13475 - Hubble Imaging of a Newly Discovered Main Belt Comet

Cycle: 21, 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) MBC-2013P5	WFC3/UVIS	1	11-Sep-2013 21:14:27.0	yes
02	(2) MBC-2013P5-V2	WFC3/UVIS	1	11-Sep-2013 21:14:37.0	yes

2 Total Orbits Used

ABSTRACT

Main-belt comets (MBCs, or ``active asteroids'') have the orbital characteristics of asteroids but also show transient, comet-like activity. Examples of mass-loss likely caused by ice sublimation and by impact 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 the next MBC

discovered in order to help determine the process driving mass-loss.

OBSERVING DESCRIPTION

This proposal is a straightforward continuation of our (so-far un-triggered) ToO approved in Cycle 20. 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 (as with P/2010 A2, for instance), the initial observations alone will be enough to determine whether the morphology is more consistent with sublimation or another origin. In others, careful study of the photometry and evolution over long intervals will be needed for this purpose. Our observing strategy is to take both short and long exposures using WFC3 and a single filter (F606W). Asteroid Scheila, with its ultra-bright nucleus V~13.7, represents an end-member case. We used an exposure time of 0.5 sec (the shortest available) to obtain S/N~200 on the nucleus itself in search of structure at ~100 km scales. An intermediate exposure time of ~40 s brought out the near-nucleus environment without saturating too many pixels, while long exposures of ~400 s provided the deepest search for debris. We plan to take a sequence of at least 3 images (one for each exposure time) at one location on the CCD and then repeat that sequence of images at a dithered location (offset by 0.2" in each dimension). Dithered, multiple images provide protection from bad pixels and cosmic ray strikes that otherwise might compromise the photometry. Previous HST observations show that the timescale for substantial change ranges from several weeks (Scheila) to several months (P/2010 A2).

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 two 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 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 ~50"/hr, 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". 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" 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.

ADDITIONAL COMMENTS

The trigger for these observations is the discovery of an object in the main-belt having a Tisserand parameter TJ >= 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 (the blue dots in Figure 1). 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 coma at (596) Scheila. 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. Over the last 6 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%.

Visit

Proposal 13475, Visit 01, scheduled Thu Sep 12 01:14:45 GMT 2013

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: VISIBILITY INTERVAL 52.5 M

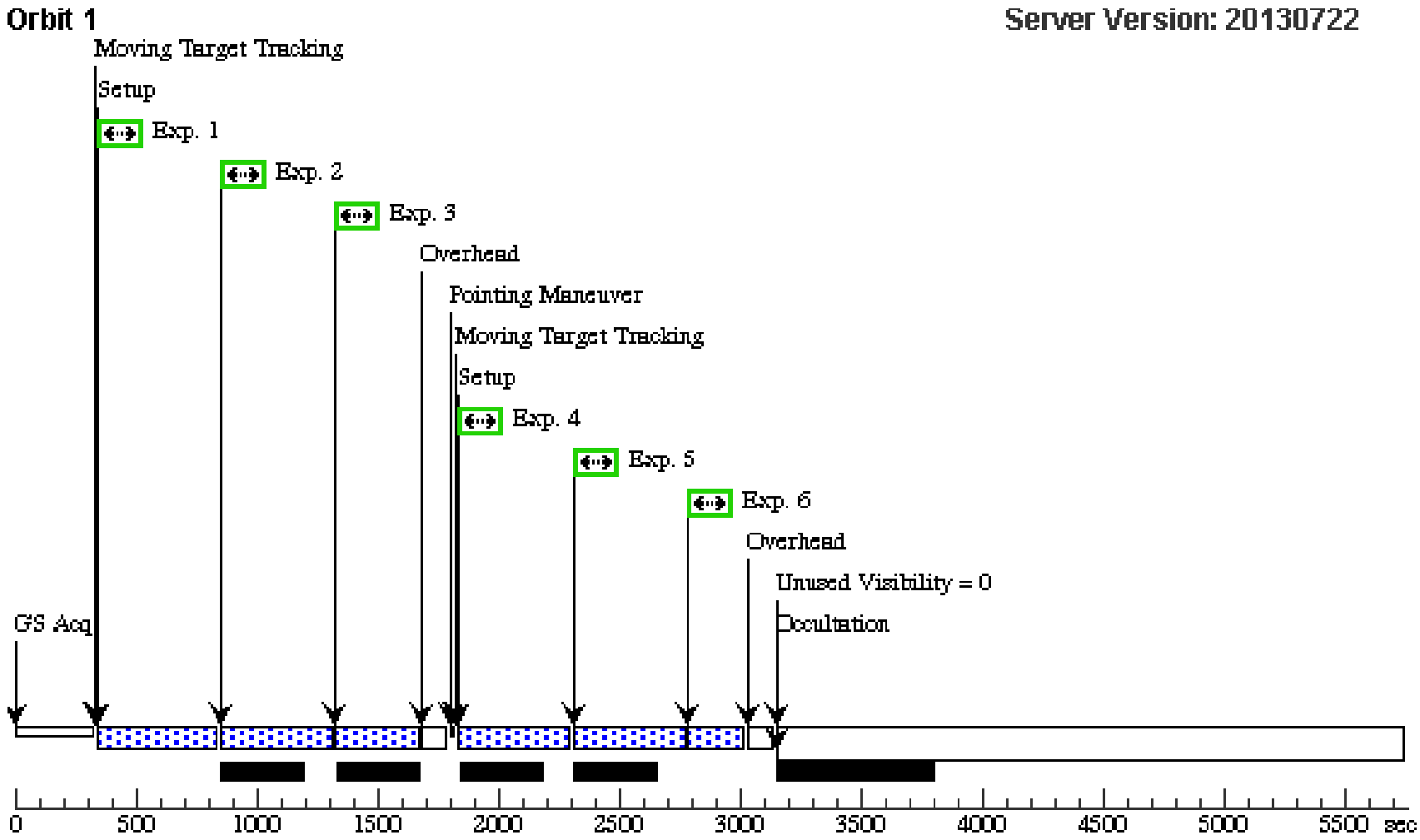
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	MBC-2013P5	TYPE=COMET,Q=1.93384934892737,E=0.1173619073956487,I=4.981097557209049,O=279.3844915611511,W=144.9317439481429,T=17-APR-2014:21:25:27,TTimeScale=TDT,EQUINOX=J2000,EPOCH=22-AUG-2013:00:00:00,EpochTimeScale=TDT				EARTH

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) MBC-2013P5	WFC3/UVIS, ACCUM, UVIS1	F350LP	CR-SPLIT=NO			348 Secs (348 Secs)	
								[==>]	***[1]***
2		(1) MBC-2013P5	WFC3/UVIS, ACCUM, UVIS1	F350LP	CR-SPLIT=NO			348 Secs (348 Secs)	
								[==>]	***[1]***
3		(1) MBC-2013P5	WFC3/UVIS, ACCUM, UVIS1	F350LP	CR-SPLIT=NO			348 Secs (348 Secs)	
								[==>]	***[1]***
4		(1) MBC-2013P5	WFC3/UVIS, ACCUM, UVIS1	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.41		348 Secs (348 Secs)	
								[==>]	***[1]***
5		(1) MBC-2013P5	WFC3/UVIS, ACCUM, UVIS1	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.41		348 Secs (348 Secs)	
								[==>]	***[1]***
6		(1) MBC-2013P5	WFC3/UVIS, ACCUM, UVIS1	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.41		233 Secs (233 Secs)	
								[==>]	***[1]***

Orbit Structure



Visit

Proposal 13475, Visit 02, implementation Thu Sep 12 01:14:47 GMT 2013

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 12-SEP-2013 AND 13-OCT-2013; VISIBILITY INTERVAL 52.5 M

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	MBC-2013P5-V2	TYPE=COMET,Q=1.936403971304516,E=0.1152027633258743,I=4.967974595638397,O=279.2852123089732,W=144.2069632687044,T=15-APR-2014:17:39:45,TTimeScale=TDT,EQUINOX=J2000,EPOCH=28-AUG-2013,EpochTimeScale=TDT				EARTH

Comments: Updated to JPL #2 orbital elements

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) MBC-2013P5-V2	WFC3/UVIS, ACCUM, UVIS1	F350LP	CR-SPLIT=NO			348 Secs (348 Secs)	
								[==>]	***[1]***
2		(2) MBC-2013P5-V2	WFC3/UVIS, ACCUM, UVIS1	F350LP	CR-SPLIT=NO			348 Secs (348 Secs)	
								[==>]	***[1]***
3		(2) MBC-2013P5-V2	WFC3/UVIS, ACCUM, UVIS1	F350LP	CR-SPLIT=NO			348 Secs (348 Secs)	
								[==>]	***[1]***
4		(2) MBC-2013P5-V2	WFC3/UVIS, ACCUM, UVIS1	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.41		348 Secs (348 Secs)	
								[==>]	***[1]***
5		(2) MBC-2013P5-V2	WFC3/UVIS, ACCUM, UVIS1	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.41		348 Secs (348 Secs)	
								[==>]	***[1]***
6		(2) MBC-2013P5-V2	WFC3/UVIS, ACCUM, UVIS1	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.41		233 Secs (233 Secs)	
								[==>]	***[1]***

Orbit Structure