14751 - Resolving Fe-rich Neutral ISM in a Massive Quiescent Galaxy at z~0.4

Cycle: 24, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Mr. Fakhri S Zahedy (PI) (Contact)	**University of Chicago**	**fsz@uchicago.edu**
Prof. Hsiao-Wen Chen (CoI) (Contact)	University of Chicago	hchen@oddjob.uchicago.edu
Prof. Ann Zabludoff (CoI)	University of Arizona	azabludoff@as.arizona.edu
Dr. Michael Rauch (CoI)	Carnegie Institution of Washington	mr@obs.carnegiescience.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) HE0047-1756AB	STIS/CCD STIS/FUV-MAMA	3	07-Feb-2017 21:02:02.0	yes
02	(2) HE0047-1756AB-COPY	STIS/CCD STIS/FUV-MAMA	1	07-Feb-2017 21:02:03.0	yes

4 Total Orbits Used

ABSTRACT

Roughly 40% of elliptical galaxies are found to contain cool gas but exhibit no on-going star formation, indicating that some feedback mechanisms are at work. While AGN feedback is commonly thought to be responsible for quenching star formation in massive halos, recent work has reiterated the importance of feedback from old stellar populations, including Type Ia supernovae (SNe Ia). In Zahedy et al. (2016), we reported detections of ultra-strong MgII absorption (>3.6 Ang) at 1-2 effective radii of a massive quiescent lensing galaxy at z=0.408. Strong MgII, FeII, MgI, and CaII absorption are found at the lens redshift along two lensed QSO sightlines separated by ~8 kpc. The absorbers are resolved into 15 components with

line-of-sight velocity spread of ~600 km/s. The large observed ionic column densities, N>1e14 cm^-2 suggest large neutral hydrogen column densities N(HI)>1e18 cm^-2 and a significant neutral gas fraction. The most striking feature is the uniformly large Fe/Mg ratio across the full 600 km/s velocity range, suggesting a large contribution in chemical enrichment from SNe Ia (>20%). Here we propose QSO absorption-line spectroscopy of this unique system using STIS and the G140L grating with the slit oriented along the two lensed QSOs. The goal is to determine N(HI) from observations of the full Lyman absorption series and gas-phase metallicity of the interstellar medium at two locations separated by ~8 kpc in an elliptical galaxy beyond the local universe. With a modest investment of HST time, we will be able to examine the extent SNe Ia-driven feedback in a distant quiescent galaxy using this unique double-lens system.

OBSERVING DESCRIPTION

We will obtain medium-resolution (R~1200) FUV spectra of the two images of the lensed QSO HE0047-1756 using the FUV-MAMA detector and the G140L grating in the Space Telescope Imaging Spectrograph (STIS). The primary goals of the proposed FUV spectroscopic observations are (1) to determine the neutral hydrogen column density, N(HI), and (2) constrain the metallicity of the cool gas found in the ISM of the lensing galaxy.

Exposure Time Estimation:

Based on our previous experience, we estimate that a signal-to-noise ratio (SNR) of >10 is necessary to place strong constraints on N(HI) and the metallicity of the gas. From GALEX observations of the field around HE 0047-1756, the combined (the two QSO images are unresolved in GALEX) FUV magnitude of the two images is FUV(AB) = 18.50. Using optical flux ratio of image A and B from Wisotzki et al. (2004) of 3.5:1, we estimate that the FUV magnitudes of images A and B of HE0047-1756 are FUV(AB)_A =18.77 and FUV(AB)_B = 20.13, respectively. Since the STIS long-slit mode will allow us to observe both images simultaneously, our exposure time estimate is determined by the required exposure time to reach the desired SNR for the fainter QSO image (image B). Using the latest STIS exposure time calculator with the FOS QSO spectral template redshifted to z_em = 1.676 and scaled to FUV(AB_)B = 20.13, we estimate that a total exposure time of 125 minutes (7.5 ks) is required to reach the desired mean SNR >10 for both QSO images using the G140L grating and the 52"x0.2" long slit.

Observing Strategy:

The observations will be performed in a single visit consisting of three HST orbits. We plan to observe both images of the lensed QSO HE0047-1756 simultaneously, which requires the STIS long slit to be aligned along the line connecting the two QSO images on the sky. This slit alignment corresponds to HST orientation (ORIENT) angles of 35.49 and 215.49 degrees. We allow a range of +/-0.5 degree in the ORIENT angles, which given the 0.2"-wide long slit, the 1.4" separation of the two QSO images, and the PSF profile of FUV-MAMA will still include more than 90% of the

light from both QSO images in the slit. Using the Bright Object Tool, we have confirmed that all bright sources within the aperture are safe for observations with FUV-MAMA.

Onboard target acquisition of the brighter QSO image (HE0047-1756A, the listed coordinates of the target) will be performed using STIS/CCD and the F28X50LP filter in the first orbit of the visit. We have confirmed that there is no brighter point source within a 5" radius from HE0047-1756A. Following guide star acquisition and target acquisition (or guide star reacquisition for subsequent orbits), we request 2 sub-exposures for each orbit, corresponding to 2 dither positions of the STIS-ALONG-SLIT dither pattern. To ensure that all spectra taken in different orbits will fall on different areas of the FUV-MAMA detector, we will employ a 6-point dither pattern with a separation of 0.4" between steps.

Proposal 14751 - Visit 01 - Resolving Fe-rich Neutral ISM in a Massive Quiescent Galaxy at z~0.4

Visit

Proposal 14751, Visit 01, failed Wed Feb 08 02:02:04 GMT 2017

Diagnostic Status: No Diagnostics

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

Special Requirements: ORIENT 214.99D TO 215.99 D; ORIENT 34.99D TO 35.99 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG		(2)
	Purpose=DITHER	Pattern Orientation=90.0		
	Number Of Points=6	Angle Between Sides=		
	Point Spacing=0.4	Center Pattern=false		
	Line Spacing=			

Fixed Targets

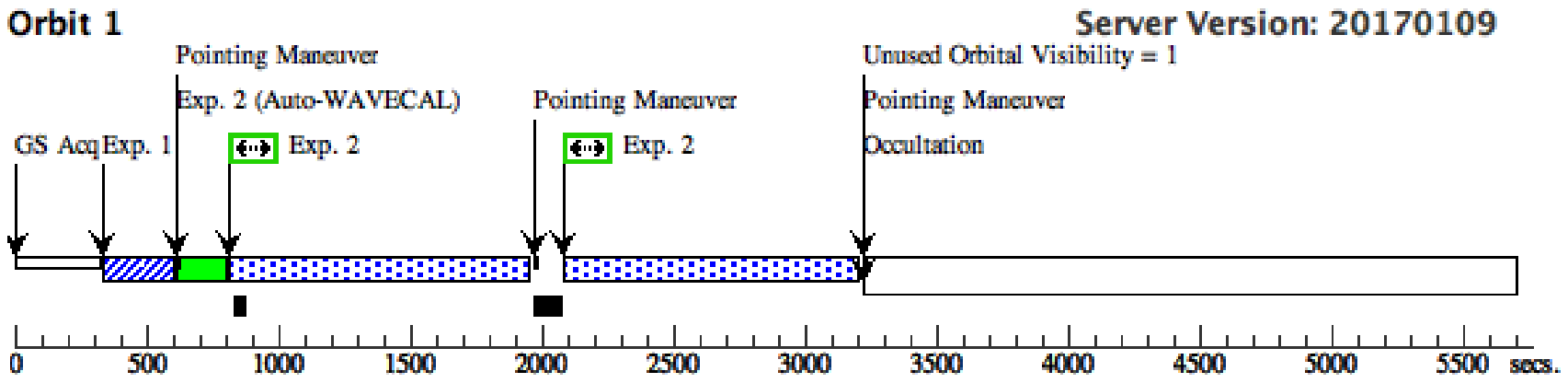
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HE0047-1756AB	RA: 00 50 27.8030 (12.6158458d) Dec: -17 40 8.80 (-17.66911d) Equinox: J2000	Redshift: 1.67	V=17.57 est. GALEX FUV(AB) = 18.77 (A), 20.13 (B)	Reference Frame: ICRS

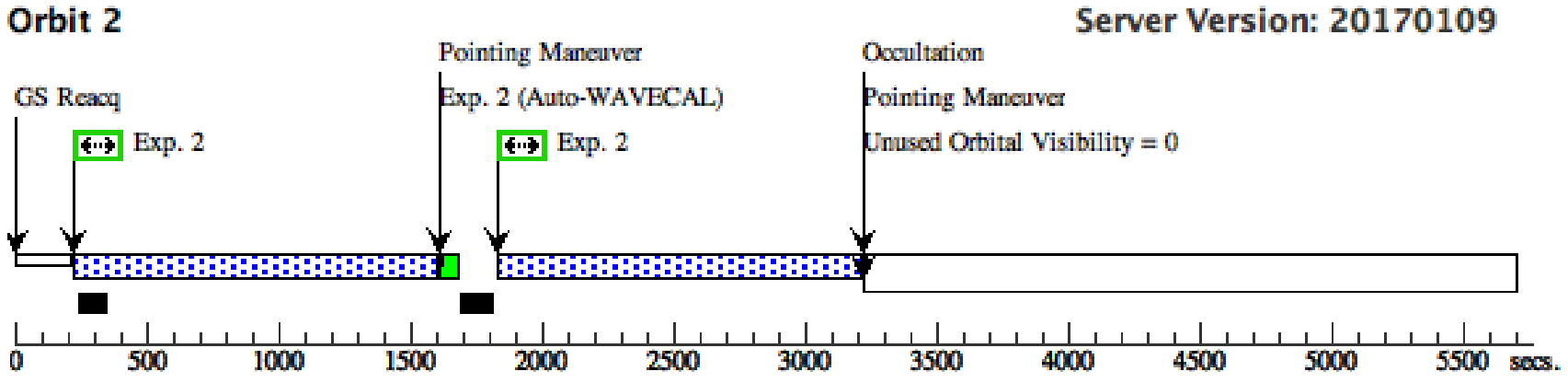
Comments: Listed coordinates are for image A (the brighter lensed QSO image).

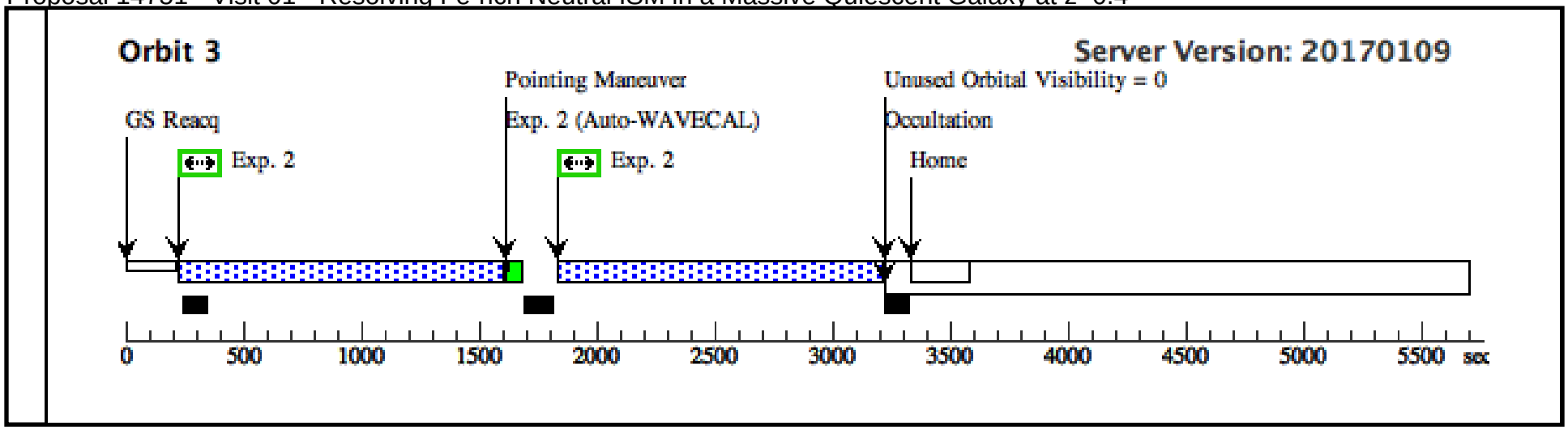
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.827019)	(1) HE0047-1756AB	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			10 Secs (10 Secs)	
								[==>]	***[1]***
2	(STIS.sp.825100)	(1) HE0047-1756AB	STIS/FUV-MAMA, ACCUM, 52X0.2	G140L 1425 A			Pattern 1, Exps 2-2 in Visit 01 (1)	1000 Secs (7689 Secs)	
								[==>1128.0 Secs (Pattern 1)] *[==>1109.0 Secs (Pattern 2)]*	***[1]***
								[==>1363.0 Secs (Pattern 3)] *[==>1363.0 Secs (Pattern 4)]*	***[2]***
								[==>1363.0 Secs (Pattern 5)] *[==>1363.0 Secs (Pattern 6)]*	***[3]***

Orbit Structure






Orbit 3
Server Version: 20170109
GS Reacq
Exp. 2
Pointing Maneuver
Exp. 2 (Auto-WAVECAL)
Exp. 2
Unused Orbital Visibility = 0
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 14751, Visit 02, implementation Wed Feb 08 02:02:04 GMT 2017

Diagnostic Status: Warning

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

Special Requirements: ORIENT 214.99D TO 215.99 D; ORIENT 34.99D TO 35.99 D

Diagnostics

(Visit 02) Warning (Orbit Planner): INVALID GS ACQ SCENARIO SPECIAL REQUIREMENT

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=STIS-ALONG-SLIT	Coordinate Frame=POS-TARG		(2)
	Purpose=DITHER	Pattern Orientation=90.0		
	Number Of Points=2	Angle Between Sides=		
	Point Spacing=0.4	Center Pattern=false		
	Line Spacing=			

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	HE0047-1756AB-COPY	RA: 00 50 27.8030 (12.6158458d) Dec: -17 40 8.80 (-17.66911d) Equinox: J2000	Redshift: 1.67	V=17.57 est. GALEX FUV(AB) = 18.77 (A), 20.13 (B)	Reference Frame: ICRS

Comments: Listed coordinates are for image A (the brighter lensed QSO image).

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(STIS.ta.827019)	(2) HE0047-1756AB-COPY	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT	GS ACQ SCENARIO BASE1B3		10 Secs (10 Secs) *[==>]*	*[1]*
2	(STIS.sp.825100)	(2) HE0047-1756AB-COPY	STIS/FUV-MAMA, ACCUM, 52X0.2	G140L 1425 A		GS ACQ SCENARIO BASE1B3	Pattern 2, Exps 2-2 in Visit 02 (2)	1000 Secs (2237 Secs) *[==>1128 Secs (Pattern 1)]* *[==>1109 Secs (Pattern 2)]*	*[1]*

Orbit Structure