15709 - An extreme interacting supernova from a very massive star: probing the immediate and galaxy-scale environment of a new pair-instability candidate

Cycle: 26, 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) PS16AQY	ACS/WFC WFC3/UVIS	2	18-Mar-2019 12:00:18.0	yes

2 Total Orbits Used

ABSTRACT

Supernovae that strongly interact with their immediate environments offer a unique way to probe mass loss from very massive stars, with critical implications for understanding stellar evolution and the expected distribution of remnant masses. We have discovered one of the most extreme interacting supernovae to date, PS16aqy, at a redshift of 0.265 but with no detectable host galaxy in ground-based imaging. We have conducted a

multi-year follow-up campaign revealing a very slowly fading light curve and a radiated energy well in excess of the canonical 1e51 erg supernova explosion energy. It may in fact exceed the electromagnetic output of any previous SN. Spectroscopy shows narrow and intermediate Balmer emission lines that persist throughout its evolution. The combination suggests ongoing interaction with several tens of solar masses of circumstellar medium. This requirement for very high mass and explosion energy may be indicative of an extremely massive star and possibly a pair instability or pulsational pair instability supernova, critical for our understanding of stellar evolution.

The transient is now sufficiently faint that it can only be studied using HST. A single optical image will extend our temporal baseline for light curve modelling by 50%, enabling much tighter constraints on the properties of the CSM, which is the key to understanding this event. At the same time a high resolution UV image of the host galaxy will allow us to determine the star-formation rate at the explosion site as a clue to the progenitor mass. This proposal could not be submitted during the regular Call for Proposals as no Small Programs were permitted in the original Cycle 26 call.

OBSERVING DESCRIPTION

We propose to obtain an optical image of supernova PS16aqy in Cycle 26 using the Advanced Camera for Surveys (ACS) in the F775W filter, where we expect the transient to be brightest due to the presence of H-alpha emission, and a UV image of the host galaxy using Wide Field Camera 3 (WFC3) in the F390W filter, corresponding to rest-frame 3000 Angstroms.

Taking into account the visibility window per orbit of 60 min, and the time needed for guide star acquisition, dithering (in a standard 4 point pattern) and per-exposure overheads for each instrument, the available time per orbit for integration on the target is about 2500s for ACS, and 2700s for WFC3. We expect to detect the transient with S/N > 20 and the galaxy with S/N > 10.

Visit

Proposal 15709, Visit 01 Mon Mar 18 16:00:18 GMT 2019

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS, ACS/WFC

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-WFC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.262 Line Spacing=0.192	Coordinate Frame=POS-TARG Pattern Orientation=18.39 Angle Between Sides=68.14 Center Pattern=false		(1)
(2)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(2)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	PS16AQY	RA: 10 19 2.1700 (154.7590417d) Dec: +74 42 24.67 (74.70685d) Equinox: J2000		V=26	Reference Frame: ICRS

Comments:
Category=EXT-STAR
Description=[SUPERNOVA]
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) PS16AQY	ACS/WFC, ACCUM, WFC1	F775W			Pattern 1, Exps 1-1 in Visit 01 (1)	500 Secs (2496 Secs) *[==>624.0 Secs (Pattern 1)]* *[==>624.0 Secs (Pattern 2)]* *[==>624.0 Secs (Pattern 3)]* *[==>624.0 Secs (Pattern 4)]*	***[1]***
2		(1) PS16AQY	WFC3/UVIS, ACCUM, UVIS1	F390W	FLASH=6		Pattern 2, Exps 2-2 in Visit 01 (2)	500 Secs (2784 Secs) *[==>696.0 Secs (Pattern 1)]* *[==>696.0 Secs (Pattern 2)]* *[==>696.0 Secs (Pattern 3)]* *[==>696.0 Secs (Pattern 4)]*	***[2]***

Orbit Structure