

A variable monster at the Epoch of Reionization



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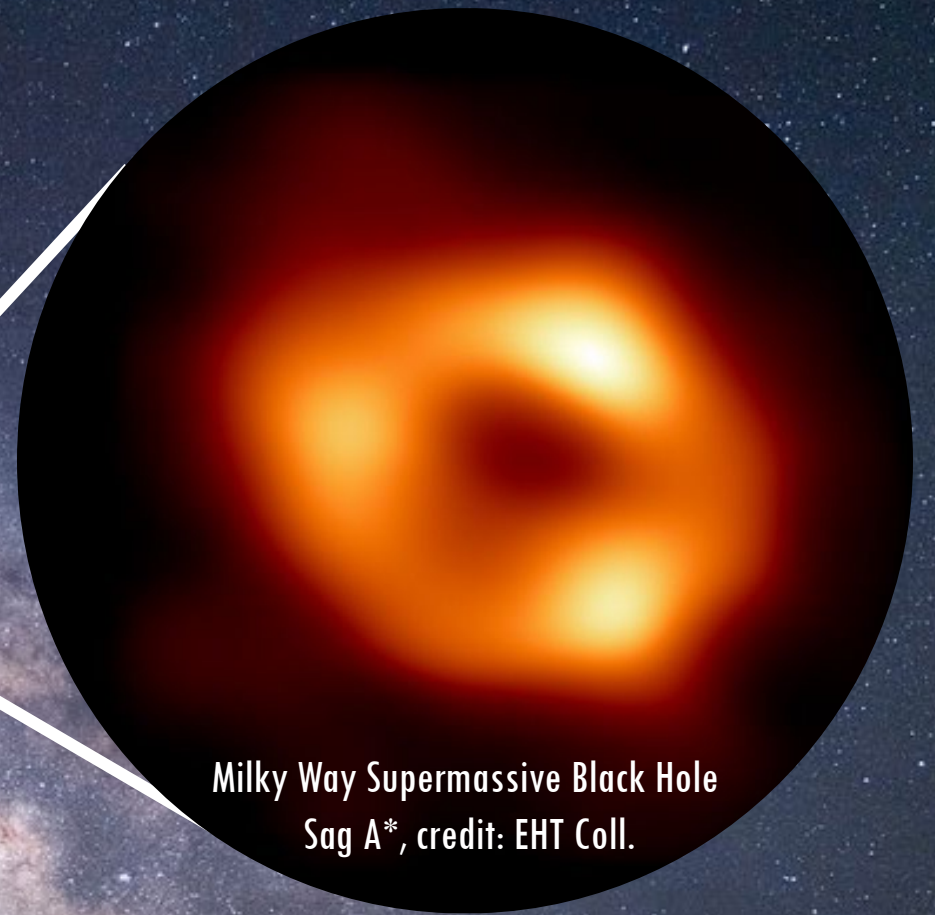


ApJL, 979, L6

Yale
Caltech

Supermassive Black Holes are found at the **center of every massive galaxy** we know of

MILKY WAY GALAXY



Milky Way Supermassive Black Hole
Sag A*, credit: EHT Coll.

**Active Supermassive
Black Holes** are among
the **oldest, brightest**
objects in the universe

Some Active Supermassive
Black Holes can also power
relativistic jets, as bright
as **100 trillion Suns**



For the first time, we found evidence that the brightest accreting supermassive black hole in X-rays at the Epoch of Reionization hosts powerful relativistic jets pointed towards Earth.



ApJL, 979, L6

VLA



Radio light

Centaurus A

Spitzer



Infrared light

Centaurus A

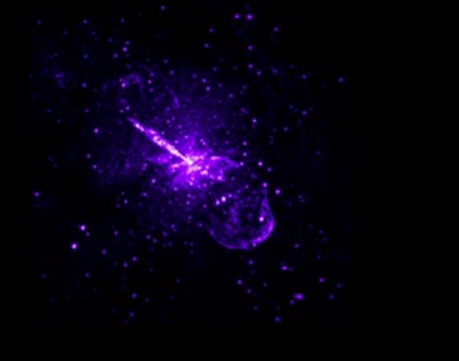
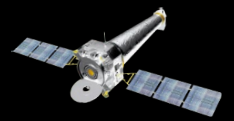
Hubble Space Telescope



Visible light

Centaurus A

Chandra



X-ray light

Centaurus A



Accreting Supermassive Black holes shine **bright at all wavelengths**

REIONIZATION

0 years ~200-400 million years 1 billion years 9 billion years 13.8 billion years

BIG BANG

DARK AGES

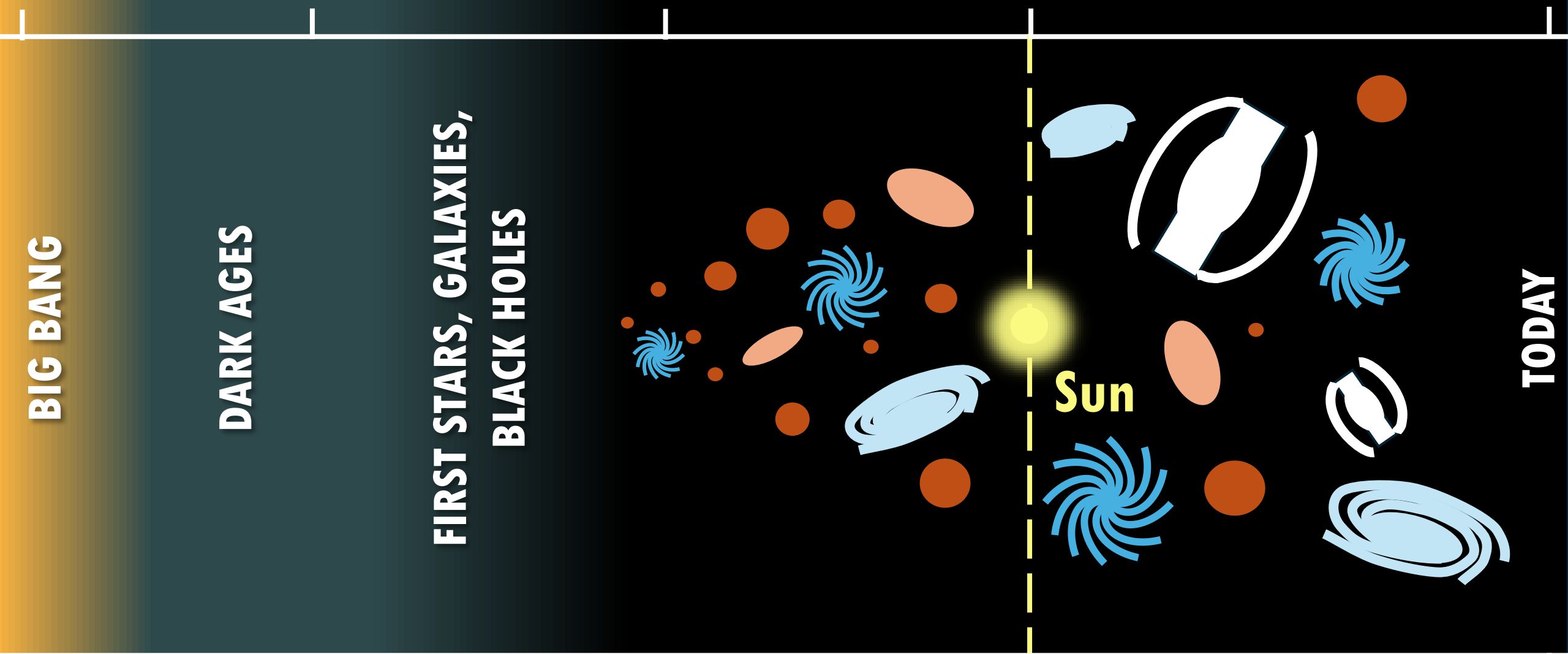
**FIRST STARS, GALAXIES,
BLACK HOLES**

Sun

TODAY

1st Jan 3rd Jan 1st Feb 1st Sept 31st Dec

AAS 245

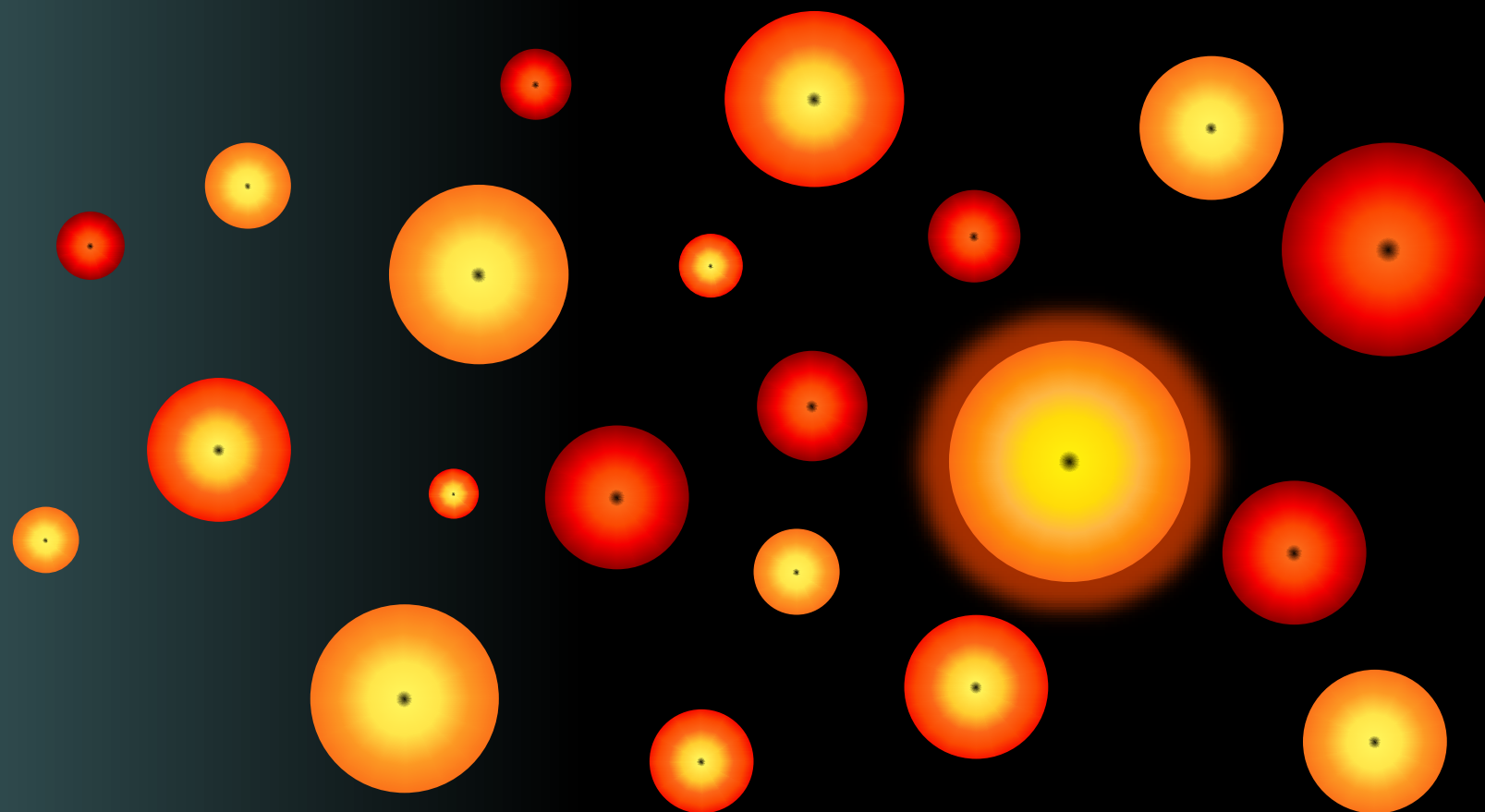


EPOCH of REIONIZATION

FIRST STARS, GALAXIES, BLACK HOLES

~200-400 million years

1 billion years



3rd Jan

AAS 245

1st Feb

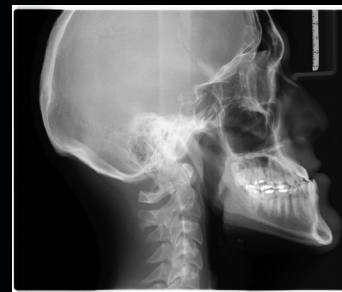
EPOCH of REIONIZATION

~200-400 million years

1 billion years

J1429+5447

Brightest known Active Supermassive Black Hole in **X-rays** within the 1st billion year of the universe



Emits in X-rays the equivalent of

1'000'000'

000'000'

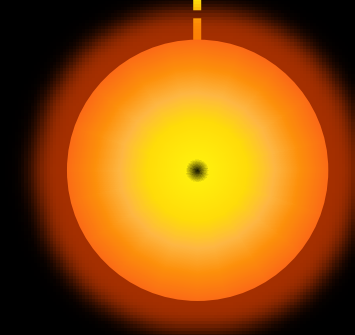
000'000'

000'000'

000'000 nuclear power plants



900 million years



EPOCH of REIONIZATION

~200-400 million years

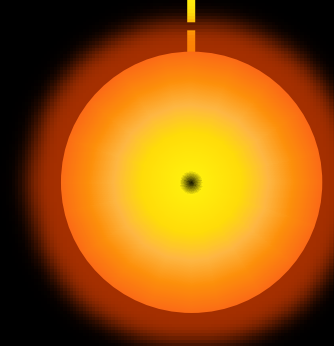
1 billion years

900 million years

Accretion only

OR

Relativistic jets??????????



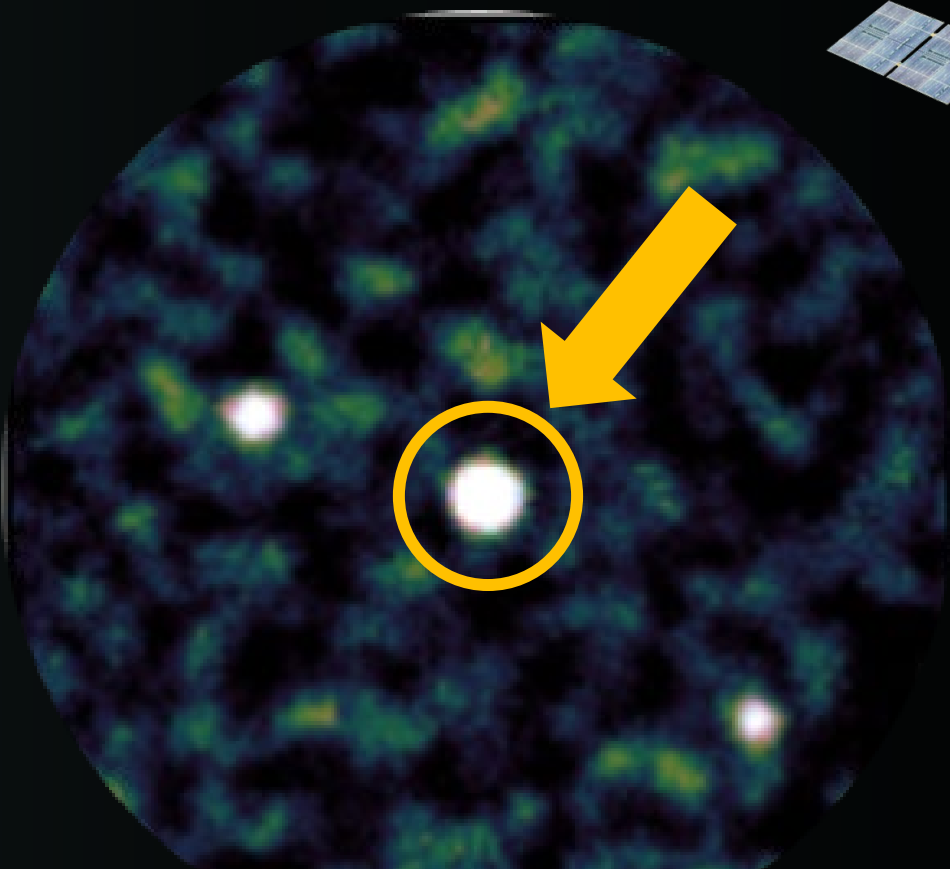
EPOCH of REIONIZATION

~200-400 million years

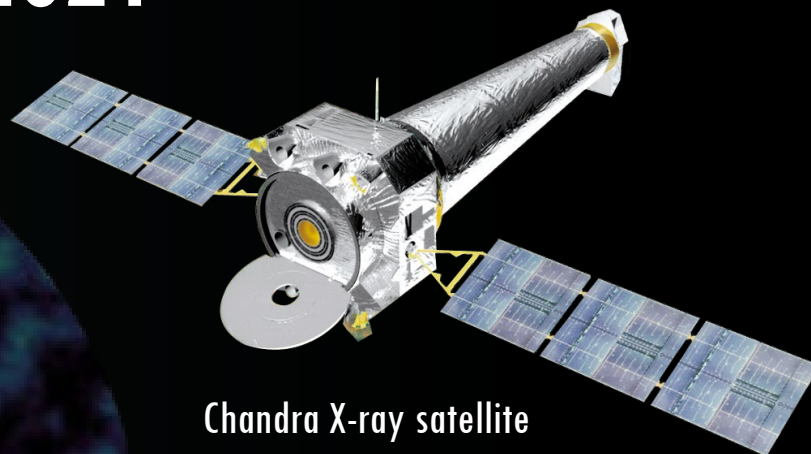
1 billion years

900 million years

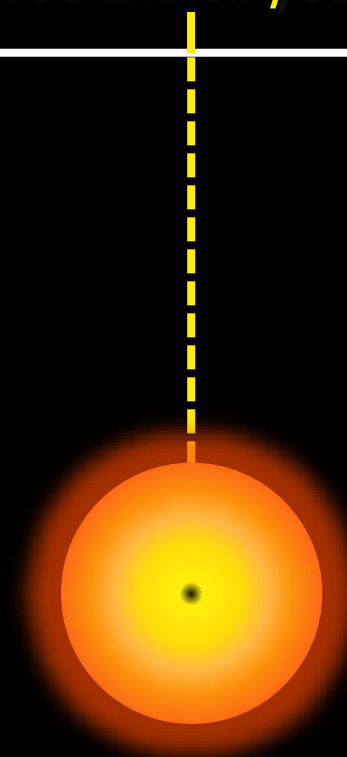
J1429+5447: August 2021



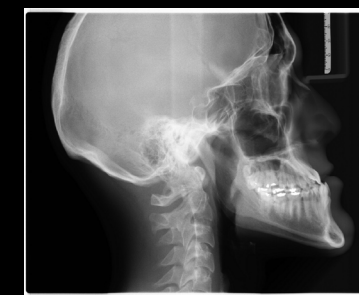
Chandra X-ray image



Chandra X-ray satellite



Marcotulli et al. 2025, ApJL, 979, L6



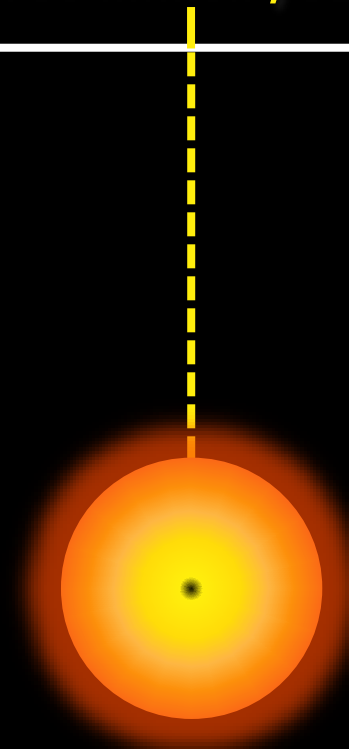
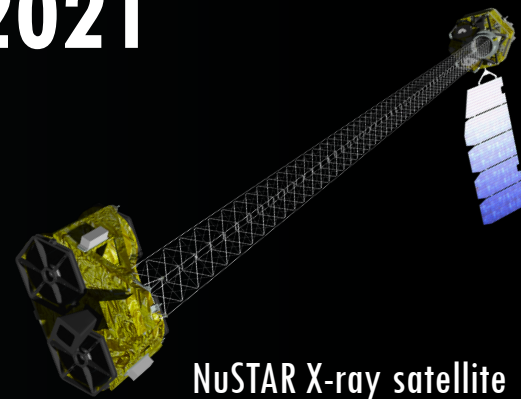
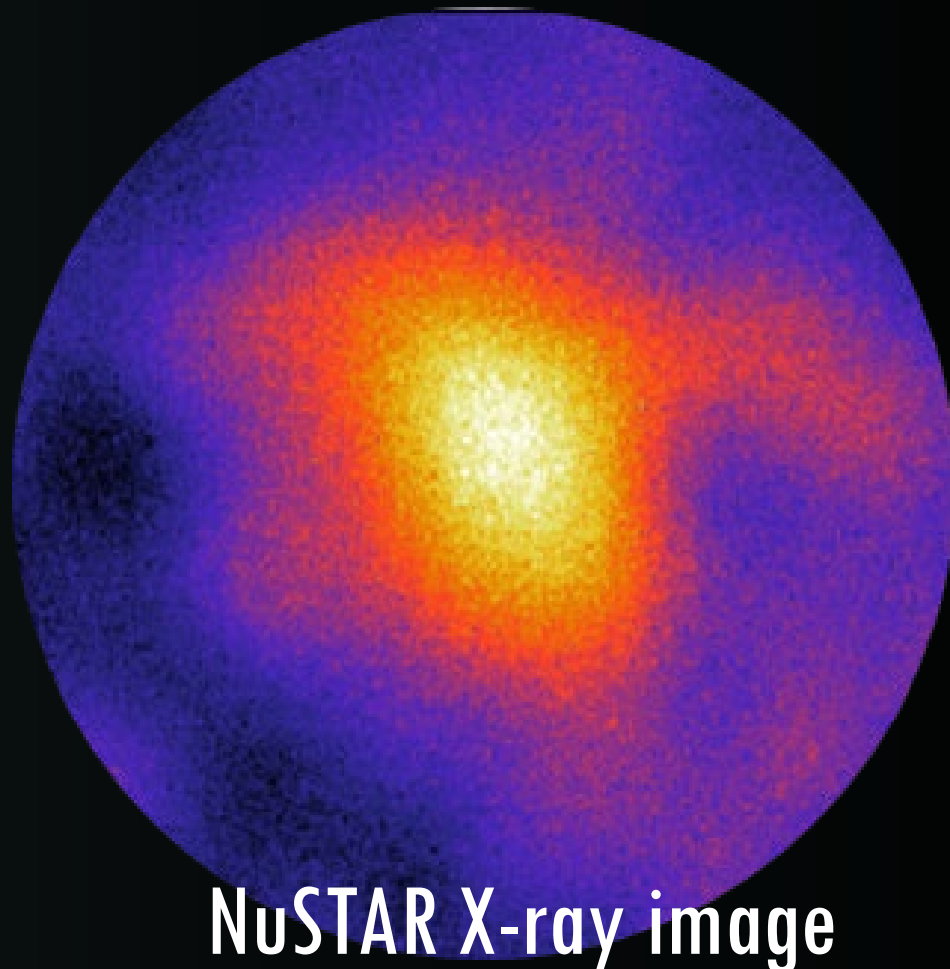
EPOCH of REIONIZATION

~200-400 million years

1 billion years

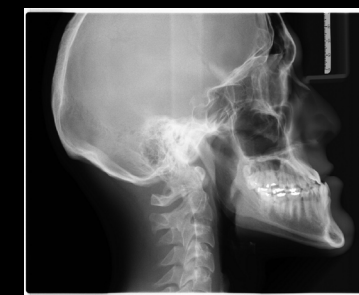
900 million years

J1429+5447: November 2021



**!!!FARTHEST OBJECT
DETECTED by
NUSTAR!!!!**

Marcotulli et al. 2025, ApJL, 979, L6



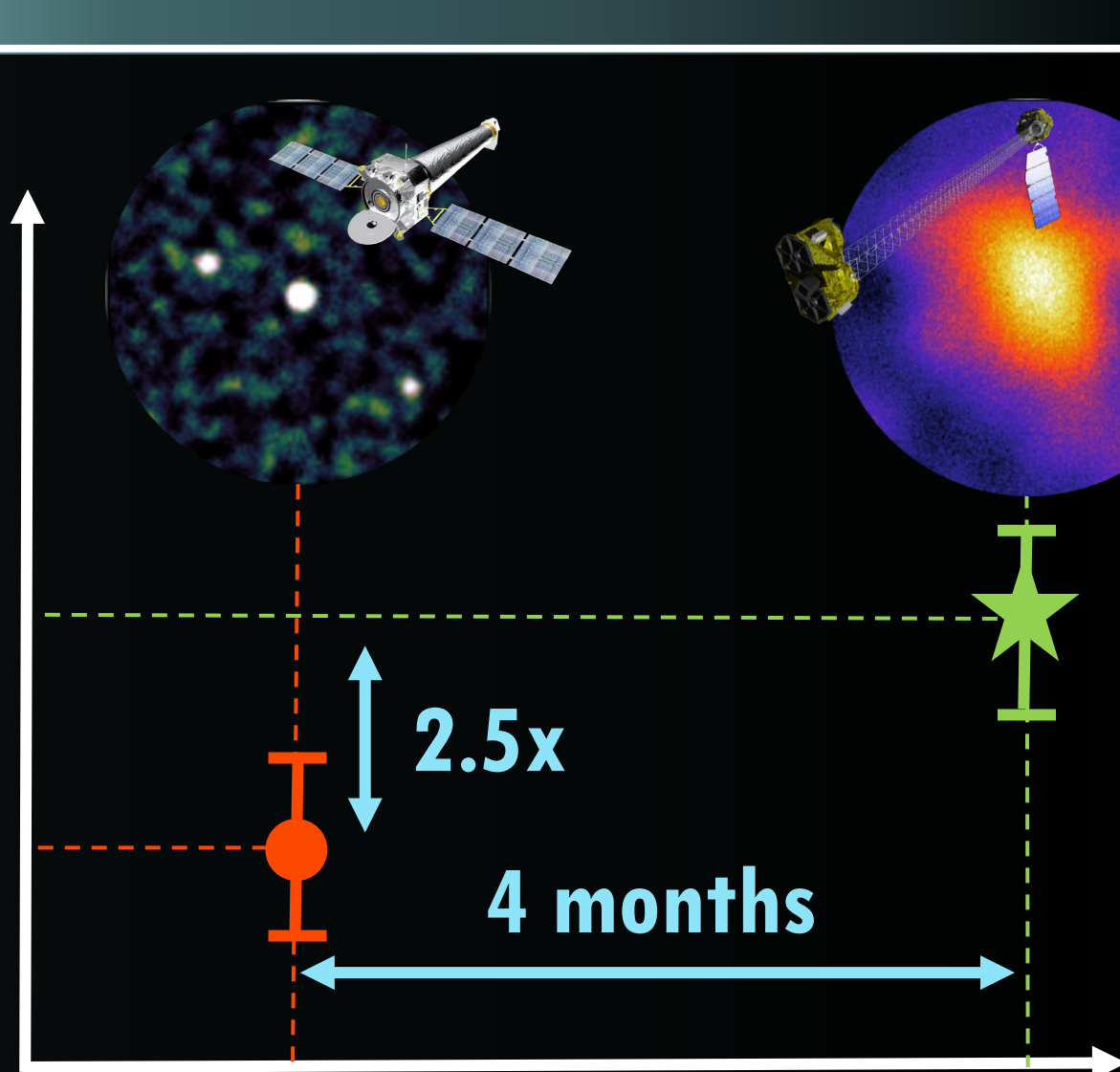
EPOCH of REIONIZATION

~200-400 million years

1 billion years

900 million years

X-ray POWER



TIME

Because of special relativity,
4 months for us corresponds
to only
2 weeks for J1429

Marcotulli et al. 2025, ApJL, 979, L6



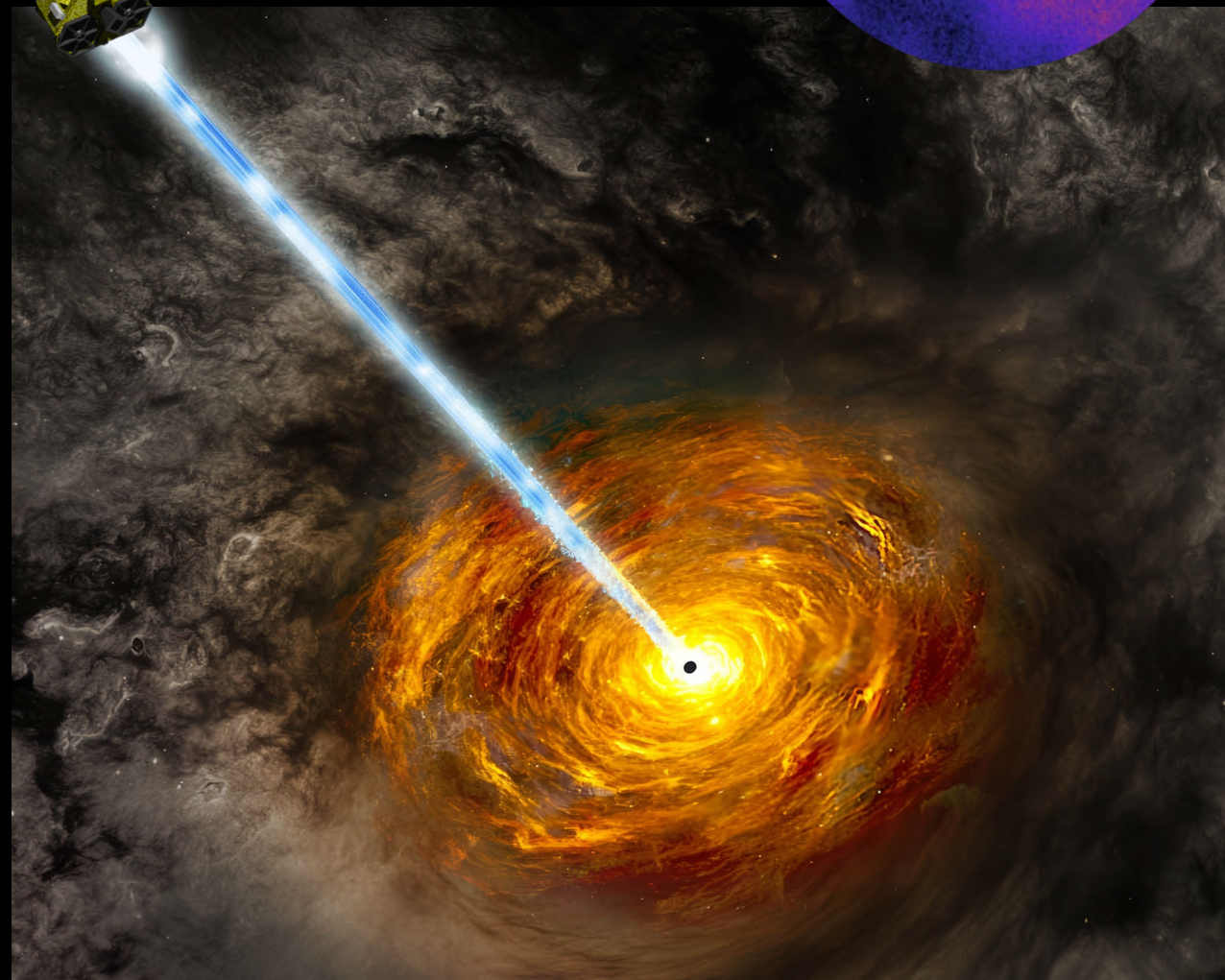
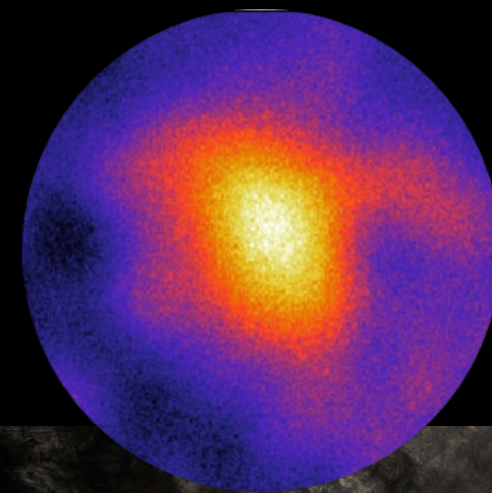
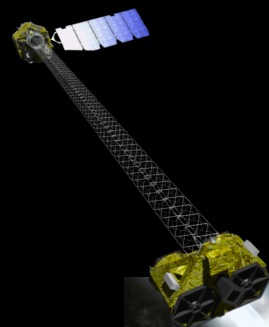
2.5x X-ray variability in
just 2 weeks is

VERY EXTREME



**Jets pointed towards
Earth is the more likely
explanation**

Marcotulli et al. 2025, ApJL, 979, L6



This results opens a window into understanding the link between **supermassive black hole growth and jet powering mechanisms.**

Finding more such sources so early on would unveil the **contribution of jets and accreting supermassive black holes to Reionization.**

Take home points

J1429 is the **most luminous active supermassive black hole** observed in **X-rays** at the **Epoch of Reionization**

Farthest source ever detected by **NuSTAR**

We found the **first evidence of extreme X-ray variability** suggesting a **jet of particles pointed towards Earth**

Rare glimpse on **interplay between supermassive black hole growth and jet powering mechanisms**



ApJL, 979, L6

