Scientific Justification

Actively accreting supermassive black holes, i.e. quasars, are known to exist at very high redshift, when the Universe was much less than a billion years old. However, we currently do not know how these first supermassive black holes (SMBHs) formed. From estimates of the black hole mass, it is seen that SMBHs with $> 10^9$ $M_\odot$ exist less than a billion years after the Big Bang. Current models (e.g. Thispaper (2012); Thispaper (2012), Thispaper (2012)) suggestion either direct collapse black holes (DCBHs) or Population III stars could be the progenitors of the very-high redshift SMBHs.

We propose to obtain MIRI imaging, coronagraphy and spectroscopy of all known $z \geq 6.8$ quasars. MIRI covers 4.9-28.8μm thus granting access to the optical/near-IR 0.63-3.7μm rest-frame at $z = 6.8$.

Three ingredients for a quasar: *(i)* supermassive black hole; *(ii)* fuel (i.e. gas) supply, annd *(iii)* mechanism for getting fuel/gas to the SMBH (i.e., setting up an accretion flow/disk).

The Science Case includes:
• How did the first SMBHs form?
• What are the BH masses from multiple lines (including rest-frame Balmer)?
• What are the host galaxy properties of $z > 6.8$ quasars?
• What is the stellar content of the quasars host galaxy? Does the Magorrian relation hold at very high-z?
• Is there evidence for (major) merging?
• What is the environment of the $z > 6.8$ quasars?
• Whats the optical/near-IR spectral slope for the highest redshift quasars?
• Are the $z > 6.8$ luminous quasars different from 'regular AGN' detected in the JWST Deep Fields?
• What are the details of the Reionization Epoch?

These questions directly address two of the four *JWST* science themes (The End of the Dark Ages: First Light and Reionization; and Assembly of Galaxies) No telescope or observatory in the midterm future will be able to access wavelengths longer than 5μm to these sensitivies.

Building on the very high redshift quasar catalog in the infrared from Ross & Cross (2020, MNRAS accepted) and from Dr. Sarah Bosmans current list: there are 20 objects with $z \geq 6.80$.

MIRI coronagraphy is a capability unique to JWST.

Some other key things to note: The JWST GTO teams are already looking at $z > 6.70$ quasars. However, only quasar J1342+0928 at $z = 7.54$ is currently being observed by MIRI. Other teams and collaborations will also be studying the very high-redshifts quasars. A key point here is not to directly compete with those observations, but moreover, complement them. As such, our team has a *a zero proprietary period* making the data immediately accessible from a webpages (e.g. github.com/d80b2t/JWST_Cycle1) The GTO and ERS

programs already have the targets and instruments and modes that they are going to be using. One could then start to build-up on that arguing that youll never have the lambda ¿5um space-based data again any time again soon, and Generating a sample for a large number (all) of the currnently known $z > 6.7$ quasars is exactly what JWST was built for, and this will tremendously legacy value. This could/would be suggested as a multi-cycle program (though not necessarily explicitly as that I dont think this category is implemented yet). Using the Cycle 1+GTO+(ERS?) data as type of Pilot program, observing maybe $\sim$5-10 objects in total first, and letting that guide observations in future cycles.

Technical Justification

Describe the overall experimental design of the program, justifying the selection of instruments, modes, exposure times, and requirements. Describe how the observations contribute to the goals described in the scientific justification. Quantitative estimates must be provided of the accuracy required to achieve key science goals. The JWST ETC generally provides sufficient information to determine the necessary exposure time. For modes that require target acquisition, proposers should verify that the exposure specifications provided meet the stated criteria for success. Successful target acquisitions are crucial for the success of the specified observations, and must be verified. The description should also include the following:

1. Special Observational Requirements (if any): Justify any special scheduling requirements, including time-critical observations. Target of Opportunity observations should estimate the probability of occurrence during Cycle 1, specify whether long-term status is requested, identify whether ToOs are disruptive or non-disruptive, and state clearly how soon JWST must begin observing after the formal activation.

2. Justification of Coordinated Parallels (if any): Proposals that include coordinated parallel observations should provide a scientific justification for and description of the parallel observations. It should be clearly indicated whether the parallel observations are essential to the interpretation of the primary observations or the science program as a whole, or whether they address partly or completely unrelated issues. The parallel observations are subject to scientific review, and can be rejected even if the primary observations are approved.

3. Justification of Duplications (if any): as detailed in the JWST Cycle 1 Proposal Policies and Funding Support and the JWST Duplicate Observations Policy. Any duplicate observations must be explicitly justified.

Special Requirements (if any)

There are no Special Requirements.

Justify Coordinated Parallel Observations (if any)

1 NIRCam imaging1 MIRI imaging1 Either template can be selected as primary, with the other as parallel.
2 NIRCam imaging1 NIRISS WFSS Either template can be selected as primary, with the other as parallel.
3 MIRI imaging NIRISS WFSS Either template can be selected as primary, with the other as parallel.
4 NIRCam imaging1 NIRISS imaging NIRCam must be primary. Use to increase areal coverage, but note NIRISS differences in pixel size and available filters.
5 NIRSpec MOS NIRCam imaging NIRSpec MOS must be primary.
(Modes added January 2020):: 6 NIRCam WFSS MIRI Imaging NIRCam WFSS must be primary.
7 NIRCam WFSS NIRISS Imaging NIRCam WFSS must be primary.
8 NIRSpec MOS MIRI Imaging NIRSpec MOS must be primary.

Justify Duplications (if any)

Analysis Plan (AR only)

Analysis Plan: (required only for AR, Calibration, and Theory Proposals) All AR Proposals should provide a detailed data analysis plan and describe the datasets that will be analyzed. Inclusion of a target list is not required.

Legacy AR Proposals should also discuss the data products that will be made available to the community, the method of dissemination, and a realistic timeline. It is a requirement that data products be delivered to STScI in suitable digital formats for further dissemination via the MAST Data Archive or related channels. Any required technical support from STScI and associated costs should be described in detail.

Theory Proposals should discuss the types of JWST data that will benefit from the proposed investigation, and references to specific data sets in the MAST Data Archive should be given where possible. They should also describe how the results of the theoretical investigation will be made available to the astronomical community, and on what timescale the results are expected.

Calibration Proposals should discuss what documentation, and data products and/or software will be made available to STScI to support future observing programs. Proposers should explain how their programs complement ongoing calibration efforts by the STScI instrument groups. They should contact the relevant instrument groups to ensure that efforts are not duplicated, and if they are, justify why the duplications are necessary.

During the budget review process, the Financial Review Committee will compare the requested costs with the commensurate work outlined in the Analysis Plan. Support for

resources outside the original scope of work will not be considered.