14058 - Using the WPVS 007 Occultation Event to Constrain the Astrophysics of Quasar Outflows

Cycle: 22, Proposal Category: GO/DD

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Prof. Karen M. Leighly (PI) (Contact)	**University of Oklahoma Norman Campus**	**leighly@nhn.ou.edu**
Dr. Dirk Grupe (CoI)	Morehead State University	d.grupe@moreheadstate.edu
Dr. Stefanie Komossa (CoI) (ESA Member)	Max-Planck-Institut fur Radioastronomie	skomossa@mpifr-bonn.mpg.de
Ms. Erin Cooper (CoI)	University of Oklahoma Norman Campus	cooper@nhn.ou.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) QSO-003916-511701	COS/FUV COS/NUV	2	14-Mar-2015 21:05:37.0	yes

2 Total Orbits Used

ABSTRACT

Outflowing gas, recognised through broad absorption lines, is an important component of quasars. Yet outflow astrophysics is poorly understood. Absorption line variability is a valuable tool, offering constraints on distance from the continuum emission region, density, and homogeneity and stability of the outflow.

Unique absorption-line variability has been observed in the Seyfert 1 galaxy WPVS 007. Observed to have a miniBAL with maximum velocity v_max~1000 km/s in an 1996 FOS observation, it displayed an additional BAL flow with v_max~6,000 km/s in a 2003 FUSE observation. A 2010 COS observation showed a dramatic increase of v_max to ~13,000 km/s, dropping to ~8,900 km/s in 2013. This unusual variability may be observable in WPVS~007 on years timescales due to its small spatial and temporal scales.

WPVS 007 is the only broad absorption line object with extensive Swift monitoring. Since 2010, it has shown a secular decrease in UV flux. Since December 2014, the rate of decrease has increased, with significant variability on timescales of a week. The most recent observations are accompanied by an strong increase in reddening.

It seems likely that WPVS 007 is now undergoing an occultation event. Observing the response of the broad absorption lines on long and short time scales to this event can constrain the location and nature of the outflowing gas. If we wait to observe it until Cycle 23, we could miss important transient effects that are key to the understanding of quasars in general and BALS in particular. We therefore request three orbits of DD time to observe the short term response of the absorption lines to this event.

OBSERVING DESCRIPTION

We were awarded one observation of WPVS 007 using COS in the FUV channel with the G140L grating. We have observed this object using HST in 2010 as part of a Cycle 17 proposal, and more recent in 2013 as

part of a Cycle 20 proposal. We have been monitoring it with Swift UVOT since 2005. Recently (since December 2014), the Swift monitoring indicated that WPVS 007 has been entered a low state, where it seems to be approaching the low-flux state observed by HST FOS in 1996.

****

PROPERTIES OF WPVS 007:

The reddening of our Galaxy in the direction of WPVS 007 is 0.012 mag. The redshift is z=0.02882. The GSC II states that the best optical magnitude is 13.6. This, however, is the integrated magnitude for the galaxy which is resolved at this redshift. A better recent estimate for the AGN is V=15.59, based on Swift UVOT observations on February 28 and March 7, 2015. Comparison with the magnitude from December 2013 (15.4) leads us to assign an uncertainty of 0.3 magnitude. The corresponding recent UVW2 magnitudes (central wavelength 1928 Angstroms) on these dates are 15.48, with an uncertainty of about 0.7 magnitudes.

The brightest line in the FUV is Lyalpha, and it will be present in the spectrum. Using an approximate spectral model based on the FOS spectrum of WPVS 007, but renormalizing it to the flux observed during the high-flux 2010 COS observation, we find that the brightest pixel (at Lyalpha) attains a count rate of only 0.09 counts/s (COS.sp.416496).

****

OBSERVATION DETAILS:

The principal absorption lines of interest are Ly alpha, SiIV, and CIV. For this object, with z=0.02882, these lines lie slightly blueward of 1250, 1440, and 1595 Angstroms. Using CENWAVE=1105 will provide good throughput at these lines. We use all four FP-POS for the best signal-to-noise ratio.

ACQUISITION:

WPVS007 is in the GSC2 and therefore it has ICRS coordinates with positional uncertainties of 0.3 arc seconds in RA and 0.33 arcseconds in dec. These uncertainties are less than the nominal value of 0.4, and therefore we do not have to do a ACQ/SEARCH. Rather, we will start with an ACQ/IMAGE to acquire the object. This is the same method we used for the 2013 observations.

To develop the acquisition strategy, we consider the range of fluxes that might possibly be present. The flux density of the object was ~1.0e-14 erg/s/cm^2/A during the 2010 COS observation; this marks the historical high flux state. Recently, the flux has been decreasing, approaching the low-flux-state spectrum that it had when observed by HST FOS in 1996. That spectrum has a flux density 2.5e-15 erg/s/cm^2/A in the vicinity of 1500 Angstroms observed frame. So we consider a flux density range of 0.25-1.0e-14 erg/s/cm^2/A account for variability. The COS Instrument handbook Figure 8.3 indicates that we can use the PSA aperture and MIRRORB for this flux range, and Table 8.3 indicates that we need a S/N of 40. Using a heavily-smoothed version of the HST FOS spectrum, extended toward short wavelengths using a

scaled FOS quasar composite (Zheng et al. 1991), we use the COS ETC to determine the exposure time, finding that 51 seconds will be adequate to produce the required S/N=40 (Table 8.3; COS.ta.668122). We increase that value to 100 seconds. This is the same value we used for the 2013 observations.

The APT BOT estimates that the object should be too bright for this acquisition. This is because the conservative assumptions made by the BOT are not appropriate for this target. First, it uses the magnitude given in the GSC2 of 13.6. That is the magnitude for the galaxy, which is resolved at this redshift, rather than the target, which has a magnitude closer to 15.6. Second, it assumes a OV star spectrum, whereas the object is a modestly reddened AGN. The continuum flux level is about 0.25--1.0e-14 erg/s/cm^2/A at 1500 Angstroms.

SCIENCE EXPOSURES:

All exposures are chosen to be in TIME-TAG mode and FLASH is set to Yes. We use a heavily smoothed version of the HST FOS spectrum (the low state), extended to shorter wavelengths using the FOS quasar composite spectrum (Zheng et al.\ 1991), to demonstrate feasibility (COS.sp.668636, COS.sp.668637). We also test a 4-times brighter spectrum, corresponding to the historical flux maximum in order to estimate the buffer time. The COS ETC estimates a buffer time of 3,144 seconds (COS.sp.668220) for the high-flux state. We choose a conservative value of 800 seconds for the buffer time.

Visit

Proposal 14058, Visit 01, implementation Sun Mar 15 01:05:38 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Diagnostics

(Visit 01) Warning (Form): If the target coordinates are not known to 0.4" (or better), an ACQ/SEARCH should precede the ACQ/IMAGE.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	QSO-003916-511701 Alt Name1: WPVS007 Alt Name2: GSC1ID0803000885	RA: 00 39 15.8290 (9.8159542d) Dec: -51 17 1.41 (-51.28373d) Equinox: J2000	Proper Motion RA: 0.0 Proper Motion Dec: 0.0 Parallax: 0.0" Epoch of Position: 2000 Redshift: 0.02882	V=15.59+/-0.3 Swift UVOT W2 (cen. wave = 1 928 Angstroms) : 15.48 +/- 0.7	Reference Frame: ICRS

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	WPVS007 ACQ (COS.ta.668122)	(1) QSO-003916-511701	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				100 Secs (100 Secs) *[==>]*	***[1]***
2	WPVS007 (COS.sp.668636)	(1) QSO-003916-511701	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=1; FLASH=YES; BUFFER-TIME=800			1186 Secs (1186 Secs) *[==>]*	***[1]***
3	WPVS007 (COS.sp.668636)	(1) QSO-003916-511701	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=2; FLASH=YES; BUFFER-TIME=800			1186 Secs (1186 Secs) *[==>]*	***[1]***
4	WPVS007 (COS.sp.668637)	(1) QSO-003916-511701	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=3; FLASH=YES; BUFFER-TIME=800			1475 Secs (1475 Secs) *[==>]*	***[2]***
5	WPVS007 (COS.sp.668637)	(1) QSO-003916-511701	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=4; FLASH=YES; BUFFER-TIME=800			1475 Secs (1475 Secs) *[==>]*	***[2]***

Orbit Structure