14939 - Extraordinary Comet C2017 K2

Cycle: 24, Proposal Category: GO/DD

(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) 2017K2	WFC3/UVIS	1	15-Jun-2017 21:07:06.0	yes

1 Total Orbits Used

ABSTRACT

A new comet has been discovered with very special characteristics. C/2017 K2 is an in-bound, short-period comet with perihelion at 1.7 AU, currently remarkably far away at 16 AU from the Sun (between the orbits of Saturn and Uranus). The fact that it is active at such large distance on the inbound leg of the orbit is very special because a) temperatures at 16 AU (~70 K) are too cold for water ice (the normal driver of cometary activity) to sublimate b) temperatures are also too cold for the leading alternate activity mechanism (the crystallization of amorphous ice) to occur and c) it is unlikely that residual heat from an earlier approach to the Sun is driving the activity. Either another volatile or another mechanism must drive the activity in this distant body. We seek HST observations to set the baseline characterization of this unique object, to constrain the size of the nucleus and to establish the morphology of the ejected material at a resolution and sensitivity only HST can provide. These data will provide

important context for observations in subsequent cycles to examine K2 as it enters first, the crystallization zone and then the water ice sublimation zone, on its way to perihelion in 2023.

OBSERVING DESCRIPTION

We request DDT orbits with WFC3 and the F350LP filter to image C/2017 K2. The broad F350LP filter (effective center ~6230A, FWHM ~4760A) gives maximum sensitivity to faint emission. We need Hubbles high angular resolution and stable point-spread function (PSF) to photometrically isolate the nucleus from surrounding dust. Early scheduling of the first observation would be advantageous in order to determine the initial morphology. If possible, one of the observations should be scheduled near June 26+/-10 in order to benefit from the largest angle (~2.8 degree) of the HST above the orbital plane of K2. This geometry will provide the best separation of syndyne and synchrone (Finson and Probstein 1968) type dust trajectories and hence the best constraints on the particle size (note: radiation pressure induces size-dependent spatial separation of particles in the orbital plane, which cannot be observed when the out-of-plane angle is small). The observing geometry is otherwise stable near heliocentric distance = 16.2 AU, geocentric distance = 16.1 AU, and phase angle = 4 deg over the next three months. Subsequent visits should be spaced by 3 to 4 weeks in order to give ample time for the morphology to change. The current ephemeris uncertainty is smaller than 1 arcsec but grows on later dates owing to the short arc of observations available at the time of writing this proposal (May 24). We will procure astrometry as needed using the Lick Observatory Nickel telescope. At 20th magnitude, continued astrometry of K2 will be simple and the ephemeris accuracy is expected to remain at the 1 arcsec level indefinitely. Given the high latitude of K2 (declination ~ +59 deg), entry into the HST 50 degree sun exclusion zone does not occur until 2024. We understand that we will have essentially no control over the spacecraft roll angle, which means that we will not be able to optimize the orientation of the dust coma on the CCD (e.g., to orient the tail along the longest dimension of the detector). However, the field-of-view of the camera is large enough and the target coma small enough that we should obtain excellent data, no matter what spacecraft roll angle is used. Our main science objectives follow.

(1) Establish the initial morphology of the dust coma of K2 and from it derive key dust parameters. In steady-state, the shape of the cometary coma is determined by the outflow speed, by the isotropy of the source emission and by the effects of solar radiation pressure. Deflection of the dust by radiation pressure allows us to make comparison with dust dynamics models to estimate dust parameters. The most strongly constrained quantity is usually the radiation pressure efficiency, " , which is an an inverse measure of particle size. The dust speed is estimated from the sunward extent of the coma (e.g. Jewitt et al., 2015) and from expansion of the coma in well-spaced images. Knowing the particle size and speed will help constrain the ejection mechanism. For example, gas drag should accelerate small particles to the speed of sound while leaving large particles at low velocities comparable to the nucleus gravitational escape speed, with a " dependence. Impact and rotational instabilities, on the other hand, should lead to a

nearly size-independent ejection speed. (2) Obtain high resolution, high signal-to-noise ratio images from which we can extract the brightness of the nucleus. The latter is proportional to the product of geometric area with albedo. Since all comets measured so-far have similar low albedos (0.03 - 0.04), we can infer the nucleus cross-section and effective radius from the HST data. We will use our convolution model to obtain the best estimate of the nucleus brightness. Angular resolution and stability of the pointsource function are key to the success of this measurement. We note that, at 20 AU, 1 arcsec corresponds to 15,000 km, while each 0.04 arcsec WFC3 pixel subtends 580 km. Measurements at ground-based resolution blur the signal from the nucleus with the light scattered from all the dust in a surrounding ~15,000 km radius circle, while from HST the coma contamination problem is reduced by at least an order of magnitude. At 20 AU, a 10 km nucleus would have magnitude V ~ 26, well within range of WFC3. (3) Determine whether or not K2 is in outburst. Photometric outbursts (essentially, explosions) are common in comets (e,g. Trigo-Rodriguez et al. 2008; Li et al. 2011) and frequently result in the discovery of comets previously unknown because they were too faint to be detected (Gronkowski and Wesolowski 2016). This could be the case for K2 (explaining why, although at 20th magnitude when integrated over a 10 arcsec radius aperture, this comet had not been previously detected by Pan STARRS or any other all-sky survey). Repeated observations will be used to assess the photometric and morphological stability of K2 at HST resolution.

Visit

Proposal 14939, Visit 01, scheduling — Fri Jun 16 01:07:07 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 27-JUN-2017:00:00:00 AND 28-JUN-2017:00:00:00

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.4 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	2017K2	TYPE=COMET,Q=1.78864152000868,E=.9662614696036717,I=87.5084336265801,O=88.66424440693754,W=239.186710850003,T=14-APR-2023:00:08:17,TTimeScale=TDB,EQUINOX=J2000,EPOCH=29-MAY-2017:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) 2017K2	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F350LP	CR-SPLIT=NO		Sequence 1-1 Non-Int in Visit 01 Pattern 1, Exps 1-1 in Sequence 1-1 Non-Int in Visit 01 (1)	285 Secs X 3 (1710 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]*	***[1]***

Proposal 14939 - Visit 01 - Extraordinary Comet C2017 K2