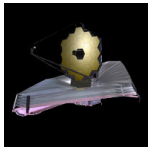

3079 - BEES: Black hole Extended Emission Search

Cycle: 2, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
Prof. Anna-Christina Eilers (PI)	**Massachusetts Institute of Technology**
Prof. Joseph Hennawi (CoI)	University of California - Santa Barbara
Dr. Frederick Davies (CoI) (ESA Member)	Max Planck Institute for Astronomy
Prof. Robert Andrew Simcoe (CoI) (US Admin CoI)	Massachusetts Institute of Technology
Dr. Gisella De Rosa (CoI)	Space Telescope Science Institute
Dr. Marianne Vestergaard (CoI) (ESA Member)	University of Copenhagen, Niels Bohr Institute
Prof. Xiaohui Fan (CoI)	University of Arizona
Prof. Zoltan Haiman (CoI)	Columbia University in the City of New York
Jan-Torge Schindler (CoI) (ESA Member)	Universitat Hamburg, Hamburger Sternwarte
Dr. Fabrizio Arrigoni Battaia (CoI) (ESA Member)	Max Planck Institute for Astrophysics
Dr. Fabian Walter (CoI) (ESA Member)	Max Planck Institute for Astronomy
Dr. Sarah E. I. Bosman (CoI) (ESA Member)	Universitat Heidelberg
Eduardo Banados (CoI) (ESA Member)	Max Planck Institute for Astronomy
Prof. Marta Volonteri (CoI) (ESA Member)	CNRS, Institut d'Astrophysique de Paris
Dominika Durovcikova (CoI)	Massachusetts Institute of Technology
Irham Taufik Andika (CoI) (ESA Member)	Max Planck Institute for Astronomy
Melanie Habouzit (CoI) (ESA Member)	Max Planck Institute for Astronomy
Dr. Rebekka Bieri (CoI) (ESA Member)	Max Planck Institute for Astrophysics
Dr. Laura Blecha (CoI)	University of Florida
Dr. Feige Wang (CoI)	University of Arizona
Dr. Emanuele Paolo Farina (CoI)	NOIRLab - Gemini North (HI)
Dr. Jinyi Yang (CoI)	University of Arizona

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
NIRSpec IFU observations of QSO and extended ionized nebulae + sky background exposures				
	1	J1335+3533	NIRSpec IFU Spectroscopy	(1) J1335+3533
	2	J158-14	NIRSpec IFU Spectroscopy	(2) J158-14
	3	J2100-1715	NIRSpec IFU Spectroscopy	(3) J2100-1715
	4	J2229+1457	NIRSpec IFU Spectroscopy	(4) J2229+1457

ABSTRACT

Observations of high-redshift quasars hosting supermassive black holes (SMBHs) with billion solar masses less than 1 Gyr after the Big Bang challenge our understanding of black hole growth. In the standard black hole growth picture these quasars need to accrete matter continuously at the Eddington limit over timescales comparable to the age of the universe at that time, i.e. ~1e9 years. However, recent estimates of the quasars' lifetimes based on the line-of-sight proximity effect suggest lifetimes several orders of magnitude shorter than expected. Such short lifetimes and the rapid concurrent SMBH growth can be explained by invoking either highly radiatively inefficient ``super-Eddington'' accretion rates, or obscured, dust-enshrouded SMBH growth phases. In order to break this degeneracy, this proposal aims to spatially map the ionizing imprint of the quasars' emission on the surrounding circumgalactic gas, in order to provide a model-independent lifetime estimate perpendicular to our sightline to the quasar, based on the light travel time of the quasar's radiation. A comparison between these two quasar activity timescales will either confirm the short lifetimes and thus require ``super-Eddington'' accretion rates to explain the rapid SMBH growth, or show a discrepancy, indicating evidence for time-variable obscuration effects along our line-of-sight. Either observational result will present novel insights into the early growth phases of SMBHs. The spatially resolved line diagnostics from the proposed NIRSpec/IFU observations will also allow us to distinguish between gas photoionized by the quasar or by the long sought-after stellar light of their host galaxy.

OBSERVING DESCRIPTION

This proposal aims to observe the extended nebular emission around four quasars at z~6 with NIRSpec IFU. We chose the G395M/F290LP disperser/filter, which provides a continuous wavelength coverage of 2.87um-5.27um, covering the brightest nebular emission lines at the redshift of our targets, i.e. [OIII] at 5007A, Halpha at 6563A, [NII] at 6583A, as well as most of the fainter emission lines, such as Hbeta at 4861A, Hgamma at 4341A, [OIII] at 4959A, HeII at 4686A, [OI] at 6300A, [NII] at 6548A, and the [SiII] doublet at 6716A and 6731A.

The spatially resolved line diagnostics will allow us to distinguish between regions ionized by the quasars or by the stellar light of their host galaxies

by means of the BPT diagram. The spectral resolution of R~1000 allows to resolve the kinematics of the surrounding gas, such as in- and outflows, which exceed velocities of a few spectral pixels, i.e. \Delta v>~1000 km/s.

The quasar will be located in the center of the NIRSpec FoV. No target acquisition is needed, as Gaia guide stars (GS) are available for any orientation, hence a 0.1" pointing accuracy is sufficient for our goals.

To ensure a greater than 10 sigma (greater than 5 sigma) detection of the azimuthally averaged surface brightness profile of the [OIII] nebulae at R~0.5 arcsec (R~1 arcsec) distance from the quasar, we need to integrate for 3.3 hours on each target, which we split into 8 individual exposures of ~1500s (100 groups) each, in order to avoid saturating any pixels on the detector. This will allow observations with a surface brightness limit of ~2e-19 erg/s/cm^2/arcsec^2. We apply a small cyclic dither pattern with 8 dithers, such that any excess light from MSA leakage can be removed, as pixels affected by this excess light appear as outliers when dithering. We will use NRSIRS2RAPID for its improved noise performance, which is essential for our program.

In total we ask for 12.97 hours of science time for three targets, 19.64 hours when including overheads.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	J1335+3533	RA: 13 35 50.8090 (203.9617042d) Dec: +35 33 15.80 (35.55439d) Equinox: J2000	Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Quasars]* *Extended=YES*				
(2)	J158-14	RA: 10 34 46.5160 (158.6938167d) Dec: -14 25 15.87 (-14.42107d) Equinox: J2000	Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Quasars]* *Extended=YES*				
(3)	J2100-1715	RA: 21 00 54.6980 (315.2279083d) Dec: -17 15 22.00 (-17.25611d) Equinox: J2000	Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Quasars]*				
(4)	J2229+1457	RA: 22 29 1.6500 (337.2568750d) Dec: +14 57 9.00 (14.95250d) Equinox: J2000	Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Quasars]*				

Observation

Proposal 3079, Observation 1: J1335+3533

Wed Mar 06 16:00:39 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	J1335+3533	RA: 13 35 50.8090 (203.9617042d) Dec: +35 33 15.80 (35.55439d) Equinox: J2000	Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Quasars]
Extended=YES

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	SMALL	1	8	

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395M/F290LP	NRSIRS2	20	1	false	true	NONE	8	8	11787.823	

Special Requirements

Aperture PA Range 188.97164917 to 28.97164917 Degrees (V3 50.0 to 250.0)

Observation

Proposal 3079, Observation 2: J158-14

Wed Mar 06 16:00:39 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	J158-14	RA: 10 34 46.5160 (158.6938167d) Dec: -14 25 15.87 (-14.42107d) Equinox: J2000	Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Quasars]
Extended=YES

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	SMALL	1	8	

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395M/F290LP	NRSIRS2	20	1	false	true	NONE	8	8	11787.823	

Observation

Proposal 3079, Observation 3: J2100-1715

Wed Mar 06 16:00:39 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	J2100-1715	RA: 21 00 54.6980 (315.2279083d) Dec: -17 15 22.00 (-17.25611d) Equinox: J2000	Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Quasars]

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	SMALL	1	8	

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395M/F290LP	NRSIRS2	20	1	false	true	NONE	8	8	11787.823	

Observation

Proposal 3079, Observation 4: J2229+1457

Wed Mar 06 16:00:39 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

(Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(4)	J2229+1457	RA: 22 29 1.6500 (337.2568750d) Dec: +14 57 9.00 (14.95250d) Equinox: J2000	Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Quasars]

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	SMALL	1	8	

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395M/F290LP	NRSIRS2	20	1	false	true	NONE	8	8	11787.823	