17268 - CO+Methanol absorption: kpc-scale diagnostic of star formation in a proto-galaxy

Cycle: 30, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Bjorn Emonts (PI) (Contact)	**Associated Universities, Inc.**	**bjornemonts@gmail.com**
Dr. George K. Miley (CoI) (ESA Member)	Universiteit Leiden	miley@strw.leidenuniv.nl
Dr. Matthew D. Lehnert (CoI) (ESA Member)	Centre de Recherche Astrophysique de Lyon	matthew.lehnert@univ-lyon1.fr
Dr. Chris Carilli (CoI)	Associated Universities, Inc.	ccarilli@nrao.edu
Dr. Ilsang Yoon (CoI)	Associated Universities, Inc.	iyoon@nrao.edu
Dr. Reinout Johannes van Weeren (CoI) (ESA Member)	Universiteit Leiden	rvweeren@strw.leidenuniv.nl

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) B20902+34	WFC3/IR	1	06-Dec-2022 09:00:31.0	yes

1 Total Orbits Used

ABSTRACT

The baryon cycle of gas in and out of galaxies is fundamental for the evolution of galaxies, clusters, and AGN. Cold molecular gas plays a critical role, but it remains challenging to detect cold gas at the (sub)-kpc scales of individual star formation regions and AGN. To overcome these limitations, molecular gas can be traced in absorption against the background continuum of distant radio sources, but such absorption signals have been mysteriously absent at z>1. We present the first high-z absorption of CO(0-1) and methanol, associated with the proto-cluster radio galaxy B2

0902+34 (z=3.4). We propose to map the CO(0-1) absorption against the complex radio source at a resolution matching that of HST. Goal is to study the distribution, kinematics, and column density of the molecular gas on kpc scales, and compare this to the galaxies, star-forming regions, and circum-galactic clumps seen with HST. We will also confirm and resolve the two 113 GHz methanol absorbers, and target for free also HCN and HCO+, which all trace much denser molecular gas compared to CO. This proposal showcases a unique diagnostic for studying star formation in the Early Universe, and offers an exciting science case for the Next-Generation VLA.

OBSERVING DESCRIPTION

This HST project will collect a 1-orbit deep exposure in the WFC3/F105W filter of radio galaxy B2 0902+34 (z=3.34) and its surrounding environment. This will complement primary VLA observations of molecular gas in this system. The F105W filter was chosen to contain no strong emission lines, hence will observe pure starlight in the radio galaxy, surrounding galaxies, and circum-galactic medium.

Dittering and artifact mitigation: The target region-of-interest is mostly the inner 10 arcsec around the target coordinates. We therefore choose the IR (rather than IR-fix) aperture, to place the target in the optimal default region of the CCD. We are interested in imaging the high-z galaxies, as well as detecting low surface brightness emission on this 10 arcsec scale, and possibly further out. Therefore, we aim to mitigate artifact (blobs) with a single 2-pointing wide ditter, with an additional single 4-point narrow box-ditter at each position to optimize the PSF response (8 exposures in total). By taking the 8 exposures at a different position on the CCD, we can also mitigate potential effects of Earth-shine or strong HeI 10,830 background, in case this would affect one or more of the exposures more than others. We have no experience with potential effects of HeI 10,830 contamination, but unless the HeI background is expected to severely limit our science case for detecting faint low-surface-brightness emission of circum-galactic starlight, we prefer not to use another filter, because those contain contaminating emission lines (e.g., F140W contains MgII, while F160W contains OII).

Zodiacal effects: Our target is at an ecliptic latitude of 16.7 degrees. To mitigate the effects of zodiacal light that may limit detection of low-surface-brightness emission, we adjusted the start and end dates of the observing window to an effective sun avoidance limit of about 65 degrees (i.e., +-10 days compared to the default). Note, however, that we left the final 90 second of our nominal orbit visibility ununsed, which more than compensated for this by increasing the possible observing window of this 1-orbit program to about 55 percent (200 days/yr) visibility over the year. Since this HST program was awarded together with a primary VLA program, and no official Phase-I proposal was submitted through the APT, we kindly request the inclusion of this Visit timing requirement.

Bright objects: While there are several relatively bright stars in the field, all of them are more than 1 arcmin away from our target region and have JHK mag between 12 and 13. Based on our limited experience with analyzing WFC3 images, we do not expect PSF-artifact of these stars to affect our target region.

Reduced-gyro operations: we expect that our program is suitable for, and not negatively affected by, reduced-gyro operations. We do not put any limitations on the orientation, and the visibility window of this proposal (55 percent/200 days per year) is large enough that further restrictions should not limit scheduling of this 1-orbit program.

Visit

Proposal 17268, Visit1 (01) Tue Dec 06 14:00:31 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: BETWEEN 25-SEP-2022:00:00:00 AND 28-MAY-2023:00:00:00; BETWEEN 25-SEP-2023:00:00:00 AND 28-MAY-2024:00:00:00

Patterns

#	Primary Pattern		Secondary Pattern		Exposures
(1)	Pattern Type=WFC3-IR-DITHER-BLOB Purpose=DITHER Number Of Points=2 Point Spacing=5.183 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=41.859 Angle Between Sides= Center Pattern=true	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365	Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false	(1)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	B20902+34 Alt Name1: NVSS-J090530+340756	RA: 09 05 30.1010 (136.3754208d) Dec: +34 07 56.90 (34.13247d) Equinox: J2000	Redshift: 3.396	V=23.8 G_AB=23.9, R_AB=23.0, K=18.8, WISE_W1=15.8 (magnitudes)	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Name was updated to reflect the B2 name of the radio source (for archival purposes), but coordinates did not change and were checked.
Category=GALAXY
Description=[HIGH REDSHIFT GALAXY, LYMAN ALPHA CLOUD, RADIO GALAXY]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Exposure1	(1) B20902+34	WFC3/IR, MULTIACCUM, IR	F105W	SAMP-SEQ=SPARS25; NSAMP=12		Pattern 1, Exps 1-1 in Visit1 (01) (1)	277.937956 Secs (2223.504 Secs) *[==>(Pattern 1,1)]* *[==>(Pattern 1,2)]* *[==>(Pattern 1,3)]* *[==>(Pattern 1,4)]* *[==>(Pattern 2,1)]* *[==>(Pattern 2,2)]* *[==>(Pattern 2,3)]* *[==>(Pattern 2,4)]*	***[1]***

Orbit Structure