVIS aperture for the long exposures. We also plan to dither the exposures to mitigate the effects from bad pixels, cosmic rays, and the inter-chip gap.

Previous HST observations show that the timescale for substantial change ranges from weeks (P/2013 P5, Scheila, P/2013 R3) to several months (P/2010 A2, 300163, 313P). Therefore, while the first observation should be scheduled as soon as possible after discovery of activity, the science does not require that the first visit be secured within the first three weeks. So ours is a non-disruptive Target of Opportunity program, which will not require heroic scheduling. The first visit will set the scene, by establishing the high-resolution morphology of the object (at 60 km pixel⁻¹ at 2 AU geocentric distance). The second visit, ideally separated from the first by 14 days, will reveal the changes. The two visits together will allow us to make a rational decision about the need for further observations with HST. Main-belt targets have apparent rates of motion typically under 50 arcsec per hour, which are easily within Hubble's tracking capabilities. This rate of motion is also slow enough to keep a single pair of guide stars within the FGS pickles for an entire visibility window. The ephemeris uncertainty of numbered asteroids is negligible (sub-arcsecond), compared to the WFC3 field-of-view of 162x162 arcsec. For newly discovered objects the uncertainty can be larger but, as we showed even for the low surface brightness and morphologically complex example set by P/2010 A2, attaining 1 to 2 arcsec accuracy is straightforward. Ephemeris issues are of no concern to this observation. We understand that we will have essentially no control over the spacecraft roll angle, which means we will not be able to optimize

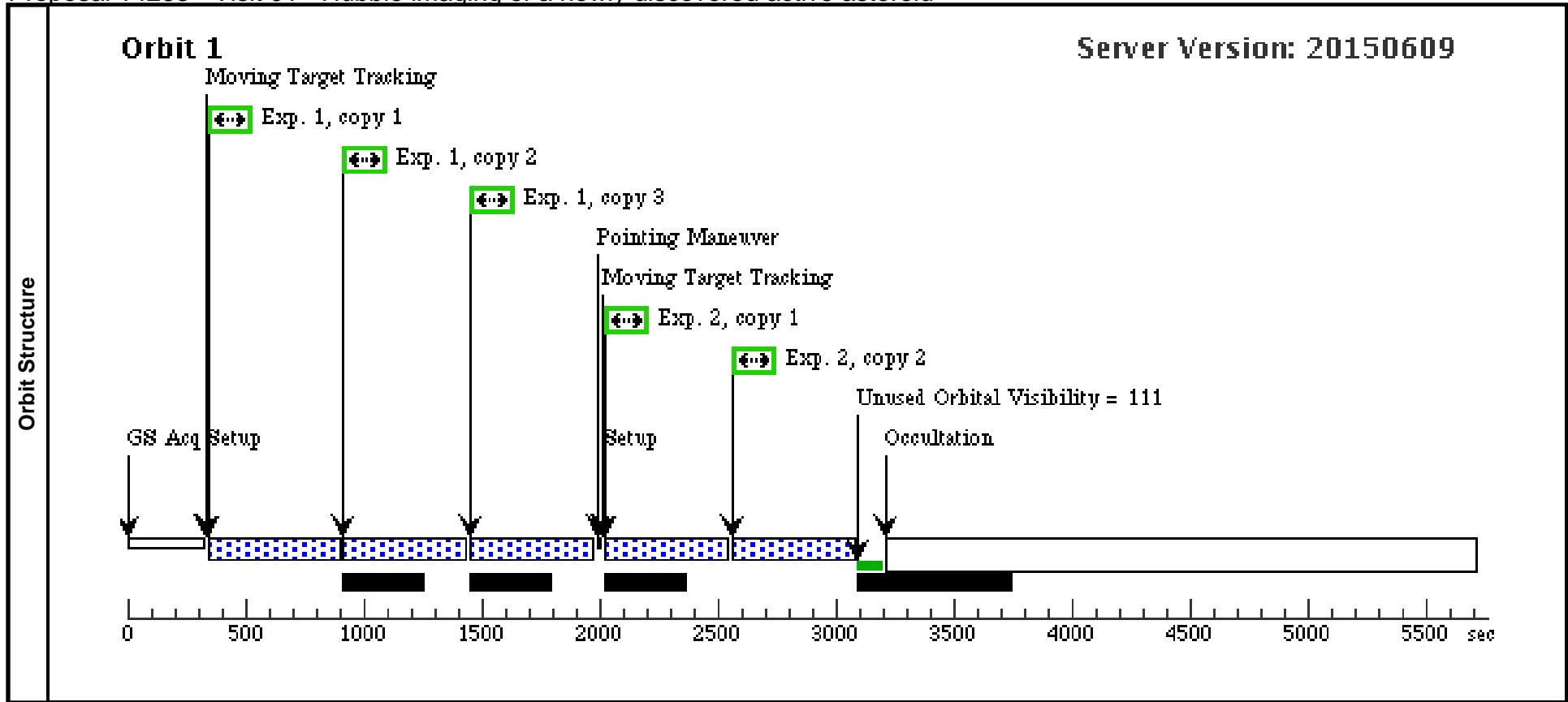
the orientation of the dust tail on the CCD (i.e., to orient the tail along the longest dimension of the detector). However, the field-of-view of the camera is large enough that we should obtain excellent data on a portion of the tail, no matter what spacecraft roll angle is used. Finally, we note that our team can prepare and submit a Phase 2 proposal within hours of activation of this ToO program.

The trigger for these observations is the discovery of an object in the main-belt having a Tisserand parameter with respect to Jupiter (TJ) greater than 3.1 and showing a coma or tail. Comets have $TJ < 3$, asteroids have $TJ > 3$. The parameter is useful only in the context of the circular, restricted three-body approximation. As a result, objects with TJ very close to 3 can be either cometary or asteroidal in nature. In practice, we take $TJ > 3.1$ as the dividing line, since objects with larger TJ cannot be dynamically linked to the classical comets. The Tisserand constraint is quite stringent, and avoids any possibility of confusion with classical comets. With one exception, the known MBCs have been discovered serendipitously by sky surveys conducted for other purposes. We expect this mode of discovery to continue. Co-I Larson is PI of the Catalina Sky Survey (CSS) which discovered or co-discovered coma at (596) Scheila, P/2013 R3 and 313P. The CSS will be used to obtain astrometric and photometric data on objects discovered elsewhere (or by CSS itself) in support of the HST observations in this proposal. When this program is triggered, we will define the real target with the best available orbital elements, possibly make other strategic adjustments, and then resubmit via APT. Over the last 7 yrs MBCs have been discovered by on-going surveys at the average rate of about one per year. From this, and bearing in mind statistical fluctuations, we estimate that the probability that an MBC will be discovered in the next HST Cycle is 50% to 100%.

Proposal 14263 - Visit 01 - Hubble imaging of a newly discovered active asteroid

Sun Sep 13 01:11:08 GMT 2015

Visit	Proposal 14263, Visit 01, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none)									
	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center		
	(1)	324P-LA-SAGRA	TYPE=COMET,Q=2.6198233109113 45,E=0.153784445570409,I=21.41695 747394586,O=270.6516569004608,W =58.56915804482286,T=29-NOV- 2015:22:58:10,TimeScale=TDB,EQ UINOX=J2000,EPOCH=28-AUG- 2015:00:00:00,EpochTimeScale=TDB					EARTH		
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(1) 324P-LA-SAGR A	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO		Sequence 1-2 Non-Int in Visit 01	410 Secs X 3 (1230 Secs) [=>(Copy 1)] [=>(Copy 2)] [=>(Copy 3)]	[1]
2		(1) 324P-LA-SAGR A	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.0		Sequence 1-2 Non-Int in Visit 01	410 Secs X 2 (820 Secs) [=>(Copy 1)] [=>(Copy 2)]	[1]



Proposal 14263 - Visit 02 - Hubble imaging of a newly discovered active asteroid

Sun Sep 13 01:11:09 GMT 2015

Visit	Proposal 14263, Visit 02, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: AFTER 01 BY 7 D TO 16 D									
	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center		
	(1)	324P-LA-SAGRA	TYPE=COMET,Q=2.6198233109113 45,E=0.153784445570409,I=21.41695 747394586,O=270.6516569004608,W =58.56915804482286,T=29-NOV- 2015:22:58:10,TimeScale=TDB,EQ UINOX=J2000,EPOCH=28-AUG- 2015:00:00:00,EpochTimeScale=TDB					EARTH		
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(1) 324P-LA-SAGR A	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO		Sequence 1-2 Non-Int in Visit 02	410 Secs X 3 (1230 Secs)	
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)]	[1]
	2		(1) 324P-LA-SAGR A	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.0	Sequence 1-2 Non-Int in Visit 02	410 Secs X 2 (820 Secs)	
								[==>(Copy 1)] [==>(Copy 2)]	[1]	

