11733 - WPVS 007: the little AGN that could

Cycle: 17, Proposal Category: GO

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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) QSO-003916-511701	COS/FUV COS/NUV	2	10-May-2010 21:03:21.0	yes

2 Total Orbits Used

ABSTRACT

Outflows are important components of AGN, potentially removing angular momentum, enriching the intergalactic medium, and potentially playing a key role in the evolution of galaxies. Yet their astrophysics is poorly understood. We propose an FUV observation of the Seyfert-luminosity AGN WPVS 007 (M_V=-19.7, z=0.02882) using COS, coordinated with a short Chandra observation. Observed to have a miniBAL with maximum velocity v_max~1000 km/s in an 1996 HST observation, it was discovered to have developed an additional BAL flow by the time of the FUSE observation in 2003. The BAL flow has maximum velocity of at least 6,000 km/s, and the unambiguous presence of PV indicates that it is very optically thick. In addition, it was found to have normal X-ray flux during the ROSAT All Sky Survey, but in subsequent observations from 1993 to 2003 it was observed to be X-ray weak, suggesting that the X-rays were absorbed by the emerging BAL.

Our proposed observations will contribute to our understanding of outflows in three key areas. First, an observed relationship between v_max and luminosity that is plausibly related to the acceleration mechanism is violated in WPVS 007; thus WPVS 007 presents a challenge to outflow models. Second, the observed evolution of the BAL flow may be related to the small black hole mass and correspondingly compact emission and absorption regions; thus, WPVS 007 offers the rare opportunity to observe evolution of the outflow on human time scales. Finally, while WPVS 007 has been observed to be X-ray weak since 1993, a recent long Swift observation revealed the first detection of hard X-ray emission. The proposed observations will reveal whether this emergence of hard X-rays is accompanied by a decrease in the UV absorption, and thus test the relationship between X-ray and UV absorbers in BALQSOs.

OBSERVING DESCRIPTION

We propose an observation of WPVS 007 using COS in the FUV channel with the G140L grating. To estimate the exposure time, we use a continuum spectrum constructed using the average of the FOS spectra from two NLS1s, Mrk 335 and Mrk 493 scaled to the HST FOS spectrum of WPVS 007. Of the spectra of NLS1s in the HST archive, these were found to be most similar to WPVS 007, and plausibly represent its unabsorbed spectrum. Note that it was scaled to the observed (i.e., absorbed) WPVS 007 spectrum. We smoothed the spectrum by fitting piecewise with a spline function. We used the absorption profile derived from the PV line in the FUSE spectrum. To estimate the optical depths of the absorption troughs, we used the lower limit on the column density inferred from the PV line in the FUSE spectrum (Leighly et al. 2008), and using the fractional ionization information in Hamann 1997, and the difference in phosphorus and carbon abundances, we find that the log of the column density in C+3 should be ~18.3. Taken as it is, this number predicts very large optical depths in the CIV (larger than the PV line by approximately a factor of the abundance ratios between phosphorus and carbon). It is more plausible that the absorption is saturated and partially covers the emission region. Therefore, for simulations, we assume the profiles to scale with the PV profile by a factor of 2.5, a median value from the deconvolution of the FUSE spectrum (Leighly et al. 2008). We simulate absorption lines from Lyalpha, NV, SiIV, and CIV.

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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 estimate for the AGN is 15.8. We estimate an uncertainty in this value of 0.5 due to AGN variability. A more relevant flux would be the continuum flux observed at 1400 Angstroms of F(lambda)=2.7e-15 erg/s/cm^2/A in the archival HST FOS spectrum. The brightest line in the FUV is Lyalpha. Integrating over the line, we find a line flux of approximately 1.5e-12 erg/s/cm^2. The line width is approximately 4 angstroms, ignoring the region of the line that is absorbed by the miniBALs.

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OBSERVATION DETAILS:

ACQUISITION:

Exposure 1 and 2 are target acquisitions. WPVS007 is in the GSCII and therefore it has ICRS coordinates with positional uncertainties of about 0.3 arc seconds. Because of the small aperture, we need to begin with an ACQ/SEARCH. As discussed in the COS Instrument Science Report 2008-01(v1), it is recommended to start with a SCAN-SIZE=2 search with default STEP-SIZE=1.767. Using the ETC (Exposure ID=COS77767) based on the simulated spectrum discussed above yields an estimate of 18.33 seconds for a signal-to-noise ratio of 40. We increase that to 27 seconds to account for possible variability of the target.

After the search phase, we use an ACQ/IMAGE in the NUV to acquire the object. We use the simulated spectrum discussed above and the exposure time calculator to estimate the time needed to attain a SNR of 40 in the NUV. The flux of the object at the peak of the NUV sensitivity curve (2400 Angstroms; Fig. 6.1 of COS Instrument handbook) is about 3.5e-15 erg/s/cm^2/A, or 3.5 FEFU. According to information on page 61 in the handbook (and also from an ETC run), the object is too bright for Mirror A, but not too bright for Mirror B. The ETC, using the HST FOS spectrum, indicates that for Mirror B, an exposure of 36 seconds is necessary to attain a signal-to-noise ratio of 40. It should be noted that the input spectrum bandpass is 1000-6626 Angstroms. However, while it is reddened in the UV, it apparently has only galactic reddening in the optical; thus the contribution to the count rate due to the red leak is not expected to be very large. The ETC number of this simulation is COS77792.

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 GSCII of 13.6. That is the magnitude for the galaxy, which is resolved at this redshift; i.e., the target is not a point source with magnitude of 13.6. Second, it assumes a OV star spectrum, whereas the object is a modestly reddened AGN, nearly flat in Flambda between 1000 and 6626 Angstroms. The continuum flux level is about 3e-15 erg/s/cm^2/A at 1400 Angstroms, falling to about 1e-15 erg/s/cm^2/A at 6000 Angstroms.

EXPOSURES:

Exposures 3-5 are choosen to be TIME-TAG. Exposure 3 accounts for the remainder of the first orbit after acquisition, and Exposure 4&5 account for the second orbit after reacquisition.

Using the HST FOS spectrum, we find that the buffer time for the 1230 central wavelength setting is 12473 seconds. Two thirds of this time is still much longer than our exposure time. Therefore, the BUFFER_TIME is set equal to the exposure time in each exposure.

In order to improve the potential signal-to-noise ratio, we choose to observe the object at several FP-POS. Rather than use FP-POS=AUTO, we explicitly assign the three science exposures to the three FP-POS positions.

In order to optimize the wavelength calibration of the spectra, we choose FLASH=YES.

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ANALYSIS

Our analysis will focus on the CIV, SiIV, and Lyalpha lines in particular. CIV and SIV are doublets, but we can deconvolve them using the technique described in Junkkarinen, Burbidge & Smith (1983). We expect that the CIV absorption should have the same kinematics as the high-ionization gas, and since it is not likely to be blended with absorption by any other ions (unlike OVI in the FUSE spectrum; Leighly et al. 2008), we

will be able to securely measure the maximum velocity of the absorber. In some BALQSOs, the lower-ionization line SiIV is observed to have a somewhat different profile than the higher-ionization lines such as CIV (e.g., Junkkarinen et al. 1983). We will compare the absorption profiles to learn about the ionization structure of the outflow. Finally, in some BALQSOs the SiIV line has a similar profile as the PV (e.g., Junkkarinen et al. 2001). We can thus compare the SiIV line with the PV line from the FUSE spectrum
to look for evolution in the absorption.

ADDITIONAL COMMENTS

A 20ks Chandra observation was approved with this proposal. The Chandra observation should be coordinated with this observation. Ideally, they should be simultaneous. However, we can tolerate up to +/-30 days offset with some loss of science. In addition, we were awarded Swift monitoring observations and a long XMM-Newton observation. They will be slaved to the HST schedule.

Visit

Proposal 11733, Visit 01, implementation — Tue May 11 01:03:26 GMT 2010

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	QSO-003916-511701 Alt Name1: 2MASXJ00391586-5117013 Alt Name2: WPVS007	RA: 00 39 15.8290 (9.8159542d) Dec: -51 17 1.41 (-51.28373d) Equinox: J2000	Redshift: 0.02882	V=13.6+/-0.5 F(lambda)=2.7e-15 erg/s/cm^2/A at 1400 Angstroms (HST FOS spectrum), integrated flux over Lyalpha=1.5 e-12 erg/s/cm^2	Reference Frame: ICRS

Comments: V magnitude given is the "best magnitude" from GSCII and includes the contribution of the host galaxy (negligible in the far UV), and resolved at this redshift.
Other fluxes were obtained from the HST FOS spectrum, including continuum flux at 1400 Angstroms, and the integrated flux over Lyalpha (the brightest line in the FUV). The FWHM of the Lyalpha line is approximately 4 angstroms (excluding portion of the line absorbed by the miniBAL).

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) QSO-003916-511701	COS/FUV, ACQ/SEARCH, PSA	G140L 1230 A	SCAN-SIZE=2; STEP-SIZE=1.767			27 Secs *[==>]*	***[1]***
2		(1) QSO-003916-511701	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				36 Secs *[==>]*	***[1]***
3		(1) QSO-003916-511701	COS/FUV, TIME-TAG, PSA	G140L 1230 A	FLASH=YES; BUFFER-TIME=2086; FP-POS=1			2086 Secs *[==>]*	***[1]***
4		(1) QSO-003916-511701	COS/FUV, TIME-TAG, PSA	G140L 1230 A	FLASH=YES; BUFFER-TIME=1487; FP-POS=2			1487 Secs *[==>]*	***[2]***
5		(1) QSO-003916-511701	COS/FUV, TIME-TAG, PSA	G140L 1230 A	FLASH=YES; BUFFER-TIME=1487; FP-POS=3			1487 Secs *[==>]*	***[2]***

Proposal 11733 - Visit 01 - WPVS 007: the little AGN that could