16728 - Physical diagnostics of AGN feedback from the first spatially resolved UV spectra of a jet-driven AGN outflow

Cycle: 29, Proposal Category: GO

(UV Initiative)

(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	(2) J0113+0106-BLOB (3) J011340.94+010730.71-ACQ-STAR	COS/FUV COS/NUV	1	11-Jan-2022 12:00:12.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
02	(1) J0113+0106-JET (3) J011340.94+010730.71-ACQ-STAR	STIS/CCD STIS/FUV-MAMA	3	11-Jan-2022 12:00:13.0	yes

4 Total Orbits Used

ABSTRACT

Galaxy evolution models require feedback from AGN to suppress star-formation in massive galaxies. However, the mechanisms that enable AGN feedback to reach galactic scales are hotly debated. Two key models are: (1) direct radiation pressure on dust and (2) ISM entrainment in hot winds. Measurements of the presence and properties of any hot wind component of AGN outflows thus represent a critical means of identifying dominant AGN feedback mechanisms. Sensitive and spatially resolved UV diagnostics from highly ionized emission go beyond differentiating AGN photoionized gas and shocks to serve as barometers that enable estimates of any hot wind pressure. These highly ionized UV line diagnostics (O VI/N V) were recently used to demonstrate that the dynamics of the UV emitting, outflowing clouds from a prototypical superwind driven by a radio-quiet AGN are dominated by radiation pressure with negligible compression by a hot wind. These observations indicate that this AGN outflow is driven by radiation pressure or was driven by a hot wind that has since dissipated despite ongoing AGN activity. On the other hand, AGN outflows driven along the jets of radio-loud systems are thought to be ISM entrained in a hot wind associated with the jets. To test this prediction, we propose the first spatially resolved UV spectroscopy and complementary high-resolution VLA data of a known 5-30 kpc outflow of a recently rejuvenated radio-loud AGN. This will enable unique insights into the wind driving mechanisms, the physical conditions/properties of the outflow, and a detailed study of the jet and cool outflow morphology compared to a radio-quiet case.

OBSERVING DESCRIPTION

Our program goal is to obtain UV spectroscopy of the outflows driven by a radio-loud obscured quasar, J0113+0106 at z=0.2809. The spectra will enable UV diagnostics of the physical conditions of the outflowing gas based on the Ly-alpha, NV, and OVI emission lines. These lines occur at observed wavelengths of 1323, 1557, and 1587 Angstroms at z=0.2809. Based on optical spectra of the source, the line widths will be hundreds of km/s, so the low-resolution UV dispersers on COS and STIS are ideal.

COS is a more sensitive UV spectrograph, and its large aperture is well-matched to the size of the Ly-alpha blob. We will therefore use COS G140L to observe the Ly-alpha blob, which covers the desired wavelength range. The spectral resolution of COS G140L will be degraded due to the

extended nature of the target but is still more than sufficient for our purposes. The desired S/N can be obtained in 1 orbit. We will split the COS observations into four exposures, each at a different FP-POS setting to minimize flat fielding errors in the final spectrum.

The COS aperture is too large to separate emission knots along the jet, so observing this region requires using STIS in longslit mode. We will orient the slit with the line connecting the knots along a position angle between 238.3 and 239.3 degrees, requiring an ORIENT of 283.3-284.3 degrees or 103.3-104.3 degrees. The knots observed in Ly-alpha emission are well matched to the 52x2" long slit, which will deliver the desired spectral coverage and resolution when paired with the G140L disperser. The desired exposure time can be achieved in three orbits which we will package into a single STIS visit to minimize overheads.

To schedule the STIS observations, we will use the 2" slit width, which enabled a larger range of ORIENT options and enabled scheduling of the observations.

The morphologies of both the nucleus and the blob are complicated and not well suited to direct target acquisition. Therefore, we will perform acquisition using a star, J011340.94+010730.71-ACQ-STAR, which has NUV- and i-band magnitudes of 22.3 and 16.3, respectively. The offset from the acquisition star to the two science targets is 1.3 arcmin. Coordinates for all three objects are from the Hyper Suprime-Cam survey. HSC astrometry is tied to GAIA and has a precision of 0.03 arcsec or better. We verified the acquisition star coordinates against GAIA directly and found excellent agreement.

For COS, we will use ACQ/IMAGE acquisition with MIRRORA and a total exposure of 130 seconds, delivering an S/N of 35 (COS.ta.1525952). For the STIS CCD acquisition, we will use the F28X50LP filter with an exposure time of 3 seconds, delivering S/N more than sufficient for target acquisition (STIS.ta.1526127).

The COS aperture and STIS slit are large enough that we do not anticipate issues if operating in 2-gyro mode apart from somewhat increased overheads when slewing from the acquisition star to the science targets.

Visit

Proposal 16728, Blob-COS (01), implementation Tue Jan 11 17:00:14 GMT 2022

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Comments: Spectroscopic observations of an [O III] emitting blob with COS+G140L. The acquisition sequence is performed on a nearby star followed by an offset to the science target position

Diagnostics

(Exposure 2 (Blob-COS (01))) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

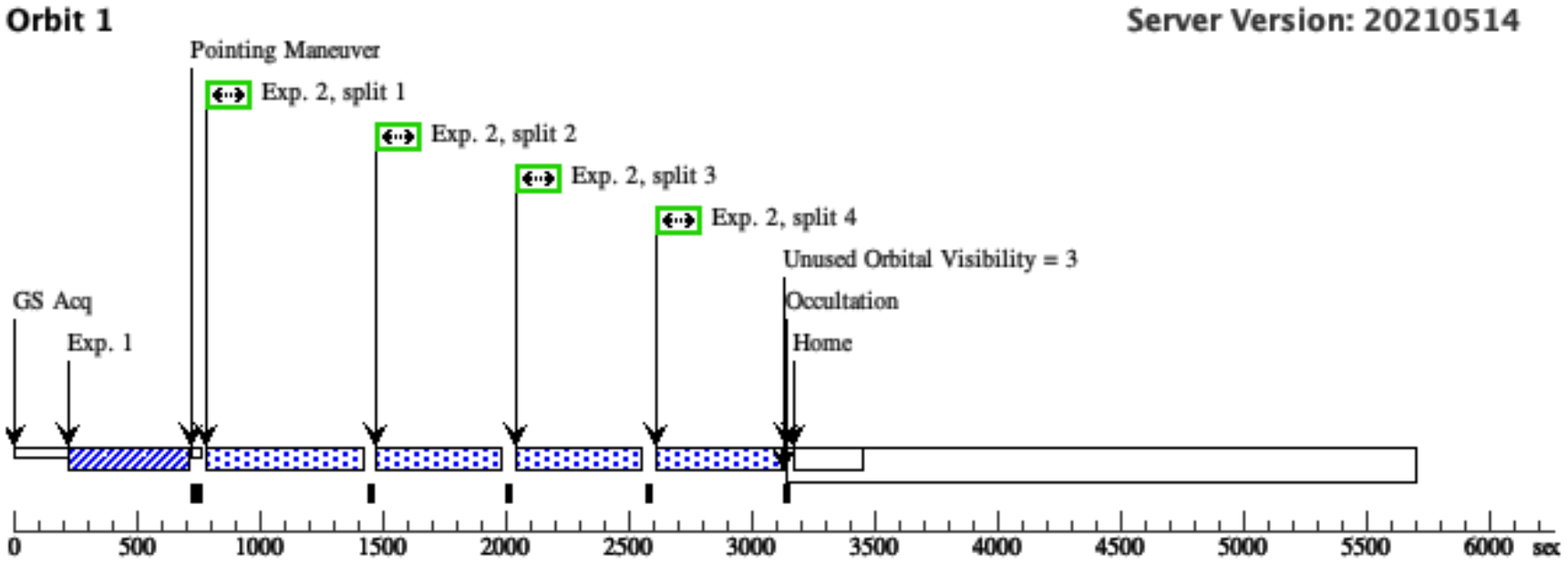
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	J0113+0106-BLOB	RA: 01 13 40.8165 (18.4200688d) Dec: +01 06 11.59 (1.10322d) Equinox: J2000		V=21.8	Reference Frame: ICRS
Comments: *Category=EXT-MEDIUM* *Description=[WIND]* *Extended=YES*					
(3)	J011340.94+010730.71-ACQ-STAR	RA: 01 13 40.9420 (18.4205917d) Dec: +01 07 30.71 (1.12520d) Equinox: J2000		V=16.5 NUV=22.3 i=16.3	Reference Frame: ICRS
Comments: Coordinates are from GAIA+HSC *Category=STAR* *Description=[G III-I, G V-IV]* *Extended=NO*					

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	acquisition (COS.ta.1525952)	(3) J011340.94+010730.71-ACQ-STAR	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				130 Secs (130 Secs) *[==>]*	 ***[1]***
2	(COS.sp.1526200)	(2) J0113+0106-BLOB	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=ALL; BUFFER-TIME=9854			300 Secs (1844 Secs) *[==>461.0 Secs (Split 1)]* *[==>461.0 Secs (Split 2)]* *[==>461.0 Secs (Split 3)]* *[==>461.0 Secs (Split 4)]*	 ***[1]***

Orbit Structure



Visit

Proposal 16728, Jet-STIS (02), implementation Tue Jan 11 17:00:14 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: SCHED 70%; ORIENT 193D TO 194 D; ORIENT 13D TO 14 D

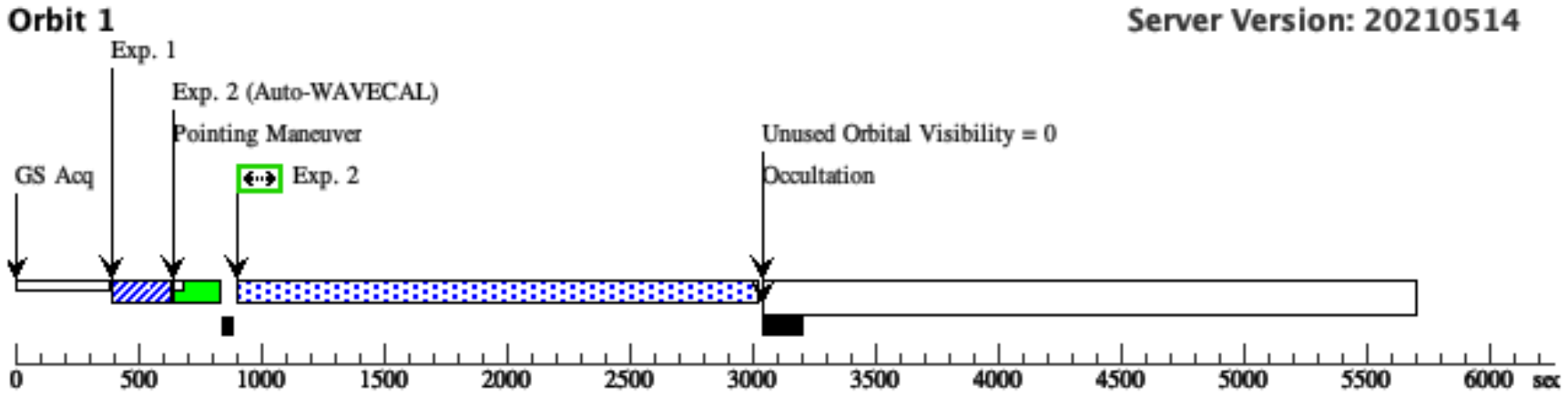
Fixed Targets

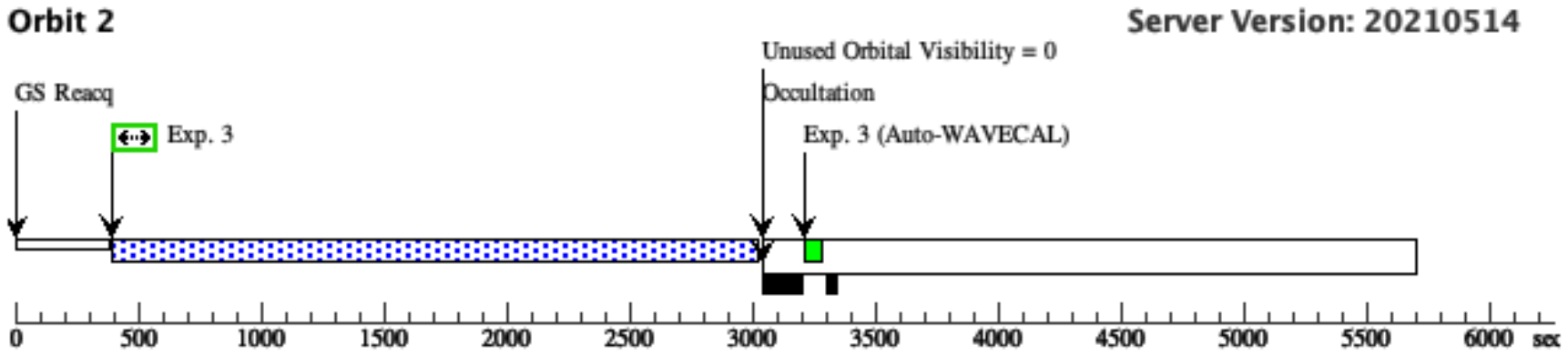
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	J0113+0106-JET	RA: 01 13 41.1198 (18.4213325d) Dec: +01 06 8.52 (1.10237d) Equinox: J2000		V=19.1 NUV=21.7	Reference Frame: ICRS
Comments: *Category=GALAXY* *Description=[QUASAR, RADIO GALAXY, WIND]* *Extended=YES*					
(3)	J011340.94+010730.71-ACQ-STAR	RA: 01 13 40.9420 (18.4205917d) Dec: +01 07 30.71 (1.12520d) Equinox: J2000		V=16.5 NUV=22.3 i=16.3	Reference Frame: ICRS
Comments: Coordinates are from GAIA+HSC *Category=STAR* *Description=[G III-I, G V-IV]* *Extended=NO*					

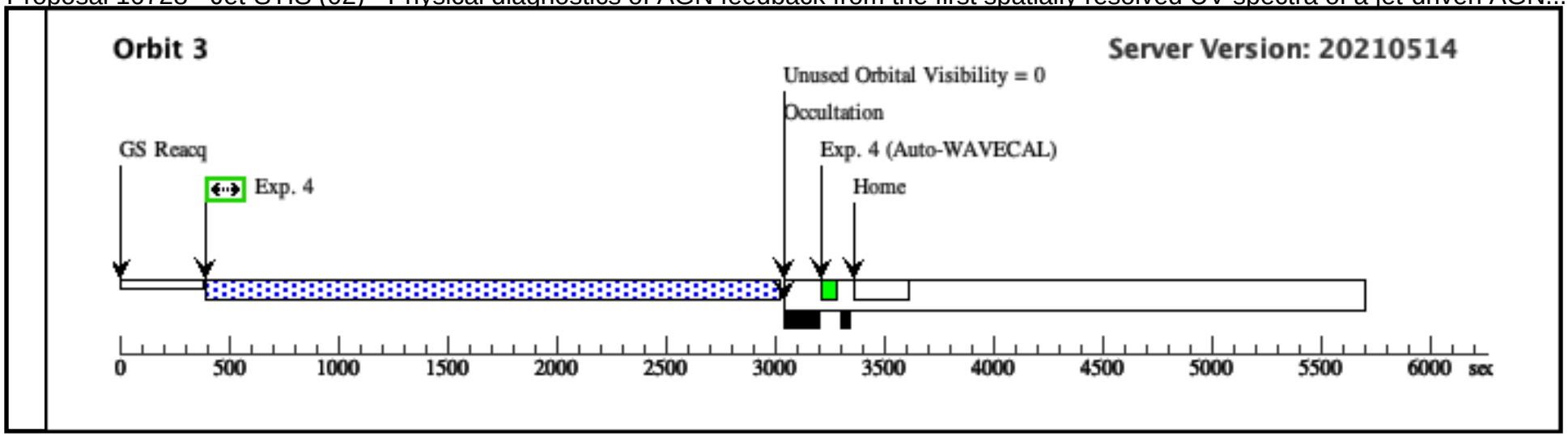
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	acquisition (STIS.ta.1526127)	(3) J011340.94+010730.71-ACQ-STAR	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			3 Secs (3 Secs) *[==>]*	 ***[1]***
2	(STIS.sp.1526186)	(1) J0113+0106-JET	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140L 1425 A	BUFFER-TIME=5864			1600 Secs (2108 Secs) *[==>2108.0 Secs]*	 ***[1]***
3	(STIS.sp.1526186)	(1) J0113+0106-JET	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140L 1425 A	BUFFER-TIME=5864			1600 Secs (2620 Secs) *[==>2620.0 Secs]*	 ***[2]***
4	(STIS.sp.1526186)	(1) J0113+0106-JET	STIS/FUV-MAMA, TIME-TAG, 52X0.2	G140L 1425 A	BUFFER-TIME=5864			1600 Secs (2620 Secs) *[==>2620.0 Secs]*	 ***[3]***

Orbit Structure



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