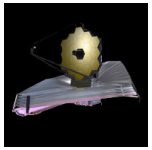

3417 - Unveiling Obscured Growth of Supermassive Black Holes in the Epoch of Reionization

Cycle: 2, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
J1423-0018				

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
	1	J1423-0018_FS	NIRSpec Fixed Slit Spectroscopy	(1) HSCJ1423-0018
J0844+0226				
	2	J0844+0226_FS	NIRSpec Fixed Slit Spectroscopy	(2) HSCJ0844+0226
J0935-0110				
	3	J0935-0110_FS	NIRSpec Fixed Slit Spectroscopy	(3) HSCJ0935-0110
J1254-0014				
	4	J1254-0014_FS	NIRSpec Fixed Slit Spectroscopy	(4) HSCJ1254-0014
J0207+0238				
	5	J0207+0238_FS	NIRSpec Fixed Slit Spectroscopy	(5) HSCJ0207+0238
J1423+0206				
	6	J1423+0206_FS	NIRSpec Fixed Slit Spectroscopy	(6) HSCJ1423+0206
J2232+0012				
	7	J2232+0012_FS	NIRSpec Fixed Slit Spectroscopy	(7) HSCJ2232+0012
J0905+0300				
	8	J0905+0300_FS	NIRSpec Fixed Slit Spectroscopy	(8) HSCJ0905+0300
J1416+0015				
	9	J1416+0015_FS	NIRSpec Fixed Slit Spectroscopy	(9) HSCJ1416+0015
J0853+0139				
	10	J0853+0139_FS	NIRSpec Fixed Slit Spectroscopy	(10) HSCJ0853+0139

ABSTRACT

Obscured quasars in the epoch of reionization (EoR) are a key population to fully understand the initial growth of supermassive black holes (SMBHs). While very few candidates have been reported to date, models and observations suggest that such objects are prevalent in the high-z (z > 6) universe, and that the >300 known UV-luminous quasars may represent just a small portion of the early SMBH growth. Recently, an unprecedentedly wide-and-deep survey with Subaru HSC has uncovered a new population of high-z galaxies showing extremely luminous Ly-alpha emission, with clearly distinct properties from any known types of objects in the EoR. Near-IR spectroscopy with ground-based 8-10m telescopes and Chandra X-ray observations have revealed a hint of hidden quasar activity in some of these galaxies, but their nature still remains inconclusive. Here we propose an ambitious NIRSpec program to carry out systematic exploration of this intriguing population. We will observe rest-optical emission lines of 10 objects with the highest Ly-alpha luminosity, in order to pin down the source(s) of line excitation via combination of three diagnostics; BPT diagrams, broad components of H-alpha, and detection of He II 4686. Our immediate goal is to establish the first spectroscopically-confirmed sample of obscured quasars in the EoR. We will use the sample to set a lower limit on the early cosmic density of obscured SMBH growth

-- a key ingredient in the models of structure formation happening through the EoR. At the same time, we will exploit the objects without quasar signatures to explore the nature of galaxies emitting such enormous Ly-alpha into the reionizing intergalactic medium.

OBSERVING DESCRIPTION

This program aims to explore the nature of 10 candidate obscured quasars at z ~ 6. Their rest-UV spectra taken with ground-based telescopes (Subaru and GTC) exhibit extremely strong and narrow (~300 km/s) Ly alpha lines and weak continuum emission. We will use NIRSpec to observe their rest-optical spectra, which will provide multiple emission lines with powerful diagnostic powers of line excitation sources, i.e., quasars or star-forming galaxies. The lines we target are He II 4686, H-beta, [OIII] 5007, H-alpha, [N II] 6586, and [S II] 6718, 6732, redshifted to 3.3 - 5.3 um. We will use the G395H grating to observe all these lines at the same time with sufficient resolution for expected line widths of ~300 km/s. The faintest line is He II 4686 with (0.8 - 2.3) x 10^(-18) erg/s/cm2 for the 10 targets, which define our exposure time; 3700 sec (50 groups x 1 integration x 1 exposure x 5 dithers) per target to detect the line with 4 - 12sigma confidence. The targets are point sources under the angular resolution of Subaru Hyper Suprime-Cam (<1 arcsec). We will adopt S200A2 slit, 5-point dither pattern, and FULL subarray in order to exploit the NRSIRS2RAPID readout mode.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	HSCJ1423-0018	RA: 14 23 31.7100 (215.8821250d) Dec: -00 18 9.10 (-.30253d) Equinox: J2000		
Comments: zAB=24.192, yAB=24.971 *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]* *Extended=NO*				
(2)	HSCJ0844+0226	RA: 08 44 56.6200 (131.2359167d) Dec: +02 26 40.50 (2.44458d) Equinox: J2000		
Comments: zAB=23.834, yAB=25.424 *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]* *Extended=NO*				
(3)	HSCJ0935-0110	RA: 09 35 43.3200 (143.9305000d) Dec: -01 10 33.30 (-1.17592d) Equinox: J2000		
Comments: zAB=23.500, yAB=24.794 *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]* *Extended=NO*				
(4)	HSCJ1254-0014	RA: 12 54 37.0800 (193.6545000d) Dec: -00 14 10.70 (-.23631d) Equinox: J2000		
Comments: zAB=23.891, yAB=25.447 *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]* *Extended=NO*				
(5)	HSCJ0207+0238	RA: 02 07 19.5900 (31.8316250d) Dec: +02 38 26.00 (2.64056d) Equinox: J2000		
Comments: zAB=23.665, yAB=25.088 *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]* *Extended=NO*				
(6)	HSCJ1423+0206	RA: 14 23 22.0100 (215.8417083d) Dec: +02 06 12.80 (2.10356d) Equinox: J2000		
Comments: zAB=31.614, yAB=23.628 *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]* *Extended=NO*				
(7)	HSCJ2232+0012	RA: 22 32 12.0300 (338.0501250d) Dec: +00 12 38.40 (.21067d) Equinox: J2000		
Comments: zAB=23.844, yAB=24.259 *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]* *Extended=NO*				

	(8)	HSCJ0905+0300	RA: 09 05 44.6500 (136.4360417d) Dec: +03 00 58.90 (3.01636d) Equinox: J2000
	Comments: zAB=24.001, yAB=24.395 *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]* *Extended=NO*		
	(9)	HSCJ1416+0015	RA: 14 16 12.7100 (214.0529583d) Dec: +00 15 46.20 (.26283d) Equinox: J2000
	Comments: zAB=24.169, yAB=23.782 *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]* *Extended=NO*		
	(10)	HSCJ0853+0139	RA: 08 53 48.8400 (133.4535000d) Dec: +01 39 11.00 (1.65306d) Equinox: J2000
	Comments: zAB=24.247, yAB=24.217 *Category=Galaxy* *Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]* *Extended=NO*		

Observation

Proposal 3417, Observation 1: J1423-0018_FS Mon Feb 12 19:02:52 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit 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)	HSCJ1423-0018	RA: 14 23 31.7100 (215.8821250d) Dec: -00 18 9.10 (-.30253d) Equinox: J2000		

Comments: zAB=24.192, yAB=24.971
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	FULL	F140X	NRSRAPIDD6	3	1	1	171.788	144663.18

Template

Slit	Subarray
S200A2	FULL

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	5	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	S200A2	NRSIRS2RAPID	50	1	1	NONE	5	5	3720.167	141268.1

Observation

Proposal 3417, Observation 2: J0844+0226_FS Mon Feb 12 19:02:52 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit 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)	HSCJ0844+0226	RA: 08 44 56.6200 (131.2359167d) Dec: +02 26 40.50 (2.44458d) Equinox: J2000		

Comments: zAB=23.834, yAB=25.424
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	FULL	F140X	NRSRAPIDD6	3	1	1	171.788	144663.9

Template

Slit	Subarray
S200A2	FULL

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	5	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	S200A2	NRSIRS2RAPID	50	1	1	NONE	5	5	3720.167	141268.2

Observation

Proposal 3417, Observation 3: J0935-0110_FS Mon Feb 12 19:02:52 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit 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)	HSCJ0935-0110	RA: 09 35 43.3200 (143.9305000d) Dec: -01 10 33.30 (-1.17592d) Equinox: J2000		

Comments: zAB=23.500, yAB=24.794
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	FULL	F140X	NRSRAPIDD6	3	1	1	171.788	144663.10

Template

Slit	Subarray
S200A2	FULL

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	5	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	S200A2	NRSIRS2RAPID	50	1	1	NONE	5	5	3720.167	141268.3

Observation

Proposal 3417, Observation 4: J1254-0014_FS Mon Feb 12 19:02:52 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit 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)	HSCJ1254-0014	RA: 12 54 37.0800 (193.6545000d) Dec: -00 14 10.70 (-.23631d) Equinox: J2000		

Comments: zAB=23.891, yAB=25.447
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	FULL	F140X	NRSRAPIDD6	3	1	1	171.788	144663.11

Template

Slit	Subarray
S200A2	FULL

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	5	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	S200A2	NRSIRS2RAPID	50	1	1	NONE	5	5	3720.167	141268.4

Observation

Proposal 3417, Observation 5: J0207+0238_FS Mon Feb 12 19:02:52 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit Spectroscopy

Diagnostics

(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(5)	HSCJ0207+0238	RA: 02 07 19.5900 (31.8316250d) Dec: +02 38 26.00 (2.64056d) Equinox: J2000		

Comments: zAB=23.665, yAB=25.088
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	FULL	F140X	NRSRAPIDD6	3	1	1	171.788	144663.12

Template

Slit	Subarray
S200A2	FULL

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	5	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	S200A2	NRSIRS2RAPID	50	1	1	NONE	5	5	3720.167	141268.5

Observation

Proposal 3417, Observation 6: J1423+0206_FS Mon Feb 12 19:02:52 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit Spectroscopy

Diagnostics

(Visit 6:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(6)	HSCJ1423+0206	RA: 14 23 22.0100 (215.8417083d) Dec: +02 06 12.80 (2.10356d) Equinox: J2000		

Comments: zAB=31.614, yAB=23.628
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	FULL	F140X	NRSRAPIDD6	3	1	1	171.788	144663.13

Template

Slit	Subarray
S200A2	FULL

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	5	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	S200A2	NRSIRS2RAPID	50	1	1	NONE	5	5	3720.167	141268.6

Observation

Proposal 3417, Observation 7: J2232+0012_FS Mon Feb 12 19:02:52 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit Spectroscopy

Diagnostics

(Visit 7:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(7)	HSCJ2232+0012	RA: 22 32 12.0300 (338.0501250d) Dec: +00 12 38.40 (.21067d) Equinox: J2000		

Comments: zAB=23.844, yAB=24.259
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	FULL	F140X	NRSRAPIDD6	3	1	1	171.788	144663.14

Template

Slit	Subarray
S200A2	FULL

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	5	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	S200A2	NRSIRS2RAPID	50	1	1	NONE	5	5	3720.167	141268.7

Observation

Proposal 3417, Observation 8: J0905+0300_FS Mon Feb 12 19:02:52 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit Spectroscopy

Diagnostics

(Visit 8:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(8)	HSCJ0905+0300	RA: 09 05 44.6500 (136.4360417d) Dec: +03 00 58.90 (3.01636d) Equinox: J2000		

Comments: zAB=24.001, yAB=24.395
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	FULL	F140X	NRSRAPIDD6	3	1	1	171.788	144663.15

Template

Slit	Subarray
S200A2	FULL

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	5	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	S200A2	NRSIRS2RAPID	50	1	1	NONE	5	5	3720.167	141268.8

Observation

Proposal 3417, Observation 9: J1416+0015_FS Mon Feb 12 19:02:52 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit Spectroscopy

Diagnostics

(Visit 9:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(9)	HSCJ1416+0015	RA: 14 16 12.7100 (214.0529583d) Dec: +00 15 46.20 (.26283d) Equinox: J2000		

Comments: zAB=24.169, yAB=23.782
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	FULL	F140X	NRSRAPIDD6	3	1	1	171.788	144663.16

Template

Slit	Subarray
S200A2	FULL

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	5	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	S200A2	NRSIRS2RAPID	50	1	1	NONE	5	5	3720.167	141268.9

Observation

Proposal 3417, Observation 10: J0853+0139_FS Mon Feb 12 19:02:52 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit Spectroscopy

Diagnostics

(Visit 10:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(10)	HSCJ0853+0139	RA: 08 53 48.8400 (133.4535000d) Dec: +01 39 11.00 (1.65306d) Equinox: J2000		

Comments: zAB=24.247, yAB=24.217
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Lyman-alpha galaxies, Quasars, Starburst galaxies]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	FULL	F140X	NRSRAPIDD6	3	1	1	171.788	144663.17

Template

Slit	Subarray
S200A2	FULL

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	5	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	S200A2	NRSIRS2RAPID	50	1	1	NONE	5	5	3720.167	141268.10