



TEEN ASTRONOMY

Café – To Go!



Welcome to the Teen Astronomy Café



Dr. Stéphanie Juneau

- Associate Astronomer, NSF's NOIRLab, since Sept 2016
- PhD in astronomy from U.Arizona in 2011
- Research interests: evolution of galaxies and supermassive black holes across cosmic time
- Astro Data Lab: Developing new methods for turning large survey data sets into scientific knowledge



A black hole is depicted as a dark sphere at the center of a swirling, orange and yellow accretion disk. A bright blue jet of light and gas extends upwards from the top of the black hole. The background is a dark, starry space with a brownish-red hue. The text 'Black Holes' is written in large, white, bold letters across the center of the image.

Black Holes

Dr. Stéphanie Juneau

Big Ideas

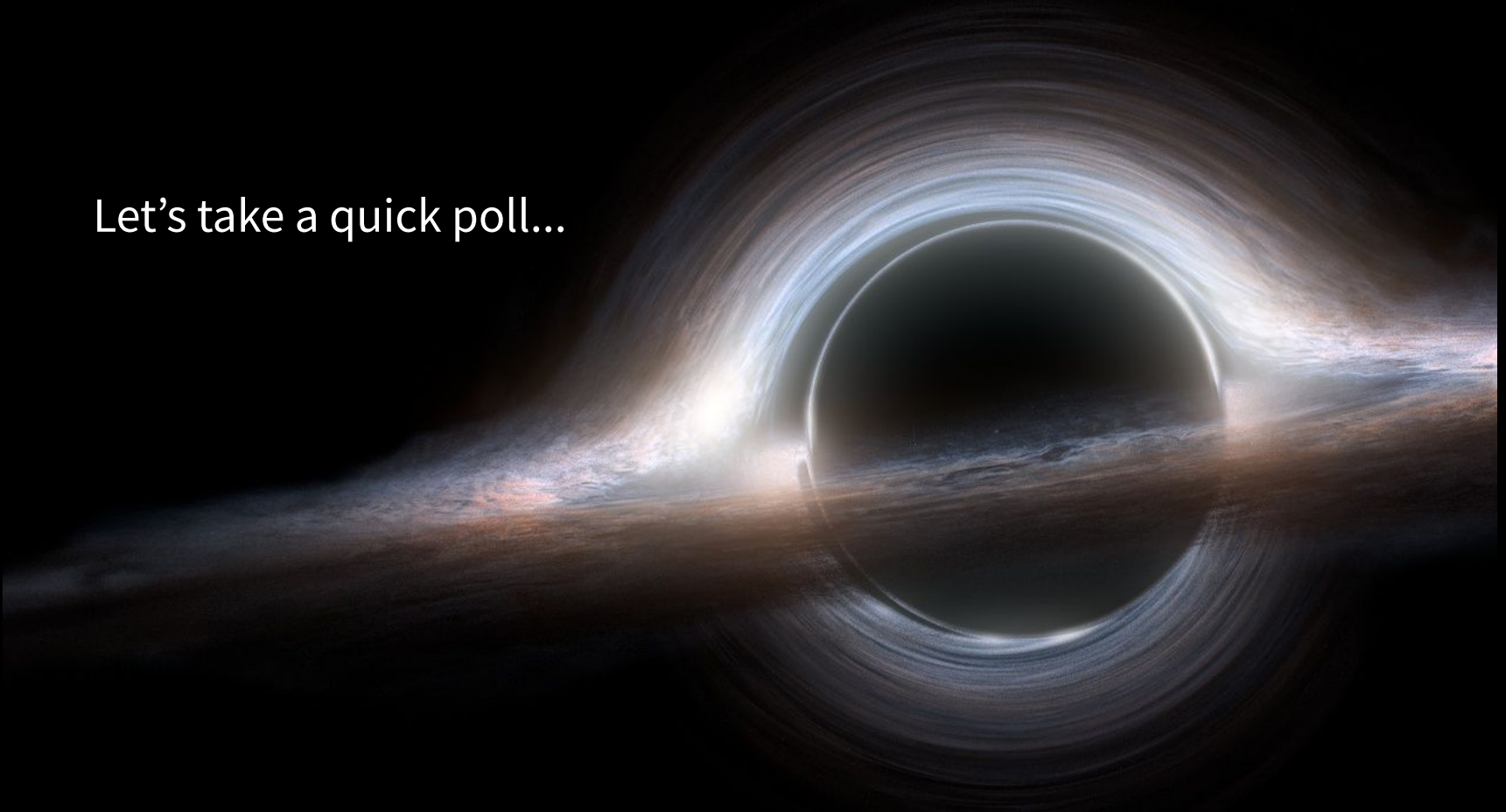
- What black holes are
- How astronomers find black holes
- How black holes can affect the fate of galaxies

What is a black hole?



What is a black hole?

Let's take a quick poll...

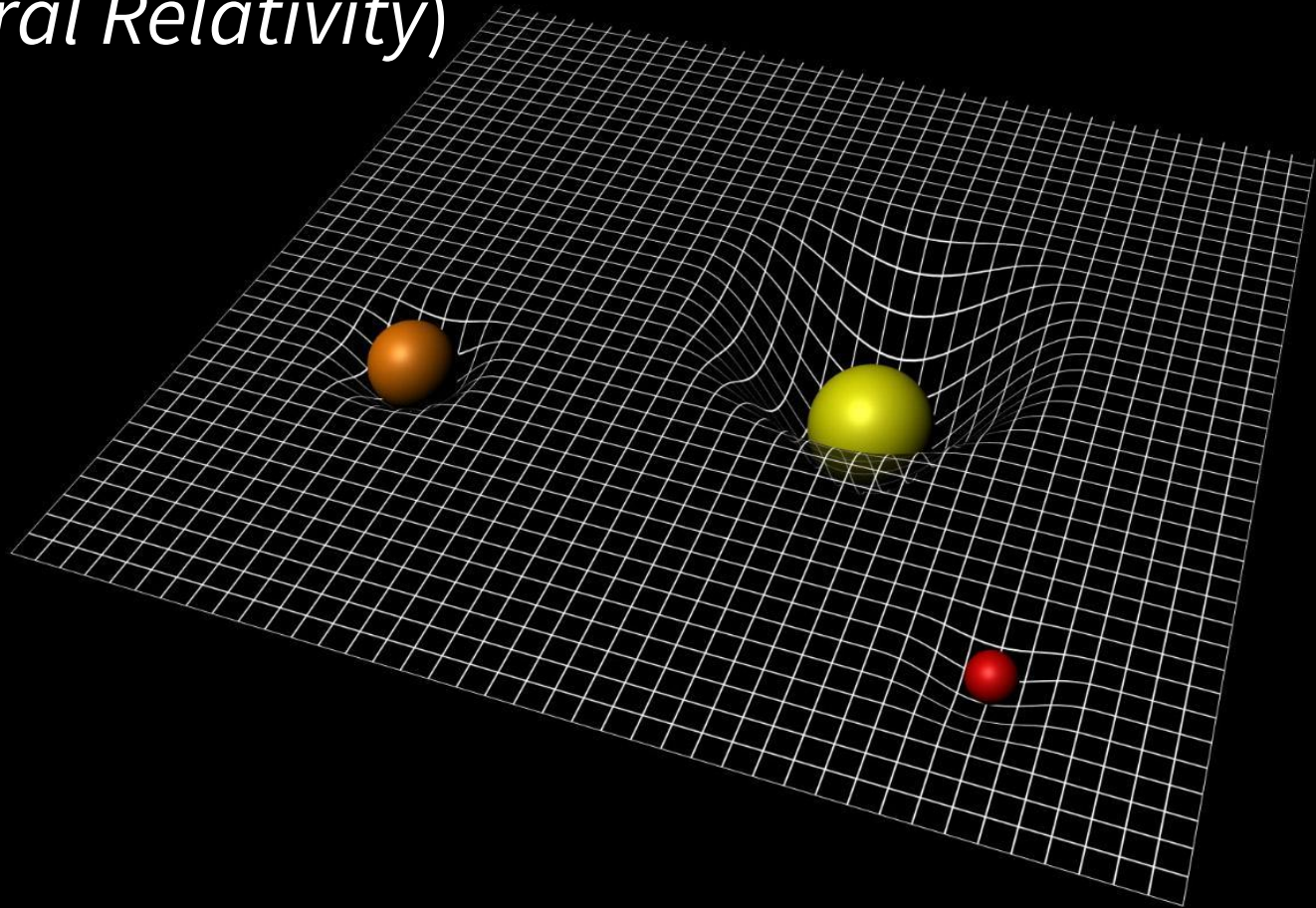


What is a black hole?

- Object (not a real “hole”) with an extreme gravitational force → it has a mass
- No light is emitted or reflected so it appears “black”
- Need to better understand gravity!

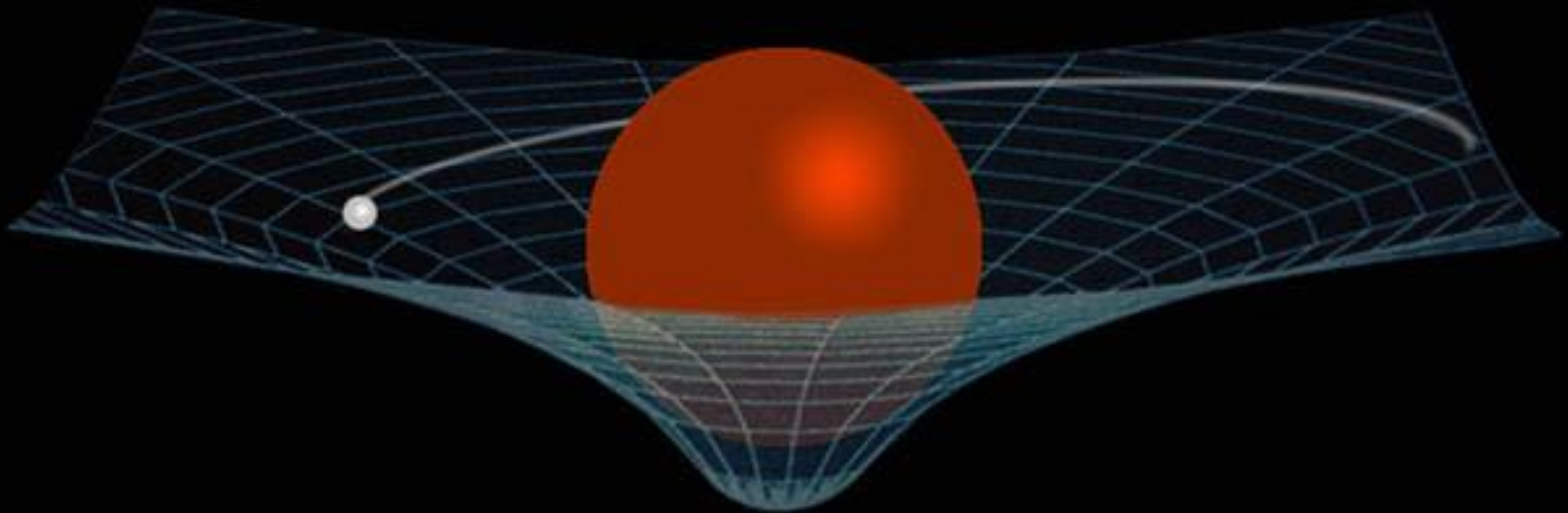
What is gravity?

- Mass bends space-time (*Einstein's theory of General Relativity*)



What is gravity?

- The curvature of space-time explains the movement of objects & their orbits (Moon around the Earth, planets around the Sun, etc.)



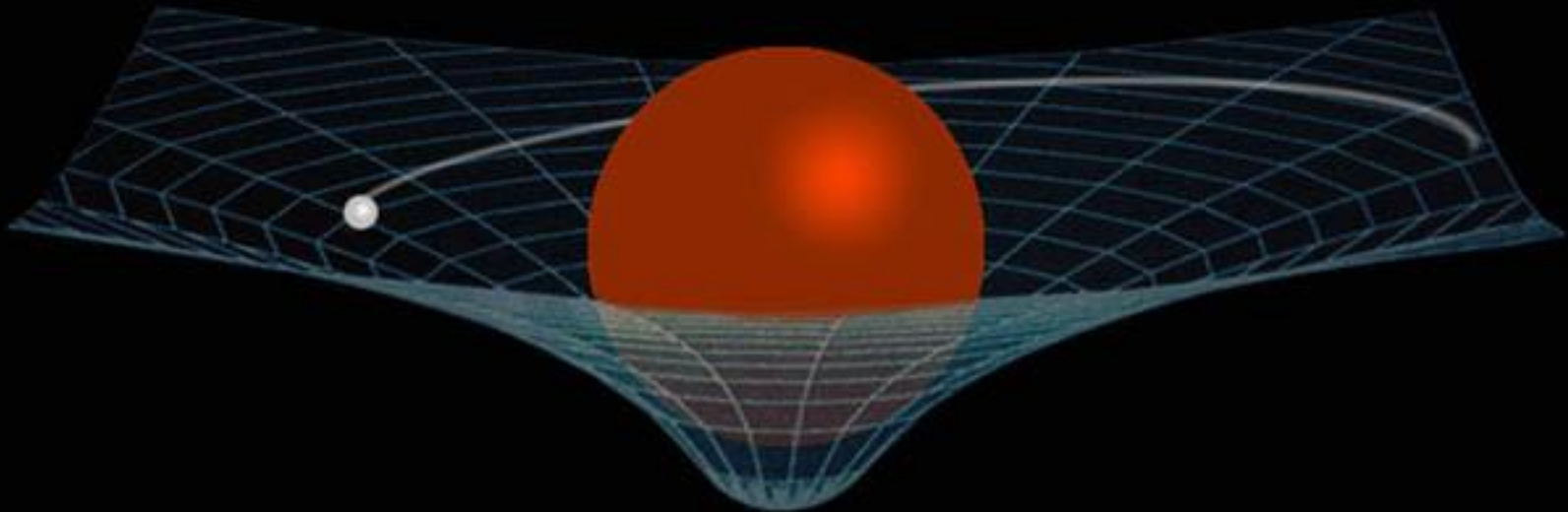
What is gravity?

Let's consider **four scenarios**. What will happen if the small white object is:

- (a) Not moving at all
- (b) Moving very slowly
- (c) Moving at average speed
- (d) Moving very fast

For each scenario, find the most likely **outcome**. The small white object will most likely:

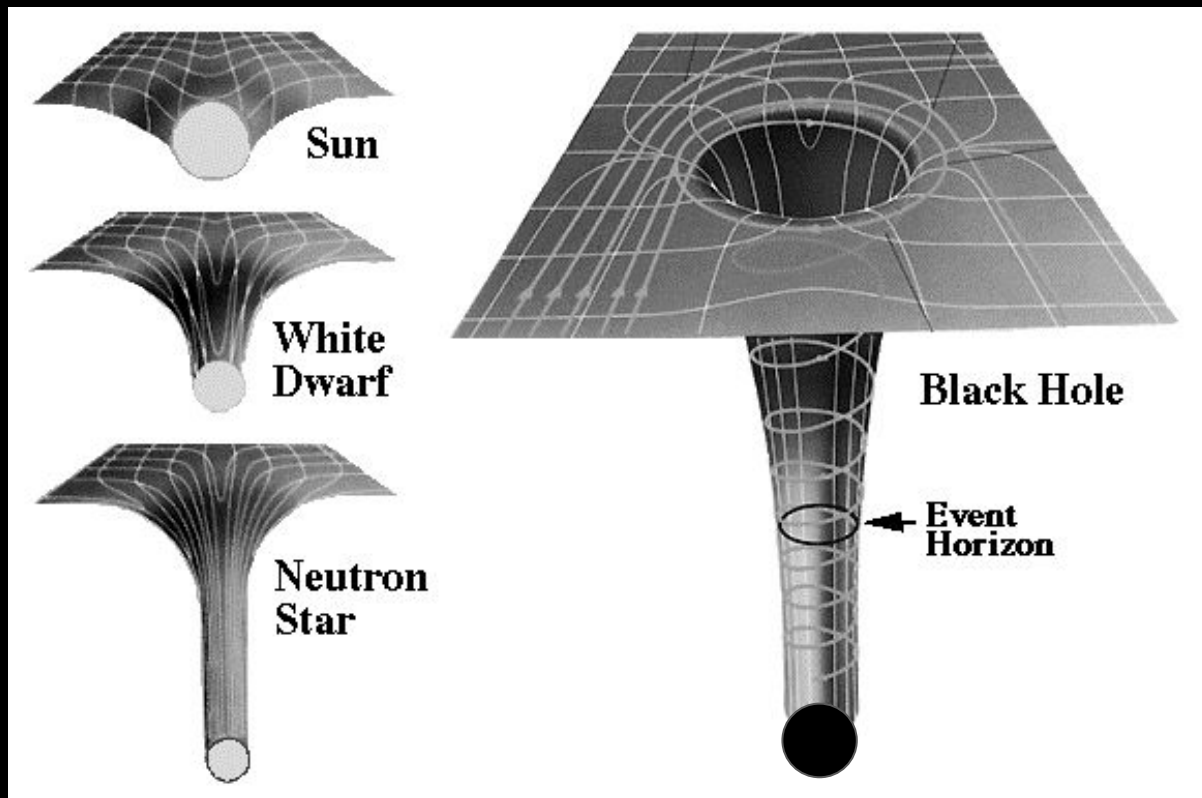
- (1) Fly away from the central object
- (2) Spiral into the well toward the central object
- (3) Fall directly toward the central object
- (4) Stay in orbit around the central object



[Demo]

What is gravity?

The greater the mass or the more concentrated (dense) → the more strongly it bends space

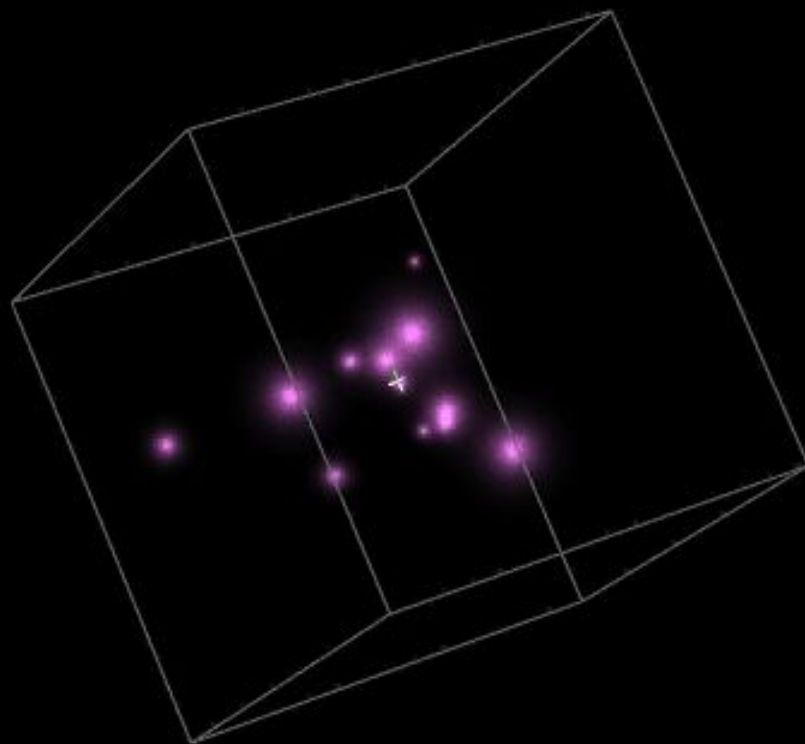


Black Holes: Big & Small

- Stellar black holes
- Supermassive (giant) black holes

Year: 1995.0

The Acceleration of Stars Orbiting
the Milky Way's Central Black Hole

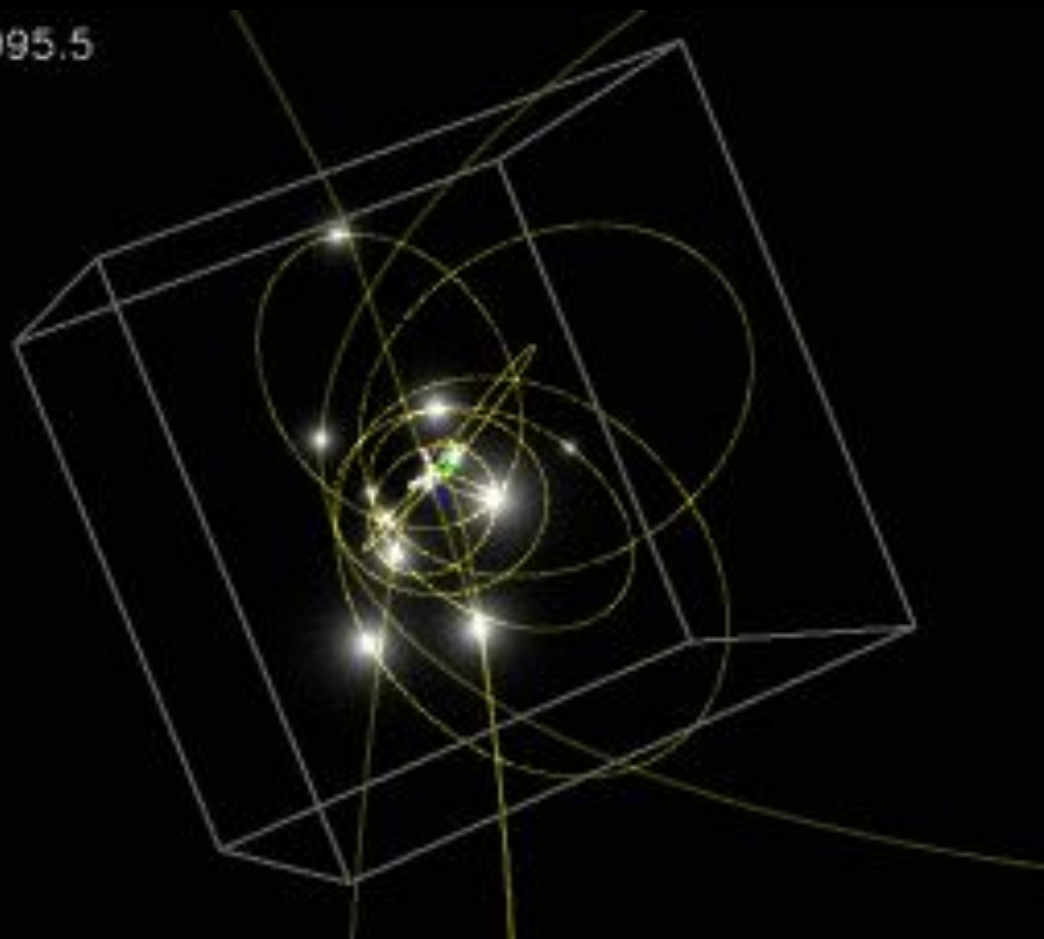


Data: Andrea Ghez, Jessica Lu (UCLA)

Visualization: Dinoj Surendran, Randy Landsberg,
Mark Subbarao (UChicago / Adler / KICP)



Year: 1995.5



THE NOBEL PRIZE IN PHYSICS 2020



Illustrations: Nikias Elmehed

Roger Penrose

“for the discovery that black hole formation is a robust prediction of the general theory of relativity”

**Reinhard
Genzel**

“for the discovery of a supermassive compact object at the centre of our galaxy”

**Andrea
Ghez**

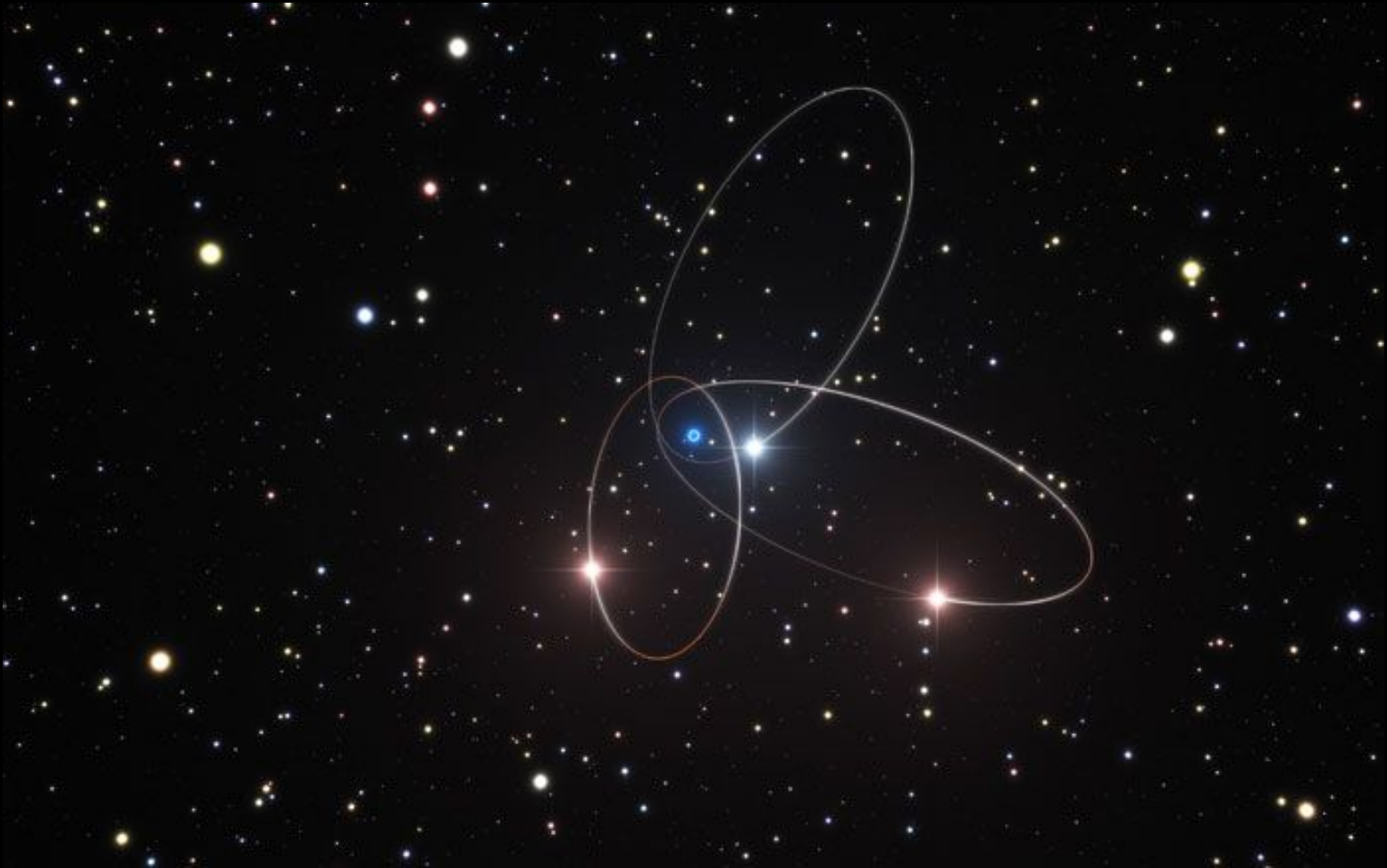
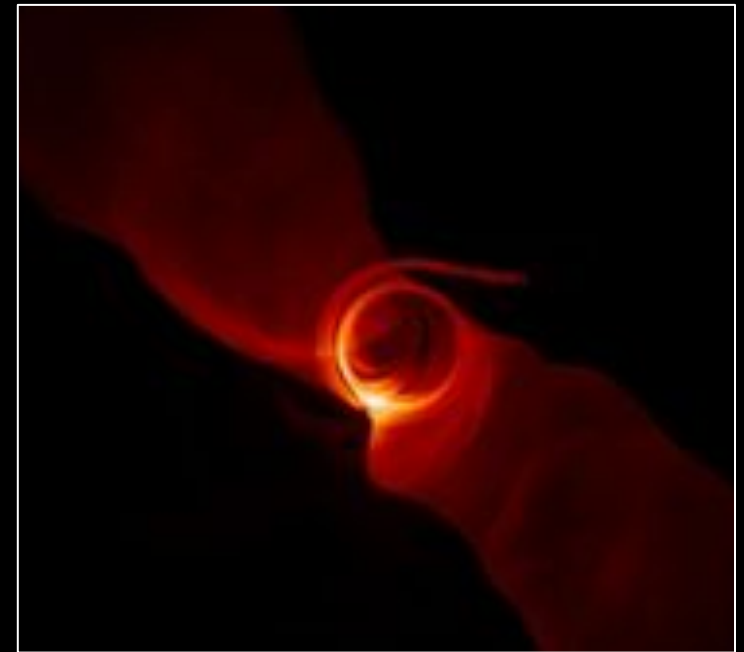


Image credit: ESO/M. Parsa/L. Calçada

Black Holes in the News!

- The Event Horizon Telescope

→ captured the first image of a black hole shadow by creating a virtual Earth-sized telescope



Simulated image: University of Arizona

Black Holes in the News!

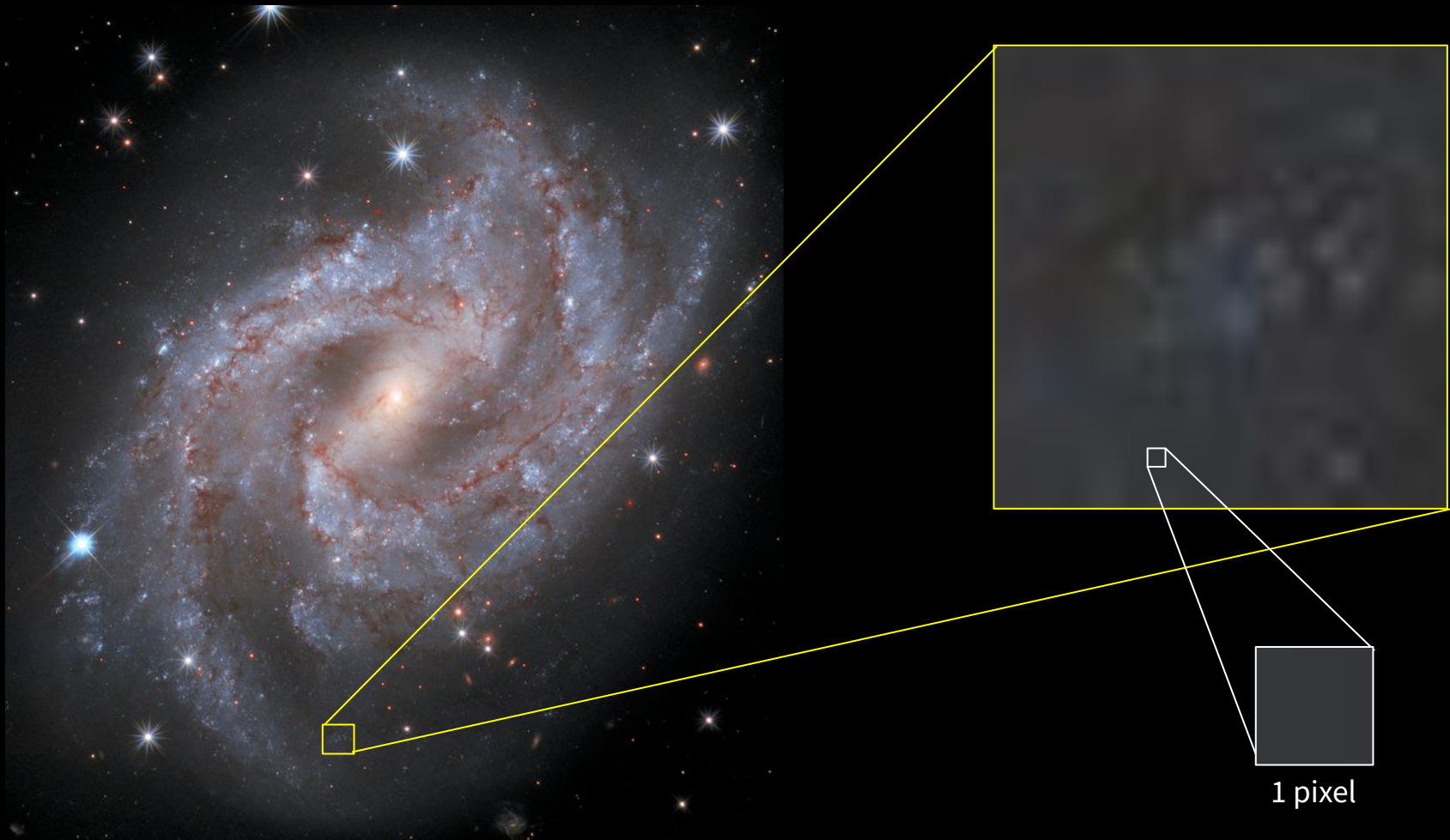
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M87 Black Hole shadow (another galaxy far from the Milky Way); April 2019

Comparison of Image Sizes

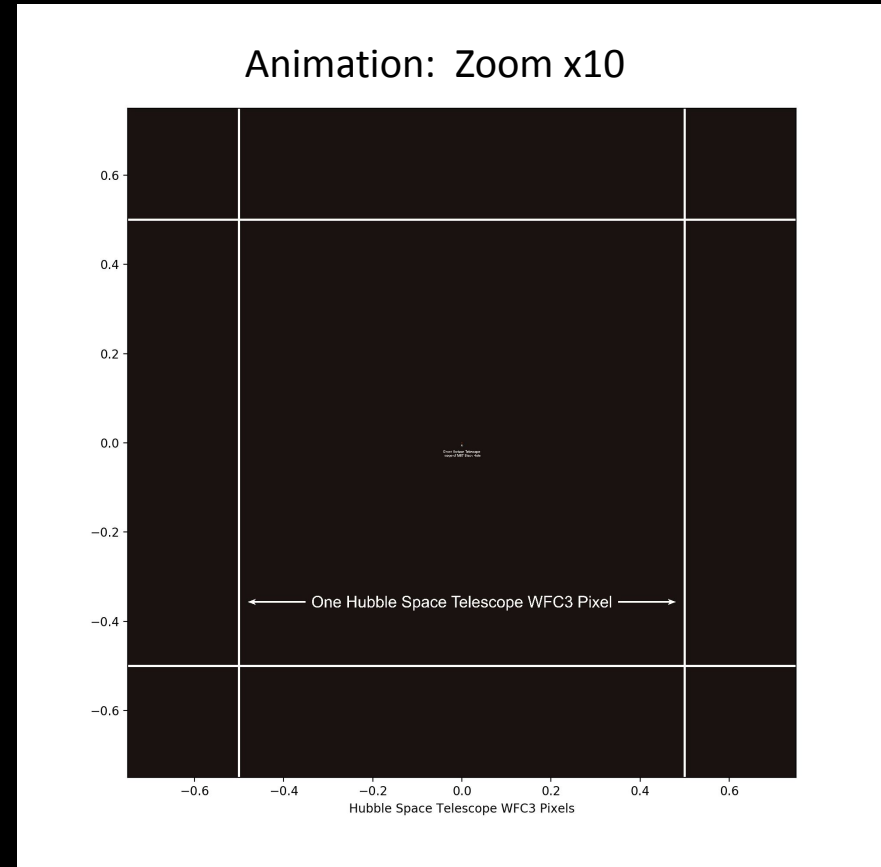


Spiral Galaxy NGC 2525 with Hubble Space Telescope
(image is about 3,630 pixels across)

Comparison of Image Sizes

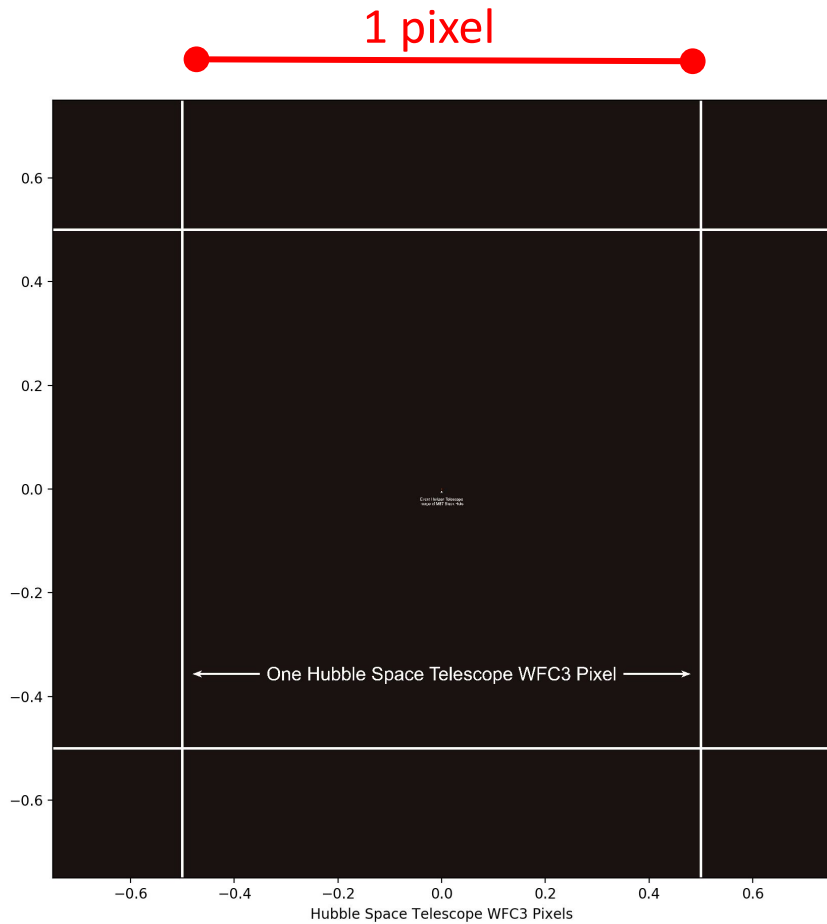


Spiral Galaxy NGC 2525 with Hubble Space Telescope
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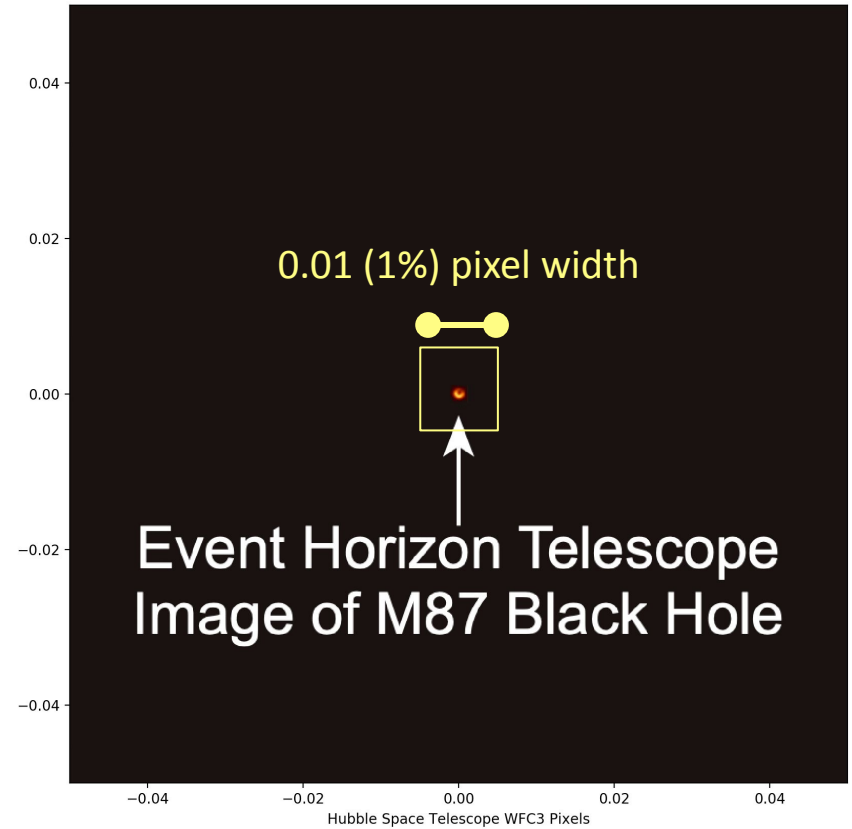


Animation by Dr. Alex Parker

Comparison of Image Sizes



Hubble Space Telescope WFC3 Pixels



Hubble Space Telescope WFC3 Pixels

Animation by Dr. Alex Parker

Question

How can supermassive black holes affect the fate of galaxies?



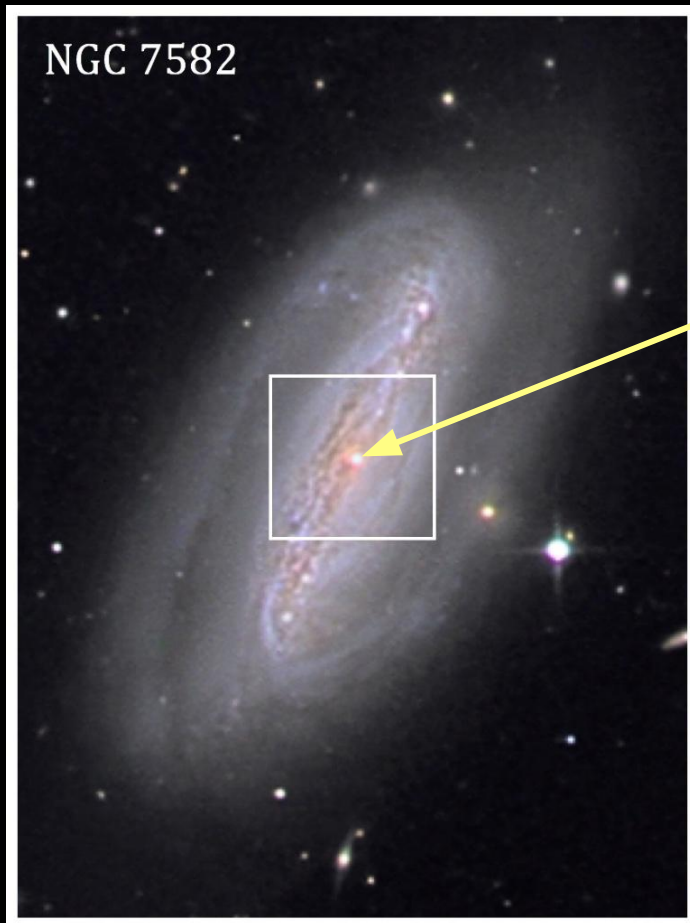
My research

*How black holes can affect the fate of galaxies
(and vice versa)*



My research

*How black holes can affect the fate of galaxies
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Recent work:

- “**nearby**” **galaxy** at 74 million light-years away
- **central black hole** with mass over 10 million X mass of the Sun

Observation:

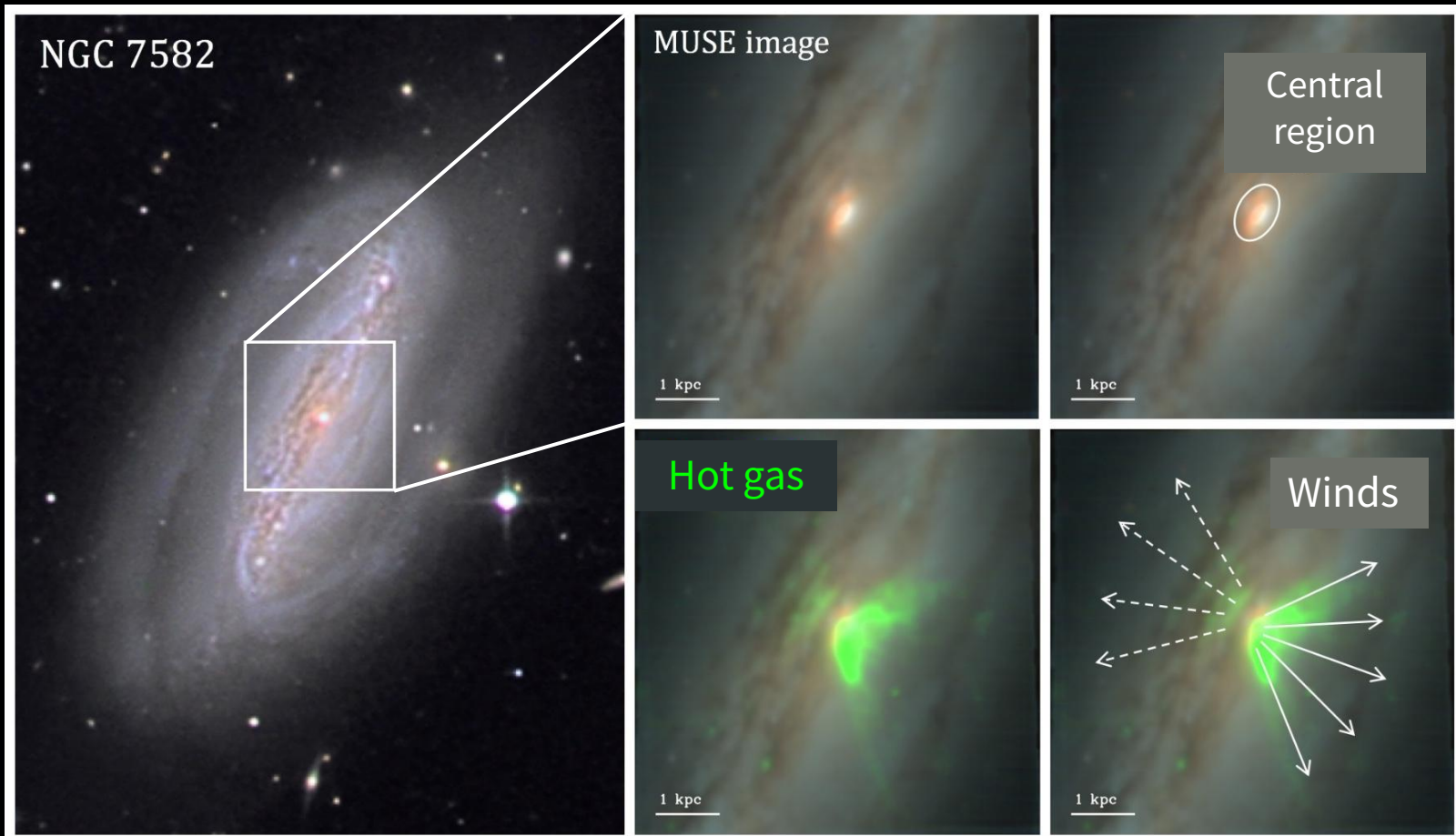
- Mapping **hot (ionized) gas** and its motion with an 8-meter telescope

Result:

- Fast **winds** powered by activity around black hole

My research

*How black holes can affect the fate of galaxies
(and vice versa)*



Questions?





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