# X-ray Astronomy in the 2030s:
# Update on the Status of the XR-SIG Science Analysis Groups


**Fabio Pacucci**
**Astrophysicist**
**Senior Member of the**
**Institute for Theory and Computation**


**APS Meeting, Denver (CO)**
**March 17, 2026**


CENTER FOR ASTROPHYSICS
HARVARD & SMITHSONIAN


Lynx Concept Study Report, Niko Maisuradze

# The X-Ray Science Interest Group

*"To Support Mission Studies and Concept Development for Future X-Ray Observatories"*

**Current Chairs**

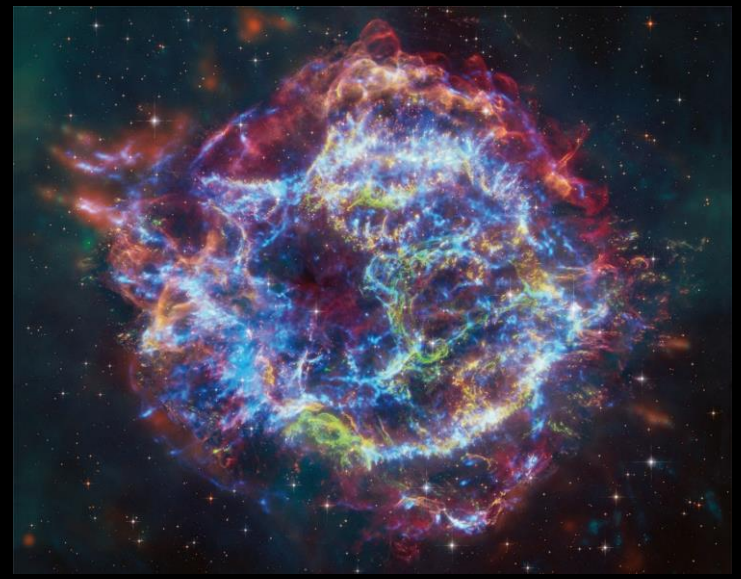
| Name | Institution | Term |
|---|---|---|
| David Pooley | Trinity University | 2021 – |
| Chien-Ting Chen | USRA / MSFC | 2023 – |
| Breanna Binder | Cal Poly Pomona | |
| Steven Ehlert | MSFC | |
| Scott Randall | CfA | |
| Fabio Pacucci | CfA | |

# The SAGs of the SIG

*“The SAG activity aims to produce one or more reports at the end of its term that will be delivered to the Astrophysics Division Director.”*

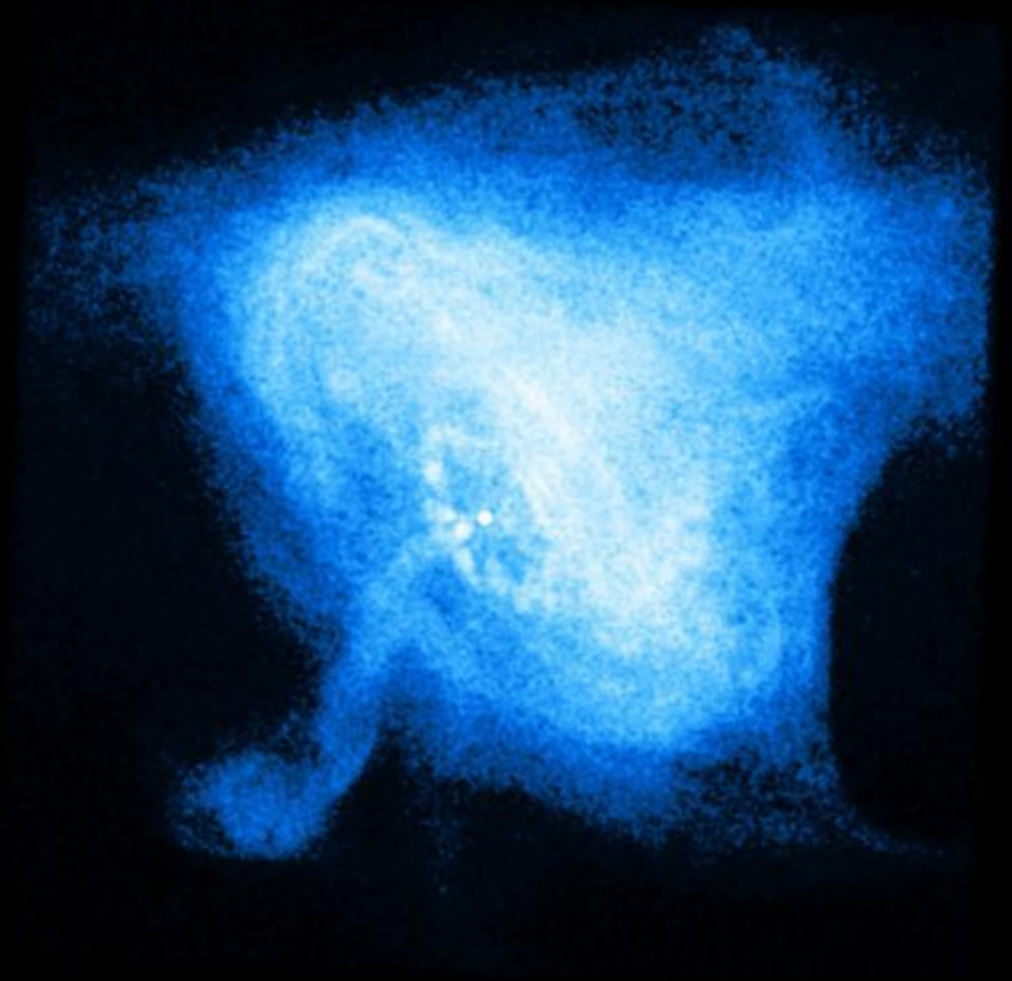
Broad-Band X-ray Observatory
BBX SAG

High Angular Resolution X-ray Imager
Hi-Rex SAG



Lynx 2030
Lynx 2030 SAG

# X-Ray Timing SAG



*NASA/CXC/MSFC/M.Weisskopf et al.*

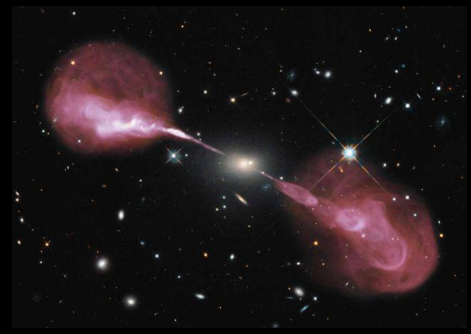
# BBX SAG

*Identify the scientific opportunities that require coverage beyond the typical [0.2 ,10] keV capabilities of focusing soft X-ray facilities.*

1. Detect sources of the obscured population of XRB (20-30 keV);
2. Study physics in extreme environments (>100 keV);
3. Resolve faint extended emission in sites of particle acceleration (e.g., AGN jets).

## BBX SAG Chairs

| Name | Institution |
|---|---|
| Chien-Ting Chen | USRA/MSFC |
| Kristin Madsen | GSFC |
| Daniel Stern | JPL |



# Hi-ReX SAG

*Identify the scientific opportunities enabled by ultra-high angular resolution X-ray imaging across broad scientific categories.*

1. Exoplanet habitability and host stars;
2. Star formation and evolution;
3. Galactic and extragalactic astrophysics;
4. Black holes;
5. Fundamental physics;
6. Cosmology

## Hi-ReX SAG Chairs

| Name | Institution |
|---|---|
| Kimberly Weaver | NASA Goddard Space Flight Center |
| Herman Marshall | MIT Kavli Institute |
| Mark Schattenburg | MIT Kavli Institute |
| Breanna Binder | Cal Poly Pomona |

# Lynx 2030 SAG

*To revisit the Lynx Science portfolio and design model in the context of the current Astronomy landscape.*


## SAG Chairs

| Name | Institution |
|---|---|
| Steven Ehlert | MSFC |
| Fabio Pacucci | SAO |

Lynx Concept Study

# SAGs Timeline

**October 2025:** SAGs begins operating

**January 2026:** Working Groups Assembled

**June 2026:** WGs report findings to SAG Chairs

**July 31, 2026:** Final report to NASA PhysCOS and APD

# Lynx2030 SAG: Website

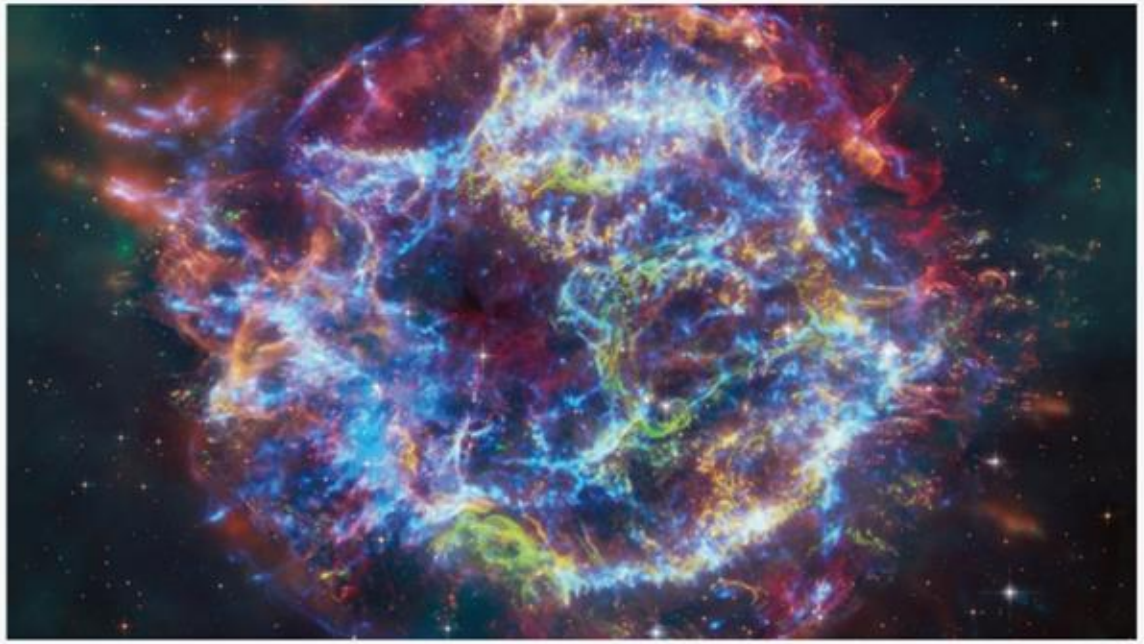
About Lynx 2030 SAG

## Lynx 2030 SAG Will Build On the Work of the Lynx Concept Study Report

**The Lynx concept study report is an excellent baseline for what the flagship X-ray mission submitted to the 2030 Decadal Survey may look like.**

The primary goal of this Science Analysis Group is to revisit the Lynx science portfolio and reference design model in the context of the current astronomy landscape.

**Subscribe to the Lynx 2030 SAG Email List**

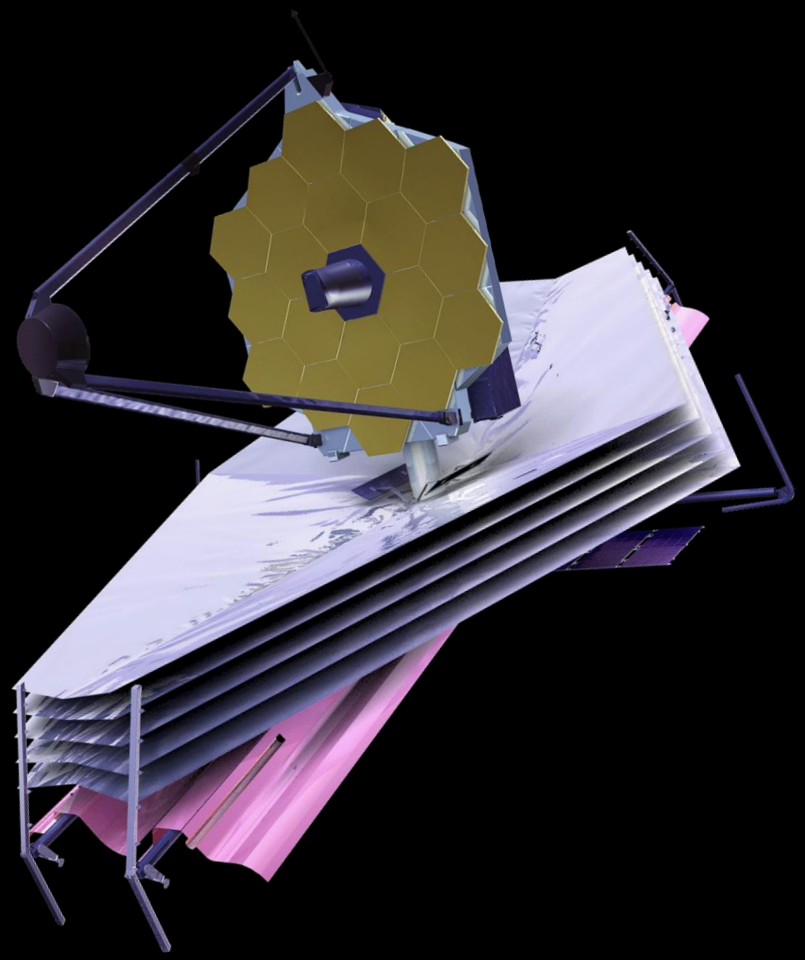


For the first time, astronomers have combined data from NASA's Chandra X-ray Observatory and James Webb Space Telescope to study the well-known supernova remnant Cassiopeia A (Cas A). This work has helped explain an unusual structure in the debris from the destroyed star called the "Green Monster," first discovered in Webb data in April 2023. The area of the Green Monster is outlined in the inset image. This composite image contains X-rays from Chandra (blue), infrared data from Webb (red, green, blue), and optical data from Hubble (red and white). The outer parts of the image also include infrared data from NASA's Spitzer Space Telescope (red, green, and blue).

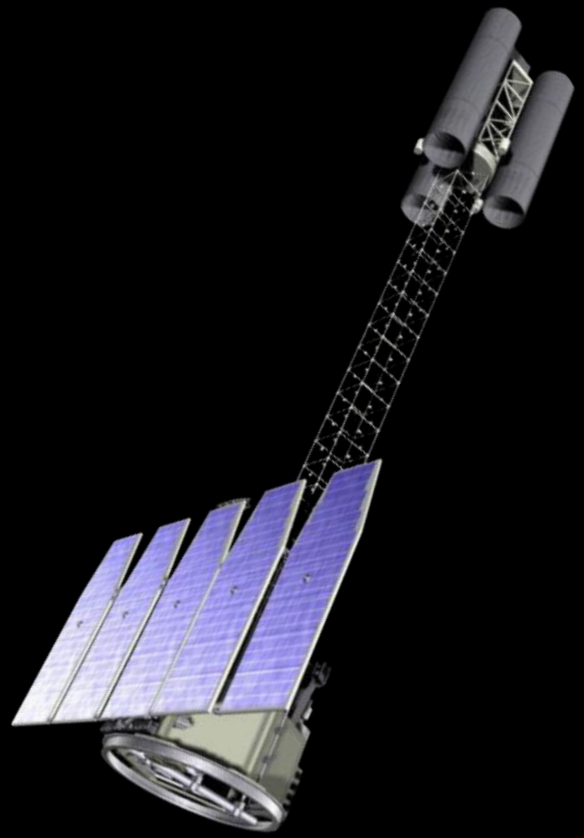
**Image and text credit: X-ray: NASA/Chandra X-ray Center (CXC)/Smithsonian Astrophysical Observatory (SAO); Optical: NASA/European Space Agency (ESA)/Space Telescope Science Institute (STScI); Infrared (IR): NASA/ESA/Canadian Space Agency (CSA)/STScI/Milisavljevic et al., NASA/Jet Propulsion Laboratory (JPL)/Caltech; Image processing: NASA/CXC/SAO/J. Schmidt and K. Arcand**

# Lynx 2030 SAG

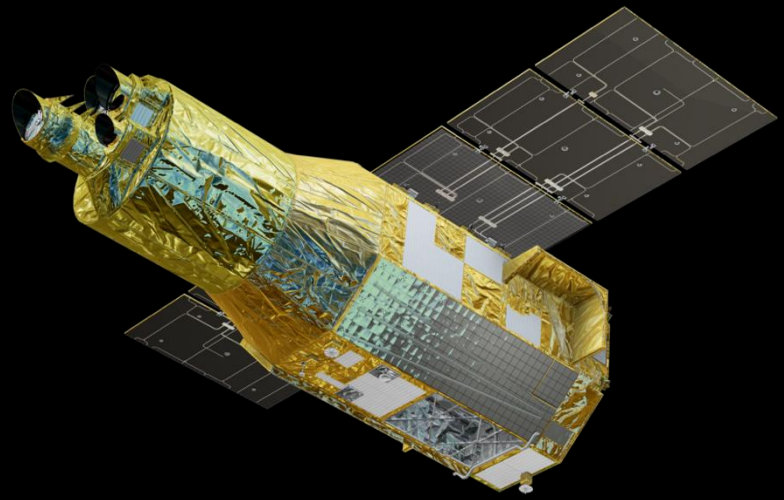
# New Observatories



JWST



IXPE



XRISM

# Lynx2030 Working Groups

ANGULAR RESOLUTION

NEW CAPABILITIES

ENERGY BANDPASS

SURVEY GRASP

MICRO CALORIMETER

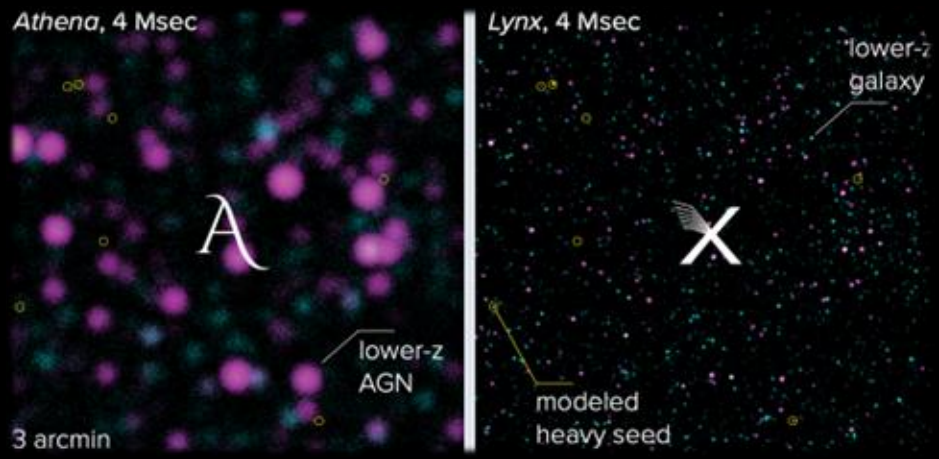
TIME DOMAIN

# ANGULAR RESOLUTION WG

Lynx Design Requirement: 0.5”

Deep Field AGN

X-ray Binaries




What Science can we unlock with a higher angular resolution?

# Dual AGN Phase

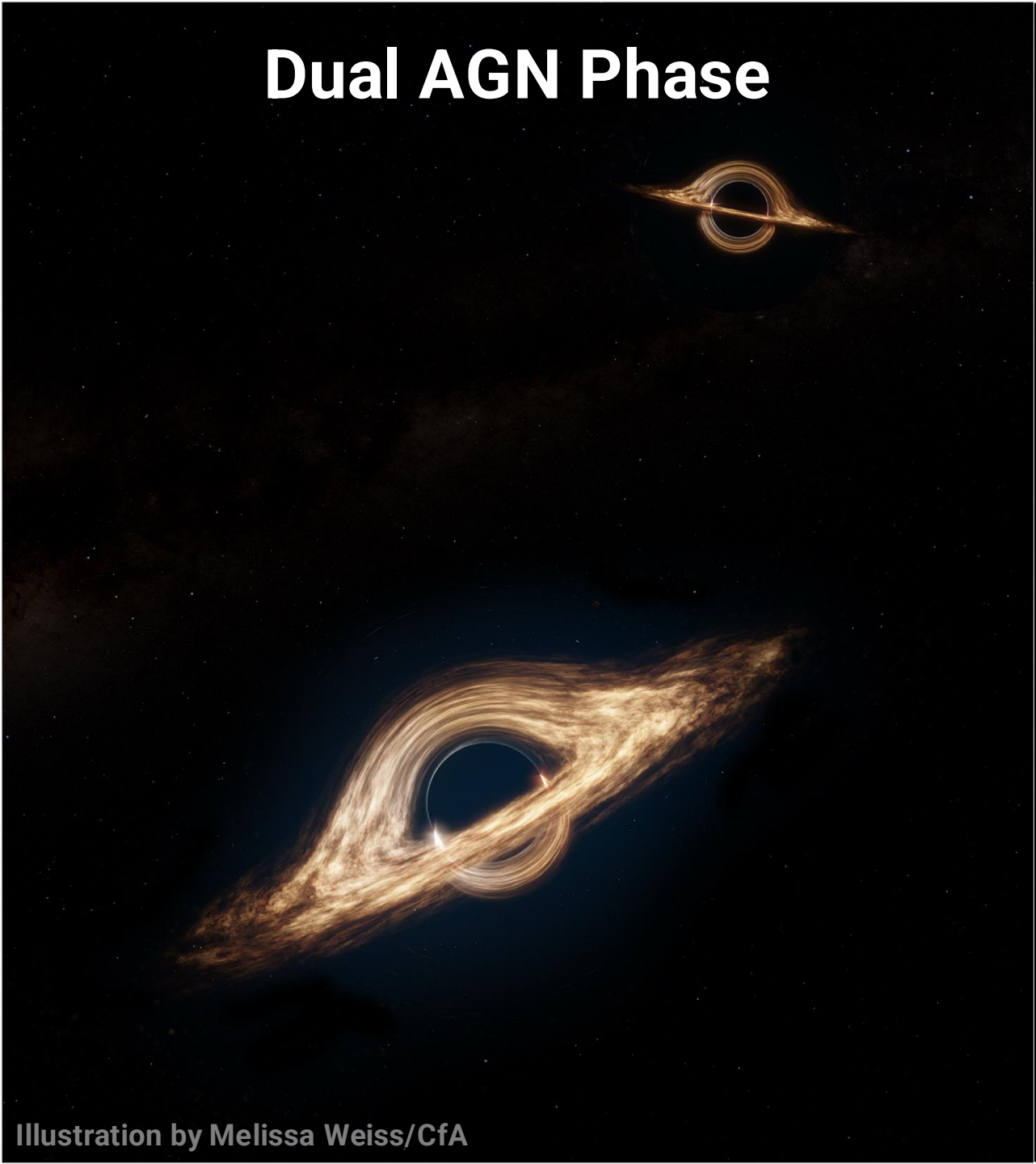
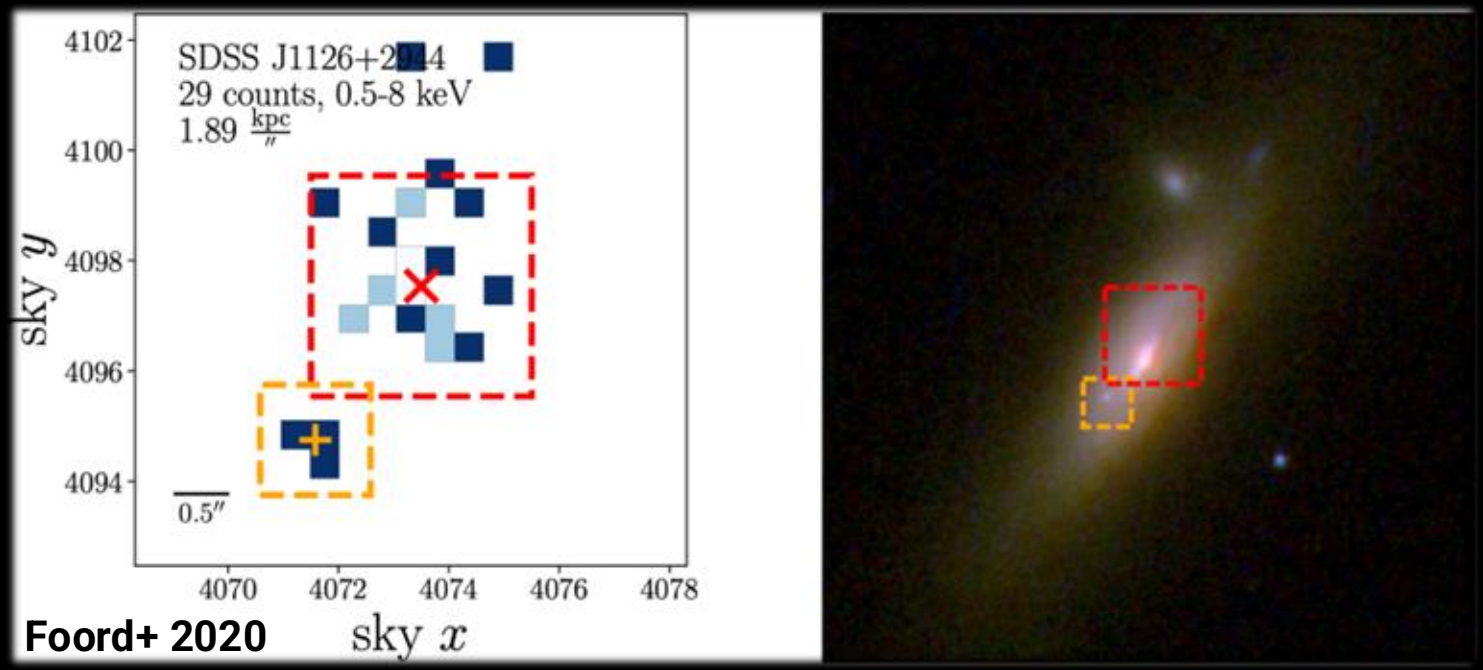


Illustration by Melissa Weiss/CfA

# Dual AGN




Foord+ 2020

## Chandra:

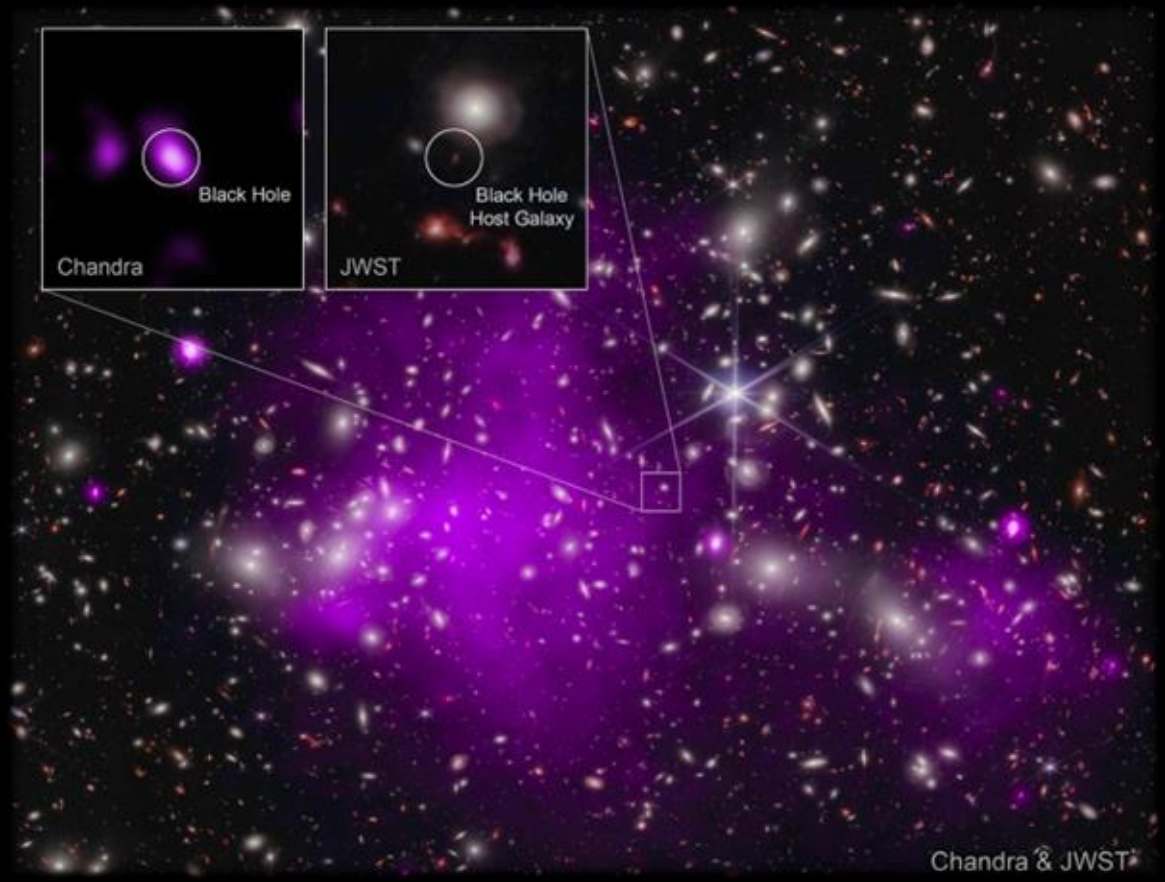
- < 50 dual AGN have been X-ray detected
- Most of them are at z < 0.1, in the very local Universe

## Lynx:

- Spatial resolution 0.5″: at maximum angular distance (z = 1.6), Lynx can resolve dual AGN separated by **3 kpc**!
- Detect dual AGN up to z ~ 5


LAUNCHING SOON
LYNX2030
WWW.HIDDENCOSMOS.ORG

# New Science for the 2030s and Beyond




UHZ1: Bodgan+ 2023
z ~ 10

nature astronomy

Review article

https://doi.org/10.1038/s41550-025-02675-8

# 25 years of groundbreaking discoveries with Chandra

Received: 24 May 2025

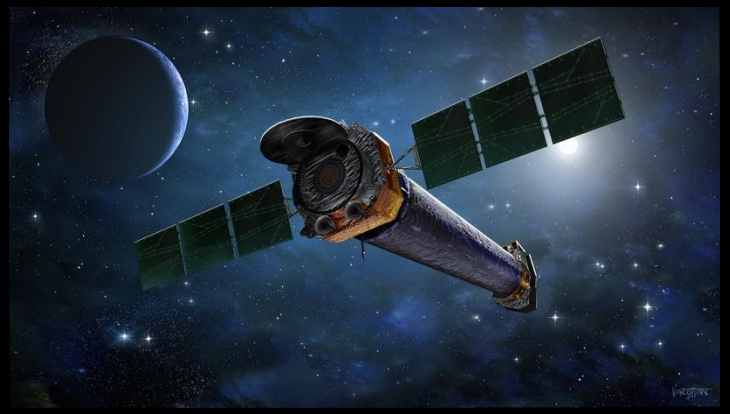
Accepted: 2 September 2025

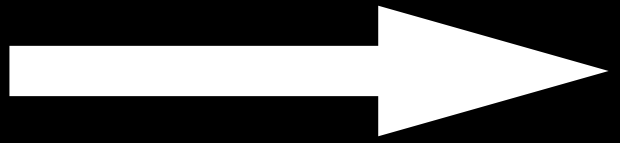
Published online: 10 October 2025

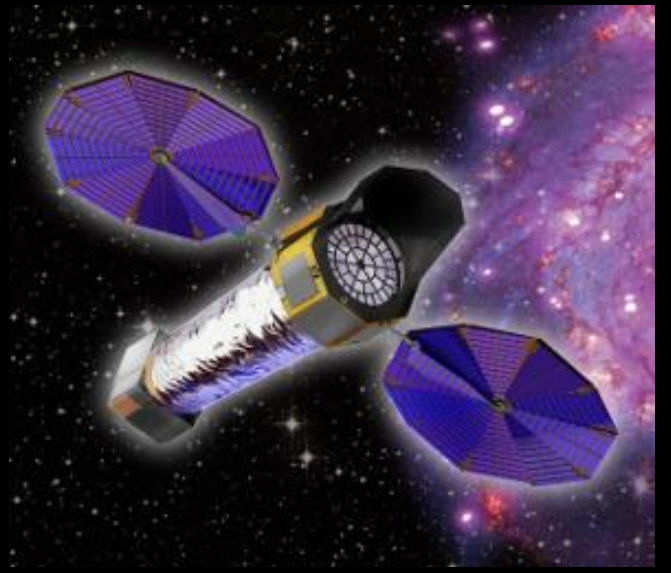
Check for updates

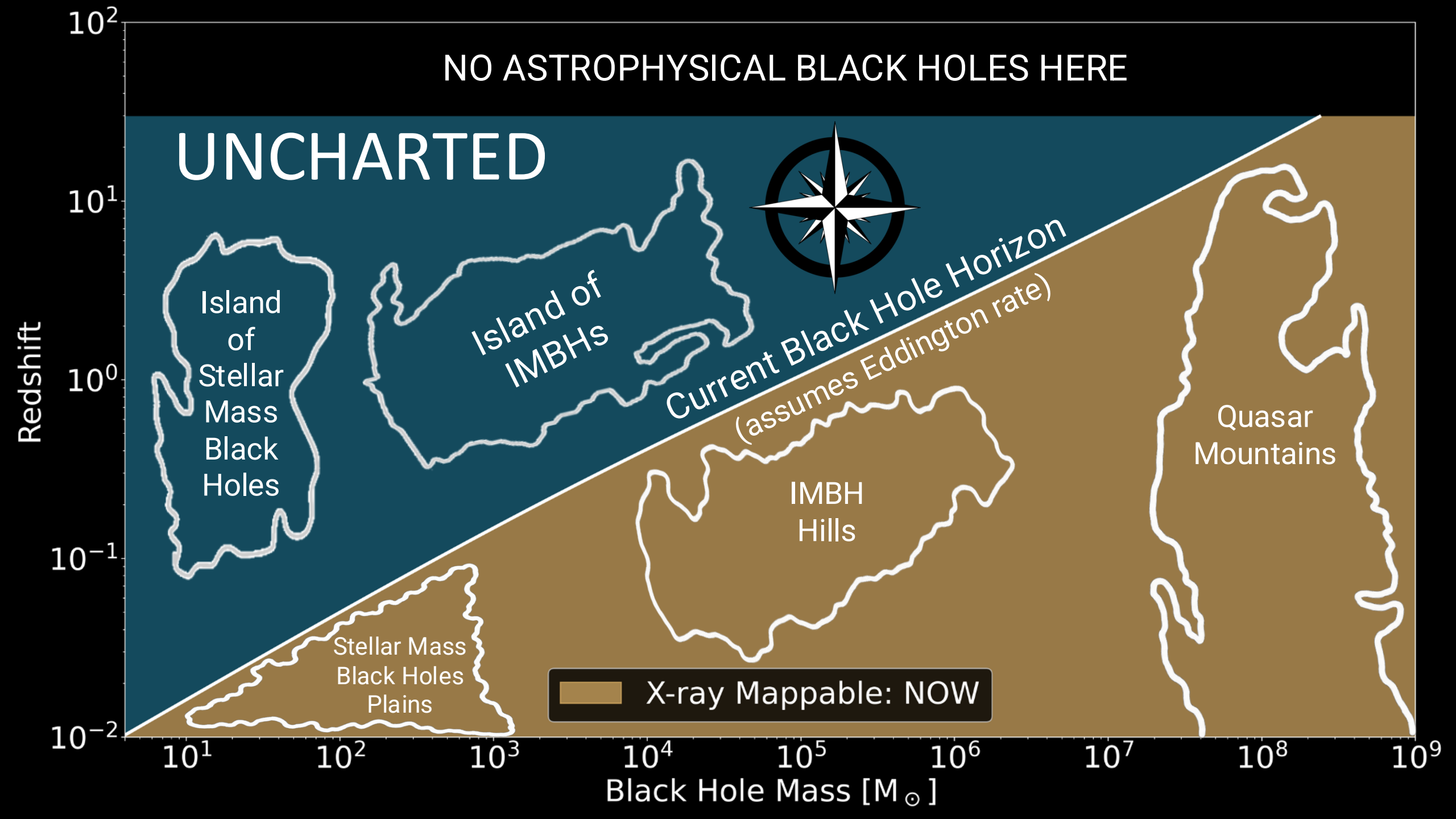
Patrick Slane[1], Ákos Bogdán[1] & David Pooley[2,3]

The Chandra X-ray Observatory is a mainstay of modern observational astrophysics. With the highest angular resolution of any X-ray facility, its imaging and spectral capabilities in the 0.5–10 keV band have led to both unique and complementary breakthroughs in nearly all areas of the field. Now, more than a quarter of a century into its mission, Chandra continues to provide invaluable information on the contributions of compact objects to the evolution of galaxies, the nature of supernova explosions, the impact of energetic jets from supermassive black holes on their host environments and the fate of exoplanet atmospheres in systems rich with stellar flares. Here we provide a summary of Chandra results—one that is embarrassingly incomplete, but representative of both the exquisite past and promising future of Chandra's contributions to high-energy astrophysics and all of mainstream astronomy.








NO ASTROPHYSICAL BLACK HOLES HERE
UNCHARTED
Island of Stellar Mass Black Holes
Island of IMBHs
Current Black Hole Horizon
(assumes Eddington rate)
IMBH Hills
Quasar Mountains
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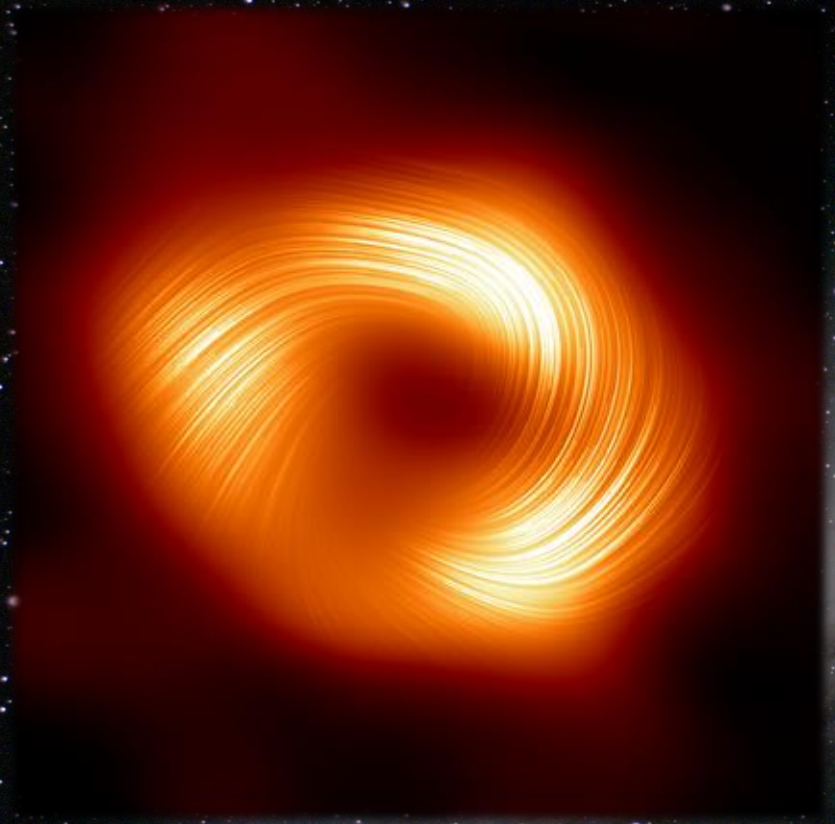
Black Hole Mass [$M_\odot$]



M31 (Credit: NASA)
Distance: 0.9 Mpc

# The Black Hole Luminarium

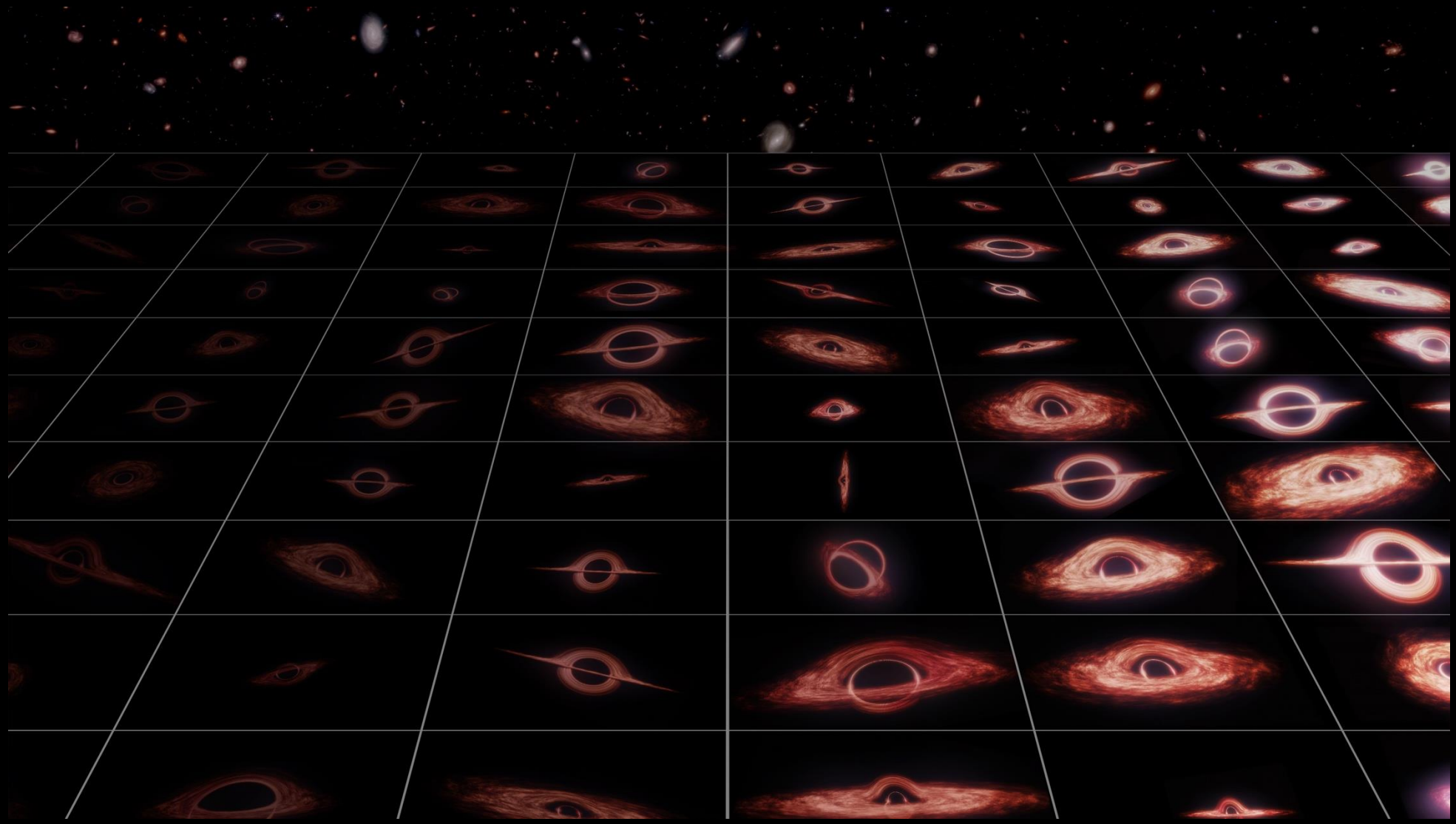


Illustration by CfA/Melissa Weiss

Epoch of Reionization

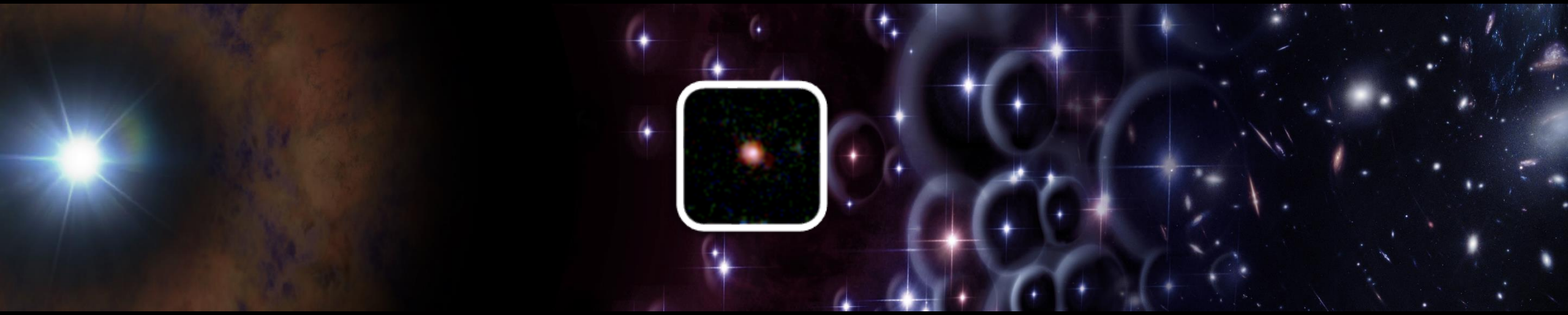
Local Universe

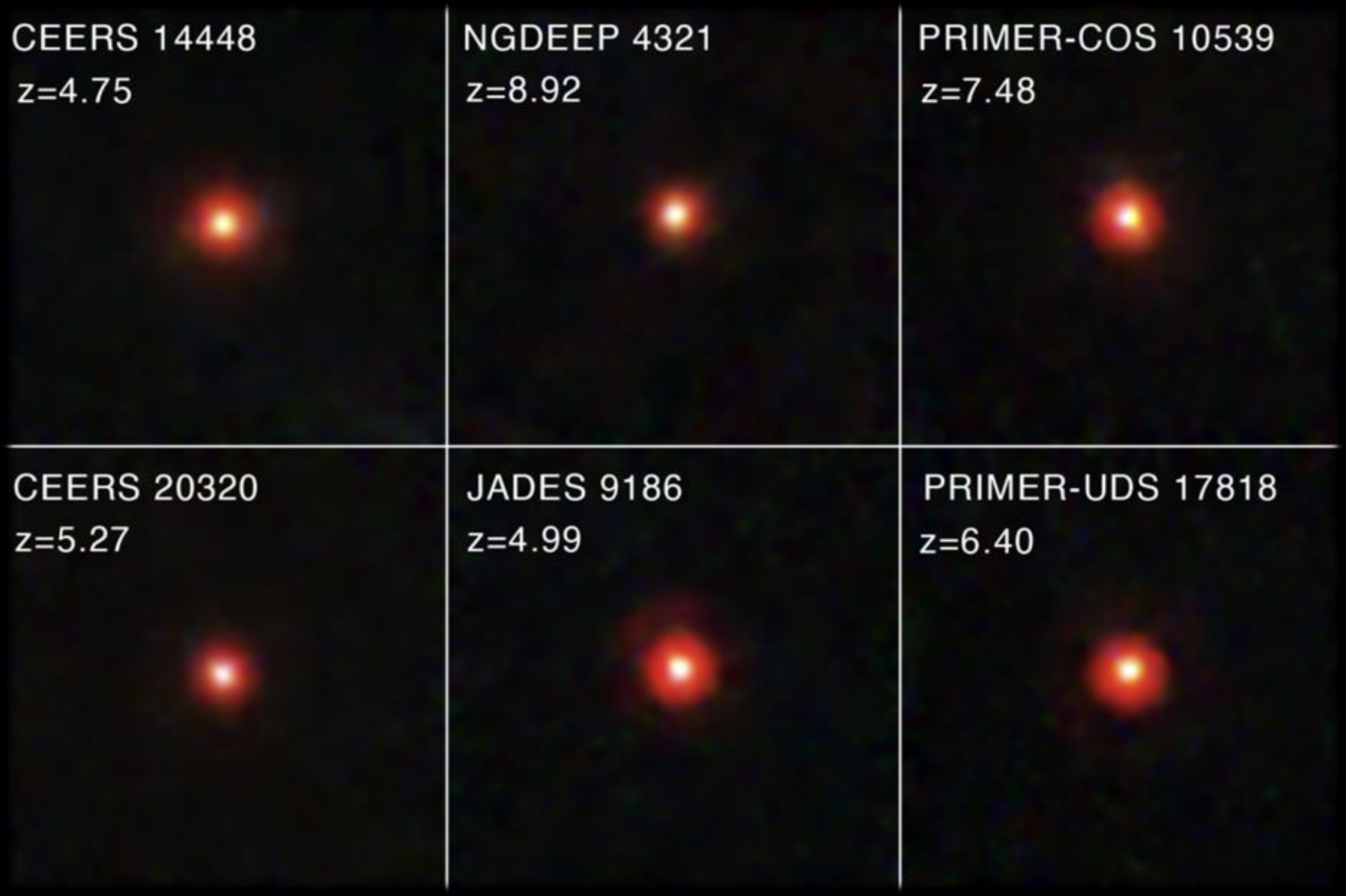
Little Red Dots


Wandering Black Holes

# #1: The Epoch of Reionization

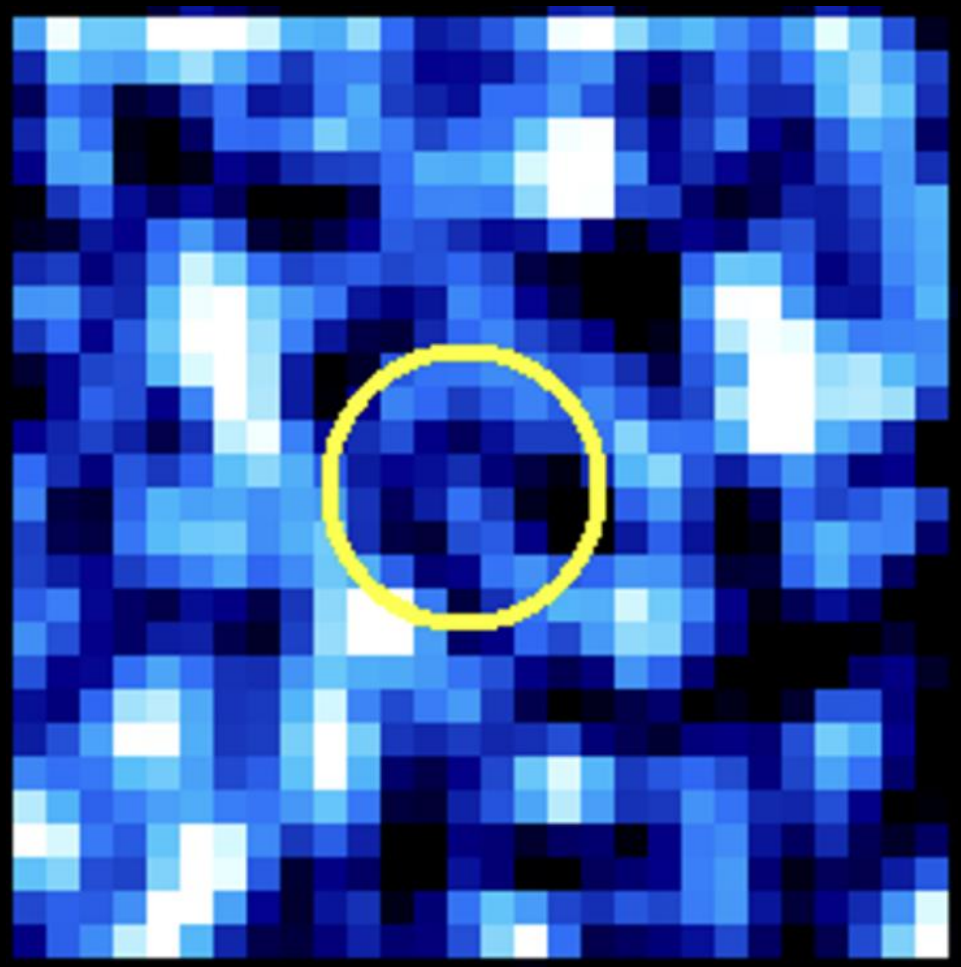
# JWST’s Little Red Dots






NASA press release, January 2025, Kocevski+

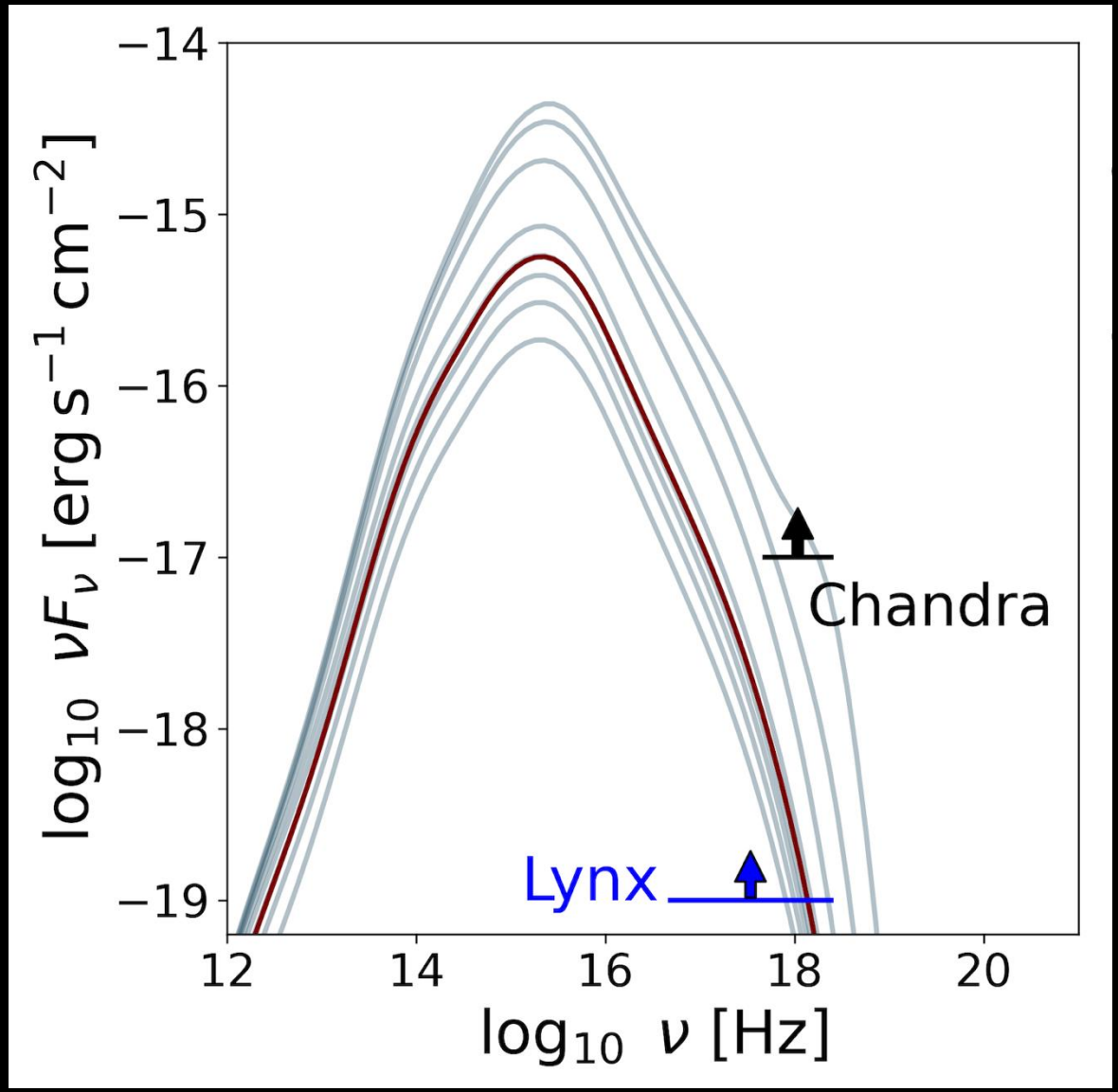
# X-ray Weakness of the LRDs



Maiolino+ 2024
Yue+ 2024
Ananna+ 2024

# The X-ray Emission of the LRDs

z = 6



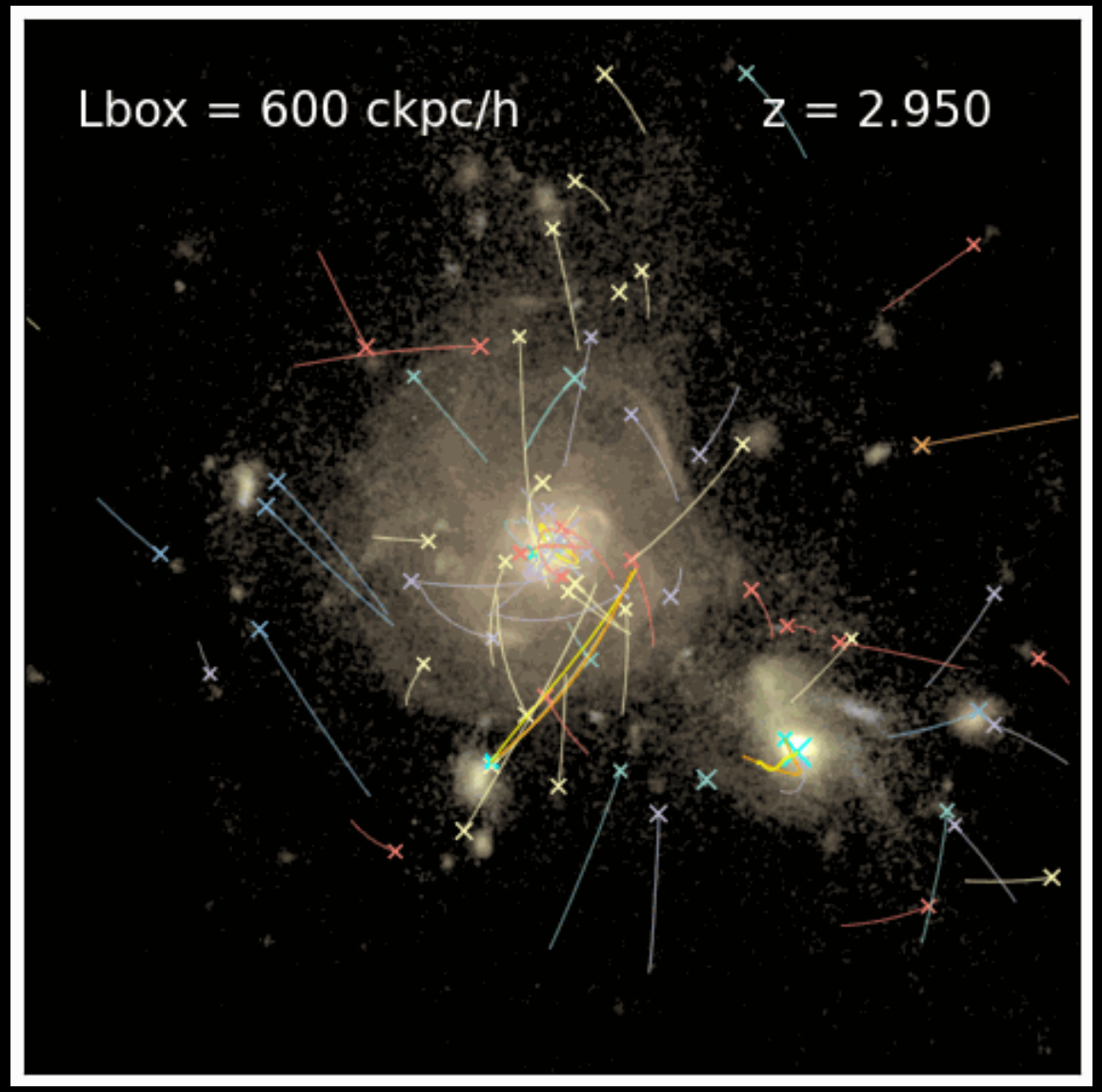

**Pacucci** & Narayan, 2024

See also:
Lambrides+ 2024;
King 2024; Lupi+ 2024;
Madau & Haardt, 2024

# #2: The Local Universe

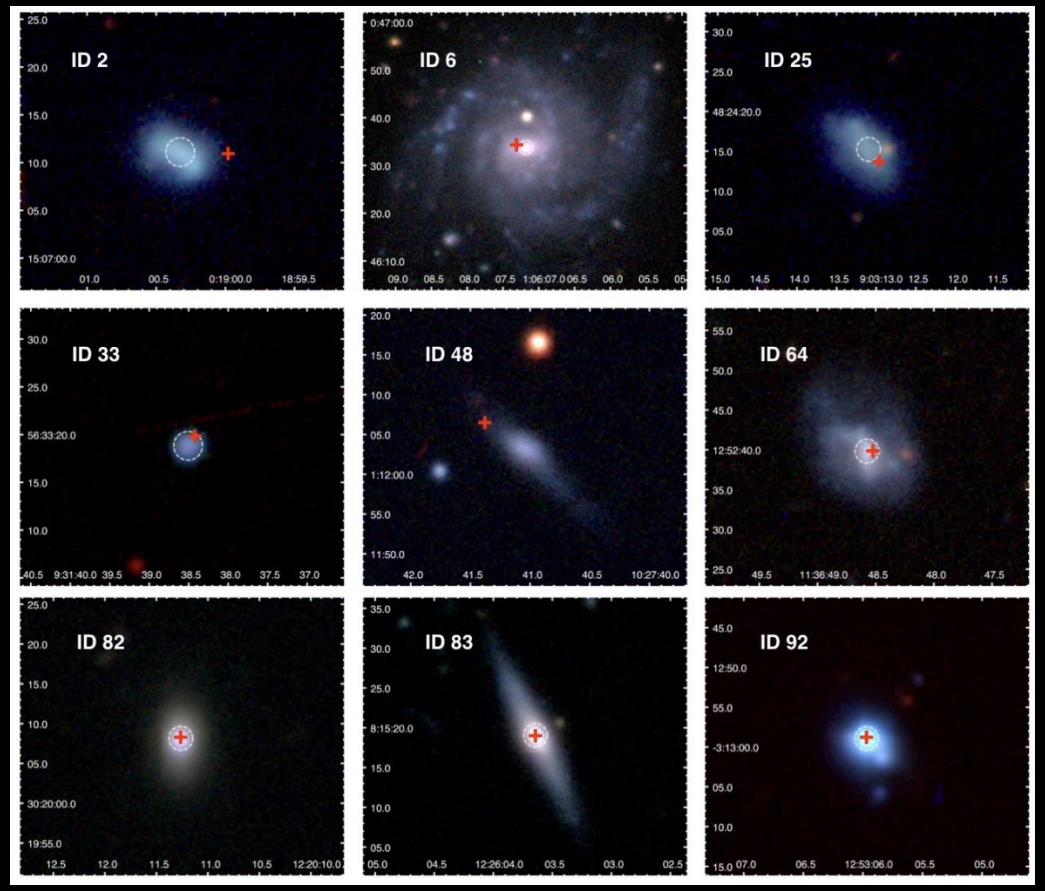
# Wandering Massive Black Holes

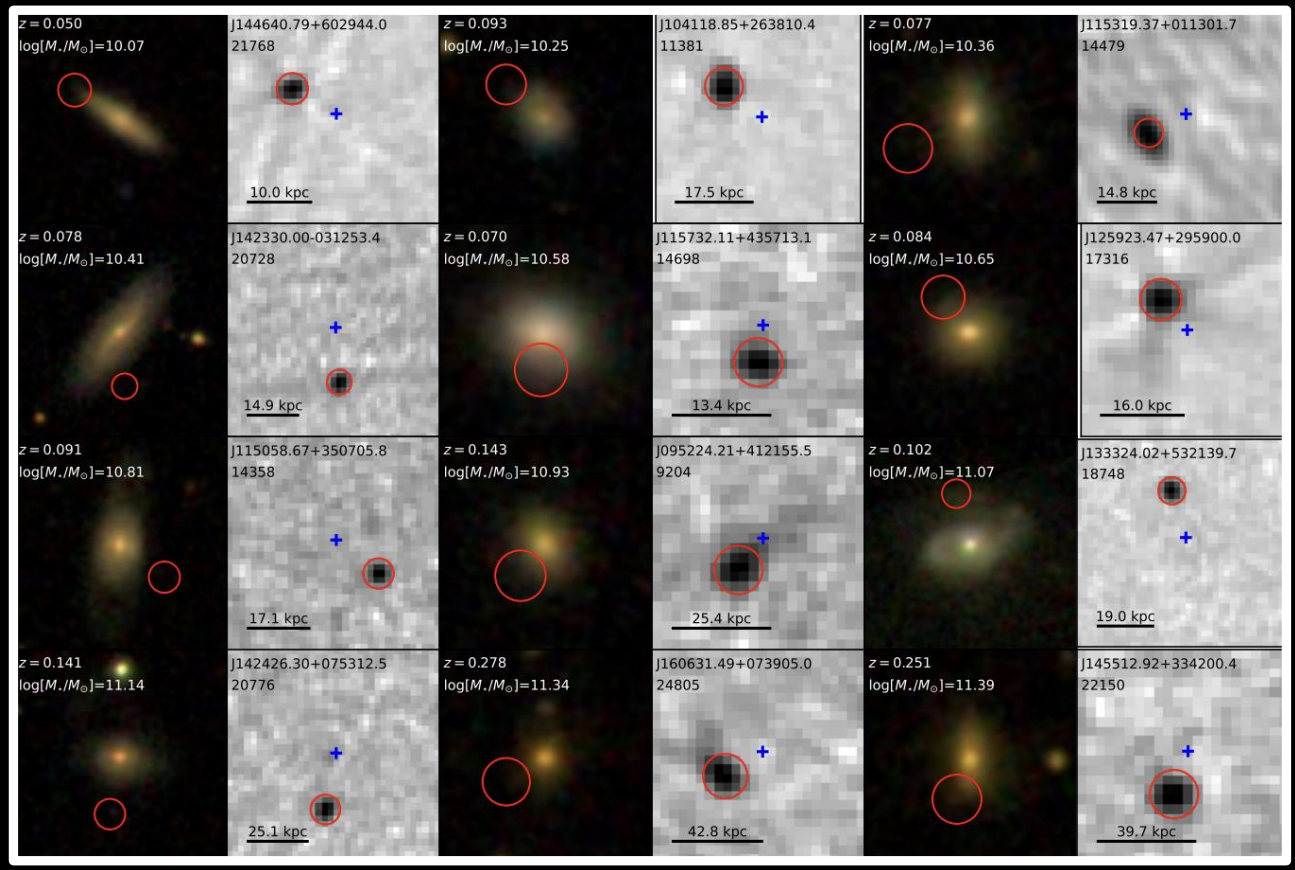
# Local Wandering Massive Black Holes




Astrid Simulation; Ni+ 2022; Bird+ 2022; Di Matteo+ 2023

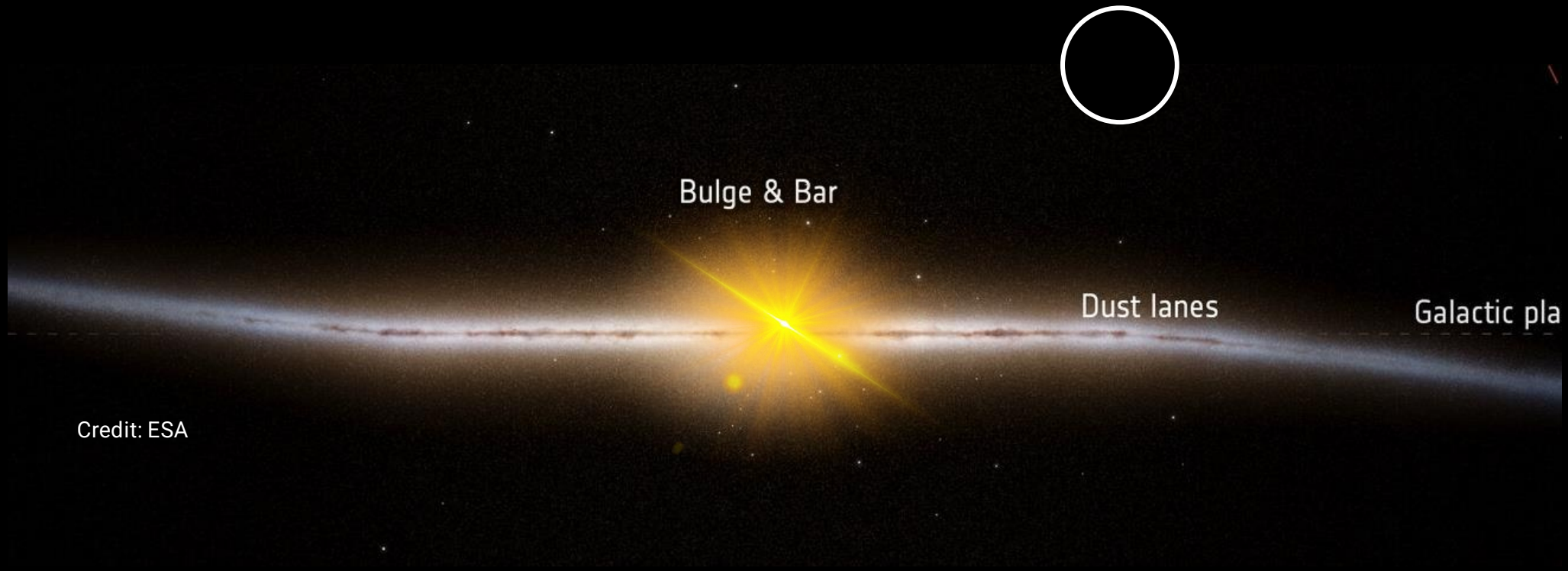
# Local Wandering Massive Black Holes



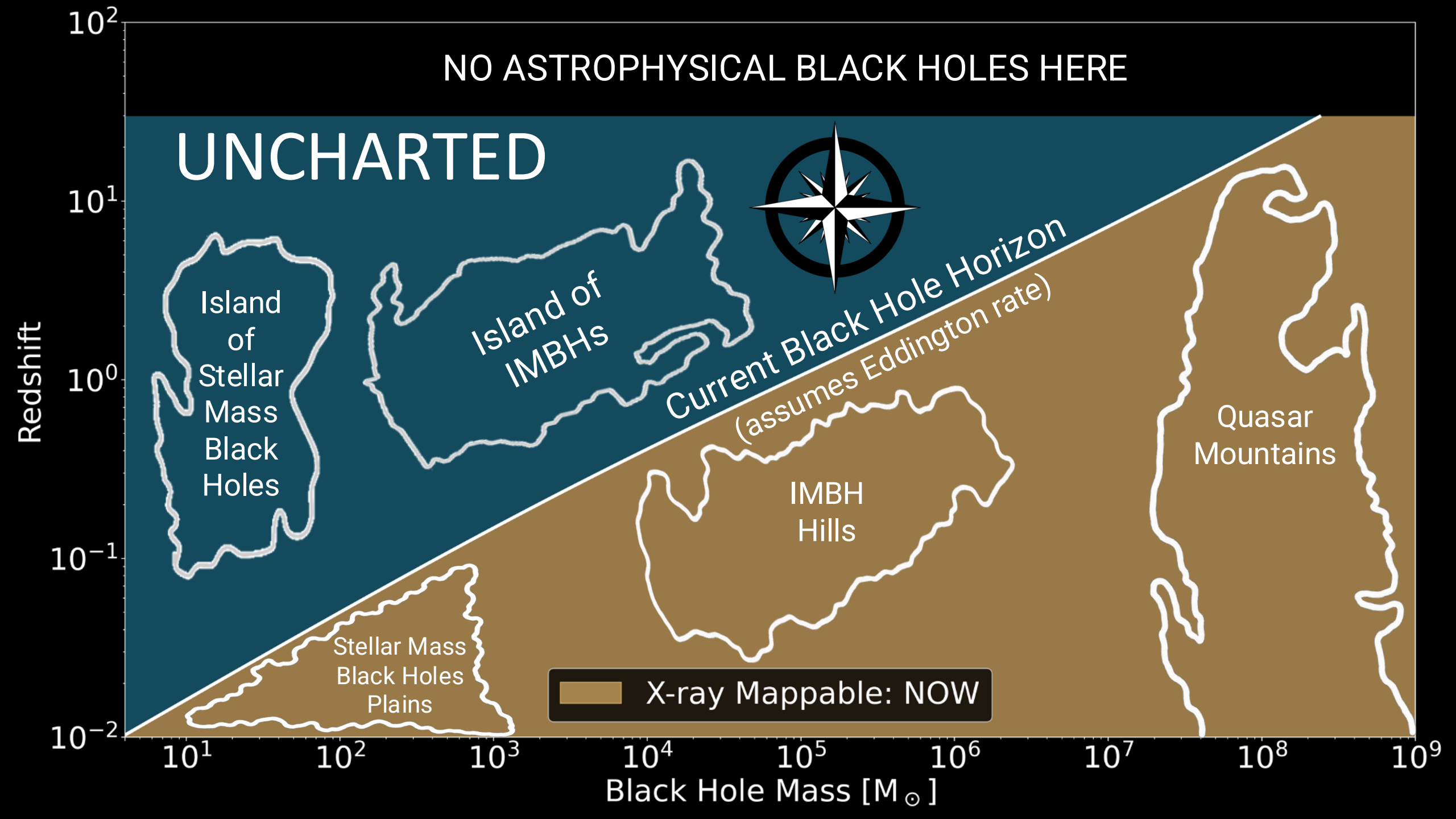




Mezcua+ 2019; Reines+ 2020; Barrows & Comerford, 2025

# Wandering MBHs Can Be Detected!




Weller+ 2022
Seepaul+ 2022
**Pacucci**+ 2023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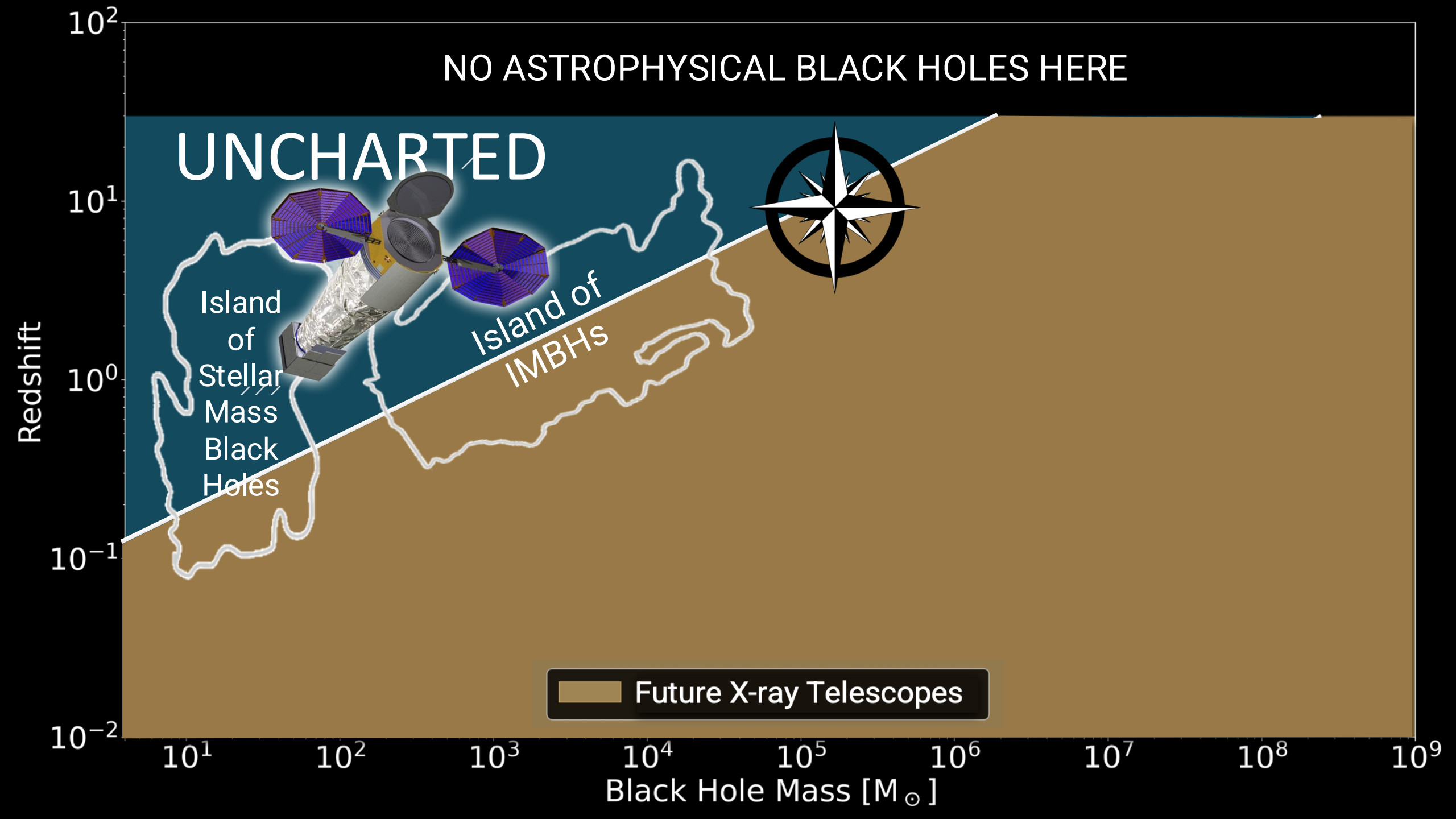
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Black Hole Mass [M⊙]
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10^1
10^0
10^−1
10^−2
10^1
10^2
10^3
10^4
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