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9TH SEPTEMBER 2015

CAN BLACK HOLES SHINE?

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Australian Government
Department of Industry and Science



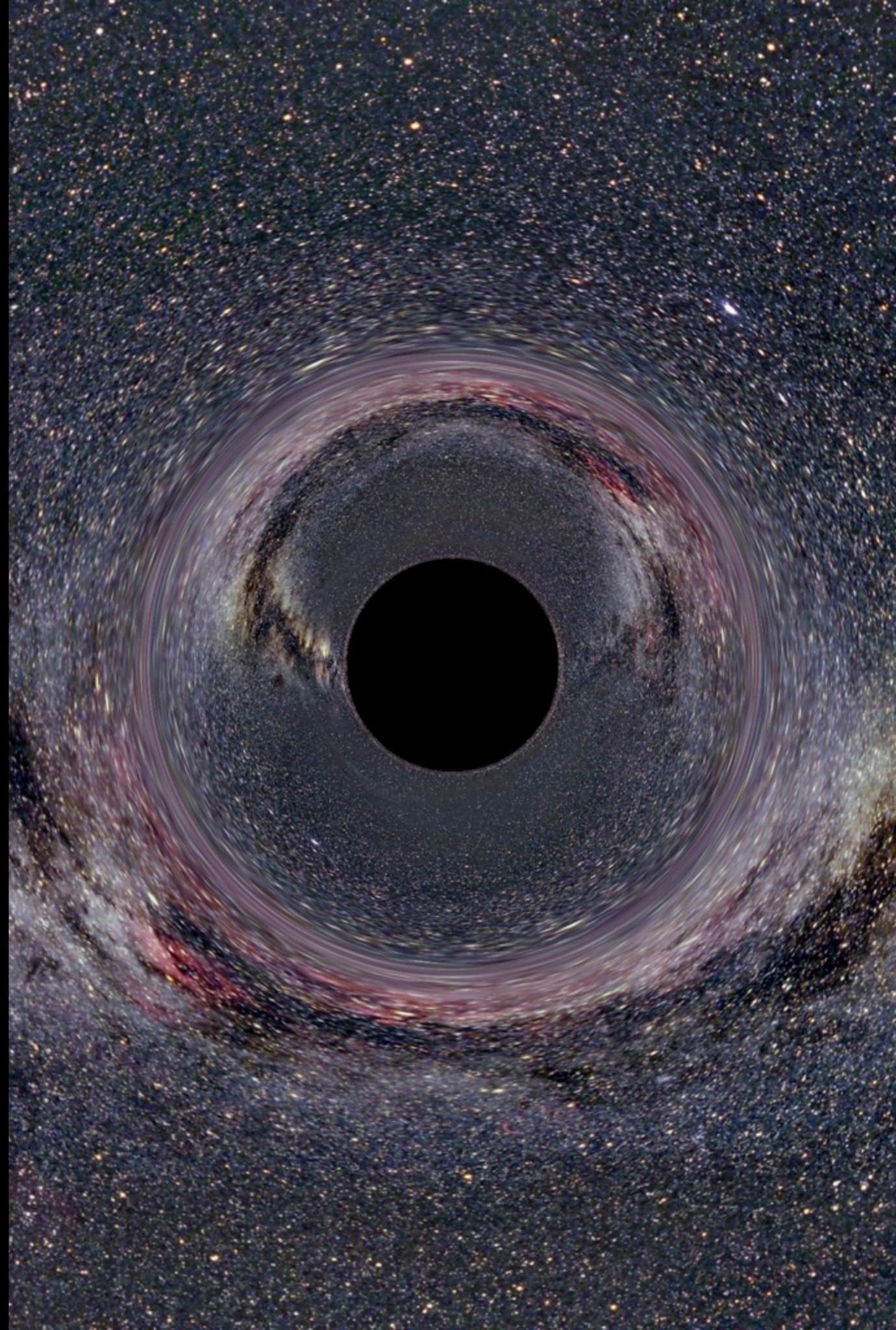
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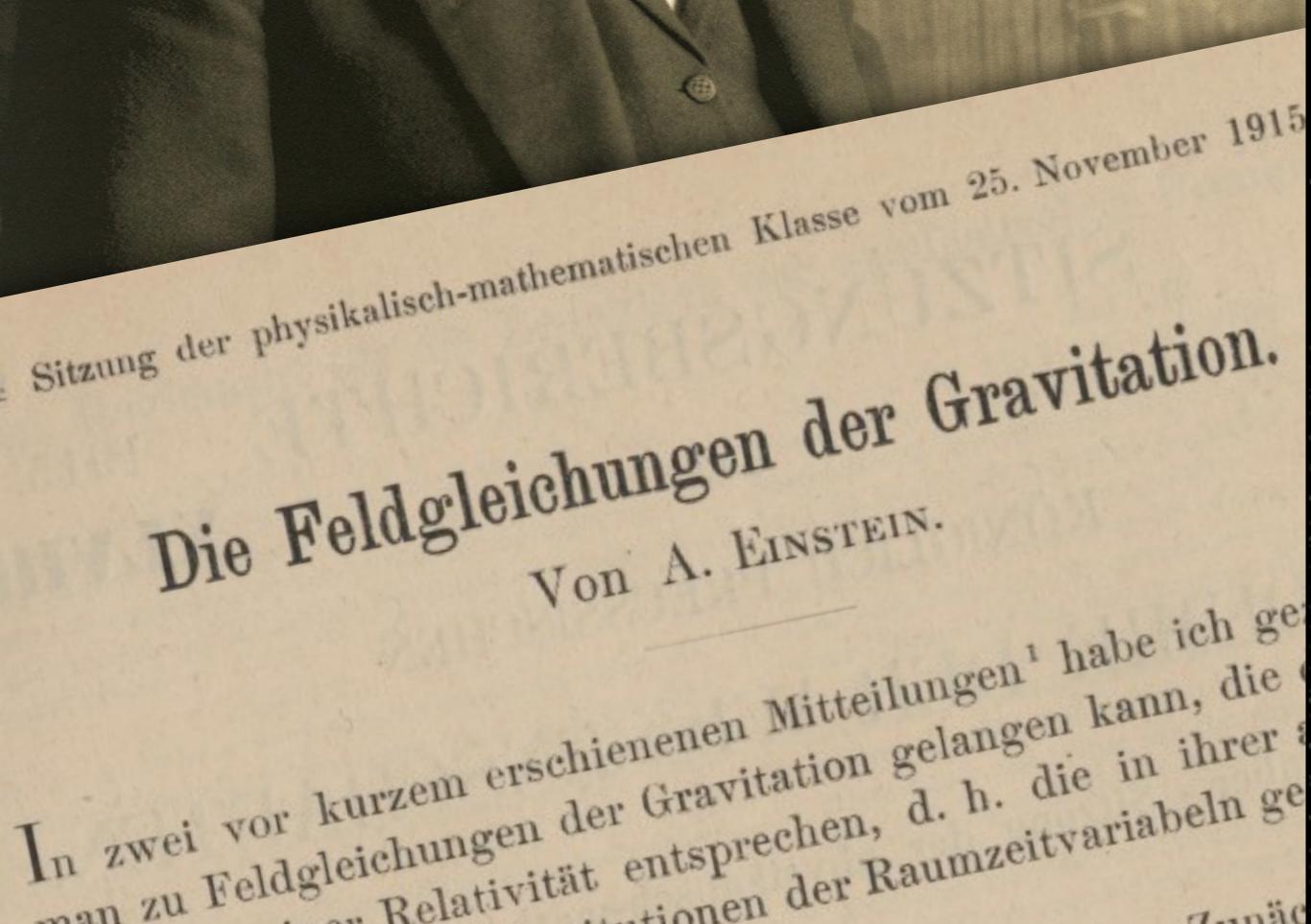
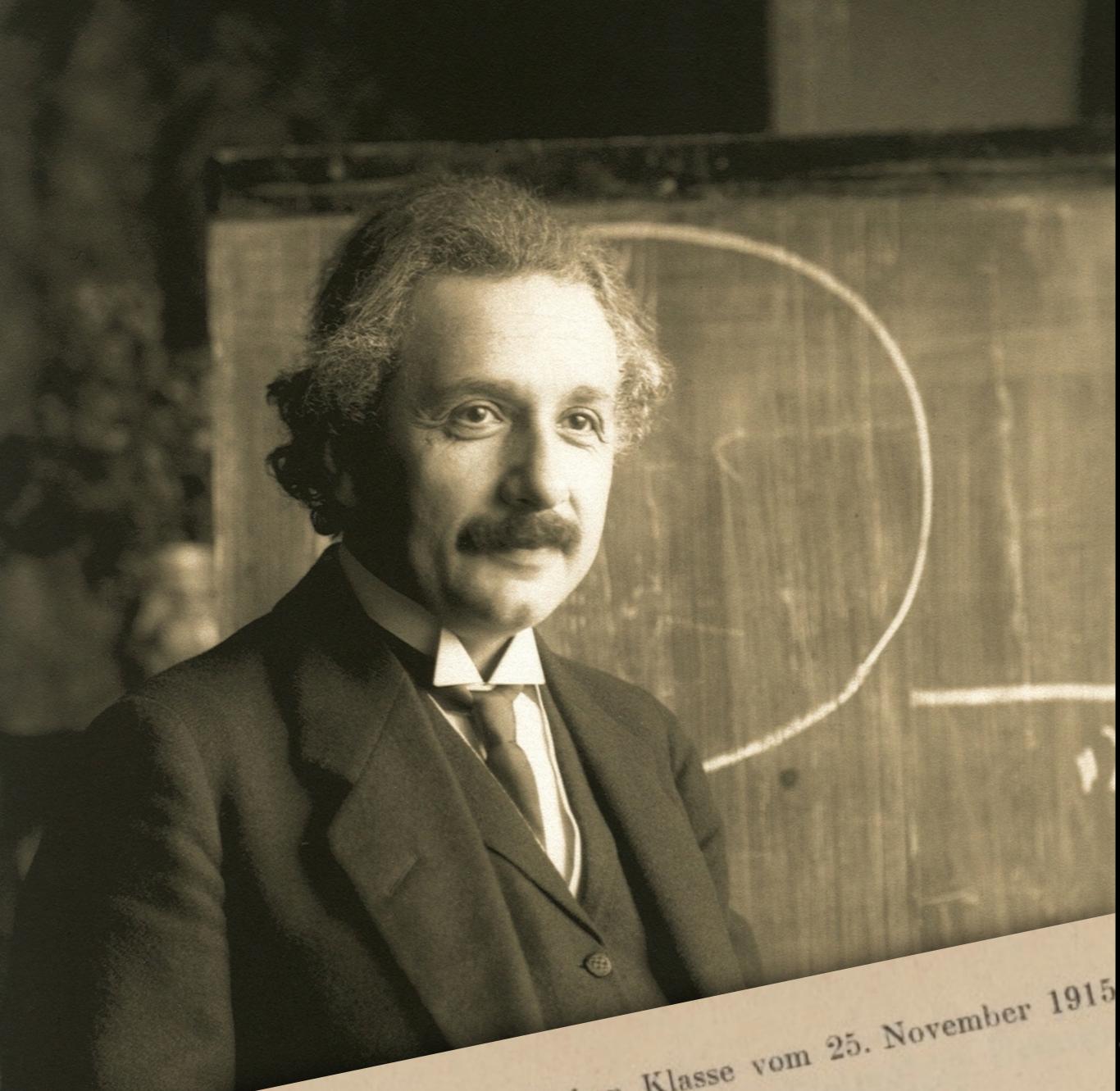


INTERNATIONAL
YEAR OF LIGHT
AUSTRALIA 2015

TIMELINE OF BLACK HOLES

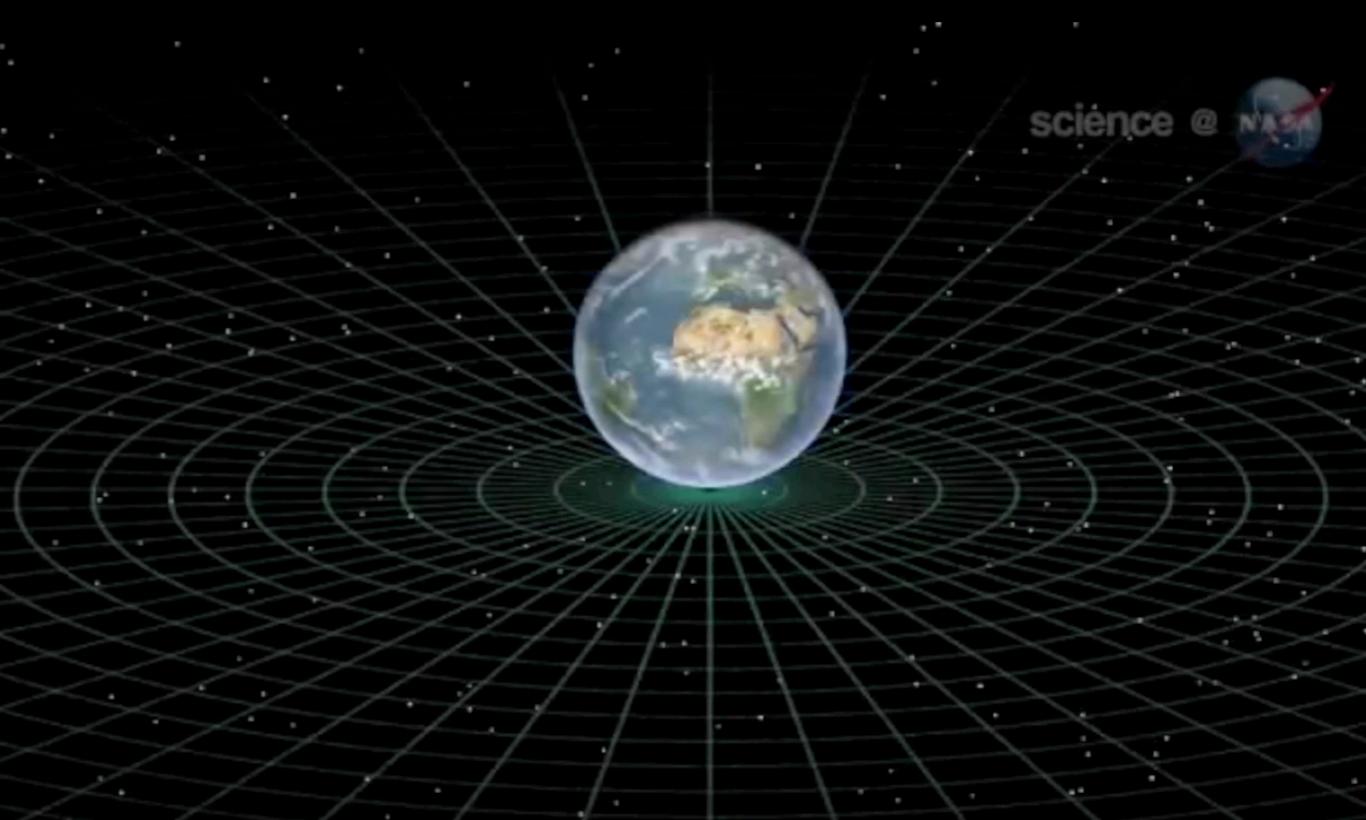
- 1915: Einstein's Theory of General Relativity
- 1919: Eddington's solar eclipse experiment
- 1967: Wheeler coins the term "black hole"
- 1970s: Hawking advances our understanding of black holes
- 2002: The Milky Way's lurking monster
- Today: What do we know and how do we find them?





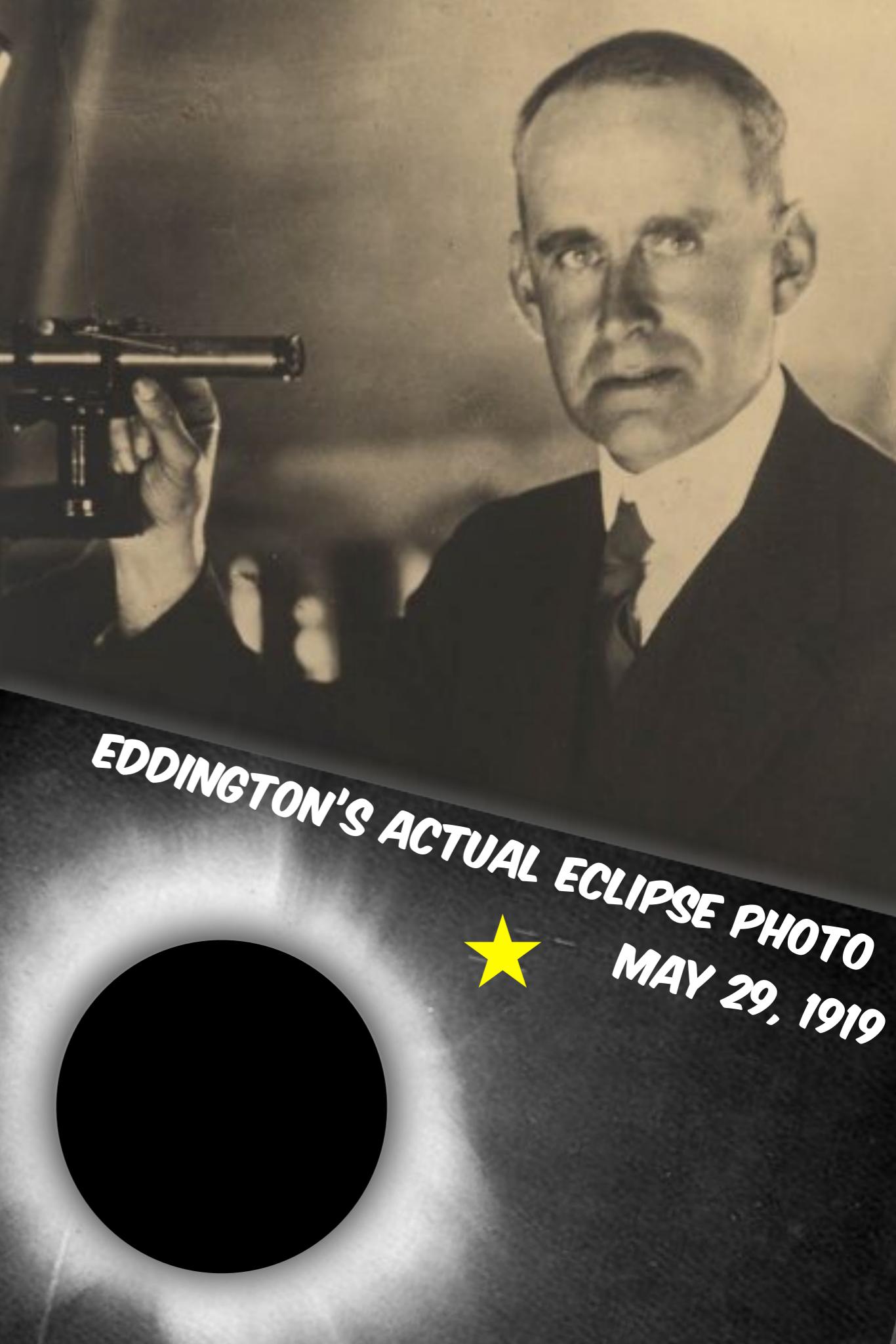
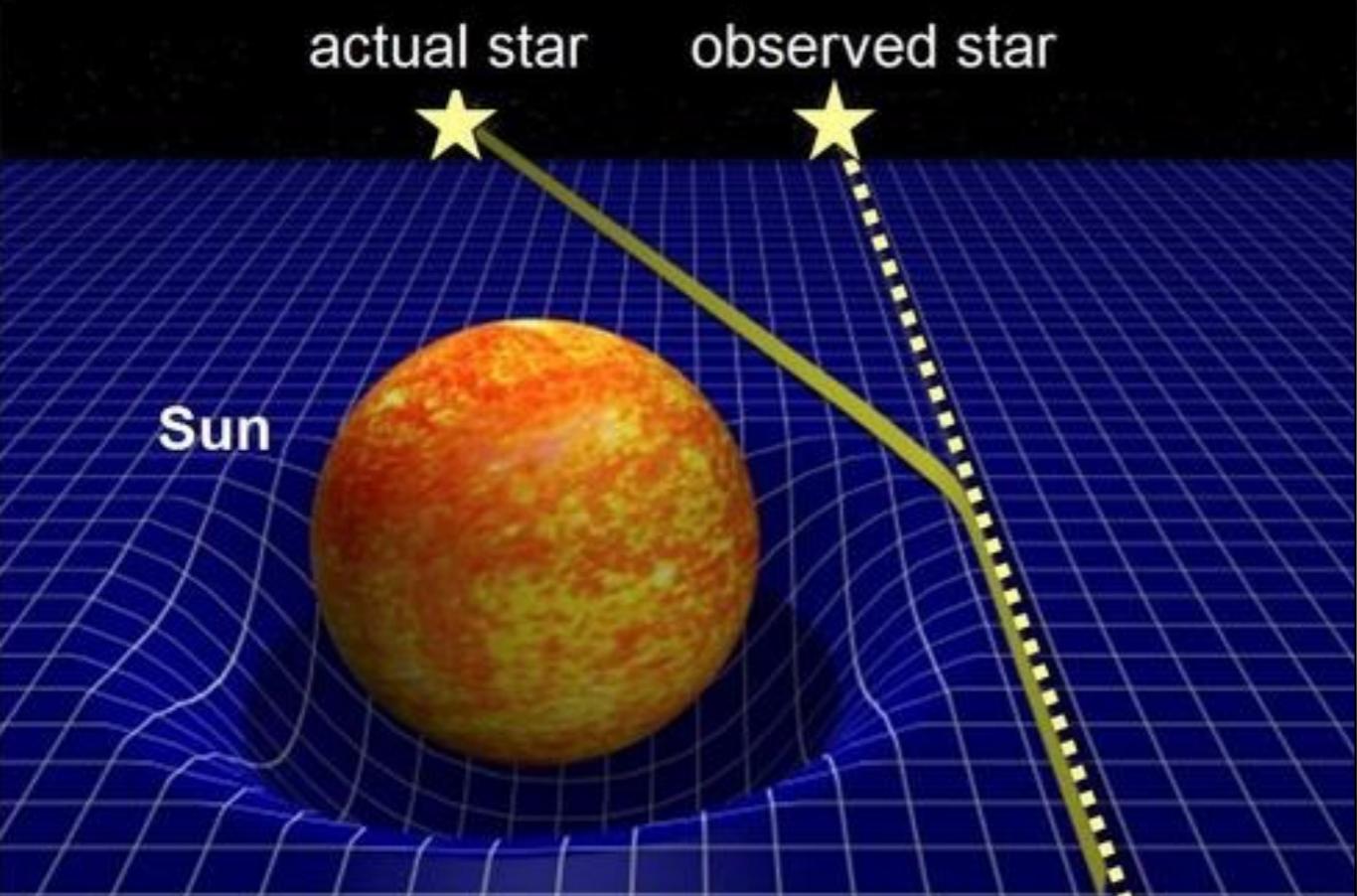
1915: Albert Einstein's
General Relativity

Albert Einstein's general theory of relativity describes the interaction of gravity as a result of space being curved by massive objects



1919: Sir Arthur Eddington's Solar Eclipse Experiment

Eddington photographed positions of stars near the Sun to test Albert Einstein's prediction of the bending of light around massive objects from his general theory of relativity

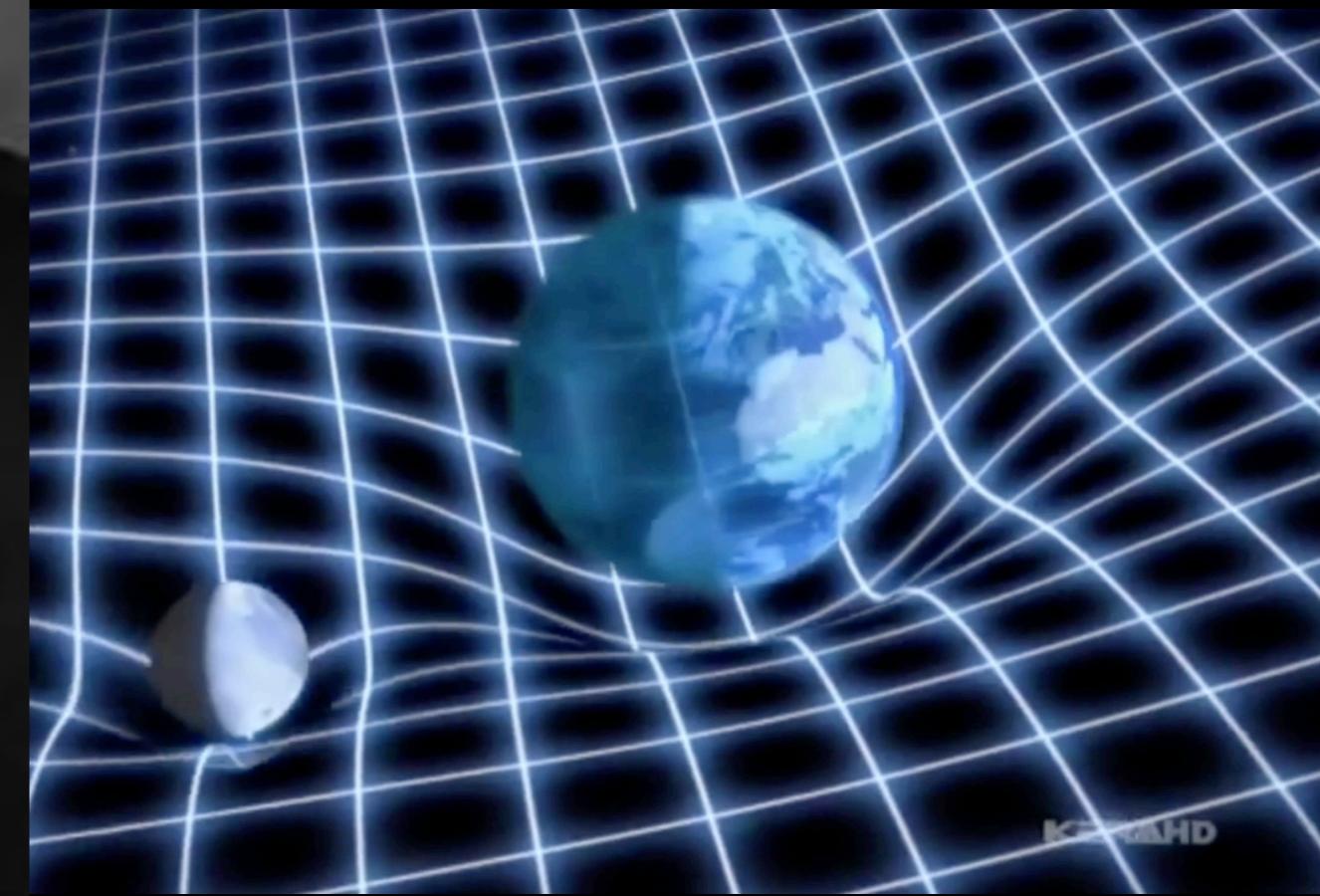


AN UNIMAGINABLY DENSE
REGION OF SPACE WHERE
SPACE IS CURVED AROUND IT
SO COMPLETELY AND
GRAVITY BECOMES SO
STRONG THAT NOTHING, NOT
EVEN LIGHT, CAN ESCAPE.



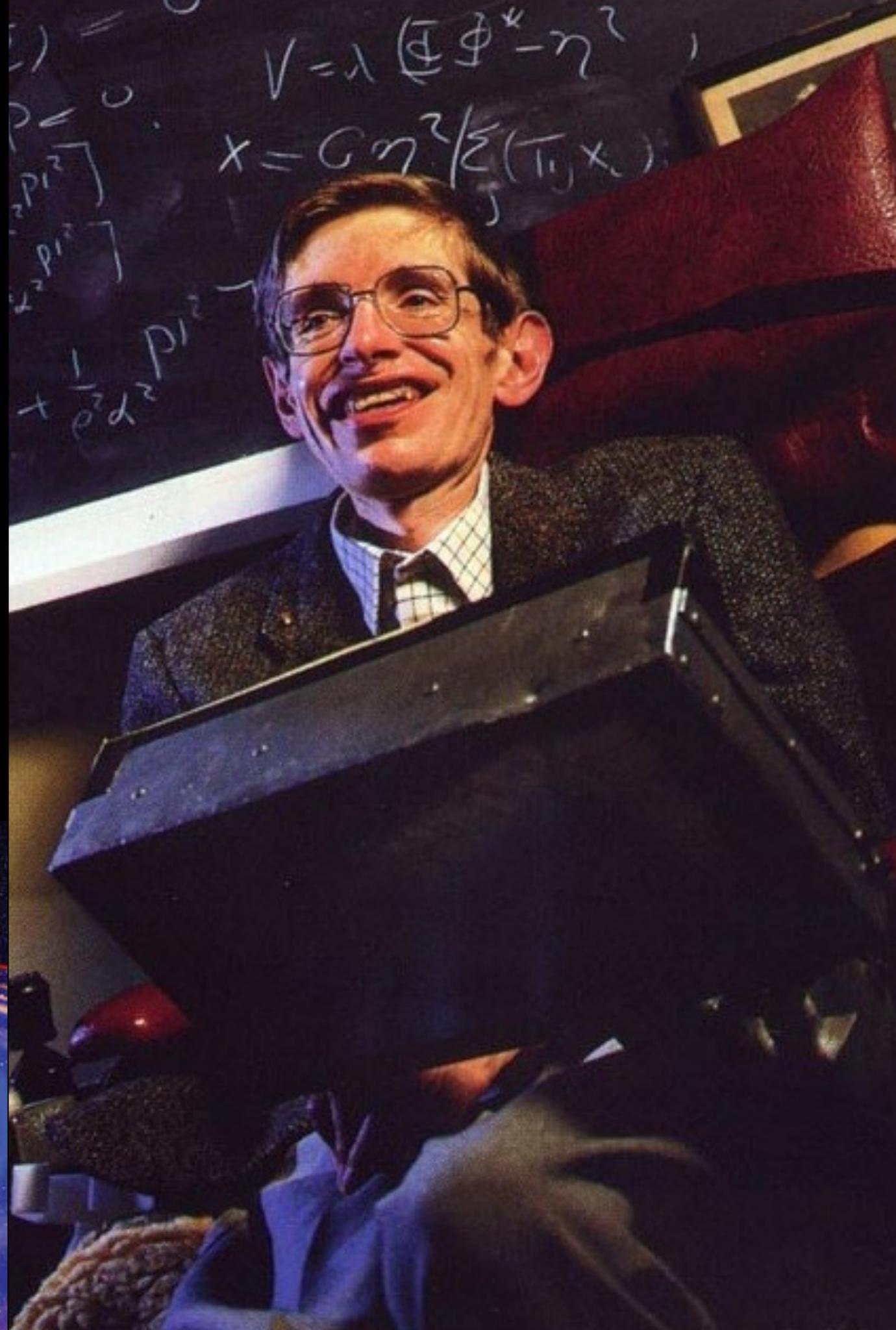
1964: John Wheeler coins
the term “black hole”

American theoretical physicist, John Wheeler helps popularise the study of general relativity in the mainstream of theoretical physics, and coins the term “black holes”

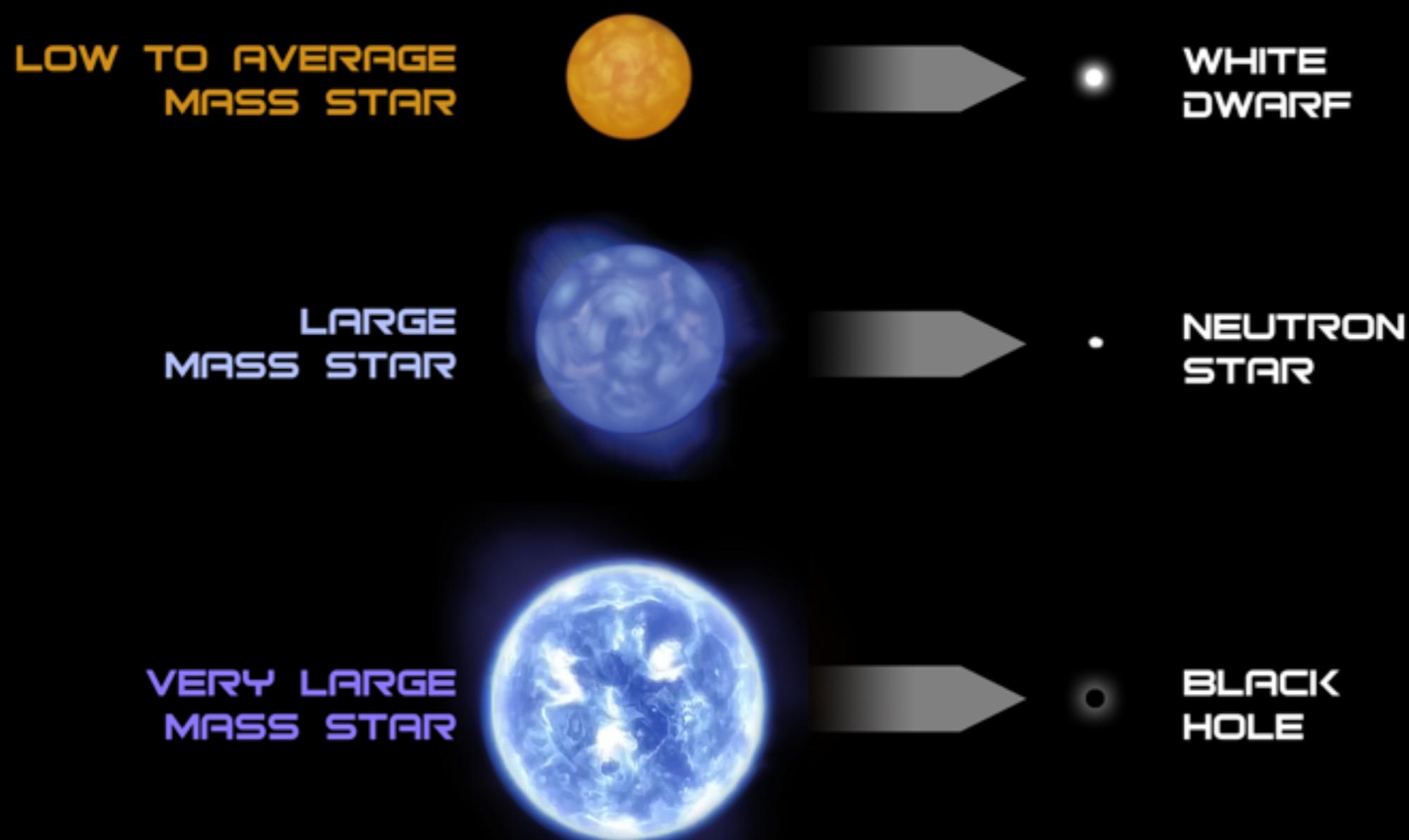


1970s: Stephen Hawking Advances our Understanding of Black Holes

In 1968, Stephen Hawking joins the Institute of Astronomy in Cambridge and begins to apply the laws of thermodynamics and quantum mechanics to black holes



BIRTH OF A BLACK HOLE



The fate of a star depends on its mass (size not to scale)

BIRTH OF A BLACK HOLE

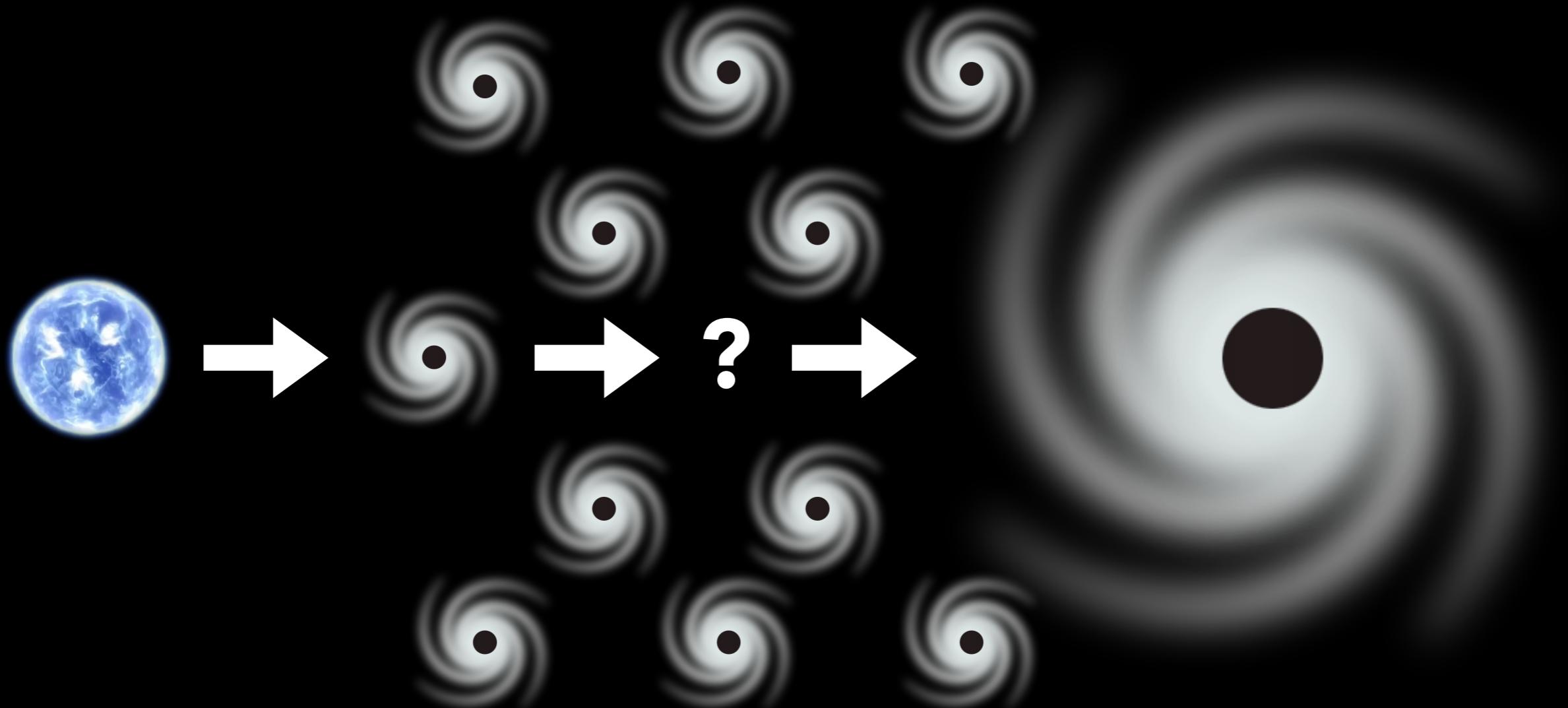


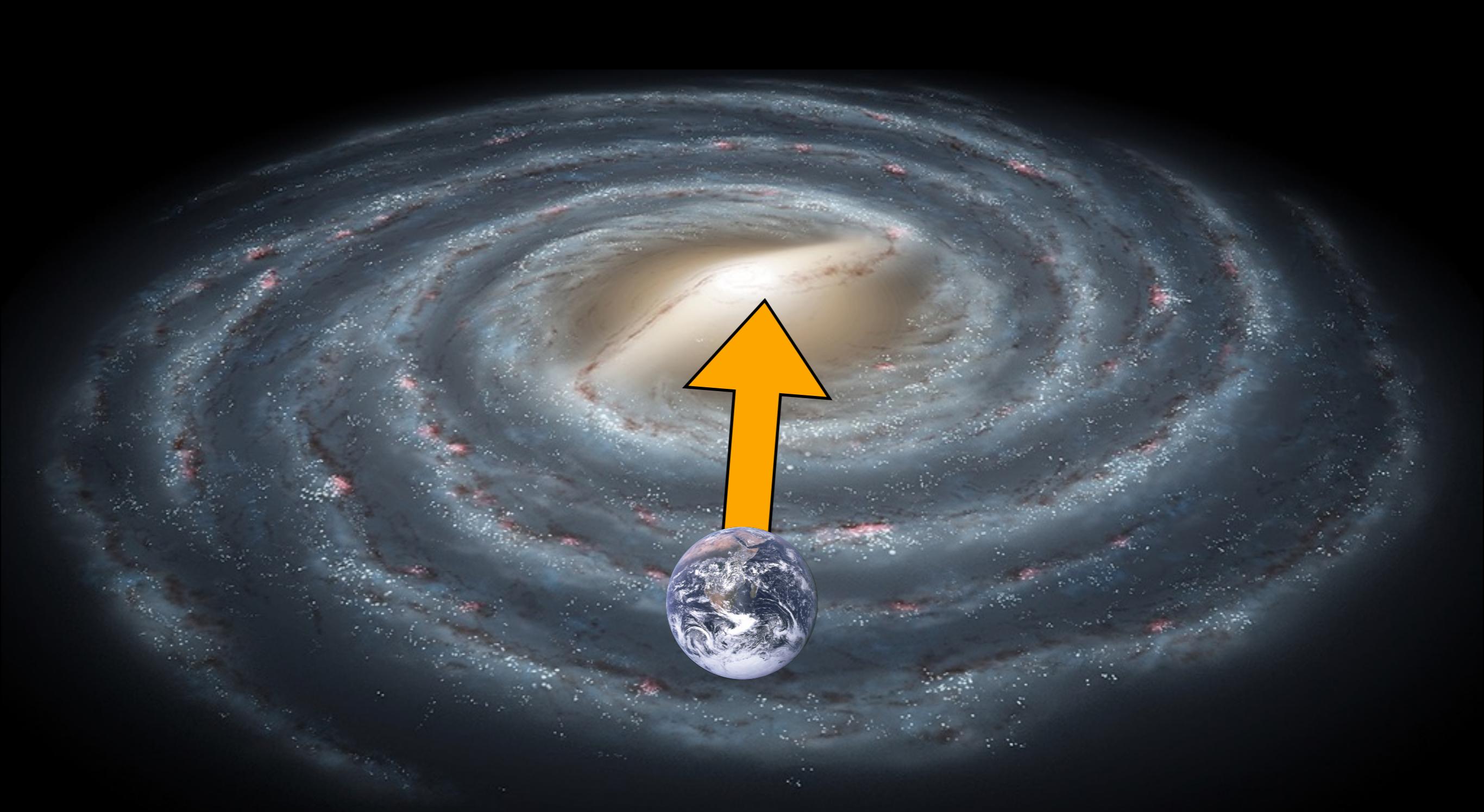
BIRTH OF A BLACK HOLE



BLACK HOLE TYPES

- **Stellar-mass**: black holes with 3 to 20 times the mass of our own Sun
- **Supermassive**: black holes with millions to billions of times the mass of our own Sun





2002: The Milky Way's
Lurking Monster



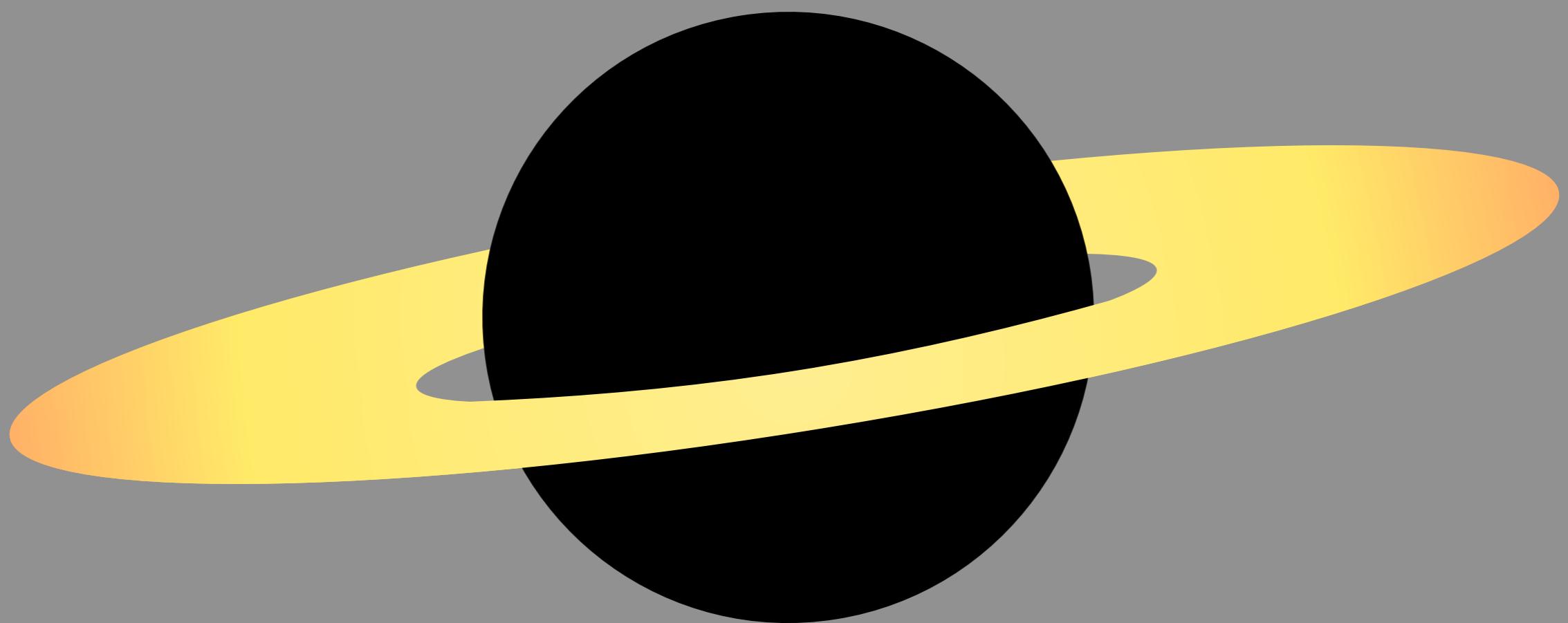
2002: The Milky Way's
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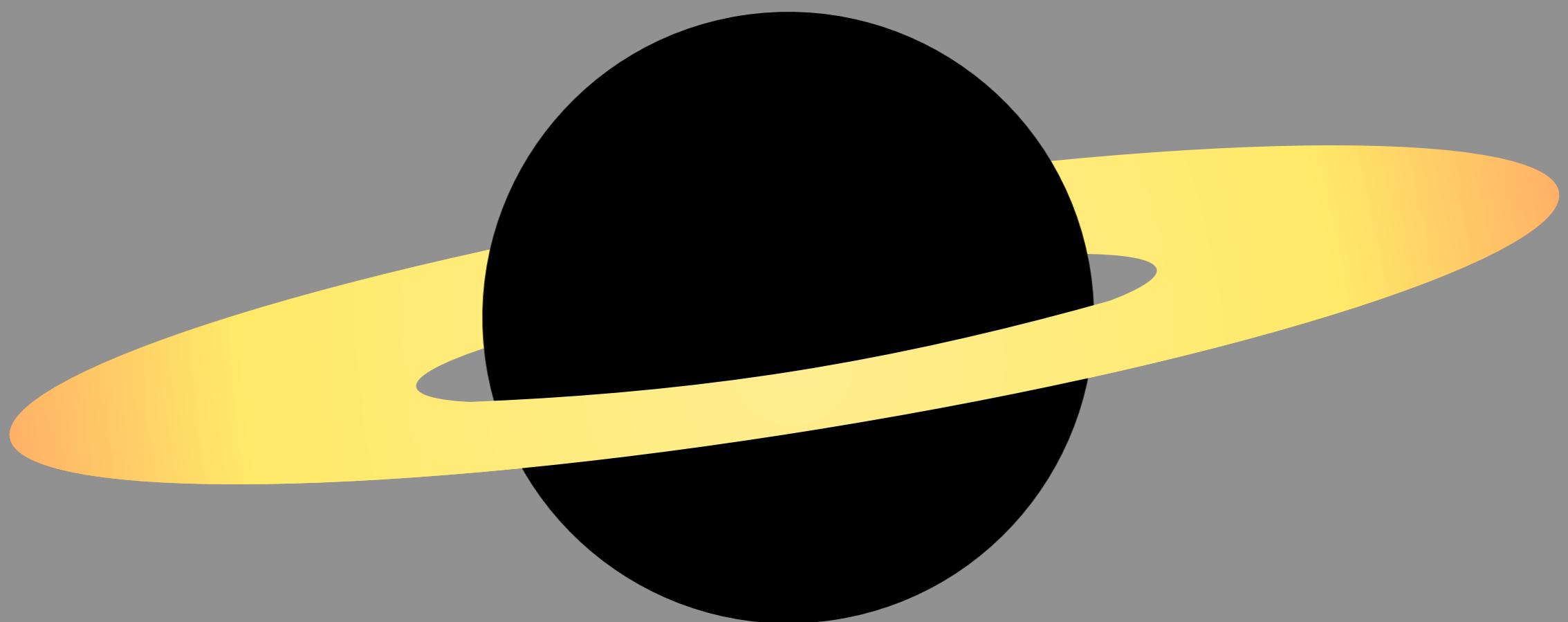


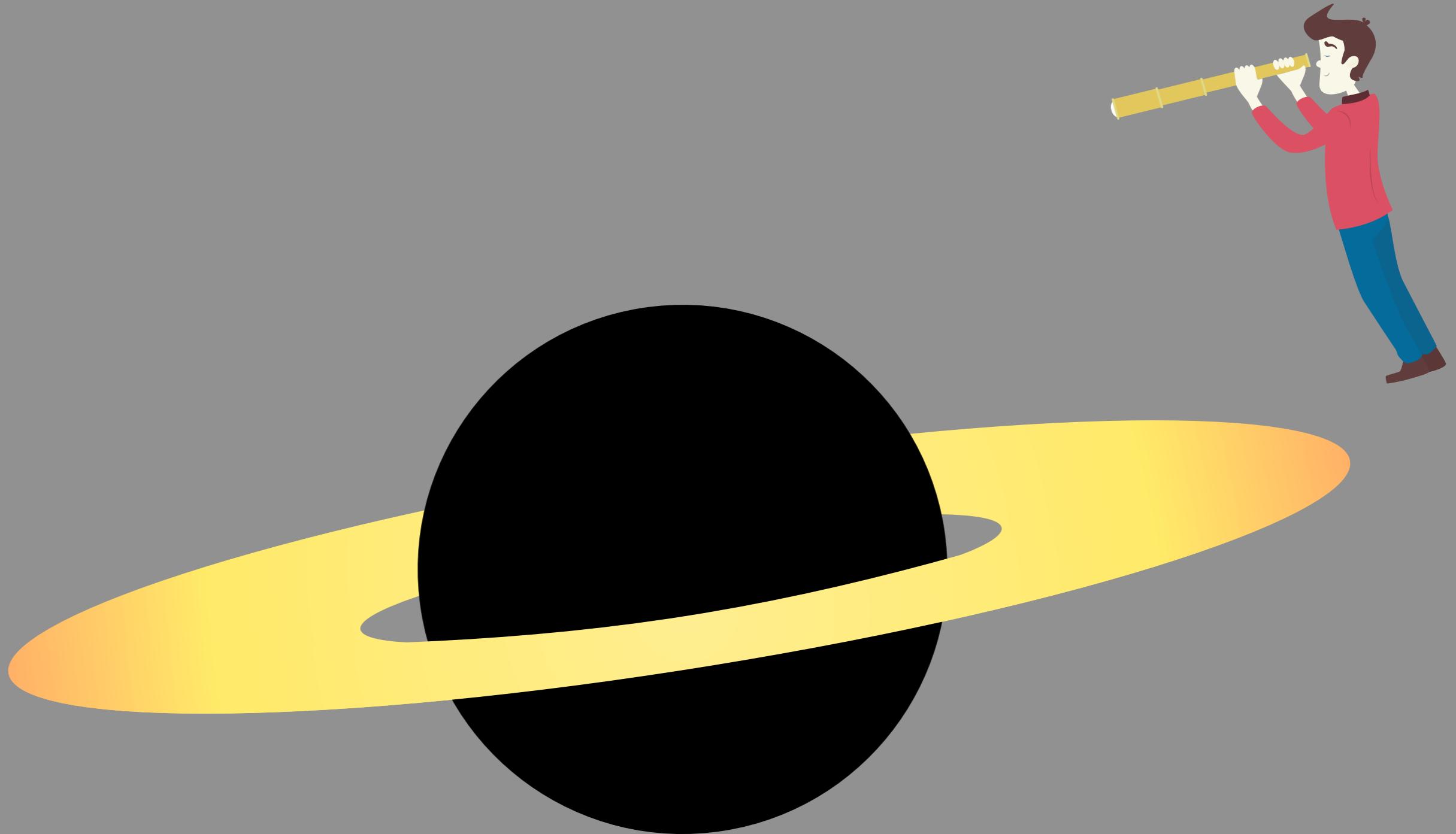
INTERSTELLAR

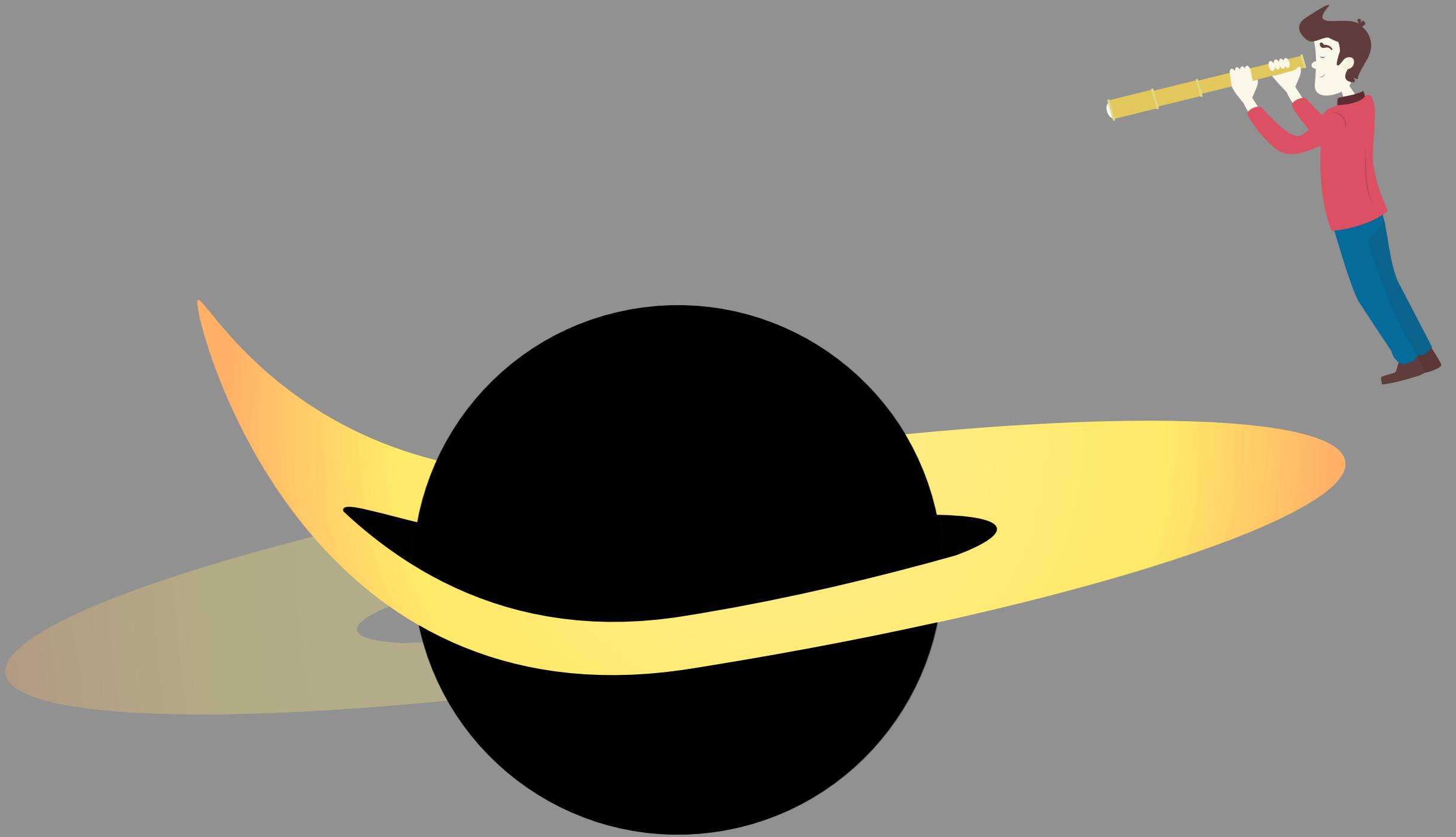


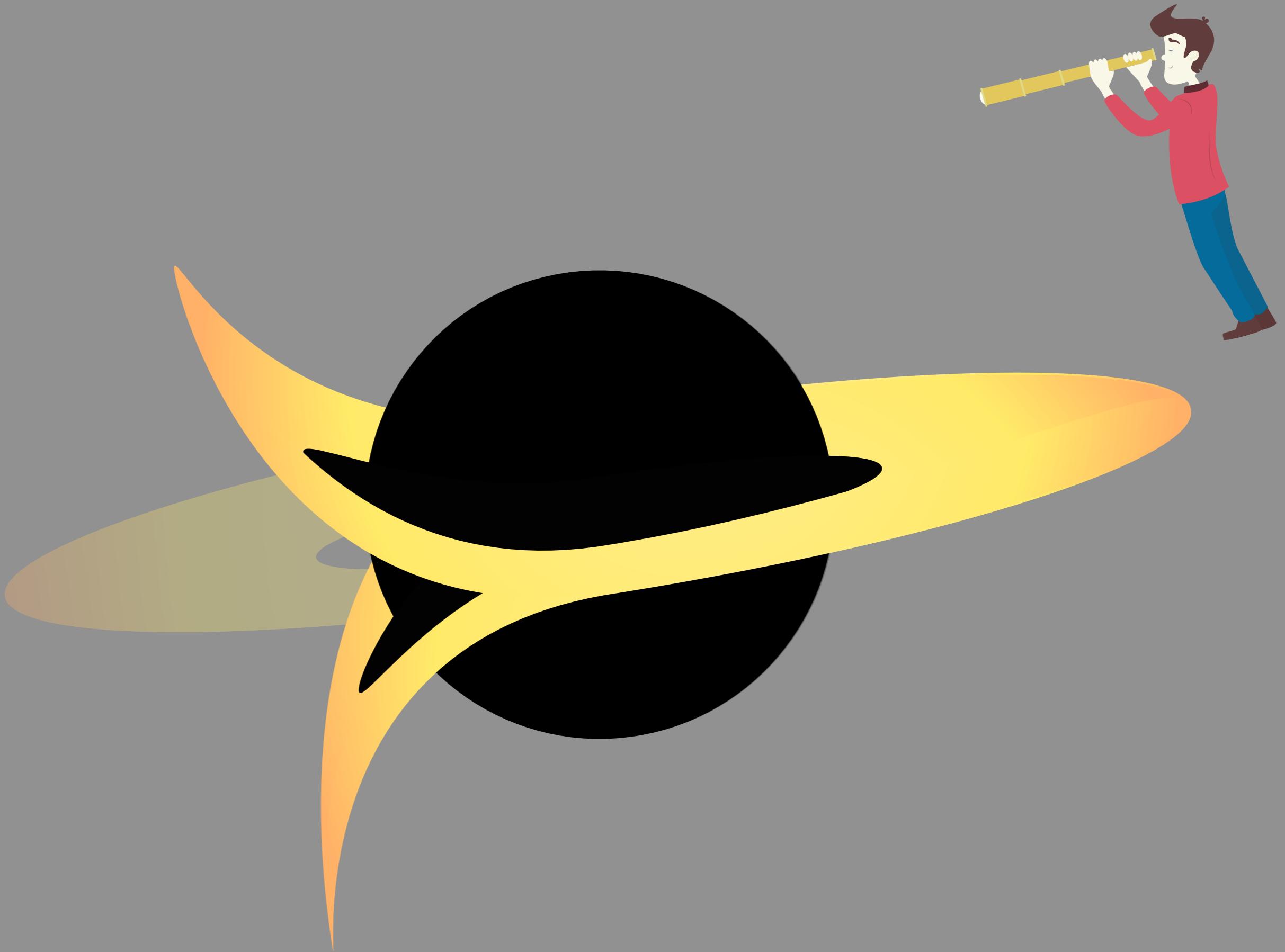
















INTERSTELLAR

Black Holes

How do we find them?



3C 273

QUASAR 3C 273



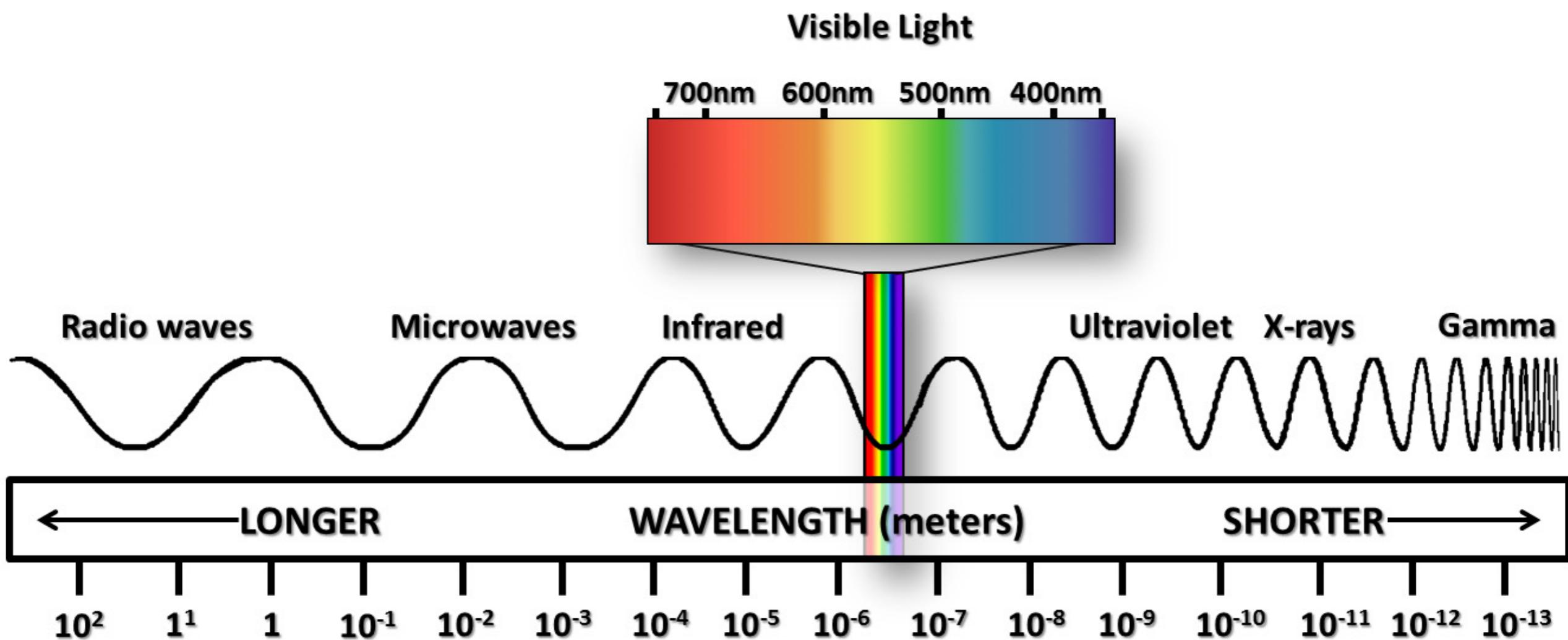
4 TRILLION
TIMES BRIGHTER
THAN THE SUN!



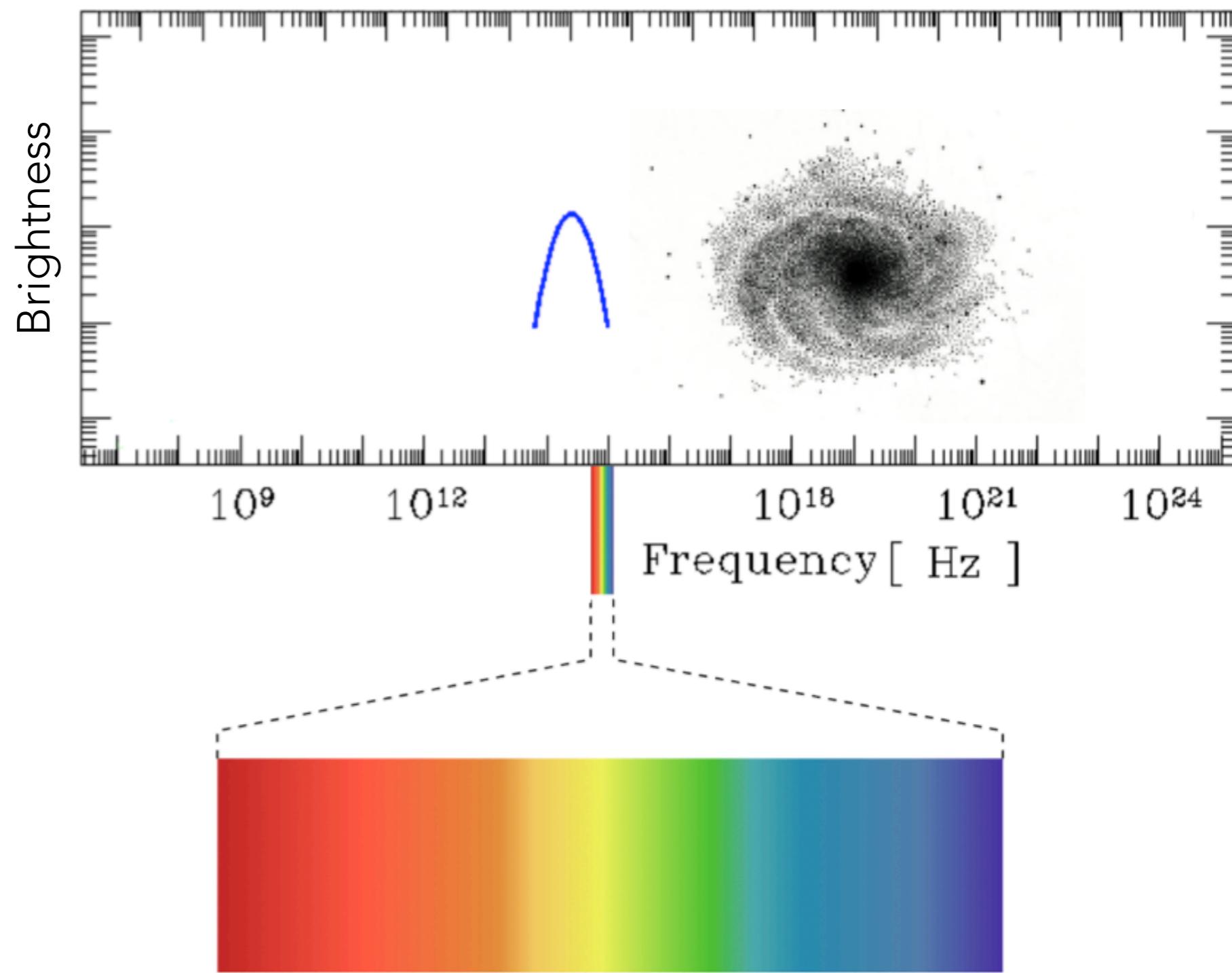
- Discovered in 1959
- **273rd** object in the **3rd Cambridge** Radio Survey (**3C 273**)
- Classified as a Quasar or quasi-stellar radio source (looks like a star, but is not)
- Approximately two billion light years away (that's 2×10^{22} or 20,000,000,000,000,000,000 kilometres away)

How Bright is it?

ELECTROMAGNETIC SPECTRUM

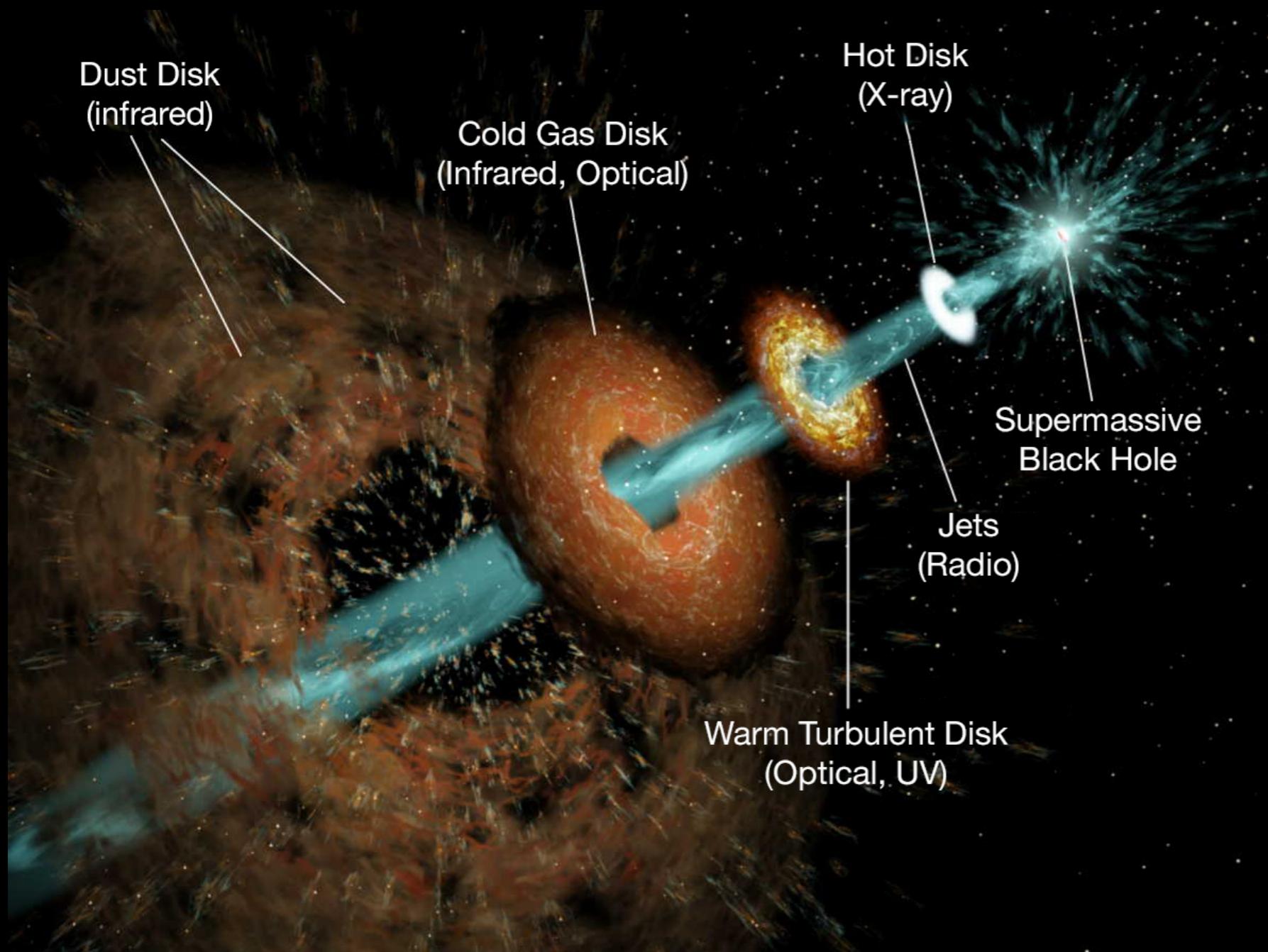


QUASAR 3C 273 SPECTRUM



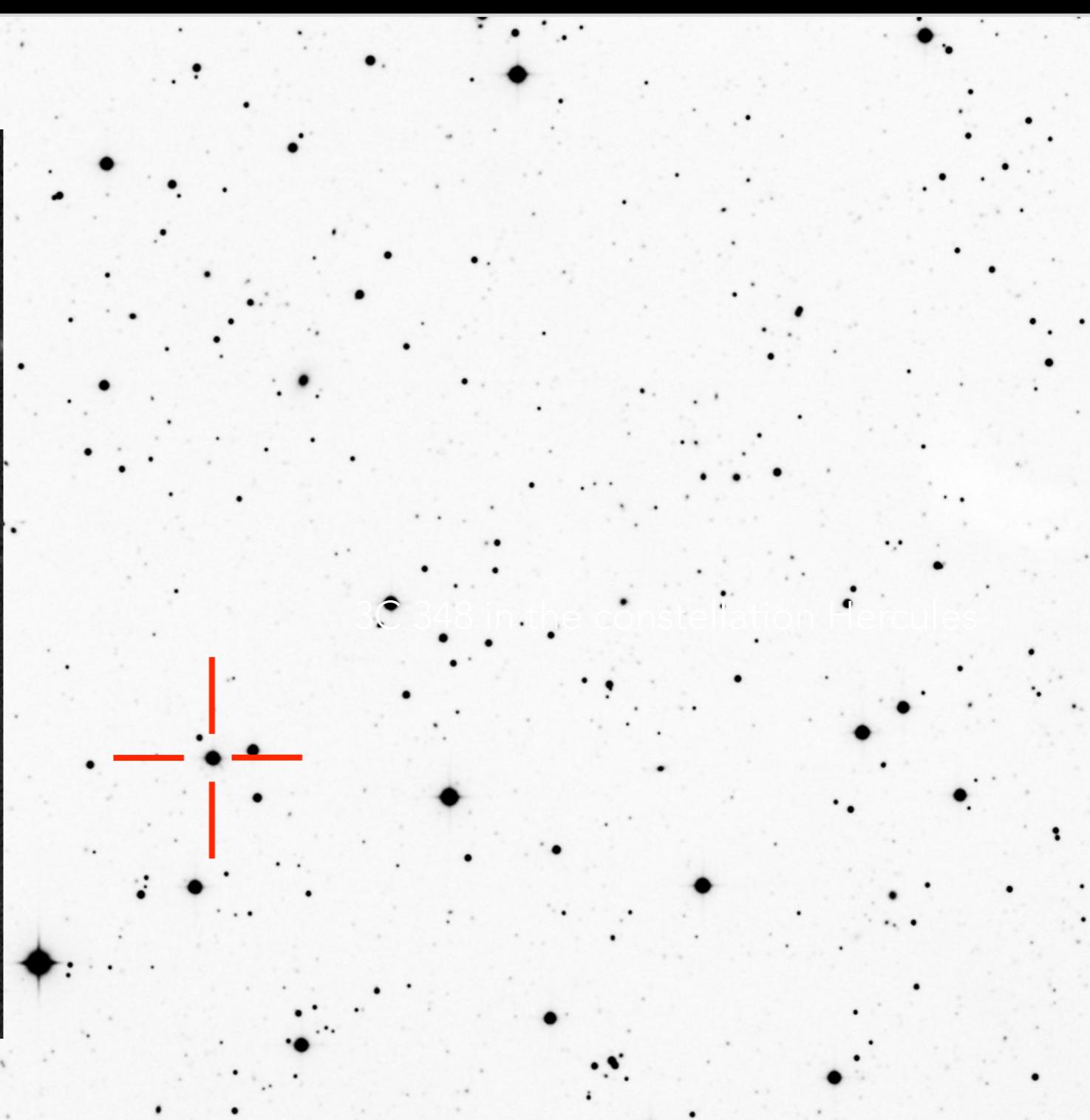
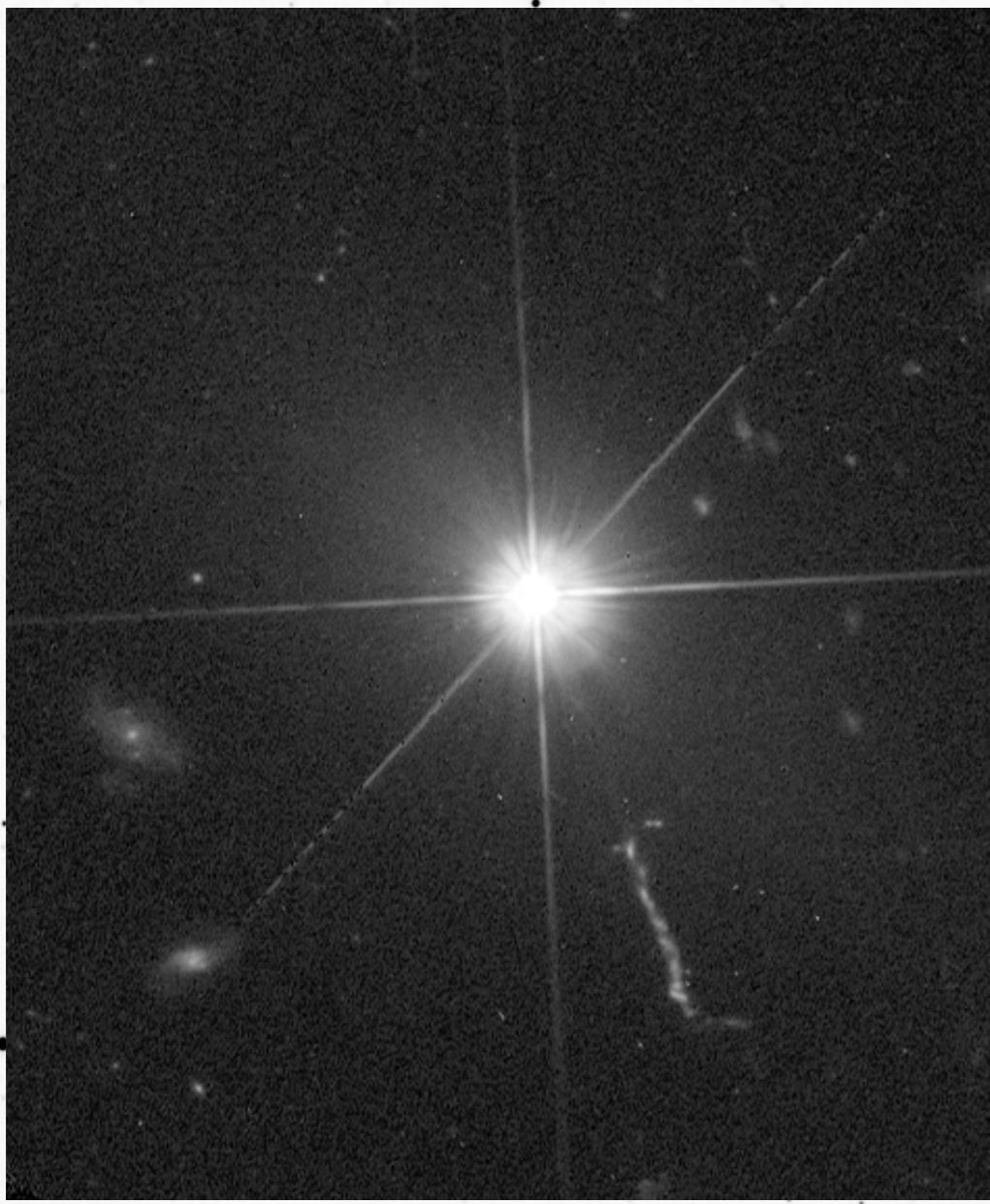
Black Holes

Where does the light come from?



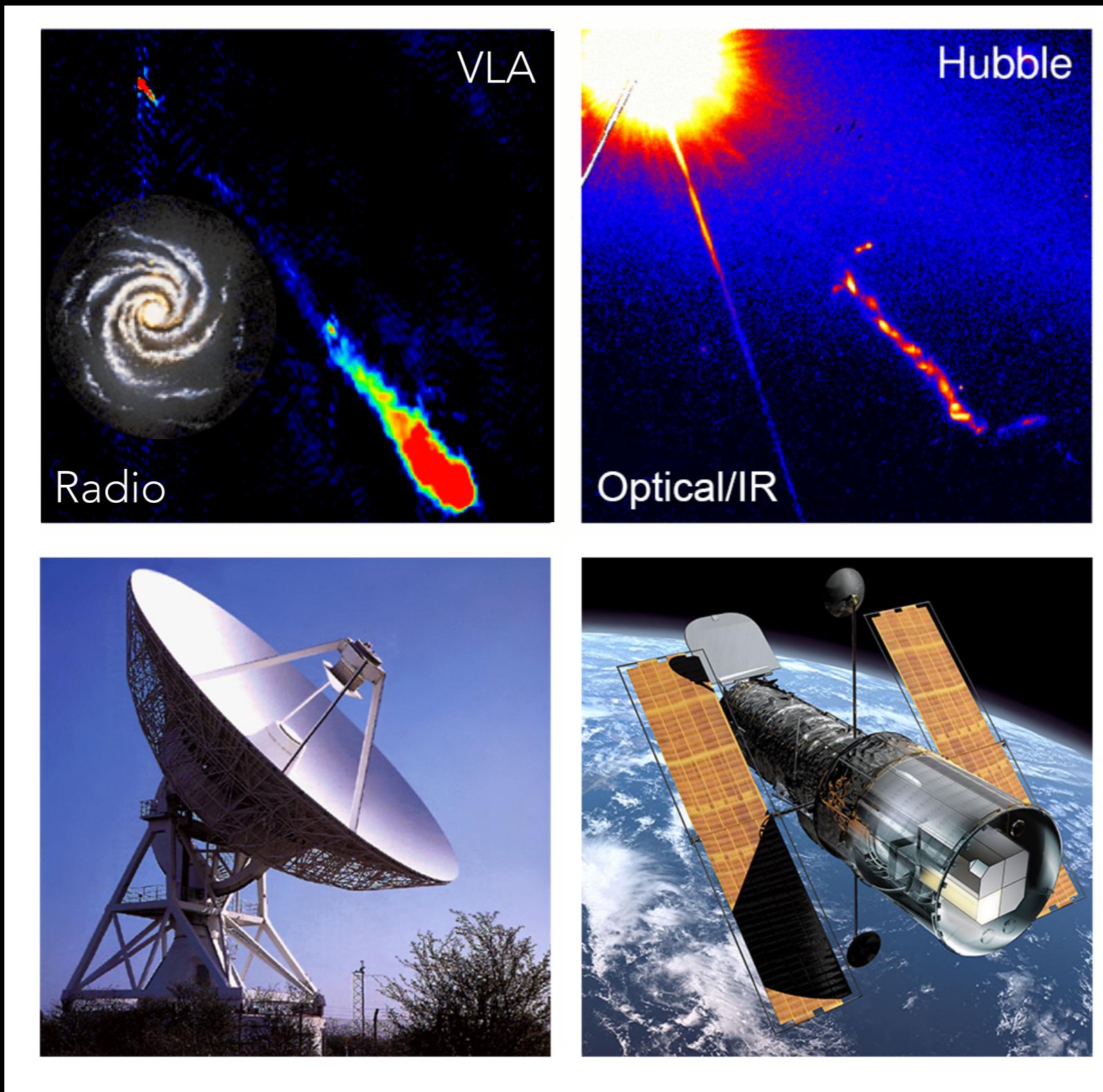
- Gravity causes material to spiral inward towards the black hole
- Frictional forces compress and raise the temperature of the material causing the emission of light ranging from X-rays to infrared
- Particles accelerated to speeds approaching that of light and emerge from the poles as radio jets

QUASAR 3C 273



QUASAR 3C 273 RADIO JET

~2 x longer than
distance across
Milky Way



I USE THESE BAD BOYS...



Magellan



Hubble
25
Years!



Herschel



12
Years!
Spitzer



Chandra



VLA

SPITZER CALENDAR



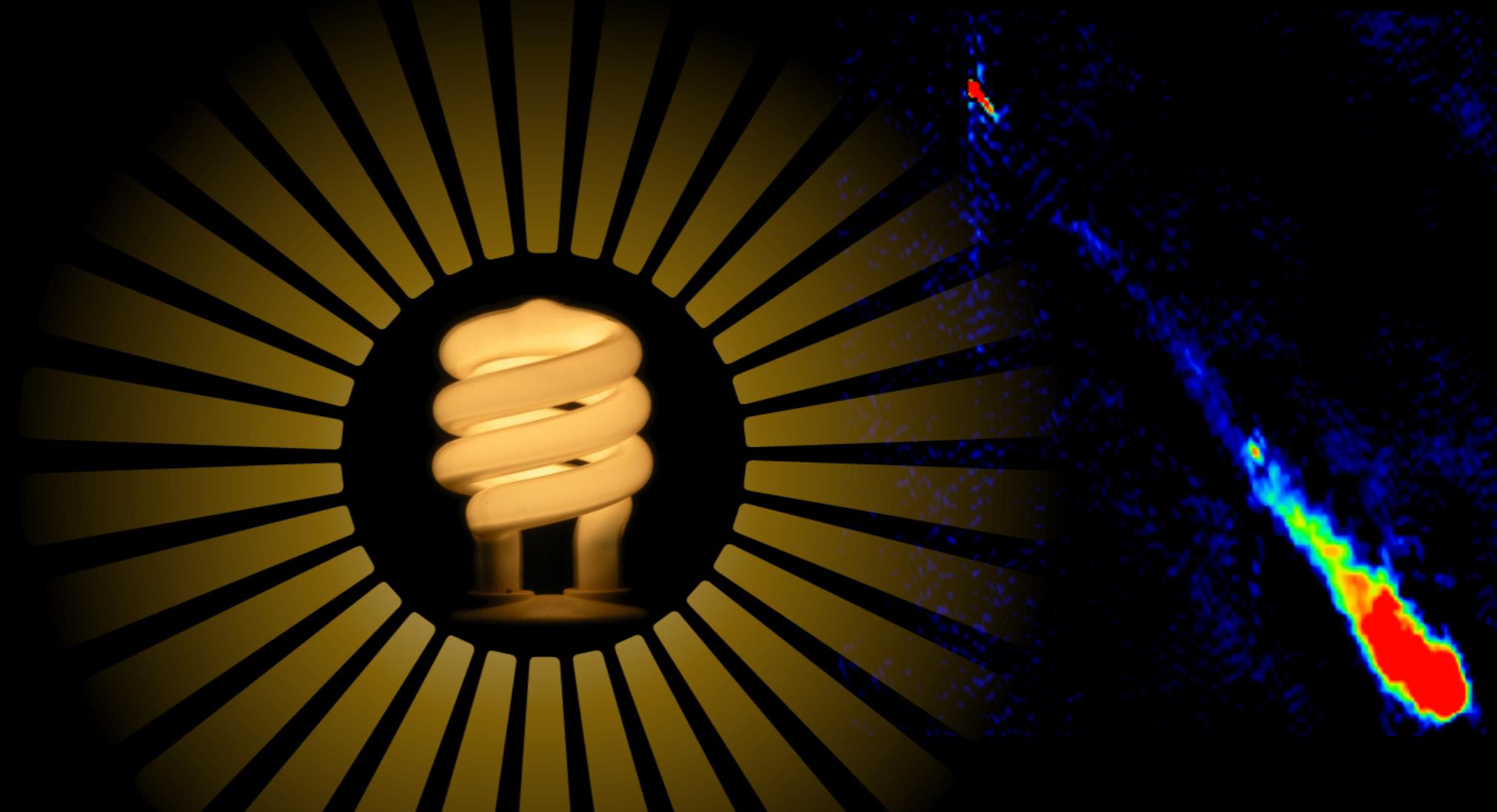
<http://goo.gl/n7IvD6>

**QR CODE
SCAN ME!**

CAN BLACK HOLES SHINE?



**4 TRILLION
TIMES BRIGHTER
THAN THE SUN!**



THANK YOU!

Want to learn more?

QR CODE
SCAN ME!

<http://hubblesite.org>



HUBBLESITE Special Feature

BLACK HOLES: Gravity's Relentless Pull

Home | Journey to a Black Hole | Black Hole Encyclopedia

Finding the Invisible | The Voyage | Up Close and Personal

99.999...95% | 99.999...95% | 99.999...95% | 99.9995% | 90% | Speed | Light Speed

1 million | 10,000 | 1000 | 1 | Distance from Earth | Light Years

Replay last part of voyage

You have reached escape velocity, but at this speed it will take you days to reach the moon ... and over 16 years to reach Pluto. Please use your engine to generate more energy for your spacecraft.

1 billion times more energy | 10 billion times more energy | 100 billion times more energy | 1,000 billion times more energy

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WHAT IS SPAGHETTIFICATION?



BLACK HOLE

AS AN OBJECT FALLS INTO A BLACK HOLE AND APPROACHES THE SINGULARITY AT THE CENTRE, IT WILL BECOME STRETCHED OUT OR "SPAGHETTIFIED" DUE TO THE INCREASING DIFFERENTIAL IN GRAVITATIONAL ATTRACTION ON DIFFERENT PARTS OF IT.



Consider four
objects falling
towards a
massive planet