



16749 - Direct imaging of CGM substructure with 50 parsec resolution

Cycle: 29, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) 2MASX-J08382309+6507160	WFC3/UVIS	2	30-Jul-2021 11:00:40.0	yes
02	(2) IRAS08339+6517CGM1 (3) IRAS08339+6517CGM2 (4) IRAS08339+6517CGM3	WFC3/UVIS	3	30-Jul-2021 11:00:41.0	yes

5 Total Orbits Used

ABSTRACT

Starbursting galaxies present the best laboratory to study the CGM since they are likely undergoing strong accretion events which trigger intense star formation-driven outflows. However, very few observations exist that have directly imaged their CGM and quantified the fine-scale substructure. Recent ultra-deep Keck/KCWI observations have mapped optical emission lines in the CGM to a distance of over 30 kpc from IRAS08, a nearby starbursting galaxy with evidence for an ongoing accretion event. These KCWI observations contain bright emission line knots with sizes of order hundreds of parsecs and no evidence of stellar continuum, implying a lack of stars. The properties of these emission knots are consistent with cool,

condensing clouds in recent simulations. However, the sizes from KCWI are near the seeing limit, and the continuum measurement is hampered by sky subtraction uncertainties. We aim to use HST to zoom in on this substructure in the CGM of IRAS08 and test hypotheses explaining the sub-kiloparsec features. We propose for 5 orbits of WFC3/UVIS to obtain the H α + [NII] (F665N) and broad-band starlight (F467M & F775W) to measure the sizes and fluxes of the CGM emission knots. These data will allow us to differentiate between three possible scenarios giving rise to these knots, including the cool condensing clouds predicted in high resolution simulations, external HII regions, and dwarf galaxies. These observations are part of a larger program to directly image the optical emission lines of the CGM in starbursting galaxies. This HST imaging will therefore be a Rosetta Stone for interpreting future data as we move into the new era of direct imaging of the CGM.

OBSERVING DESCRIPTION

Narrowband filter F665N: Using the faintest CGM knot from the KCWI observations, we estimate an H α surface brightness by converting the knot's H β surface brightness from KCWI to H α assuming no extinction. This gives an H α surface brightness of $\sim 1 \times 10^{-17}$ erg s $^{-1}$ cm $^{-2}$ arcsec $^{-2}$. For SNR=10, the WFC3 UVIS ETC requires an exposure time of 1334 s (22.2 min), including a post flash of 16 electrons/pix to reach the recommended threshold of 20 electrons/pix to avoid poor CTE. The orbit visibility of our target is ~ 58 minutes, which allows for 46.8 min of exposure time per orbit, or two 23 min exposures, given typical overheads of 11.2 min. We opt to increase our exposure times by a factor of 2x in order to identify fainter emission peaks that may have been washed out due to poor spatial resolution in the KCWI data, which will allow us to measure knot sizes. This will increase our S/N to 15 on the nominal CGM knot measurement and serve to help make more robust observations. The F665N filter is likely to have very significant problems with low background, and is our most important filter for characterizing the morphology and size of the knots. We therefore opt to readout a subset of the pixels in the WFC3 array. We will use the 1k x 1k subarray, and use 3 separate pointings centered on the knots, one pointing per orbit. For each orbit we will use the WFC-UVIS-DITHER-LINE-3PT dither pattern. Thus we require 3 orbits with F665N to cover all CGM knots.

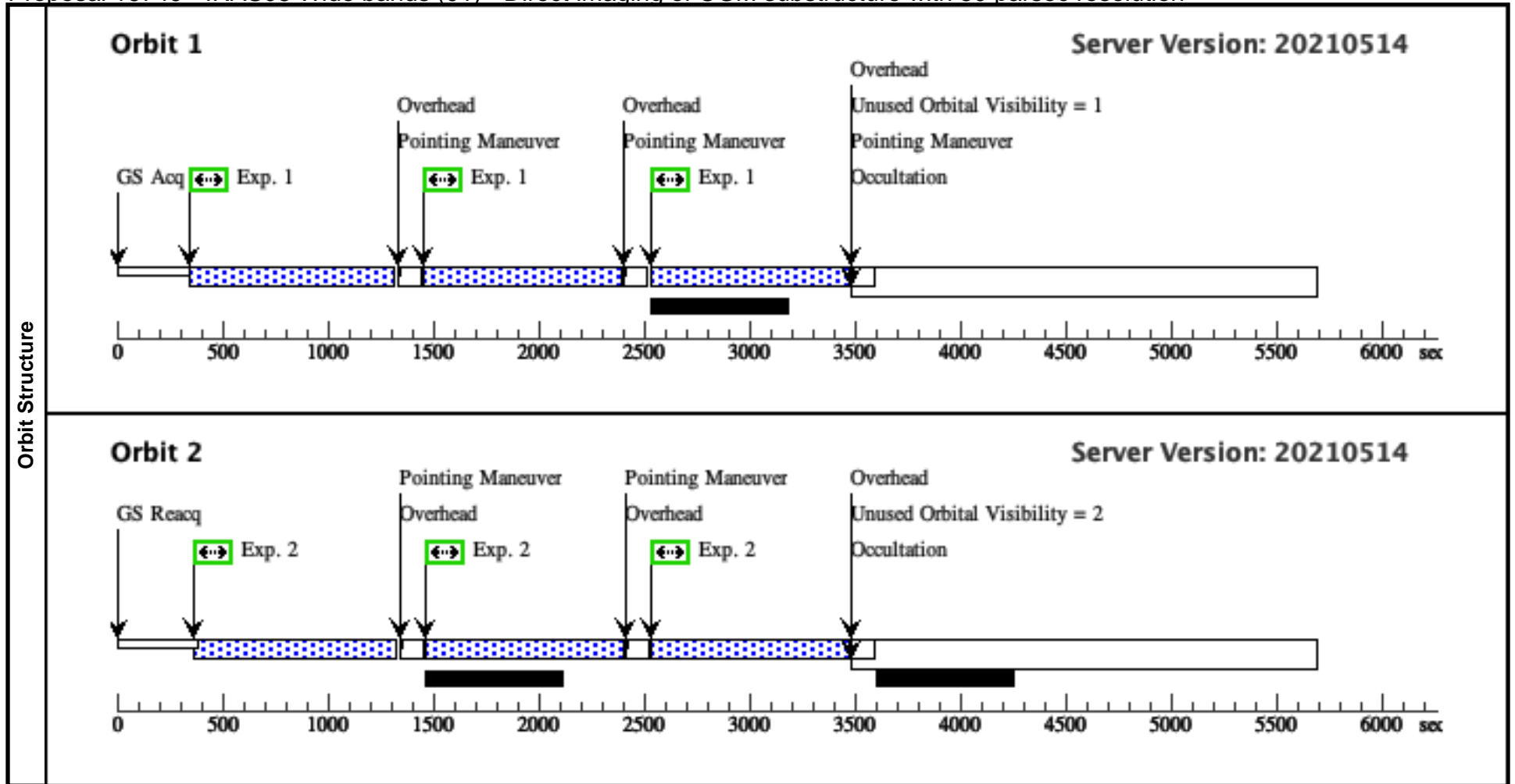
Broadband filters F467M and F775W: In nearby spiral galaxies the median globular cluster luminosity is $M_V \sim -7.5$ mag (Harris 1991). Werk et al (2008) finds that external HII regions are comprised of associations of clusters. Those associations have magnitudes of $M_V \sim -8$ mag and sizes of 50-70 pc, which is similar to our resolution limit. If we consider a point source with $M_V \sim -8$ AB mag (apparent magnitude of 26 mag) at the distance of IRAS08, we can make a 5 sigma detection in F467M just under 1 orbit of HST time (including overheads). We can obtain a similar detection limit in F775W. We will use a full orbit for each filter with the WFC3-UVIS-DITHER-LINE-3PT dither pattern. To mitigate the CTE, the broadband filters require lower levels of post-flash, and therefore we can readout the entire field.

Reduced-gyro operations are likely to have minimal impact given the small number of orbits requested and minimal adjustments in each orbit.

Proposal 16749 - IRAS08 Wide bands (01) - Direct imaging of CGM substructure with 50 parsec resolution

Fri Jul 30 15:00:42 GMT 2021

Visit	Proposal 16749, IRAS08 Wide bands (01) Diagnostic Status: Warning Scientific Instruments: WFC3/UVIS Special Requirements: ORIENT 135D TO 150 D; ORIENT 315D TO 330 D <i>Comments: We have offset the target coordinates slightly from SIMBAD to ensure the central disk is not in the CCD gap with the UVIS-CENTER aperture and to allow for a wider orient range for schedulability. Using the UVIS aperture reduces the available orient range.</i>									
	(Exposure 1 (Pattern 1, Exps 1-1 in IRAS08 Wide bands (01))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser (Exposure 2 (Pattern 1, Exps 2-2 in IRAS08 Wide bands (01))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser									
Diagnosics										
Patterns	#	Primary Pattern				Secondary Pattern			Exposures	
	(1)	Pattern Type=WFC3-UVIS-DITHER- LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=				Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false			(1), (2)	
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	2MASX-J08382309+6507160	RA: 08 38 21.6251 (129.5901046d) Dec: +65 07 3.86 (65.11774d) Equinox: J2000	Epoch of Position: 2015.5	V=14.16	Reference Frame: SIMBAD				
<i>Comments: This object was generated by the target selector and retrieved from the SIMBAD database.</i> <i>We have offset the target coordinates slightly from SIMBAD to ensure the central disk is not in the CCD gap with the UVIS-CENTER aperture and to allow for a wider orient range for schedulability. Using the UVIS aperture reduces the available orient range.</i> Category=GALAXY Description=[STARBURST]										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(1) 2MASX-J08382309+6507160	(1) 2MASX-J08382309+6507160	WFC3/UVIS, ACCUM, UVIS-CENTER	F467M	FLASH=16		Pattern 1, Exps 1-1 in IRAS08 Wide bands (01) (1)	900 Secs (2820 Secs) [==>940 Secs (Pattern 1)] [==>940 Secs (Pattern 2)] [==>940 Secs (Pattern 3)]	[1]
<i>Comments: Post-flash added to get the background levels to the new recommendation of 20 electrons/pix.</i>										
2	(1) 2MASX-J08382309+6507160	(1) 2MASX-J08382309+6507160	WFC3/UVIS, ACCUM, UVIS-CENTER	F775W	FLASH=4		Pattern 1, Exps 2-2 in IRAS08 Wide bands (01) (1)	900 Secs (2820 Secs) [==>940 Secs (Pattern 1)] [==>940 Secs (Pattern 2)] [==>940 Secs (Pattern 3)]	[2]	
<i>Comments: Post-flash added to get the background levels to the new recommendation of 20 electrons/pix.</i>										



Proposal 16749 - CGM Knots (02) - Direct imaging of CGM substructure with 50 parsec resolution

Fri Jul 30 15:00:42 GMT 2021

Visit	Proposal 16749, CGM Knots (02) Diagnostic Status: Warning Scientific Instruments: WFC3/UVIS Special Requirements: ORIENT 345D TO 30 D; ORIENT 165D TO 210 D; ORIENT 250D TO 290 D; ORIENT 70D TO 110 D						
	(Exposure 1 (Pattern 1, Exps 1-1 in CGM Knots (02))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser (Exposure 2 (Pattern 1, Exps 2-2 in CGM Knots (02))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser (Exposure 3 (Pattern 1, Exps 3-3 in CGM Knots (02))) Warning (Form): FLASH level may be too high for this exposure or a long subexposure. See extended explanation in the diagnostic browser						
Diagnosics							
Patterns	#	Primary Pattern	Secondary Pattern	Exposures			
	(1)	Pattern Type=WFC3-UVIS-DITHER- LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1), (2), (3)			
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	
	(2)	IRAS08339+6517CGM1	RA: 08 38 20.2804 (129.5845017d) Dec: +65 07 40.56 (65.12793d) Equinox: J2000		V=(?) 10^{-16} erg s ⁻¹ cm ⁻² arcsec ⁻²	Reference Frame: ICRS	
	<i>Comments:</i> Category=EXT-MEDIUM Description=[DAMPED LYMAN ALPHA CLOUD, EMISSION LINE NEBULA, HII REGION, IGM, KNOT]						
	(3)	IRAS08339+6517CGM2	RA: 08 38 17.7760 (129.5740667d) Dec: +65 08 1.08 (65.13363d) Equinox: J2000		V=(?) 10^{-16} erg s ⁻¹ cm ⁻² arcsec ⁻²	Reference Frame: ICRS	
<i>Comments:</i> Category=EXT-MEDIUM Description=[DAMPED LYMAN ALPHA CLOUD, EMISSION LINE NEBULA, HII REGION, IGM, KNOT]							
(4)	IRAS08339+6517CGM3	RA: 08 38 28.5740 (129.6190583d) Dec: +65 07 44.22 (65.12895d) Equinox: J2000		V=(?) 10^{-16} erg s ⁻¹ cm ⁻² arcsec ⁻²	Reference Frame: ICRS		
<i>Comments:</i> Category=EXT-MEDIUM Description=[DAMPED LYMAN ALPHA CLOUD, EMISSION LINE NEBULA, HII REGION, IGM, KNOT]							

Proposal 16749 - CGM Knots (02) - Direct imaging of CGM substructure with 50 parsec resolution

Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(2) IRAS08339+651 7CGM1	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F665N	FLASH=17		Pattern 1, Exps 1-1 i n CGM Knots (02) (1)	940 Secs (2901 Secs)	
									[==>967.0 Secs (Pattern 1)]	[1]
									[==>967.0 Secs (Pattern 2)]	
								[==>967.0 Secs (Pattern 3)]		
	<i>Comments: Post-flash added to get the background levels to the new recommendation of 20 electrons/pix.</i>									
2		(3) IRAS08339+651 7CGM2	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F665N	FLASH=17		Pattern 1, Exps 2-2 i n CGM Knots (02) (1)	950 Secs (2892 Secs)		
								[==>964.0 Secs (Pattern 1)]	[2]	
								[==>964.0 Secs (Pattern 2)]		
								[==>964.0 Secs (Pattern 3)]		
	<i>Comments: Post-flash added to get the background levels to the new recommendation of 20 electrons/pix.</i>									
3		(4) IRAS08339+651 7CGM3	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F665N	FLASH=17		Pattern 1, Exps 3-3 i n CGM Knots (02) (1)	950 Secs (2892 Secs)		
								[==>964.0 Secs (Pattern 1)]	[3]	
								[==>964.0 Secs (Pattern 2)]		
								[==>964.0 Secs (Pattern 3)]		
	<i>Comments: Post-flash added to get the background levels to the new recommendation of 20 electrons/pix.</i>									

