



# 15475 - Constraining the Stellar Mass and Mode of Star-formation in an Extremely Starbursting Lensed Sub-millimeter Galaxy During Peak Epoch of Star-formation

Cycle: 25, 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) HERS1	WFC3/IR	2	18-Jun-2018 18:06:23.0	yes

2 Total Orbits Used

## **ABSTRACT**

We propose to use the HST/WFC3 near-IR imaging to study the physical properties of an extremely star-forming sub-millimeter galaxy (SMG) at  $z=2.553$  identified from wide area Herschel observations with very high resolution follow-up data from sub-millimeter array, ALMA and Spitzer. The SMG is identified as one of the most IR-luminous galaxies during the peak epoch of star-formation at the very bright end of the luminosity function. The requested WFC3 blue filter observations is essential in constructing the SED and is aimed at constraining the stellar mass of the system decreasing the uncertainties by more than 0.5 dex according to our simulations. This is necessary to robustly measure the gas mass fractions and star-formation efficiency when combined with our high resolution SMA and ALMA observations. The WFC3 data is also crucial in building a robust lens model and detecting sub-structures in the near infrared where our Keck observation at longer wavelengths show a large blending contamination between foreground lensing galaxies and the background SMG. The gravitational lensing magnification ( $\sim 10$  based on current model) makes HERS1 as one of the few dust attenuated optically faint systems at high- $z$  that could be studied with HST using modest telescope time. We will finally compare our measurements of the stellar mass and assembly to hydrodynamic simulations of SMGs and to our mm and radio observations of dust and molecular gas to shed light on underlying physical processes responsible for gas accretion and star-formation at the very bright end of the IR luminosity function at  $z\sim 2.5$ .

## **OBSERVING DESCRIPTION**

The aim of the proposed observations is to use WFC3 F125W filter to map the stellar emission in a very bright gravitationally lensed galaxy (HERS1) at  $z=2.553$ . HERS1 is lensed by a foreground massive galaxy at  $z=0.202$  into an arc and counter image with an Einstein ring radius  $\sim 2$  arcsec. The proposed HST observation are designed to be blue-ward of the 4000Å break for the high- $z$  galaxy to be able to fully sample the SED and to measure the stellar mass with the specific choice of filter to maximize the separation of the foreground and background system. In fact, our simulations showed that the availability of this deep HST data-set can improve the stellar mass measurements by a factor of at least two.

Our best-fit SED model based on existing K-band and longer wavelength data combined with spectroscopic redshift measurements revealed that we could achieve a  $S/N\sim 10$  over the spatial extent of HERS1 with  $\sim 6500$  sec of integration in the F125W filter (corresponding to two orbits). The high  $S/N$  is crucial in separating the high- $z$  SMG from the foreground lensing galaxy which is essential in our lens model construction and identification of any faint undetected features. These observations will provide one of the very few existing direct observations of the stellar emission in a high- $z$  SMG. This, combined with long wavelength dust and molecular gas observations, will provide a complete picture of star-formation and gas recycling. We will achieve this by measuring the extent, morphology, location and content of the stellar emission as derived from our HST

observations and HST-aided lens modeling in comparison with the dust emission as measured from existing SMA and ALMA data.

To improve the image quality and resolution and to better sample the PSF we dither our observations in each orbit also helping with the removal of any residual artifacts, cosmic rays, etc. For this we used the linear WFC3 IR dither pattern with the default settings using a four point sampling. To make maximum use of the orbital visibility and to reduce the read-out noise, we used 15 sampled readouts (NSAMP=14) with a SPARS50 sampling sequence per orbit using our dithering pattern. This is also in line with integrating as long as possible with large number of sampling to be limited by the background and not the read noise. We further use the IR aperture placing the target at the optimum center of the detector which is appropriate for non-extended objects and we iterate only once for each exposure.

Proposal 15475 - Visit 01 - Constraining the Stellar Mass and Mode of Star-formation in an Extremely Starbursting Lensed Sub-millim...

Mon Jun 18 22:06:25 GMT 2018

Visit	<b>Proposal 15475, Visit 01, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: WFC3/IR Special Requirements: (none)										
	Patterns	#	Primary Pattern				Secondary Pattern			Exposures	
		(1)	Pattern Type=WFC3-IR-DITHER-BLOB Purpose=DITHER Number Of Points=8 Point Spacing=5.183 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=41.859 Angle Between Sides= Center Pattern=true				(1)			
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous		
	(1)	HERS1	RA: 02 09 41.2670 (32.4219458d) Dec: +00 15 58.46 (.26624d) Equinox: J2000				V=(?) K-band: 18.26 +/-0.02 (AB mag)		Reference Frame: ICRS		
<i>Comments:</i> Category=GALAXY Description=[EINSTEIN RING, GRAVITATIONAL LENS, HIGH REDSHIFT GALAXY, ULTRALUMINOUS IR GAL]											
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1	HERS1	(1) HERS1	WFC3/IR, MULTIACCUM, IR	F125W	NSAMP=14; SAMP-SEQ=SPAR S50		Pattern 1, Exps 1-1 in Visit 01 (1)	652.938154 Secs (5223.505 Secs)		
									[=>(Pattern 1)]	[1]	
									[=>(Pattern 2)]		
									[=>(Pattern 3)]		
									[=>(Pattern 4)]		
									[=>(Pattern 5)]		
									[=>(Pattern 6)]		
									[=>(Pattern 7)]	[2]	
									[=>(Pattern 8)]		

