Some tips from ARC staffs (from approved proposals)

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General points

- Start as early as possible! Now!!
  ○ There is a correlation between “Time spent on the preparation” and the “proposal grade” in some person’s proposals… :p
  ○ Co-Is are also busy around the deadline!!

- Try to make the proposal goal **clear** and **concise** but not too specific (重箱の隅をつつかない)

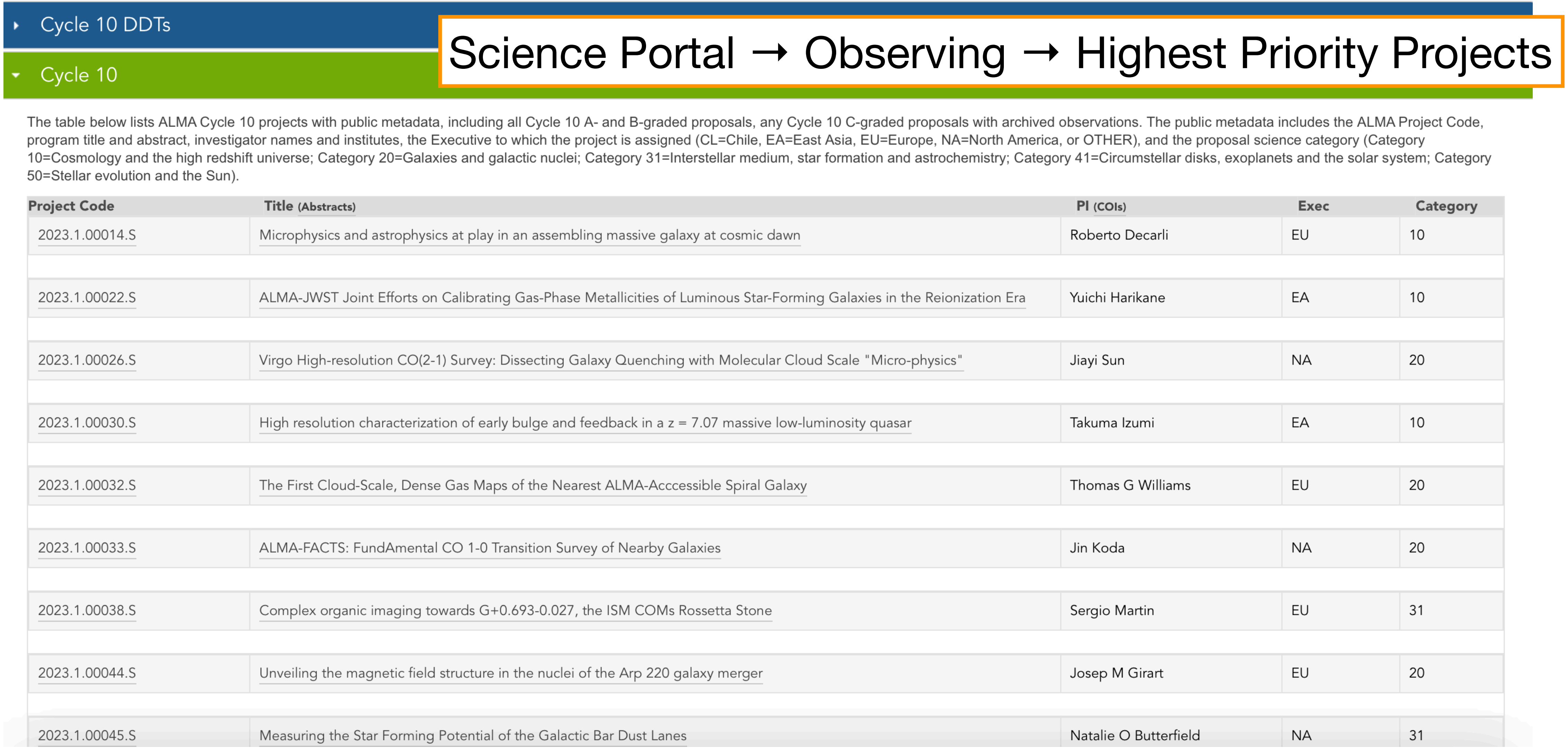
- Ask yourself repeatedly whether the proposal goals are really important from a perspective of broad astronomical community.
  → Describe a “**Big Picture**”! A few sentences are fine. Pictures are appreciated!

- Clear objective: a sort of “**working hypothesis**” can be shown. And you should describe how ALMA can test that hypothesis.
  - My case: “Our observations on this statistical sample can distinguish these two models at >99.9% significance”

General points

- Search archival data/accepted proposals extensively!!
  + Make sure that your idea has not been done yet.
  + Quantitatively demonstrate that your idea cannot be done with the archival data.
  + Reviewers will immediately ask "Why you can't do this science with the rich archival data? Why do you need to get new data?"
- Consider carefully about your **strategy**!
  + good science = good idea × good effort × good strategy, in my opinion.
- In case of "resubmission", please take care of the reviewers comments as much as possible.
- Involve reliable collaborators! Listen attentively to their comments (not be selfish).
- Brush up English. If you don't have native co-Is, please consider to use English proof-reading service (and/or…ChatGPT; this works nicely in my case)

Searching for existing programs



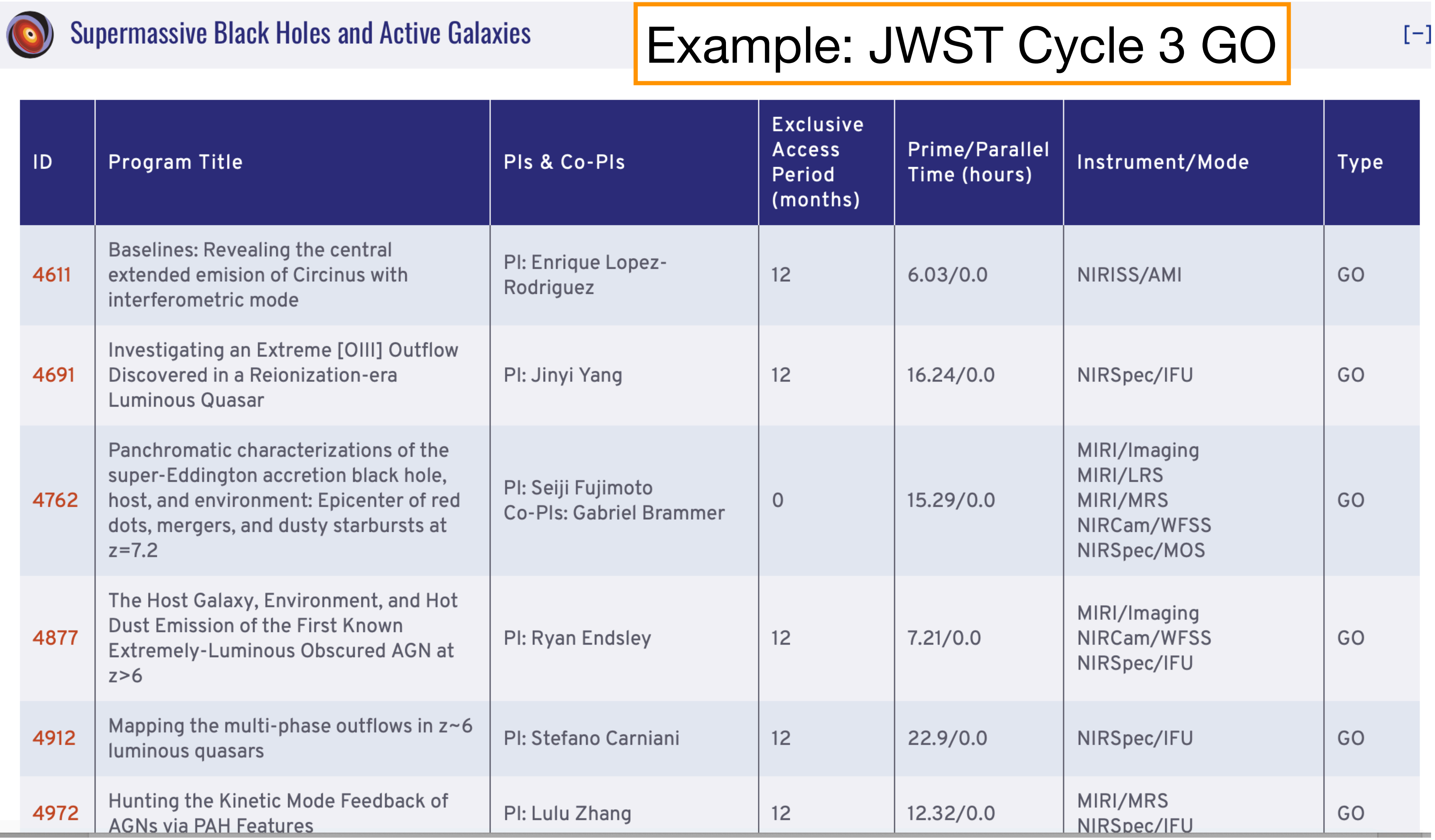
Science Portal → Observing → Highest Priority Projects

- Cycle 10 DDTs
- Cycle 10

The table below lists ALMA Cycle 10 projects with public metadata, including all Cycle 10 A- and B-graded proposals, any Cycle 10 C-graded proposals with archived observations. The public metadata includes the ALMA Project Code, program title and abstract, investigator names and institutes, the Executive to which the project is assigned (CL=Chile, EA=East Asia, EU=Europe, NA=North America, or OTHER), and the proposal science category (Category 10=Cosmology and the high redshift universe; Category 20=Galaxies and galactic nuclei; Category 31=Interstellar medium, star formation and astrochemistry; Category 41=Circumstellar disks, exoplanets and the solar system; Category 50=Stellar evolution and the Sun).

Project Code	Title (Abstracts)	PI (COIs)	Exec	Category
2023.1.00014.S	Microphysics and astrophysics at play in an assembling massive galaxy at cosmic dawn	Roberto Decarli	EU	10
2023.1.00022.S	ALMA-JWST Joint Efforts on Calibrating Gas-Phase Metallicities of Luminous Star-Forming Galaxies in the Reionization Era	Yuichi Harikane	EA	10
2023.1.00026.S	Virgo High-resolution CO(2-1) Survey: Dissecting Galaxy Quenching with Molecular Cloud Scale "Micro-physics"	Jiayi Sun	NA	20
2023.1.00030.S	High resolution characterization of early bulge and feedback in a z = 7.07 massive low-luminosity quasar	Takuma Izumi	EA	10
2023.1.00032.S	The First Cloud-Scale, Dense Gas Maps of the Nearest ALMA-Acccessible Spiral Galaxy	Thomas G Williams	EU	20
2023.1.00033.S	ALMA-FACTS: FundAmental CO 1-0 Transition Survey of Nearby Galaxies	Jin Koda	NA	20
2023.1.00038.S	Complex organic imaging towards G+0.693-0.027, the ISM COMs Rossetta Stone	Sergio Martin	EU	31
2023.1.00044.S	Unveiling the magnetic field structure in the nuclei of the Arp 220 galaxy merger	Josep M Girart	EU	20
2023.1.00045.S	Measuring the Star Forming Potential of the Galactic Bar Dust Lanes	Natalie O Butterfield	NA	31

Searching for existing programs



Example: JWST Cycle 3 GO

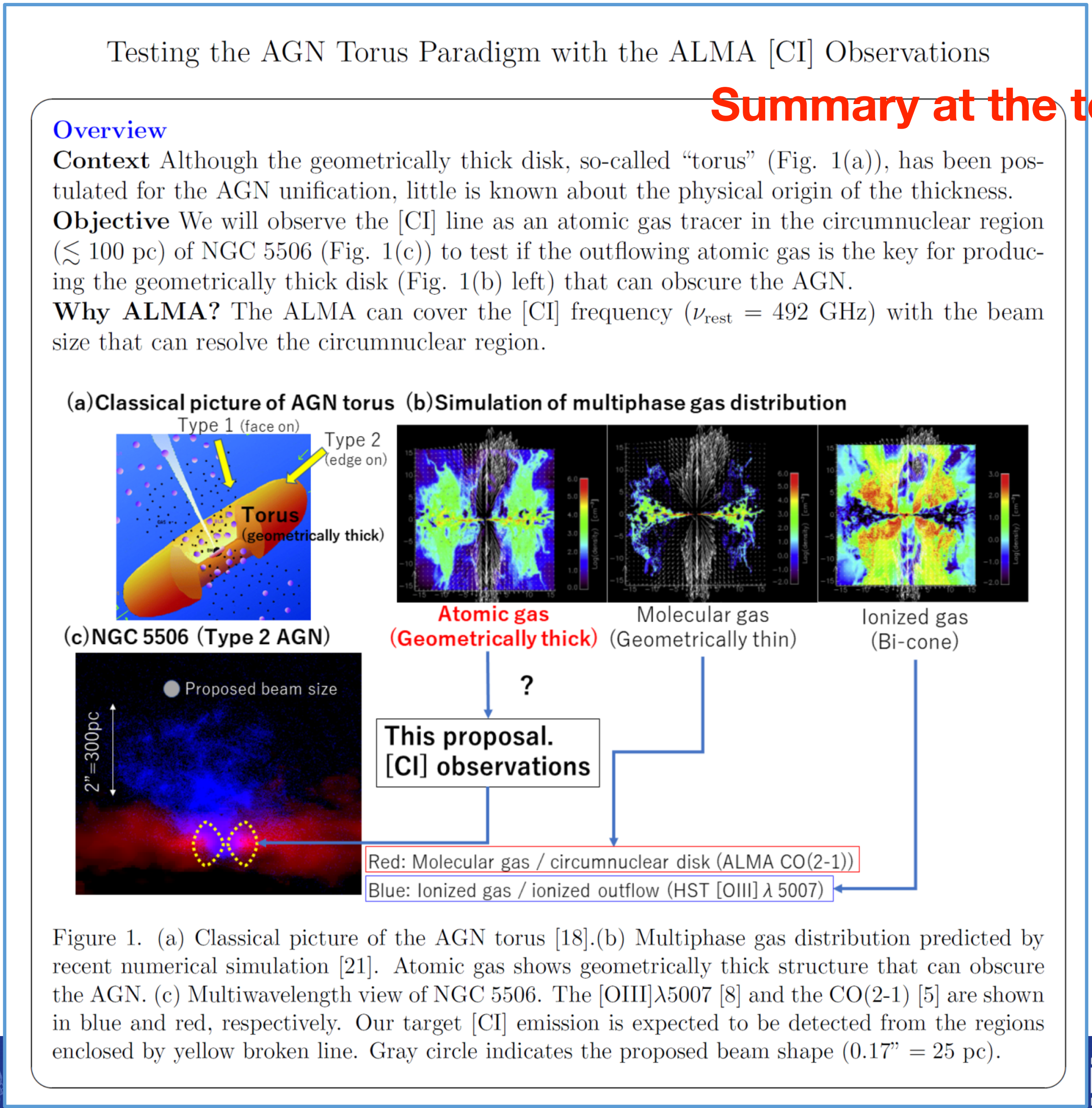
ID	Program Title	PIs & Co-PIs	Exclusive Access Period (months)	Prime/Parallel Time (hours)	Instrument/Mode	Type
4611	Baselines: Revealing the central extended emision of Circinus with interferometric mode	PI: Enrique Lopez-Rodriguez	12	6.03/0.0	NIRISS/AMI	GO
4691	Investigating an Extreme [OIII] Outflow Discovered in a Reionization-era Luminous Quasar	PI: Jinyi Yang	12	16.24/0.0	NIRSpec/IFU	GO
4762	Panchromatic characterizations of the super-Eddington accretion black hole, host, and environment: Epicenter of red dots, mergers, and dusty starbursts at z=7.2	PI: Seiji Fujimoto Co-PIs: Gabriel Brammer	0	15.29/0.0	MIRI/Imaging MIRI/LRS MIRI/MRS NIRCam/WFSS NIRSpec/MOS	GO
4877	The Host Galaxy, Environment, and Hot Dust Emission of the First Known Extremely-Luminous Obscured AGN at z>6	PI: Ryan Endsley	12	7.21/0.0	MIRI/Imaging NIRCam/WFSS NIRSpec/IFU	GO
4912	Mapping the multi-phase outflows in z~6 luminous quasars	PI: Stefano Carniani	12	22.9/0.0	NIRSpec/IFU	GO
4972	Hunting the Kinetic Mode Feedback of AGNs via PAH Features	PI: Lulu Zhang	12	12.32/0.0	MIRI/MRS NIRSpec/IFU	GO

- Checking the accepted programs in other facilities (VLA, VLT, JWST, etc) is also helpful for you to brush up your strategy + to catch-up cutting-edge science cases.
- These are the boundary conditions for your strategy.

Some tips (personal view)

- Reviewers are knowledgeable, but they may not be experts of your science.
  + Is the proposal text clear enough for non-experts?
  + Are you confident to make reviewers (non experts) excited with the proposed idea?
  + Why do we need ALMA? Why now? Why this method? Why this source?
- I usually make “FAQ” section to concisely justify resolution, sensitivity, sample size, etc.
- Reviewers might get tired when reading many proposals *including yours*.
  → State the main goal of the proposal concisely in early chapters? Details later?
- One may want to put a summary of the proposal and/or schematic picture of the proposal objective at the beginning, so that reviewers can understand your intent quickly without thorough reading. (e.g., “Executive Summary”)
- Avoid putting too much in a single paragraph. Separate and organize.
- Use colorized text appropriately, colorized caption background?

Examples (good summary)



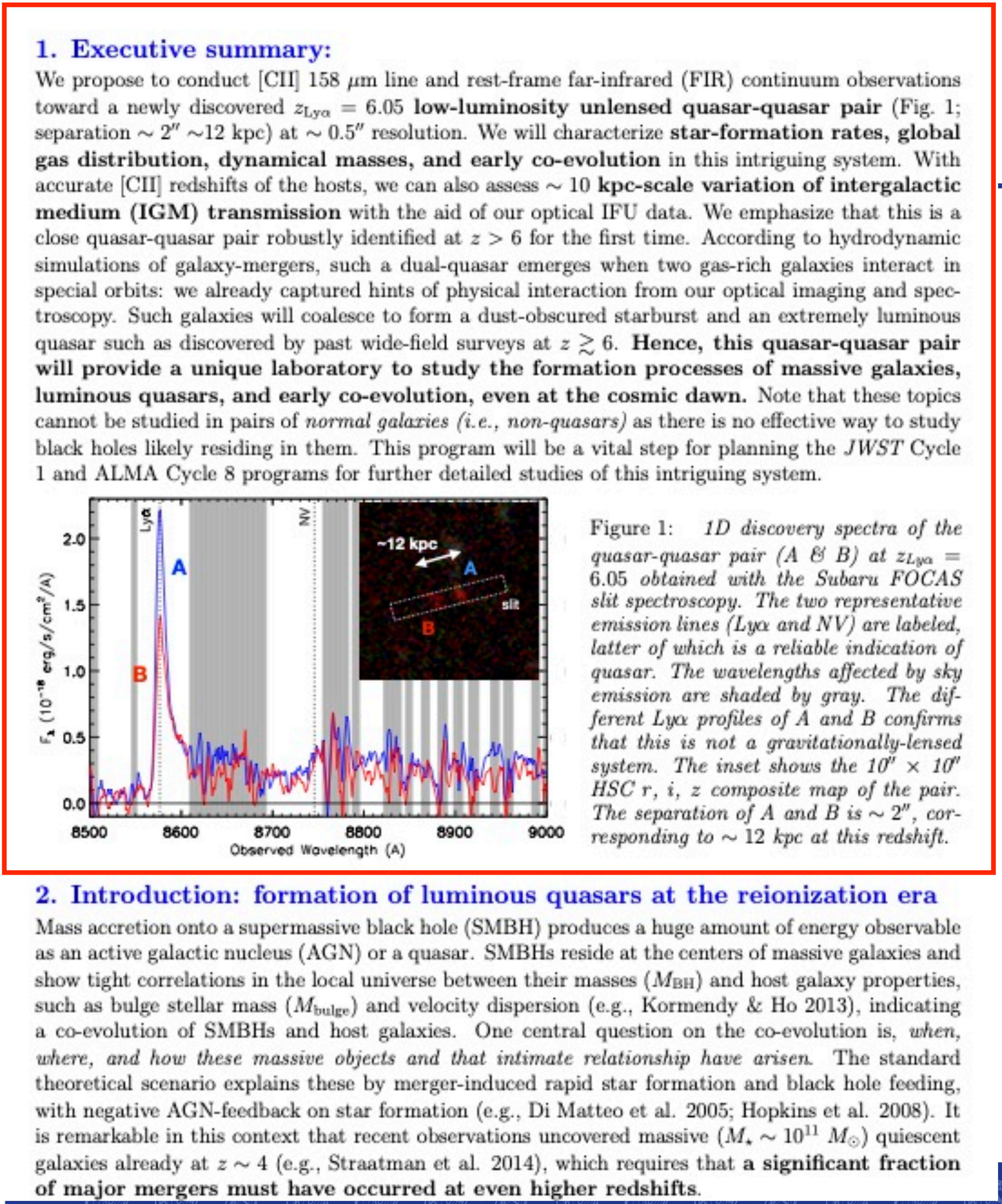
Testing the AGN Torus Paradigm with the ALMA [CI] Observations

Summary at the top

Overview

Context Although the geometrically thick disk, so-called "torus" (Fig. 1(a)), has been postulated for the AGN unification, little is known about the physical origin of the thickness.
Objective We will observe the [CI] line as an atomic gas tracer in the circumnuclear region ($\lesssim$ 100 pc) of NGC 5506 (Fig. 1(c)) to test if the outflowing atomic gas is the key for producing the geometrically thick disk (Fig. 1(b) left) that can obscure the AGN.
Why ALMA? The ALMA can cover the [CI] frequency ($\nu_{\rm rest}$ = 492 GHz) with the beam size that can resolve the circumnuclear region.

Figure 1. (a) Classical picture of the AGN torus [18].(b) Multiphase gas distribution predicted by recent numerical simulation [21]. Atomic gas shows geometrically thick structure that can obscure the AGN. (c) Multiwavelength view of NGC 5506. The [OIII]λ5007 [8] and the CO(2-1) [5] are shown in blue and red, respectively. Our target [CI] emission is expected to be detected from the regions enclosed by yellow broken line. Gray circle indicates the proposed beam shape (0.17" = 25 pc).



1. Executive summary:

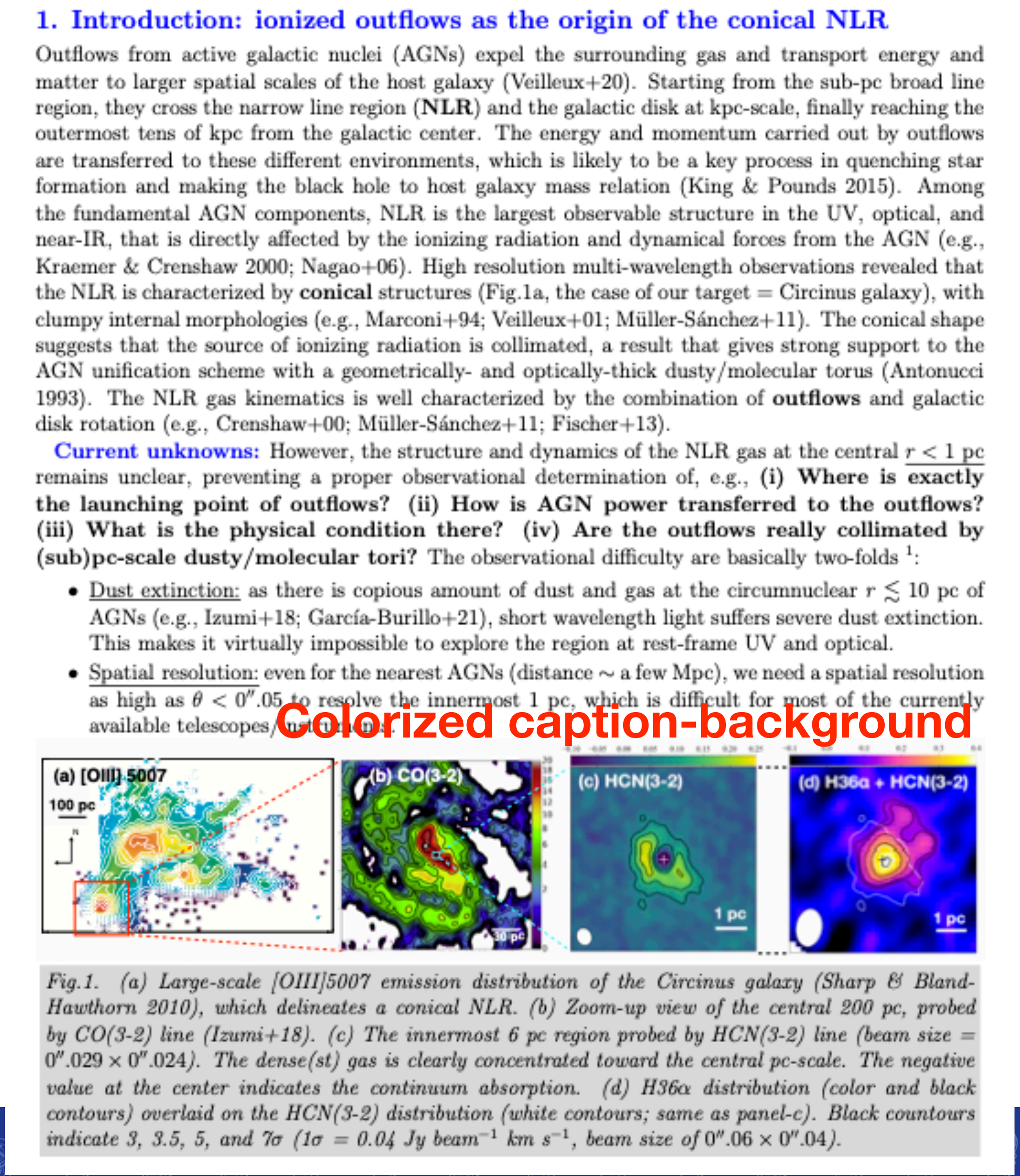
We propose to conduct [CII] 158 μm line and rest-frame far-infrared (FIR) continuum observations toward a newly discovered $z_{\rm Ly\alpha}$ = 6.05 **low-luminosity unlensed quasar-quasar pair** (Fig. 1; separation ~ 2″ ~12 kpc) at ~ 0.5″ resolution. We will characterize **star-formation rates, global gas distribution, dynamical masses, and early co-evolution** in this intriguing system. With accurate [CII] redshifts of the hosts, we can also assess ~ 10 **kpc-scale variation of intergalactic medium (IGM) transmission** with the aid of our optical IFU data. We emphasize that this is a close quasar-quasar pair robustly identified at $z > 6$ for the first time. According to hydrodynamic simulations of galaxy-mergers, such a dual-quasar emerges when two gas-rich galaxies interact in special orbits: we already captured hints of physical interaction from our optical imaging and spectroscopy. Such galaxies will coalesce to form a dust-obscured starburst and an extremely luminous quasar such as discovered by past wide-field surveys at $z \gtrsim 6$. **Hence, this quasar-quasar pair will provide a unique laboratory to study the formation processes of massive galaxies, luminous quasars, and early co-evolution, even at the cosmic dawn.** Note that these topics cannot be studied in pairs of *normal galaxies (i.e., non-quasars)* as there is no effective way to study black holes likely residing in them. This program will be a vital step for planning the *JWST* Cycle 1 and ALMA Cycle 8 programs for further detailed studies of this intriguing system.

Figure 1: *1D discovery spectra of the quasar-quasar pair (A & B) at $z_{\rm Ly\alpha}$ = 6.05 obtained with the Subaru FOCAS slit spectroscopy. The two representative emission lines (Lyα and NV) are labeled, latter of which is a reliable indication of quasar. The wavelengths affected by sky emission are shaded by gray. The different Lyα profiles of A and B confirms that this is not a gravitationally-lensed system. The inset shows the 10″ × 10″ HSC r, i, z composite map of the pair. The separation of A and B is ~ 2″, corresponding to ~ 12 kpc at this redshift.*

2. Introduction: formation of luminous quasars at the reionization era

Mass accretion onto a supermassive black hole (SMBH) produces a huge amount of energy observable as an active galactic nucleus (AGN) or a quasar. SMBHs reside at the centers of massive galaxies and show tight correlations in the local universe between their masses ($M_{\rm BH}$) and host galaxy properties, such as bulge stellar mass ($M_{\rm bulge}$) and velocity dispersion (e.g., Kormendy & Ho 2013), indicating a co-evolution of SMBHs and host galaxies. One central question on the co-evolution is, *when, where, and how these massive objects and that intimate relationship have arisen*. The standard theoretical scenario explains these by merger-induced rapid star formation and black hole feeding, with negative AGN-feedback on star formation (e.g., Di Matteo et al. 2005; Hopkins et al. 2008). It is remarkable in this context that recent observations uncovered massive ($M_\star \sim 10^{11}$ $M_\odot$) quiescent galaxies already at $z \sim 4$ (e.g., Straatman et al. 2014), which requires that **a significant fraction of major mergers must have occurred at even higher redshifts**.

Examples



1. Introduction: ionized outflows as the origin of the conical NLR

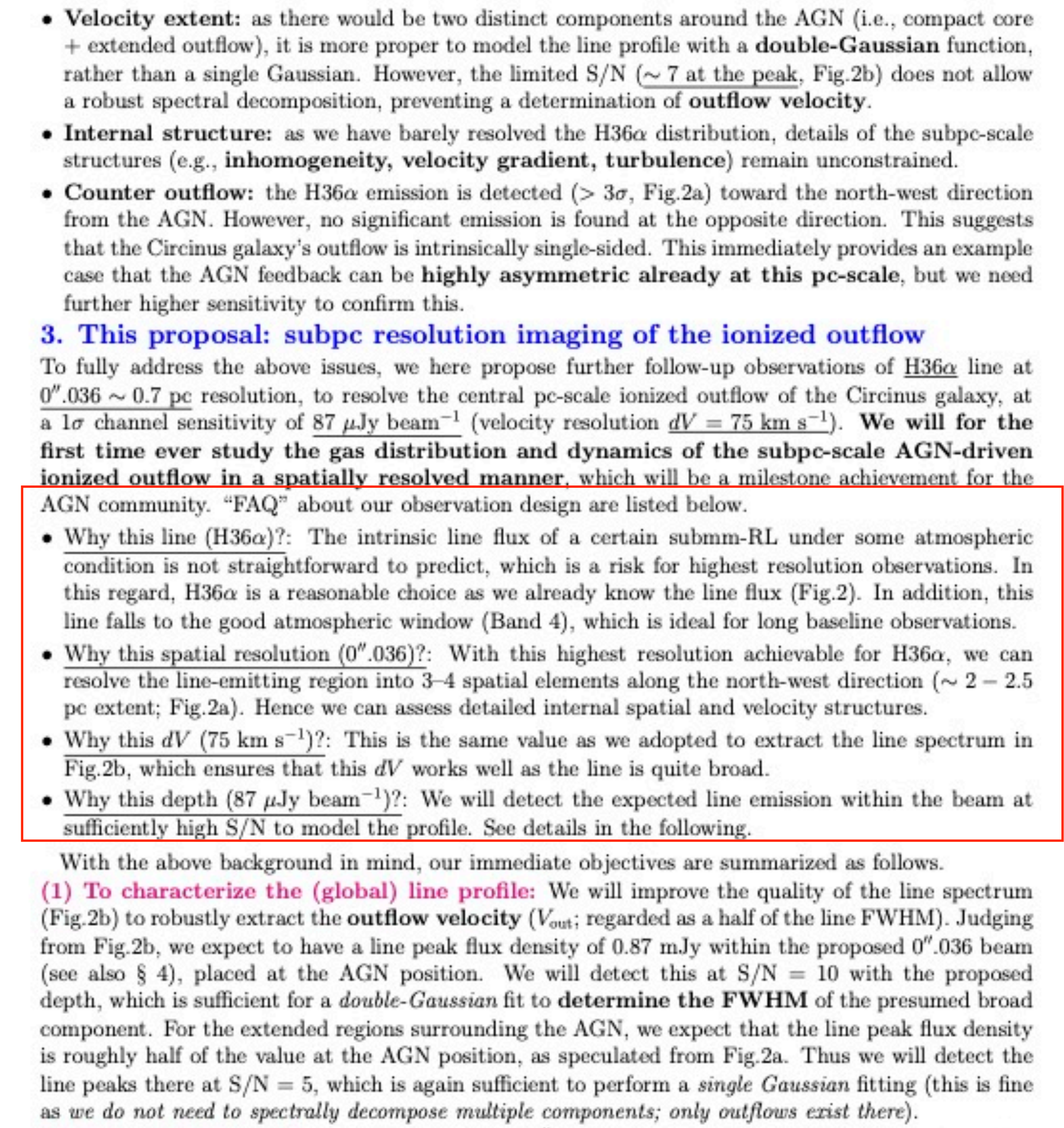
Outflows from active galactic nuclei (AGNs) expel the surrounding gas and transport energy and matter to larger spatial scales of the host galaxy (Veilleux+20). Starting from the sub-pc broad line region, they cross the narrow line region (**NLR**) and the galactic disk at kpc-scale, finally reaching the outermost tens of kpc from the galactic center. The energy and momentum carried out by outflows are transferred to these different environments, which is likely to be a key process in quenching star formation and making the black hole to host galaxy mass relation (King & Pounds 2015). Among the fundamental AGN components, NLR is the largest observable structure in the UV, optical, and near-IR, that is directly affected by the ionizing radiation and dynamical forces from the AGN (e.g., Kraemer & Crenshaw 2000; Nagao+06). High resolution multi-wavelength observations revealed that the NLR is characterized by **conical** structures (Fig.1a, the case of our target = Circinus galaxy), with clumpy internal morphologies (e.g., Marconi+94; Veilleux+01; Müller-Sánchez+11). The conical shape suggests that the source of ionizing radiation is collimated, a result that gives strong support to the AGN unification scheme with a geometrically- and optically-thick dusty/molecular torus (Antonucci 1993). The NLR gas kinematics is well characterized by the combination of **outflows** and galactic disk rotation (e.g., Crenshaw+00; Müller-Sánchez+11; Fischer+13).

Current unknowns: However, the structure and dynamics of the NLR gas at the central $r < 1$ pc remains unclear, preventing a proper observational determination of, e.g., **(i) Where is exactly the launching point of outflows? (ii) How is AGN power transferred to the outflows? (iii) What is the physical condition there? (iv) Are the outflows really collimated by (sub)pc-scale dusty/molecular tori?** The observational difficulty are basically two-folds [1]:

- Dust extinction: as there is copious amount of dust and gas at the circumnuclear $r \lesssim 10$ pc of AGNs (e.g., Izumi+18; García-Burillo+21), short wavelength light suffers severe dust extinction. This makes it virtually impossible to explore the region at rest-frame UV and optical.
- Spatial resolution: even for the nearest AGNs (distance ~ a few Mpc), we need a spatial resolution as high as $\theta < 0''.05$ to resolve the innermost 1 pc, which is difficult for most of the currently available telescopes/instruments.

Fig.1. (a) Large-scale [OIII]5007 emission distribution of the Circinus galaxy (Sharp & Bland-Hawthorn 2010), which delineates a conical NLR. (b) Zoom-up view of the central 200 pc, probed by CO(3-2) line (Izumi+18). (c) The innermost 6 pc region probed by HCN(3-2) line (beam size = $0''.029 \times 0''.024$). The dense(st) gas is clearly concentrated toward the central pc-scale. The negative value at the center indicates the continuum absorption. (d) H36α distribution (color and black contours) overlaid on the HCN(3-2) distribution (white contours; same as panel-c). Black countours indicate 3, 3.5, 5, and 7σ ($1\sigma = 0.04$ Jy beam^{-1} km s^{-1}, beam size of $0''.06 \times 0''.04$).

Colorized caption-background



- **Velocity extent:** as there would be two distinct components around the AGN (i.e., compact core + extended outflow), it is more proper to model the line profile with a **double-Gaussian** function, rather than a single Gaussian. However, the limited S/N (~ 7 at the peak, Fig.2b) does not allow a robust spectral decomposition, preventing a determination of **outflow velocity**.
- **Internal structure:** as we have barely resolved the H36α distribution, details of the subpc-scale structures (e.g., **inhomogeneity, velocity gradient, turbulence**) remain unconstrained.
- **Counter outflow:** the H36α emission is detected ($> 3\sigma$, Fig.2a) toward the north-west direction from the AGN. However, no significant emission is found at the opposite direction. This suggests that the Circinus galaxy's outflow is intrinsically single-sided. This immediately provides an example case that the AGN feedback can be **highly asymmetric already at this pc-scale**, but we need further higher sensitivity to confirm this.

3. This proposal: subpc resolution imaging of the ionized outflow

To fully address the above issues, we here propose further follow-up observations of H36α line at $0''.036 \sim 0.7$ pc resolution, to resolve the central pc-scale ionized outflow of the Circinus galaxy, at a 1σ channel sensitivity of 87 μJy beam^{-1} (velocity resolution $dV = 75$ km s^{-1}). **We will for the first time ever study the gas distribution and dynamics of the subpc-scale AGN-driven ionized outflow in a spatially resolved manner**, which will be a milestone achievement for the AGN community. "FAQ" about our observation design are listed below.

FAQ

- Why this line (H36α)?: The intrinsic line flux of a certain submm-RL under some atmospheric condition is not straightforward to predict, which is a risk for highest resolution observations. In this regard, H36α is a reasonable choice as we already know the line flux (Fig.2). In addition, this line falls to the good atmospheric window (Band 4), which is ideal for long baseline observations.
- Why this spatial resolution ($0''.036$)?: With this highest resolution achievable for H36α, we can resolve the line-emitting region into 3–4 spatial elements along the north-west direction (~ 2 – 2.5 pc extent; Fig.2a). Hence we can assess detailed internal spatial and velocity structures.
- Why this dV (75 km s^{-1})?: This is the same value as we adopted to extract the line spectrum in Fig.2b, which ensures that this dV works well as the line is quite broad.
- Why this depth (87 μJy beam^{-1})?: We will detect the expected line emission within the beam at sufficiently high S/N to model the profile. See details in the following.

With the above background in mind, our immediate objectives are summarized as follows.

(1) To characterize the (global) line profile: We will improve the quality of the line spectrum (Fig.2b) to robustly extract the **outflow velocity** ($V_{\rm out}$; regarded as a half of the line FWHM). Judging from Fig.2b, we expect to have a line peak flux density of 0.87 mJy within the proposed $0''.036$ beam (see also § 4), placed at the AGN position. We will detect this at S/N = 10 with the proposed depth, which is sufficient for a *double-Gaussian* fit to **determine the FWHM** of the presumed broad component. For the extended regions surrounding the AGN, we expect that the line peak flux density is roughly half of the value at the AGN position, as speculated from Fig.2a. Thus we will detect the line peaks there at S/N = 5, which is again sufficient to perform a *single Gaussian* fitting (this is fine as *we do not need to spectrally decompose multiple components; only outflows exist there*).

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