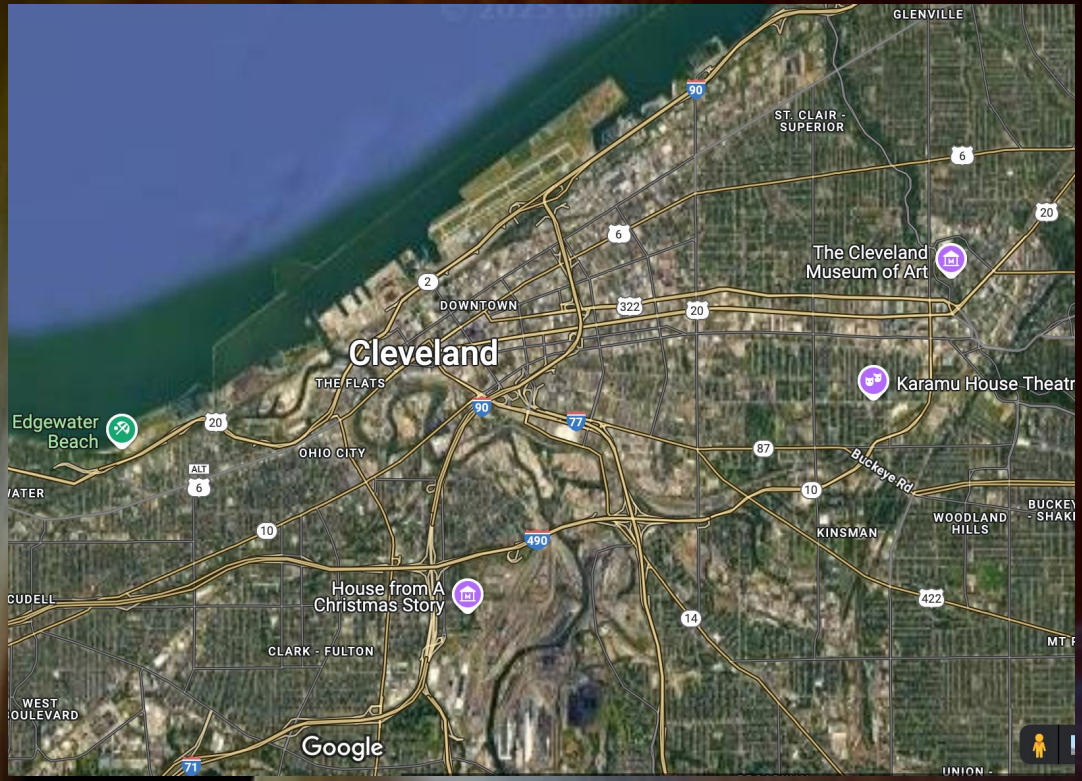
Supermassive Black Holes as Singular Schelling Points

Steve DiKerby

23 June 2025

@ Ohio State University

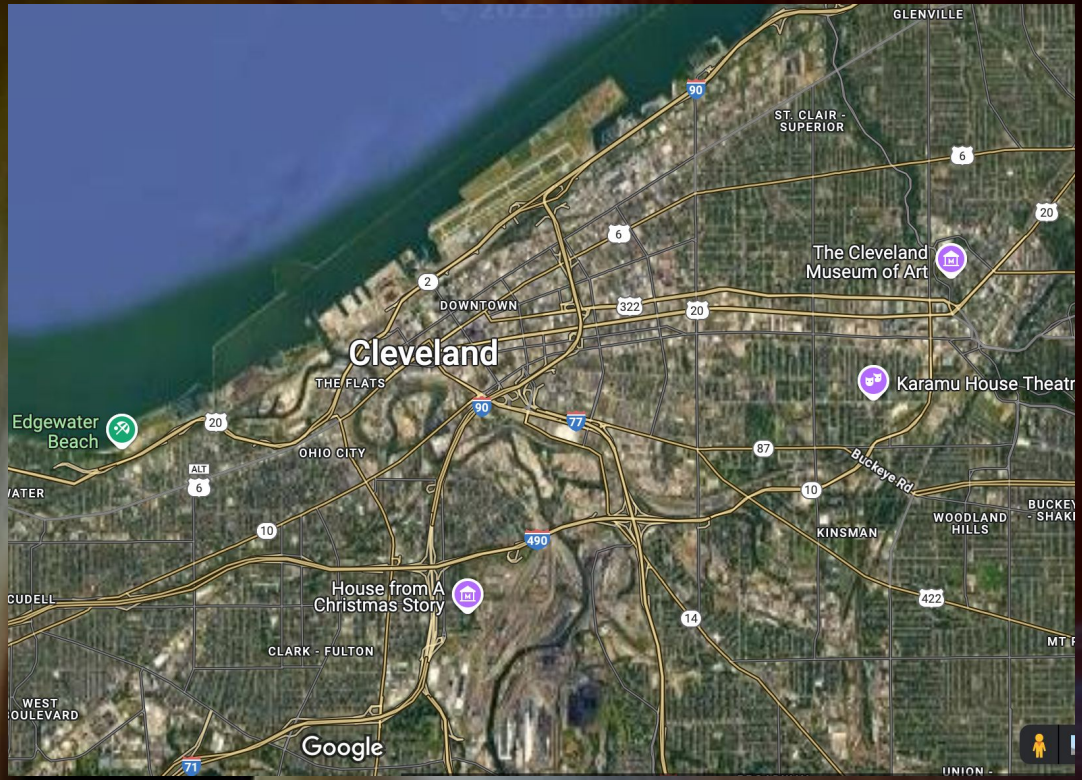


Google Maps

One day, you wake up utterly alone in Cleveland.

You're told that there is a single other person in the entire city.

How could you find them without a cell phone, internet, etc?



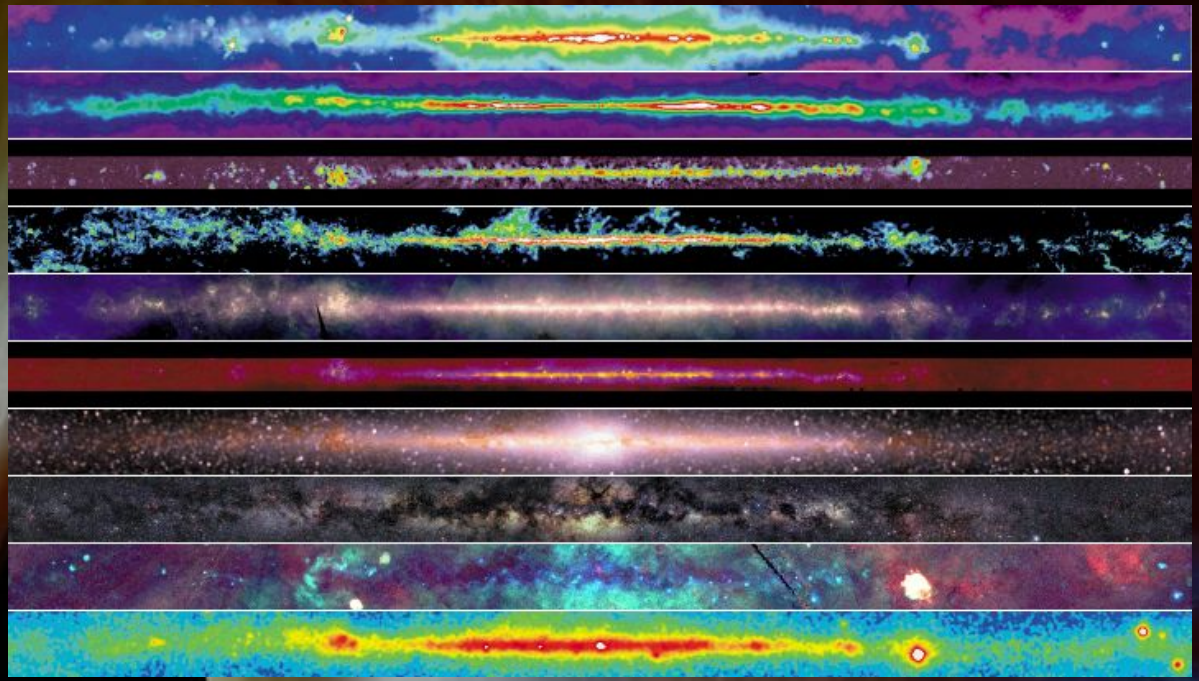
Google Maps

While it's possible to do a blind search, you could **think about what spots are most likely to be visited**…

- Browns Stadium
- The "Free" stamp thingy
- Public Square
- Rock & Roll Hall of Fame
- Taxidermied corpse of Balto the sled dog

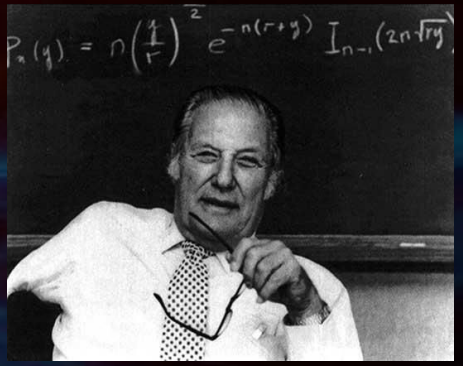
… and focus on those spots

“Schelling Points” / Water(ing) Holes



The Galactic Plane - Image Credit: NASA/GSFC

Thomas Schelling
Image Credit: New America



Bernard Oliver

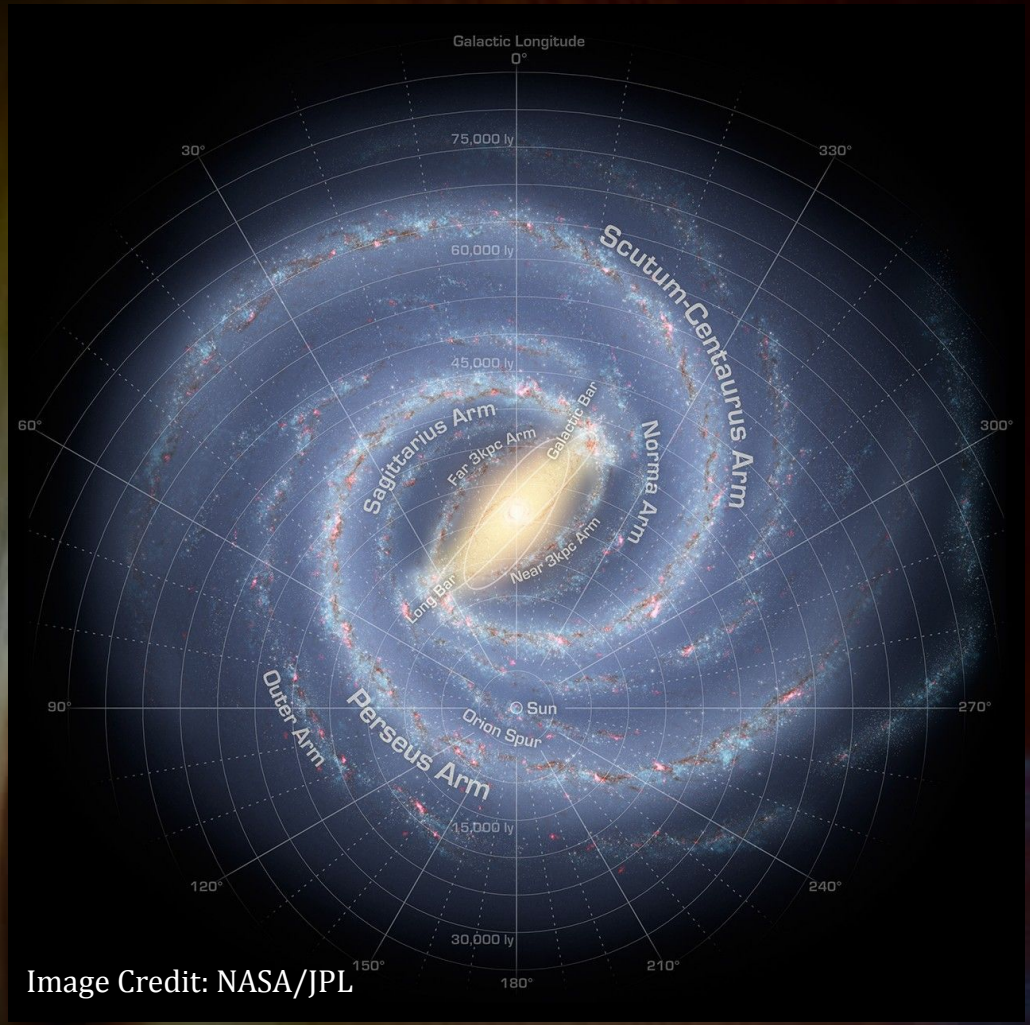


Image Credit: NASA/JPL

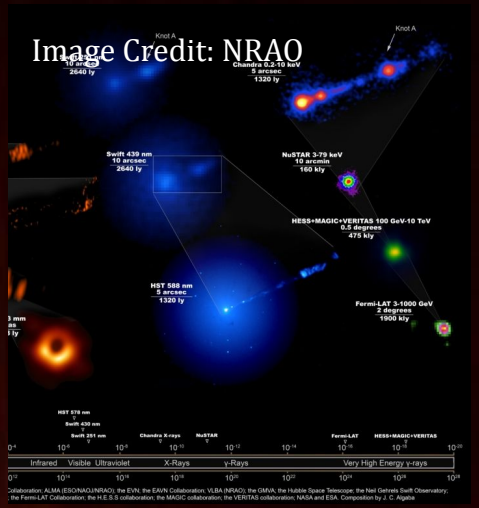
The Challenge of SETI:

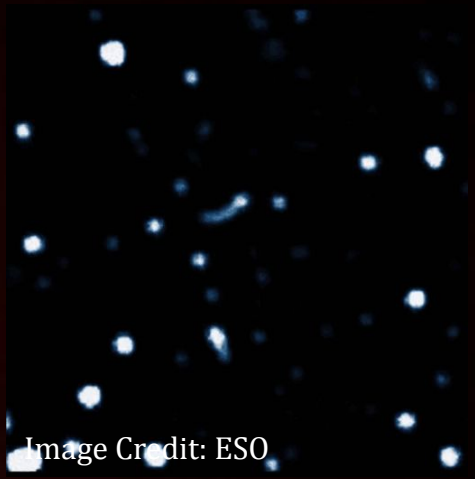
- We have no evidence/priors for ETI
- The set of all possible astronomical observations is a HUGE phase space to explore

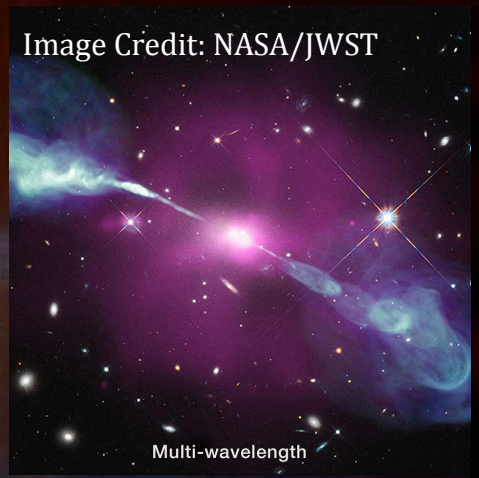
What physical **“Schelling Point” / Water(ing) Hole** in the MW can we automatically assume is an “attractor”?

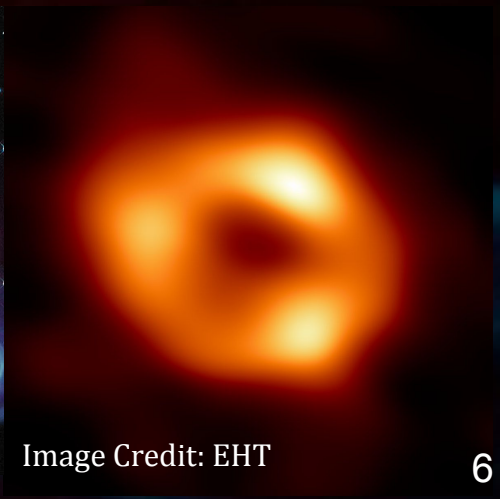
Supermassive black holes…

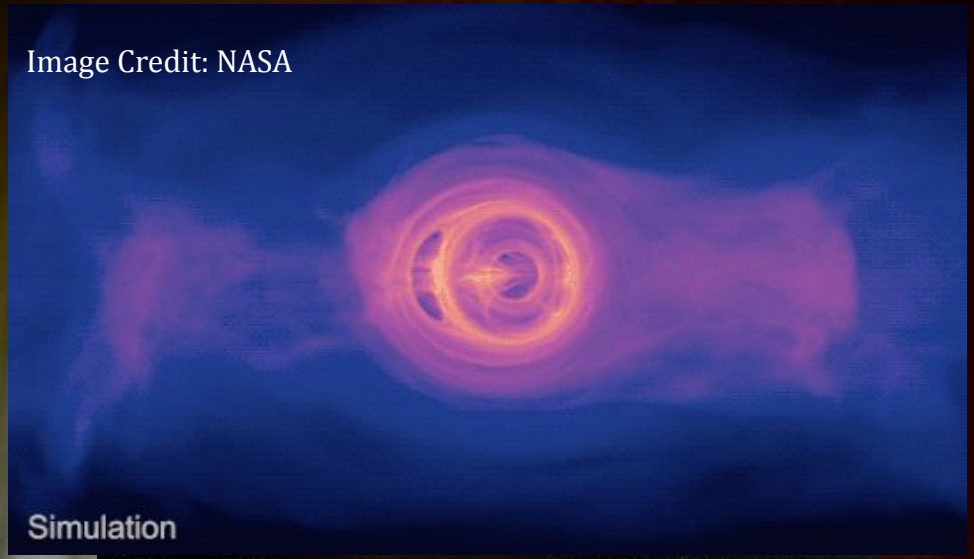
- …are entirely unique in their galaxy (modulo mergers)
- …have relativistic gravity but gentle tides
- …are the only compact objects with masses greater than ~100 $M_\odot$
- …are easily detectable throughout the universe
- …can “activate” into an AGN





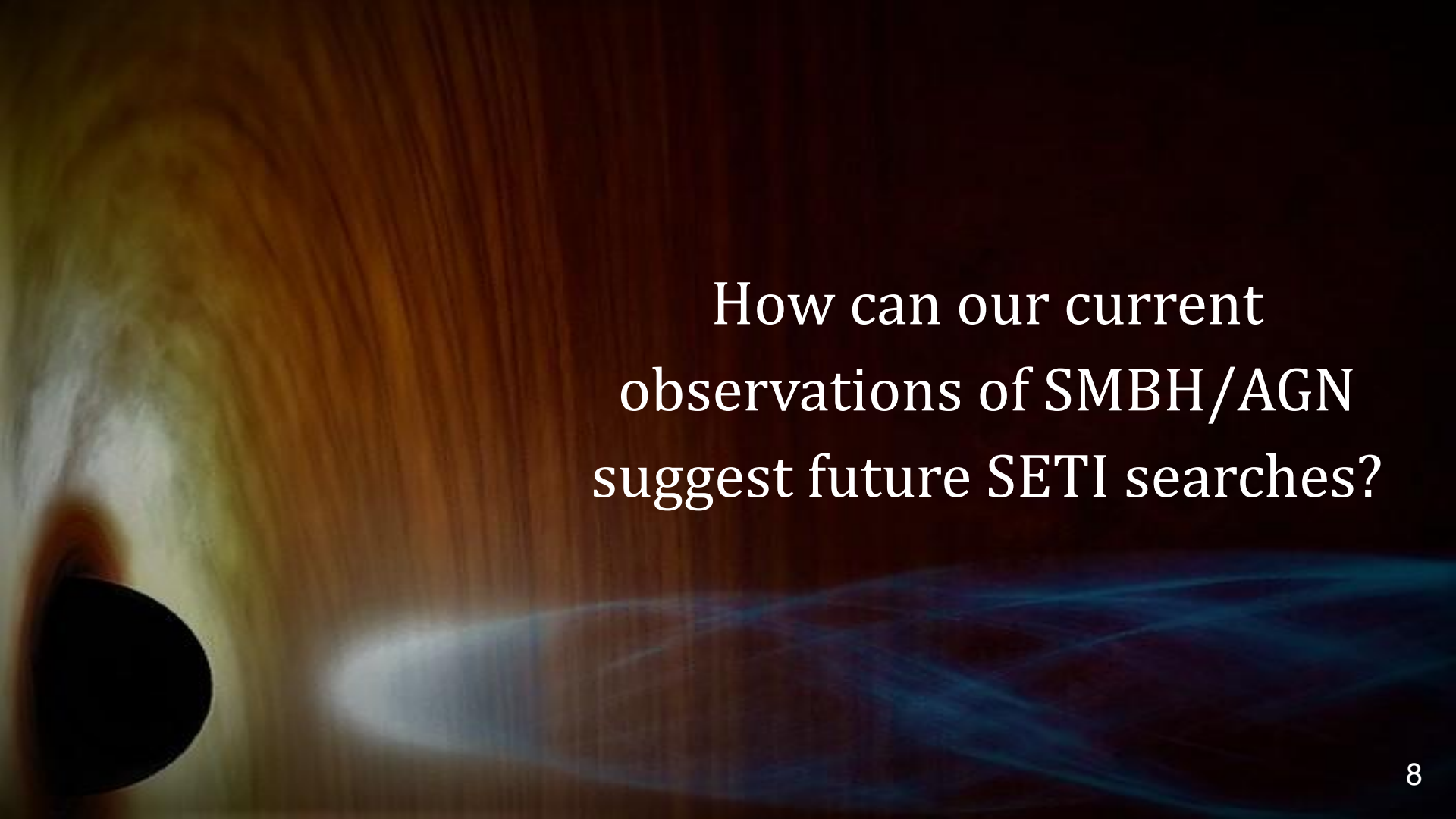






Scientific / Industrial processes only possible at a SMBH could include…

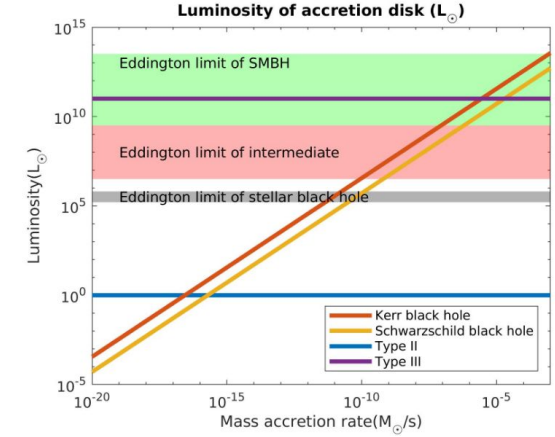
- Up-close investigations of gravitational physics (Vidal 2011)
- Gravitational lensing for astro observations or comms (Hippke, Landis 2018, Maccone 2011)
- Gravitational slingshots (Everitt+2011)
- Disposal/Energy production via accretion
- **“Dyson Sphere”-ing an AGN** (Hsiao+2021)

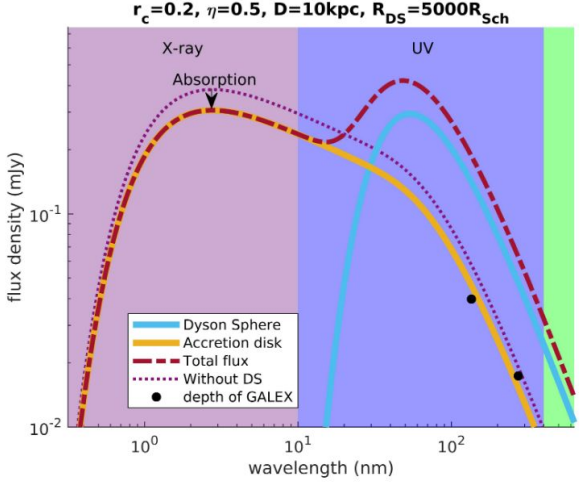

How can our current observations of SMBH/AGN suggest future SETI searches?

Proposal 1: SMBH Dyson Sphere Search

Image Credit: Hsiao+2021

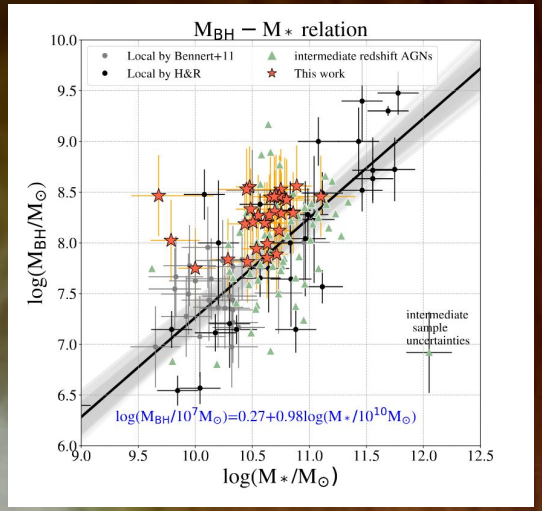
- Dyson sphere/swarm around SMBH bootstraps up to Kardashev III energy extraction
- Hsiao+2021 describes spectrum modification (Optical > IR) akin to searches for Dyson stars/stellar populations
- Contaminant factors: dust, stellar emission, AGN systems
- Theory: How do DS affect jet, corona spectra?
- Observations: MWL fitting, variability modeling





Proposal 2: AGN - Galaxy Mismatch Search

Image Credit: Ding+2019



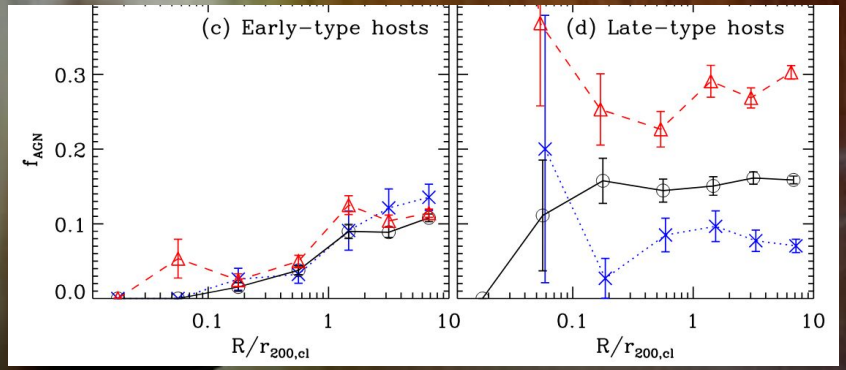
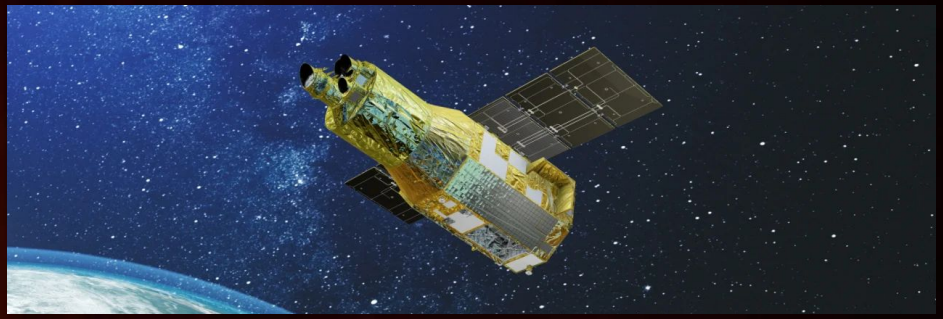


Image Credit: Hwang+2012

- Established trends in host galaxies and SMBH/AGN can be tested for outliers
  - SMBH mass v. galactic stellar mass
  - AGN type v. galaxy morphology
  - AGN history v. SFR/morphology history
- Existing AGN surveys lead to MWL followup for unusual, outlier systems
- Supports non-SETI AGN science by identifying unique AGN
- Identify targets akin to BL “Exotica” Catalog

Proposal 3: AGN Components with XRISM

- XRISM - X-ray microcalorimeter with R~1000 resolution
- Finally achieves high resolution X-ray spectroscopy, can search for narrow-band X-ray emission
- Unlocks detailed compositional analysis of AGN components
- Look at known outlier AGN to characterize unusual astrochemistry and/or technosignatures



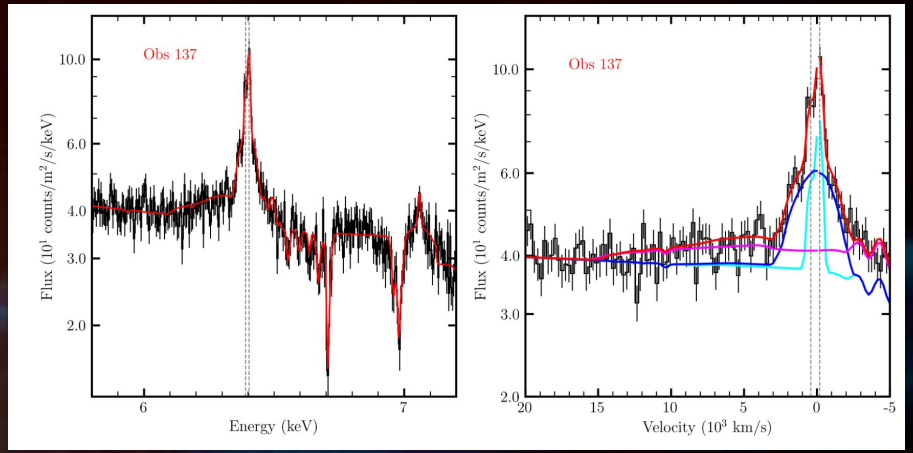
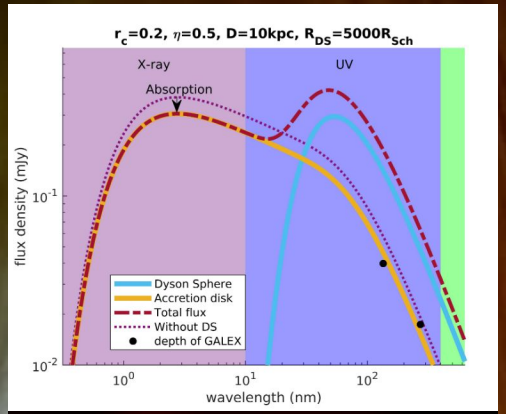


Image Credit: XRISM Collab. 2024

Image Credit: Hsiao+2021



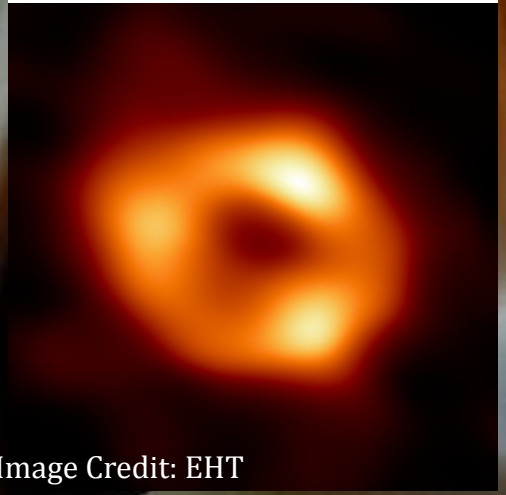


Image Credit: EHT

Conclusions

- Within each galaxy, SMBH are “attractors” for scientific/industrial processes that cannot be conducted elsewhere
- AGN in particular are attractive targets for “Kardashev 3”-scale energy extraction
- The study of unusual or unique AGN is a starting point to identify how current + future HE observatories can support SETI work at SMBH/AGN

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