

PDF version (animations missing)

9TH SEPTEMBER 2015

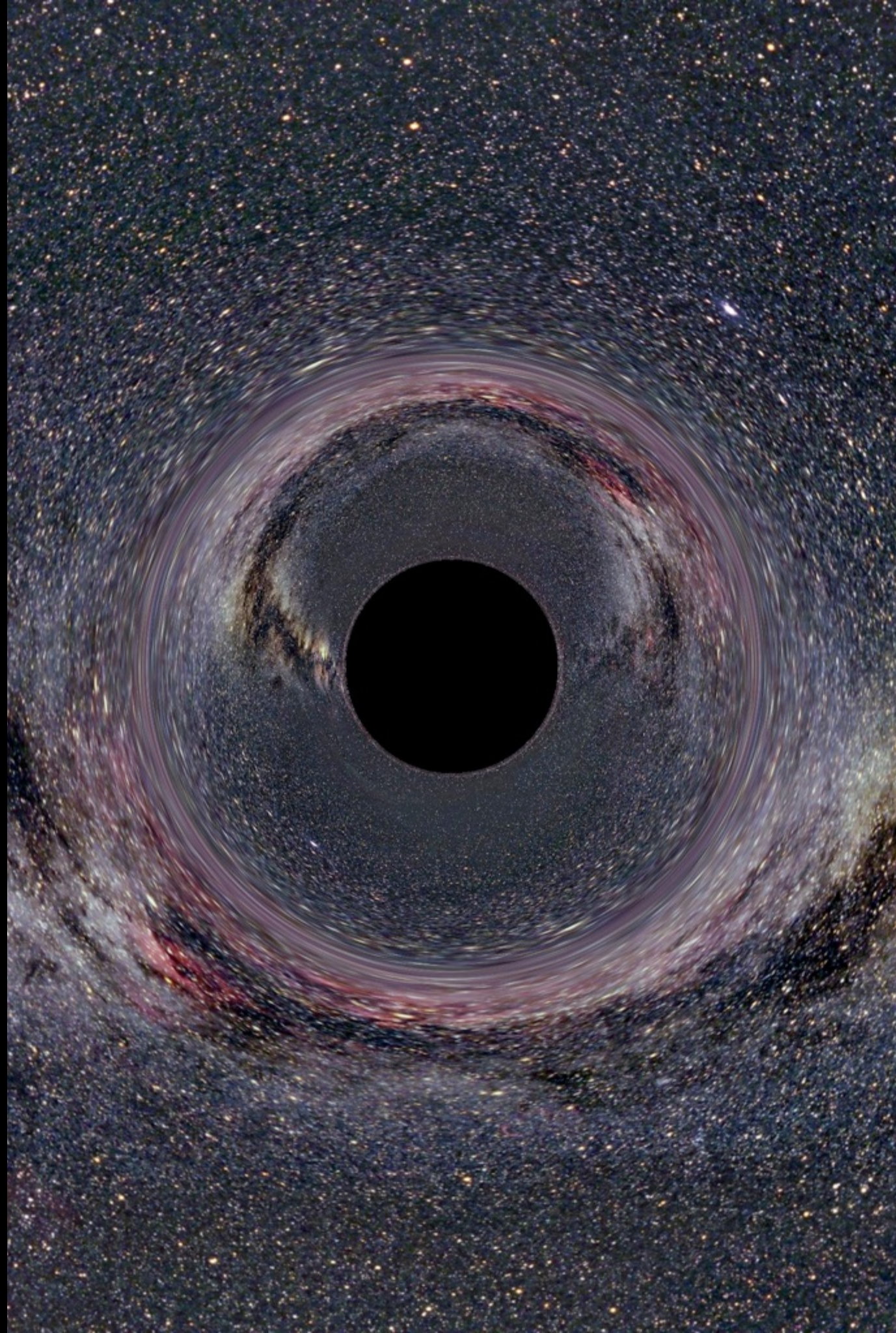
CAN BLACK HOLES SHINE?

MICHAEL COWLEY



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?



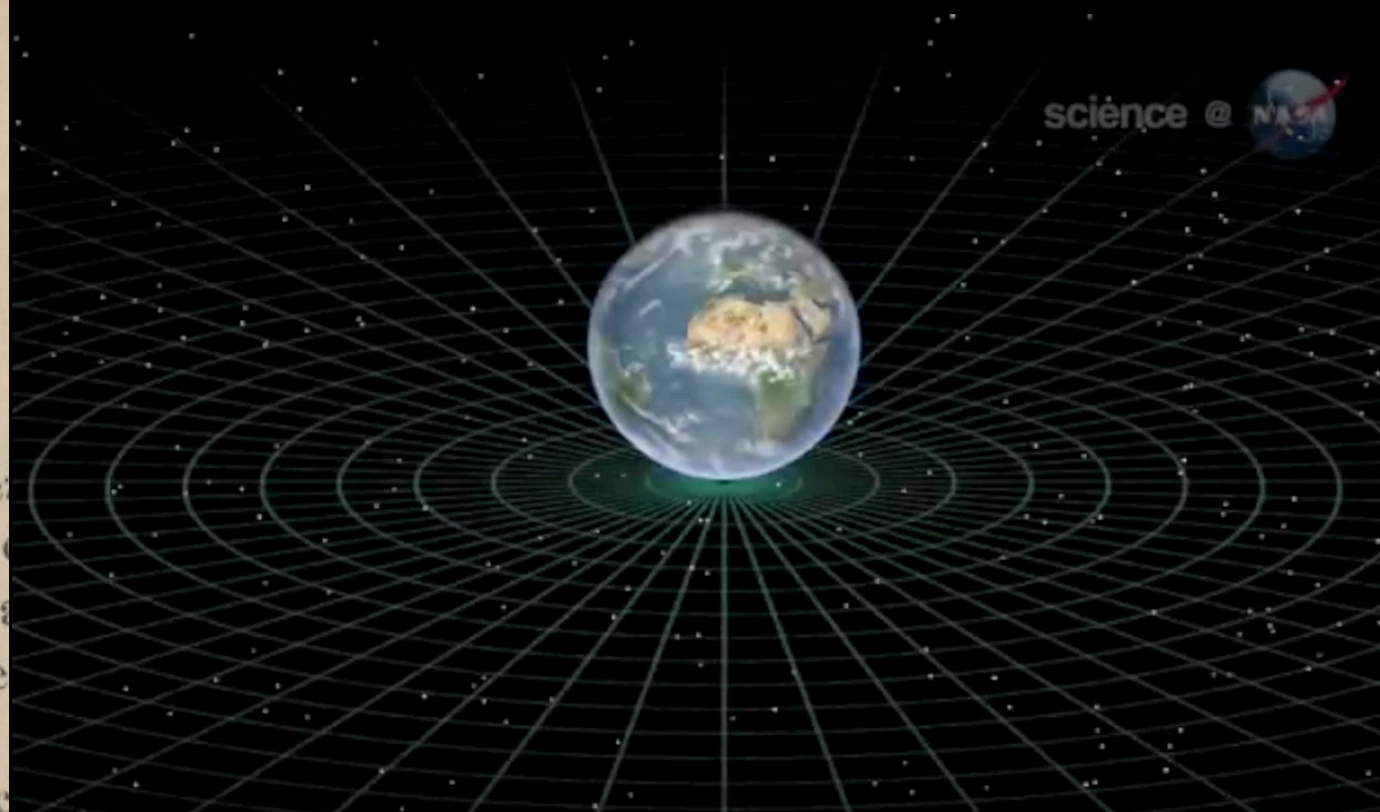
1915: Albert Einstein's General Relativity

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

Sitzung der physikalisch-mathematischen Klasse vom 25. November 1915

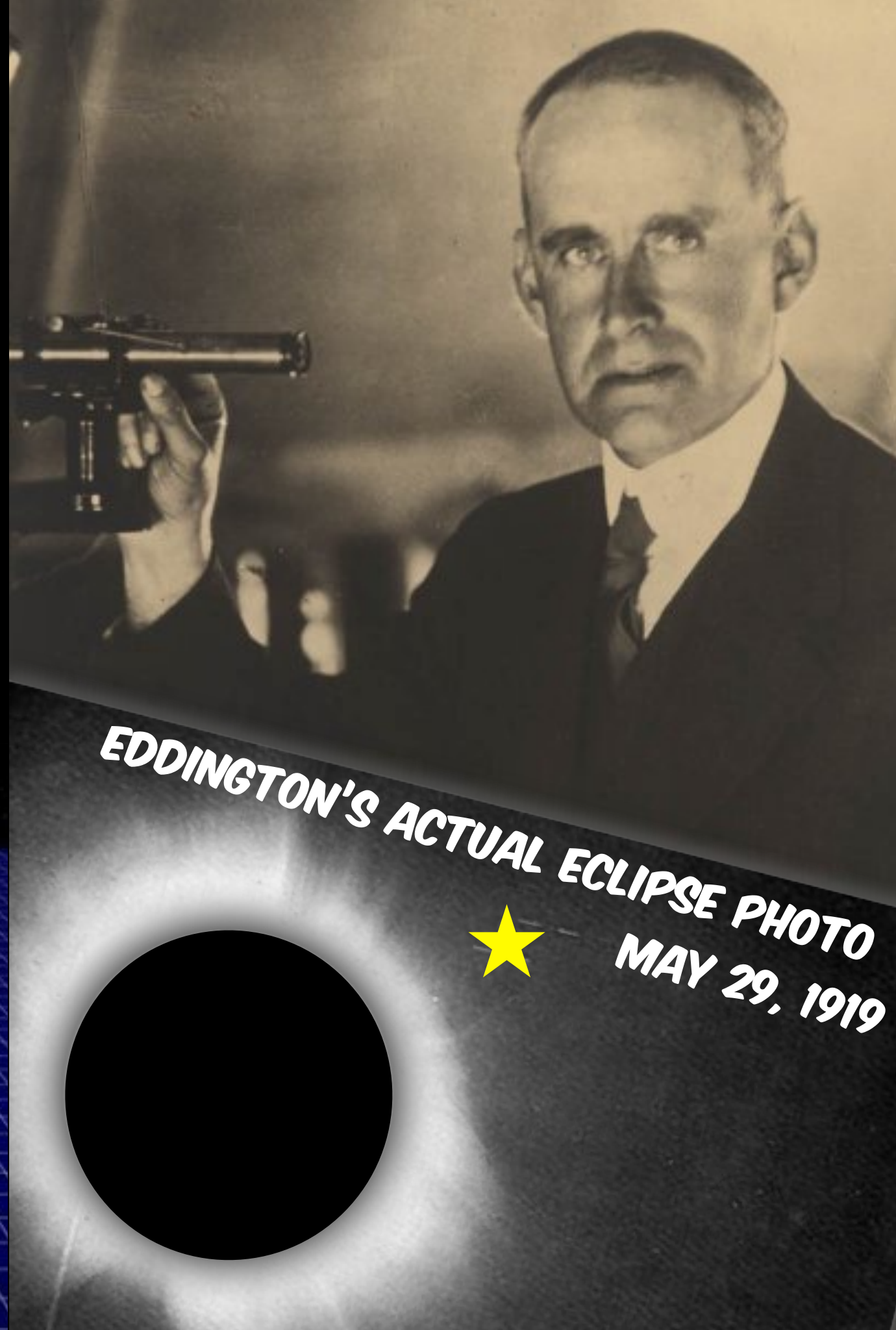
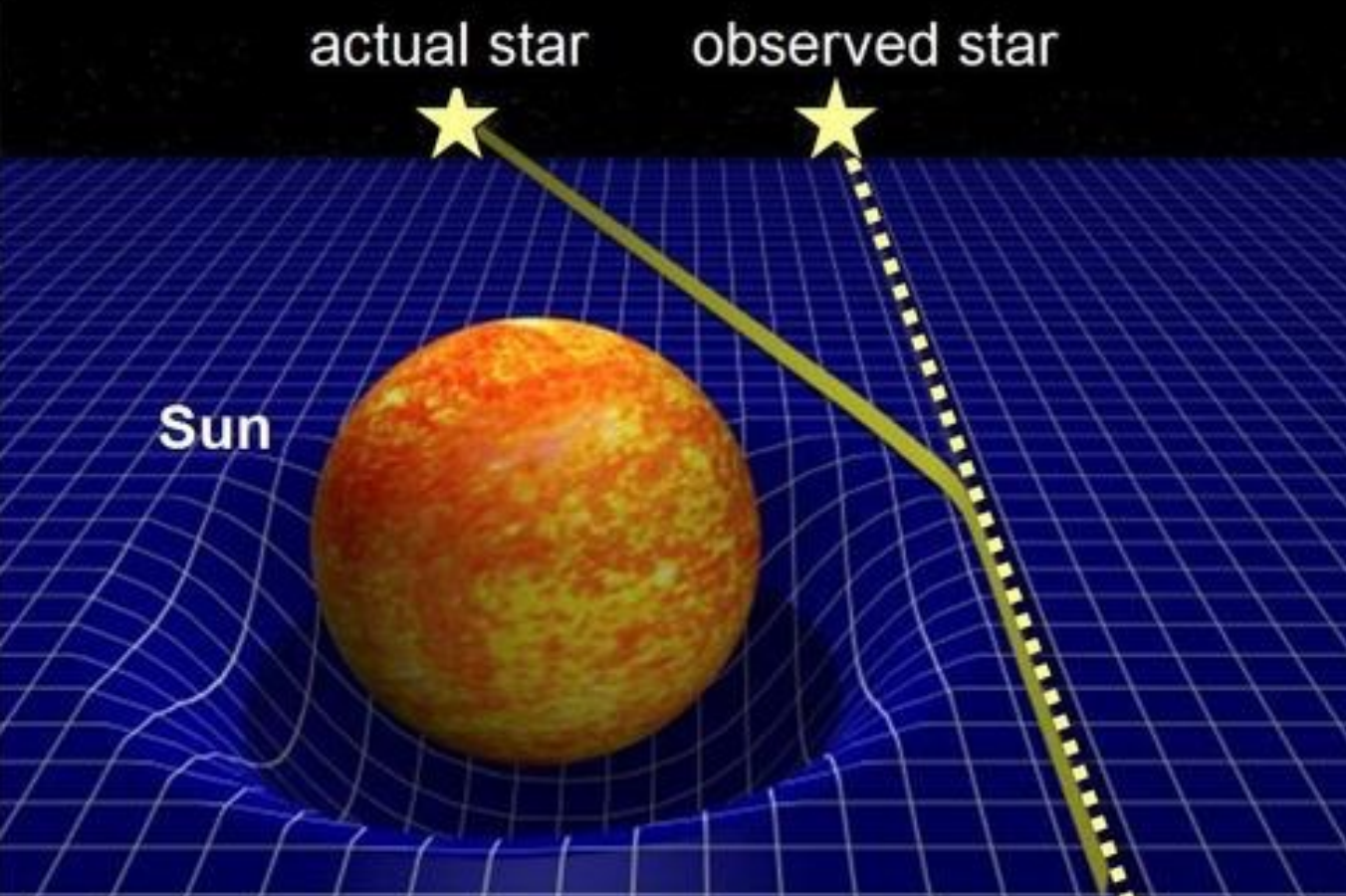
Die Feldgleichungen der Gravitation. Von A. EINSTEIN.

In zwei vor kurzem erschienenen Mitteilungen¹ habe ich gezeigt, dass man zu Feldgleichungen der Gravitation gelangen kann, die mit der Relativität entsprechen, d. h. die in ihrer Form den Forderungen der Raumzeitvariablen genügen.



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

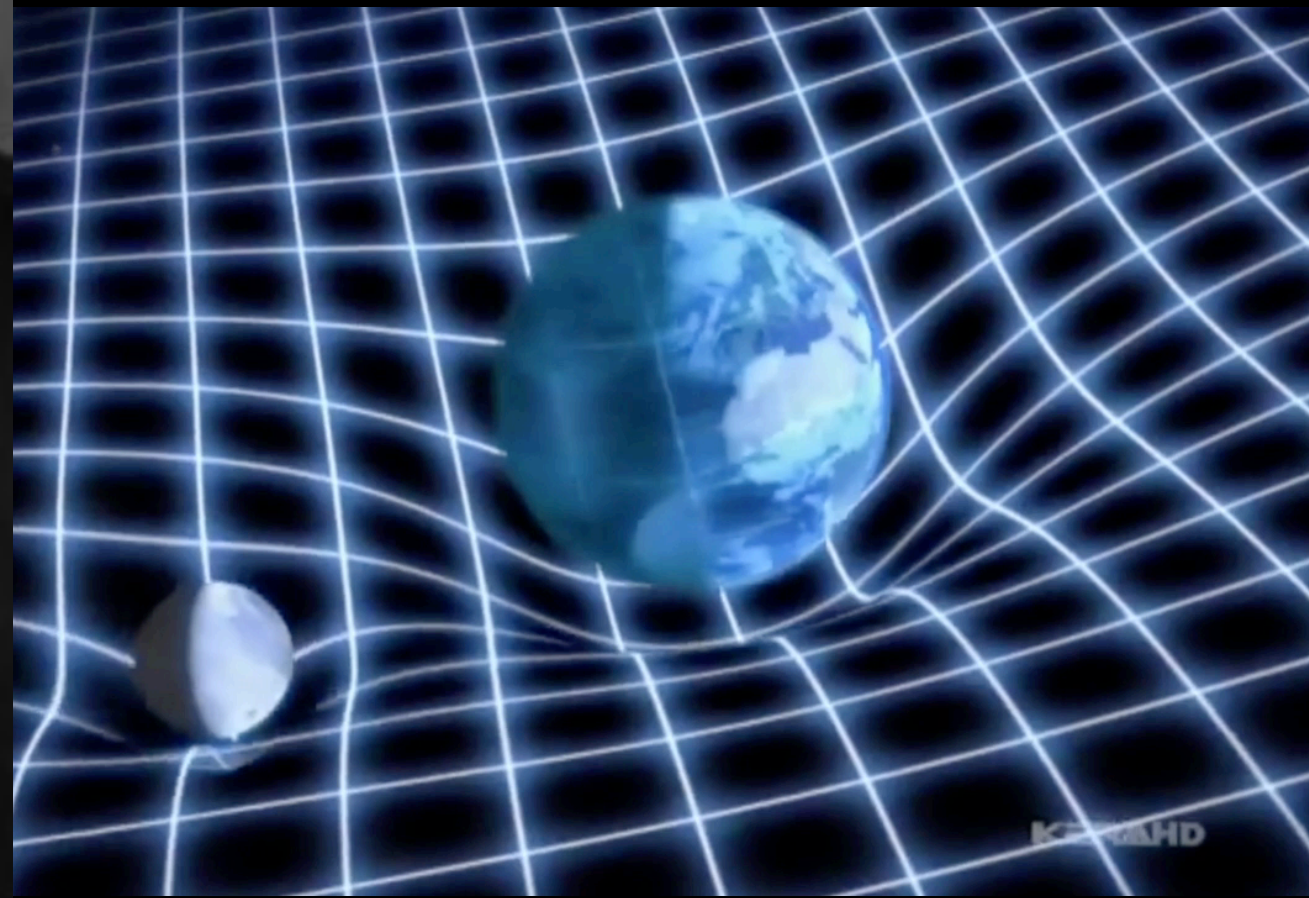


AN UNIMAGINABLY DENSE
REGION OF SPACE WHERE
SPACE IS CURVED AROUND IT
SO COMPLETELY AND
GRAVITY BECOMES SO
STRONG THAT NOTHING, NOT
EVEN LIGHT, CAN ESCAPE.



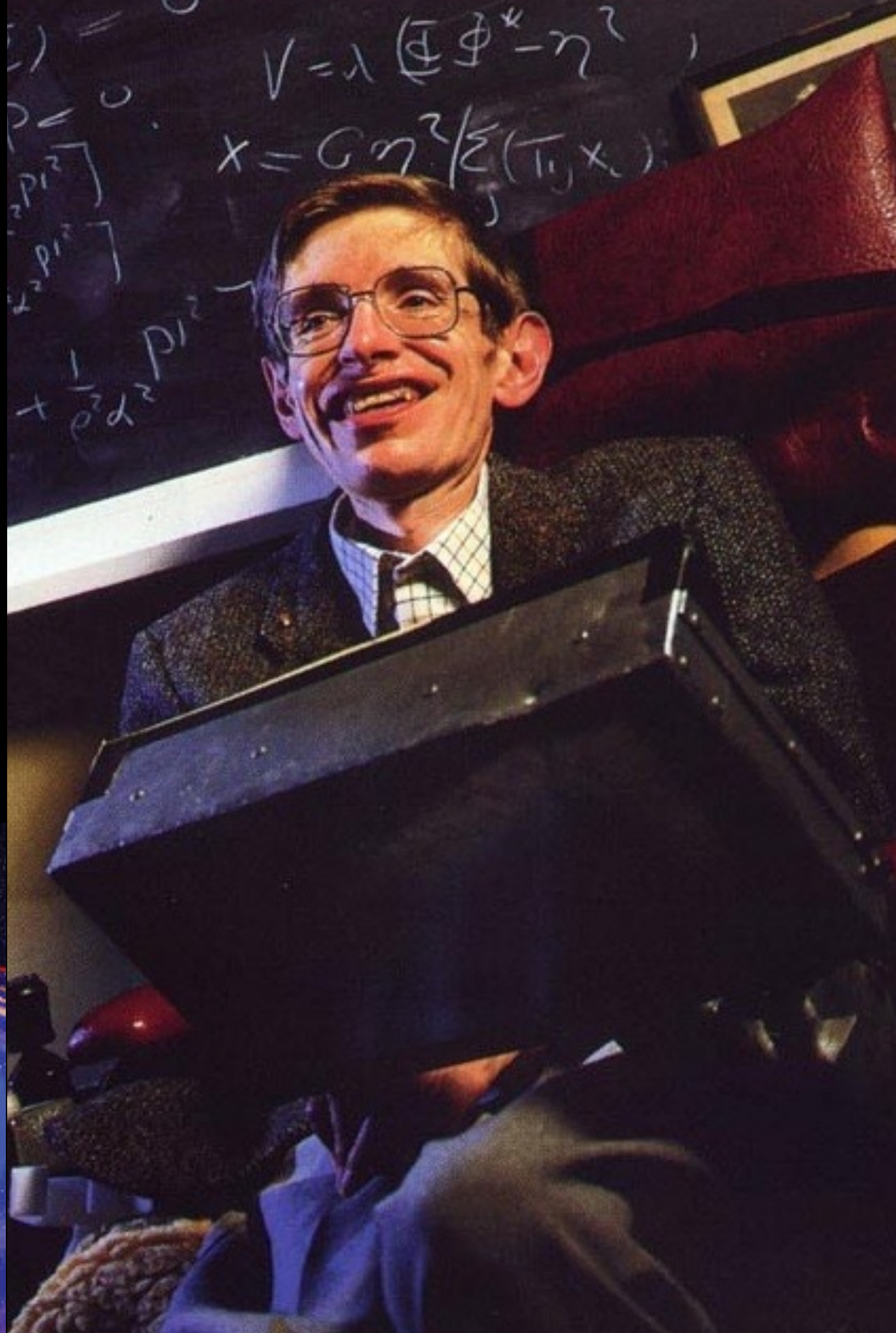
1964: John Wheeler coins
the term "black hole"

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**



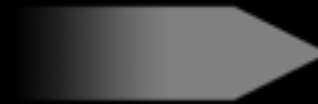
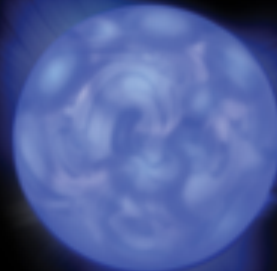
BIRTH OF A BLACK HOLE

LOW TO AVERAGE
MASS STAR



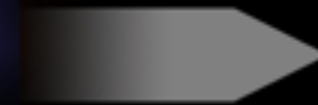
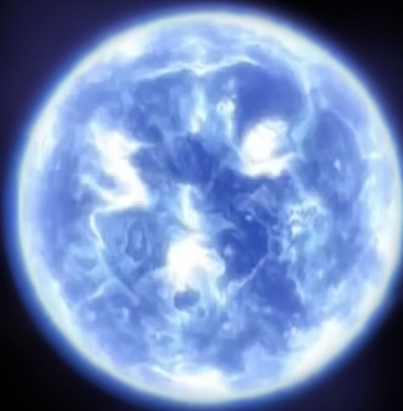
WHITE
DWARF

LARGE
MASS STAR



NEUTRON
STAR

VERY LARGE
MASS STAR



BLACK
HOLE

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

BIRTH OF A BLACK HOLE

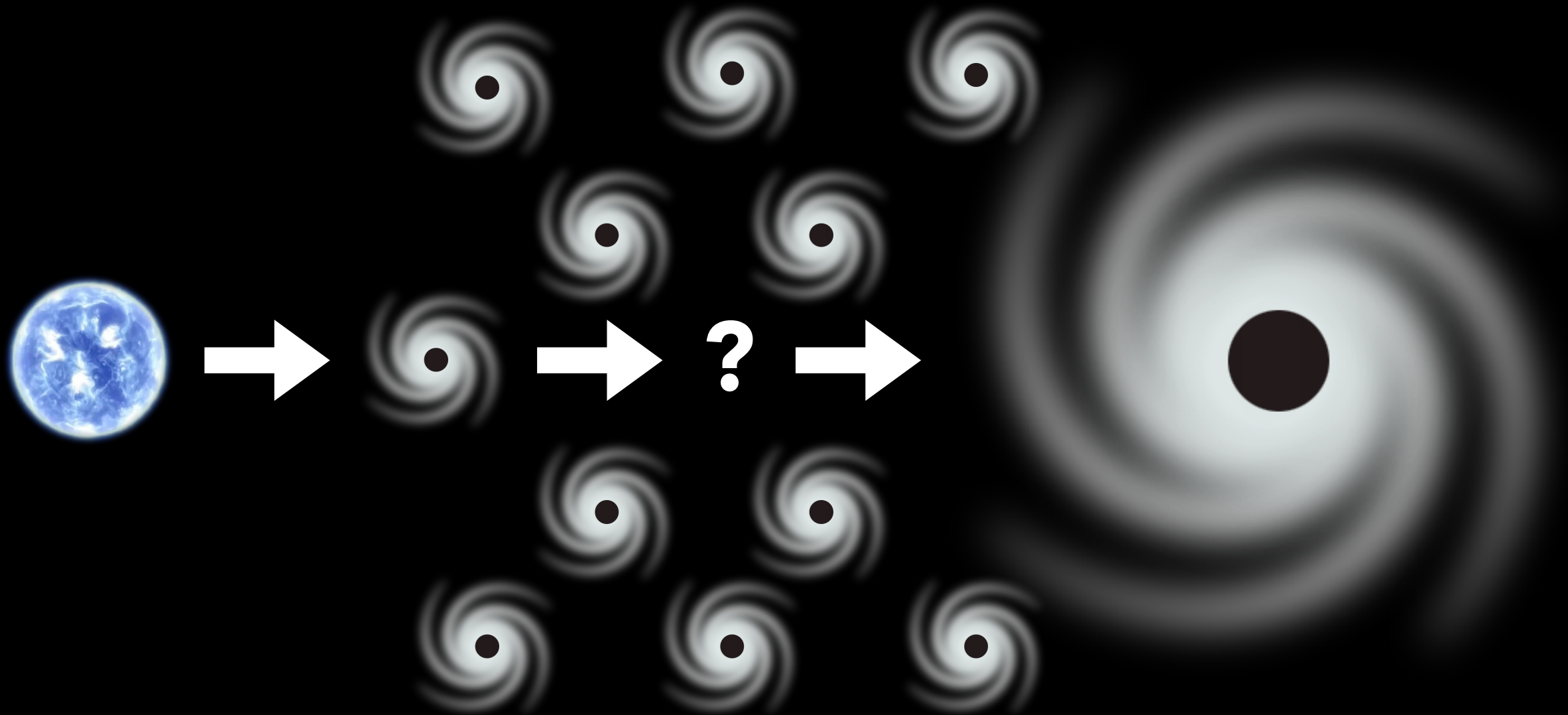


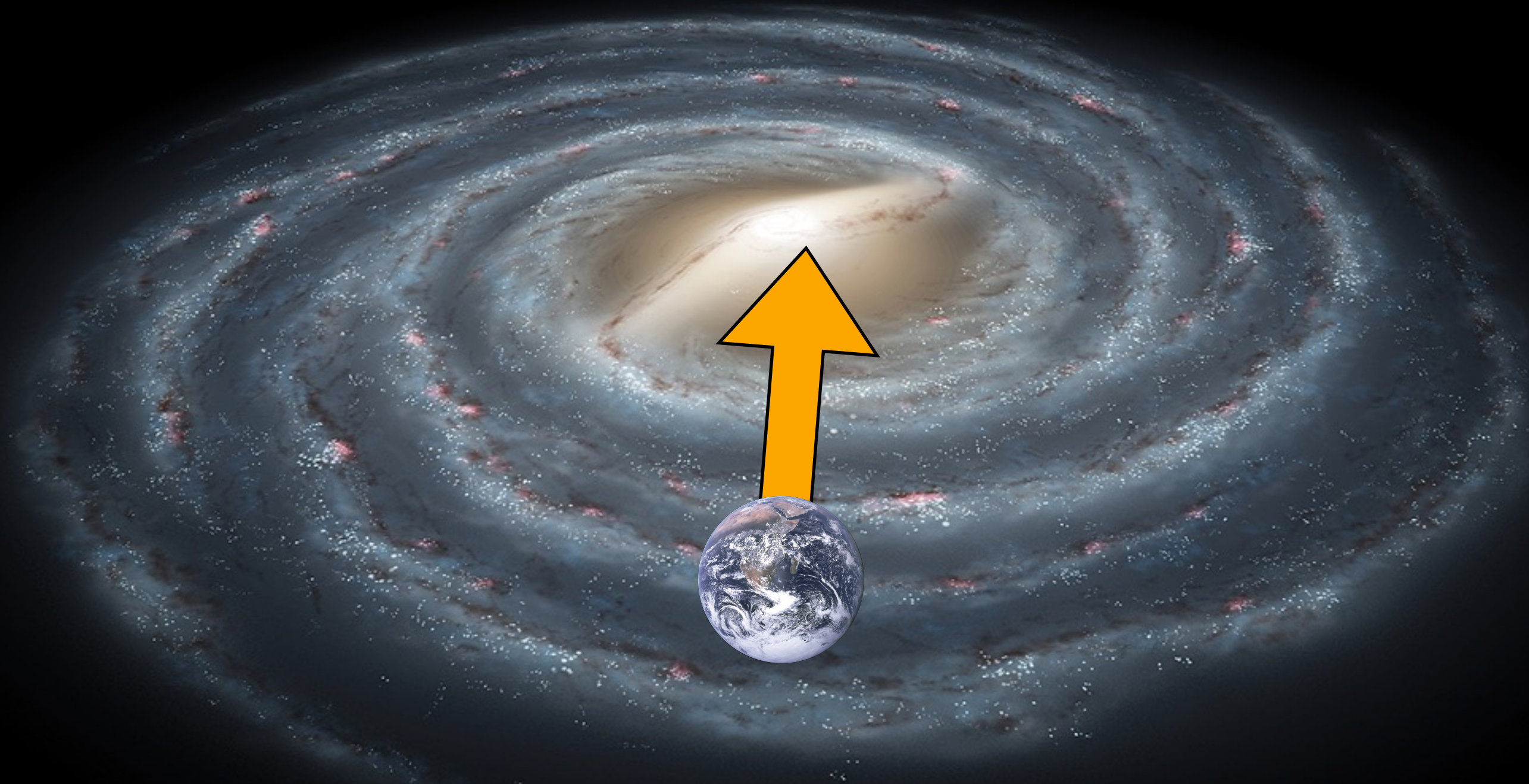
BIRTH OF A BLACK HOLE



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

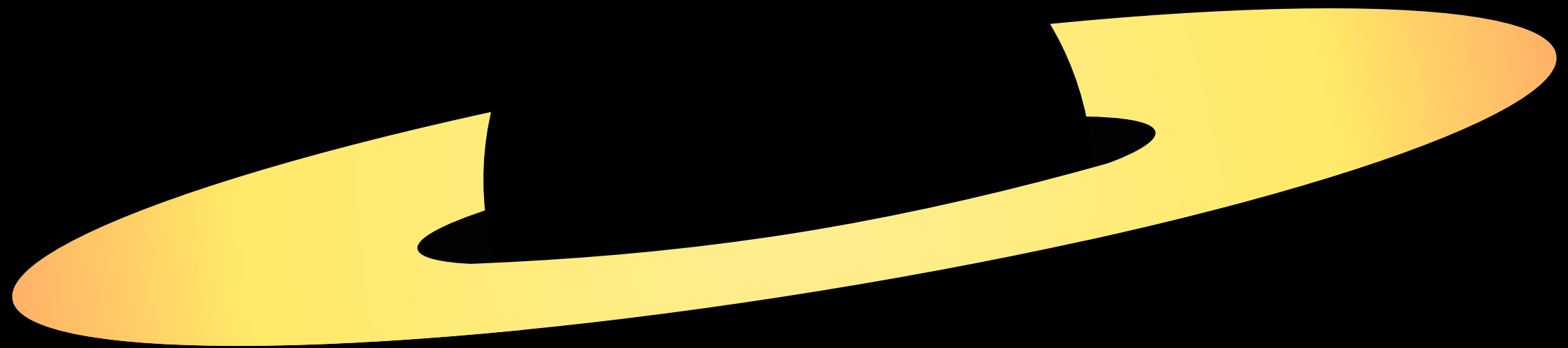


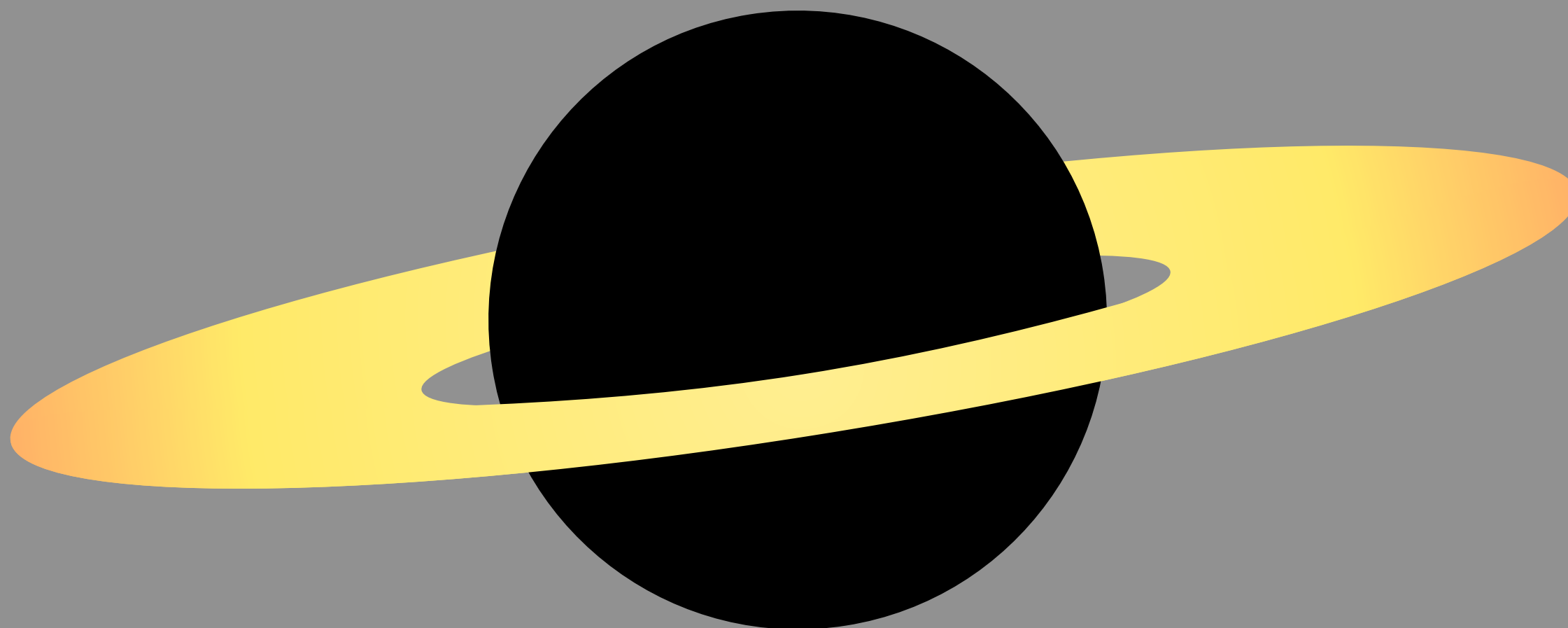
2002: The Milky Way's
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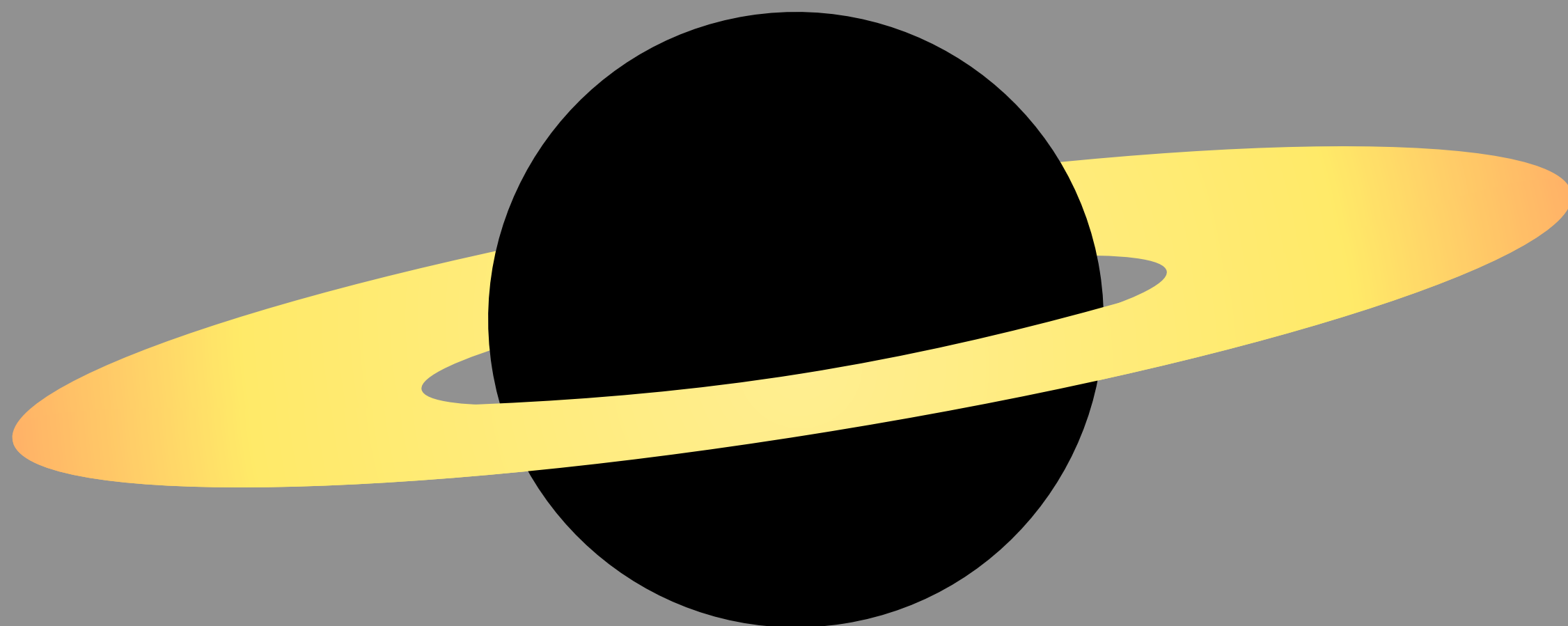


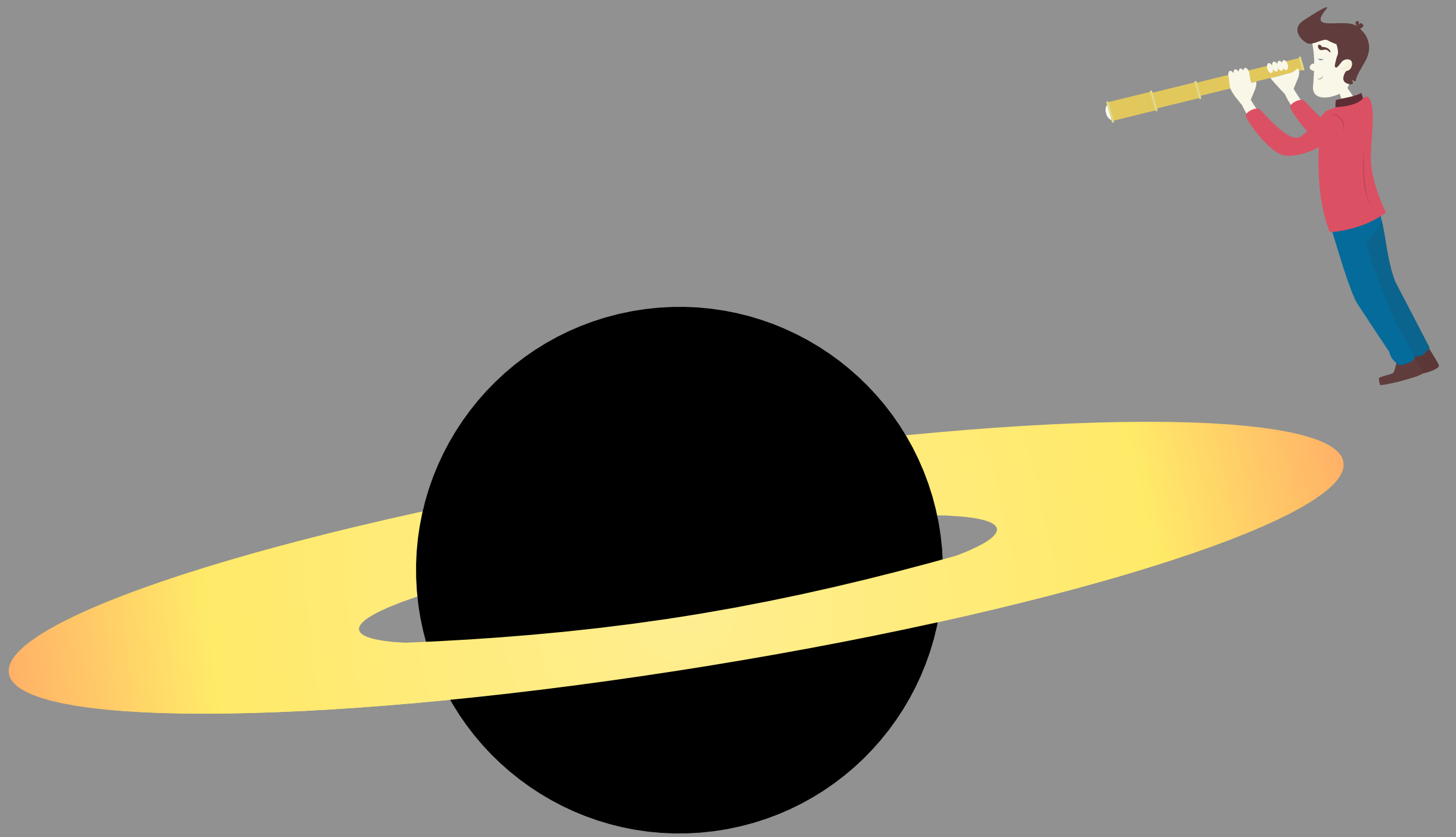
INTERSTELLAR

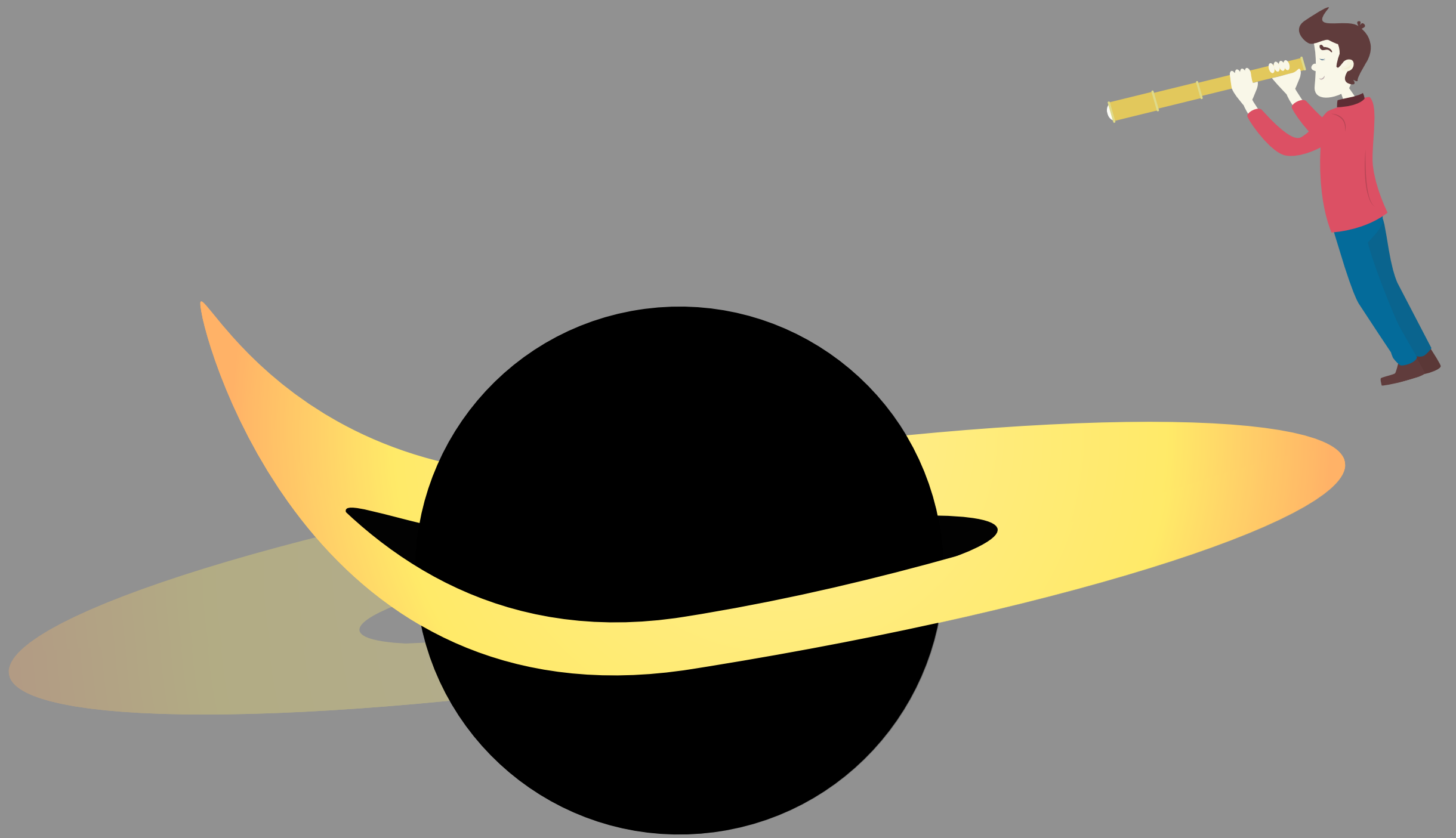


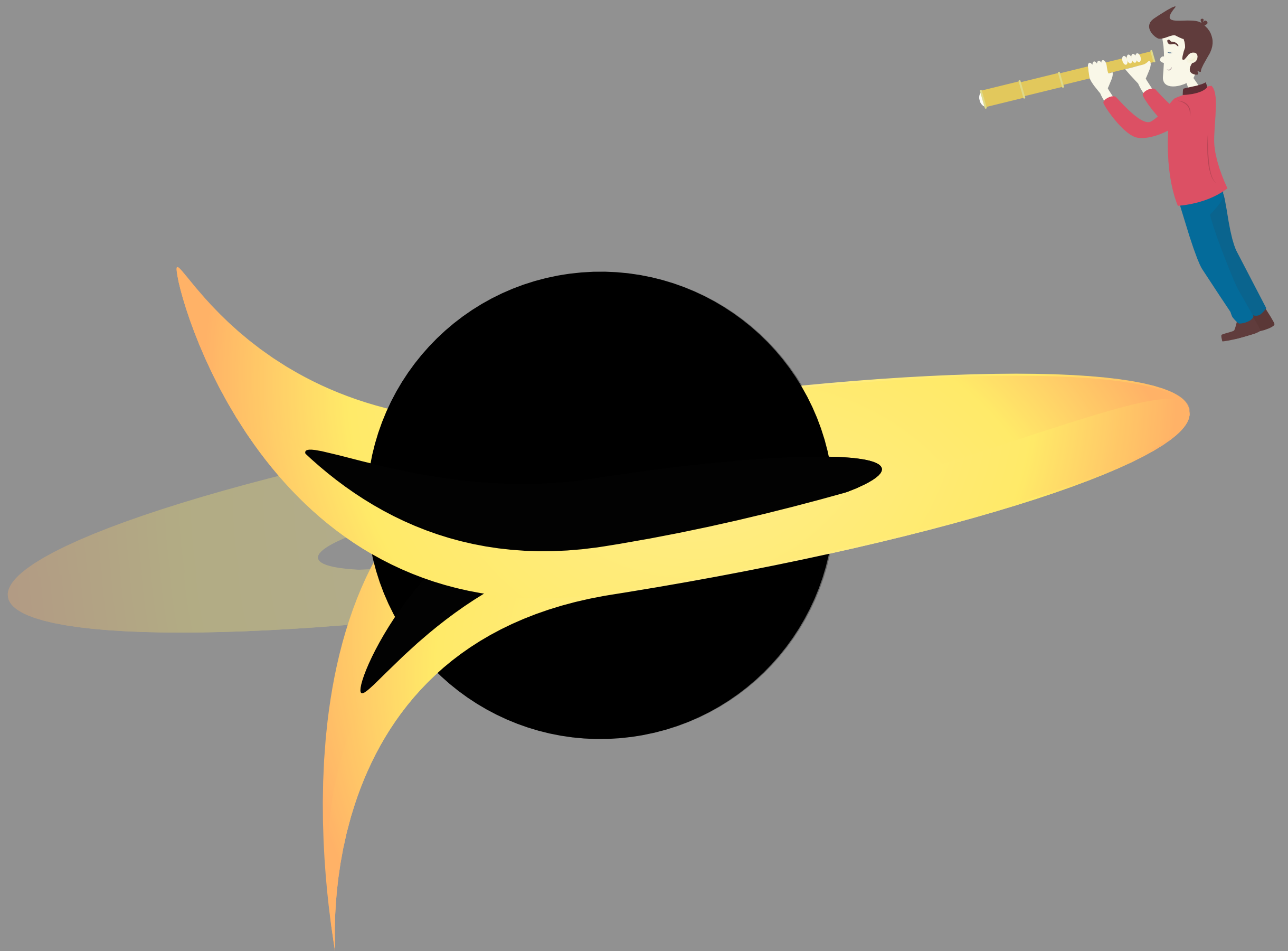
















INTERSTELLAR

Black Holes

How do we find them?



QUASAR

3C 273

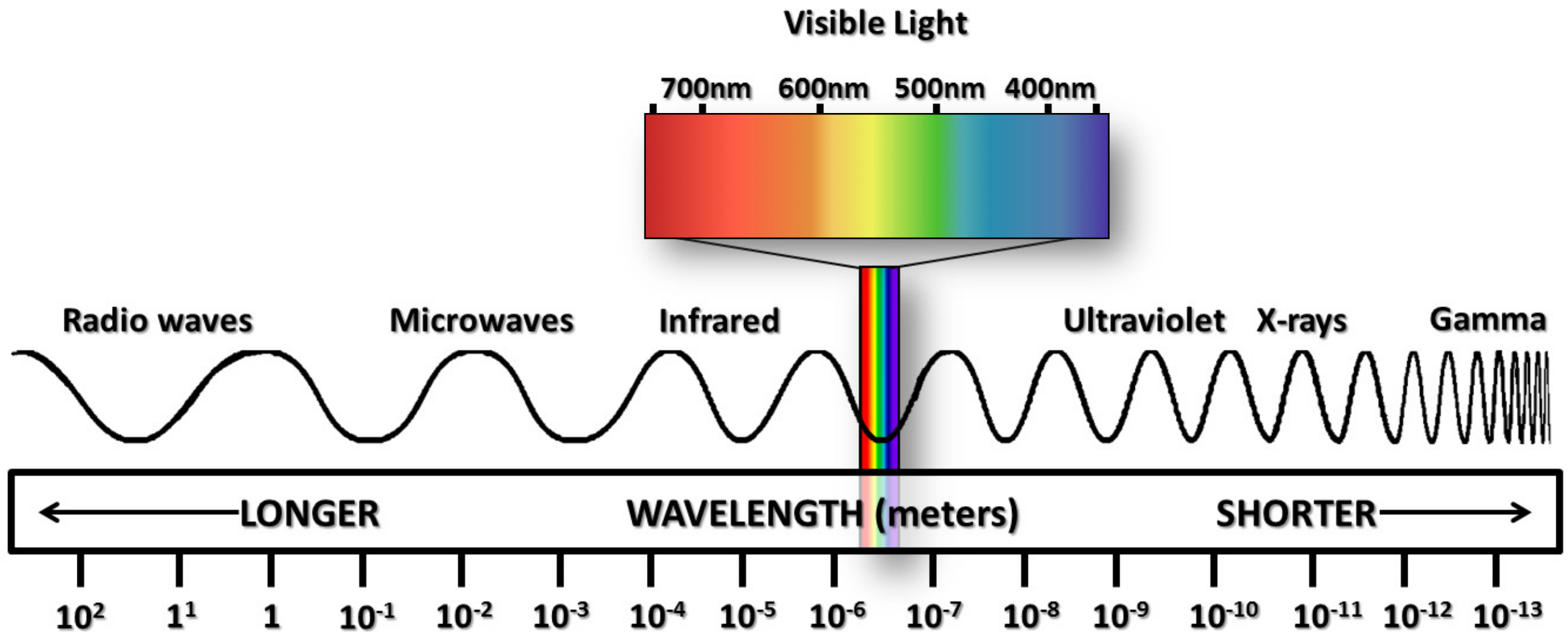
**4 TRILLION
TIMES BRIGHTER
THAN THE SUN!**

- 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 20,000,000,000,000,000,000,000 kilometres away)

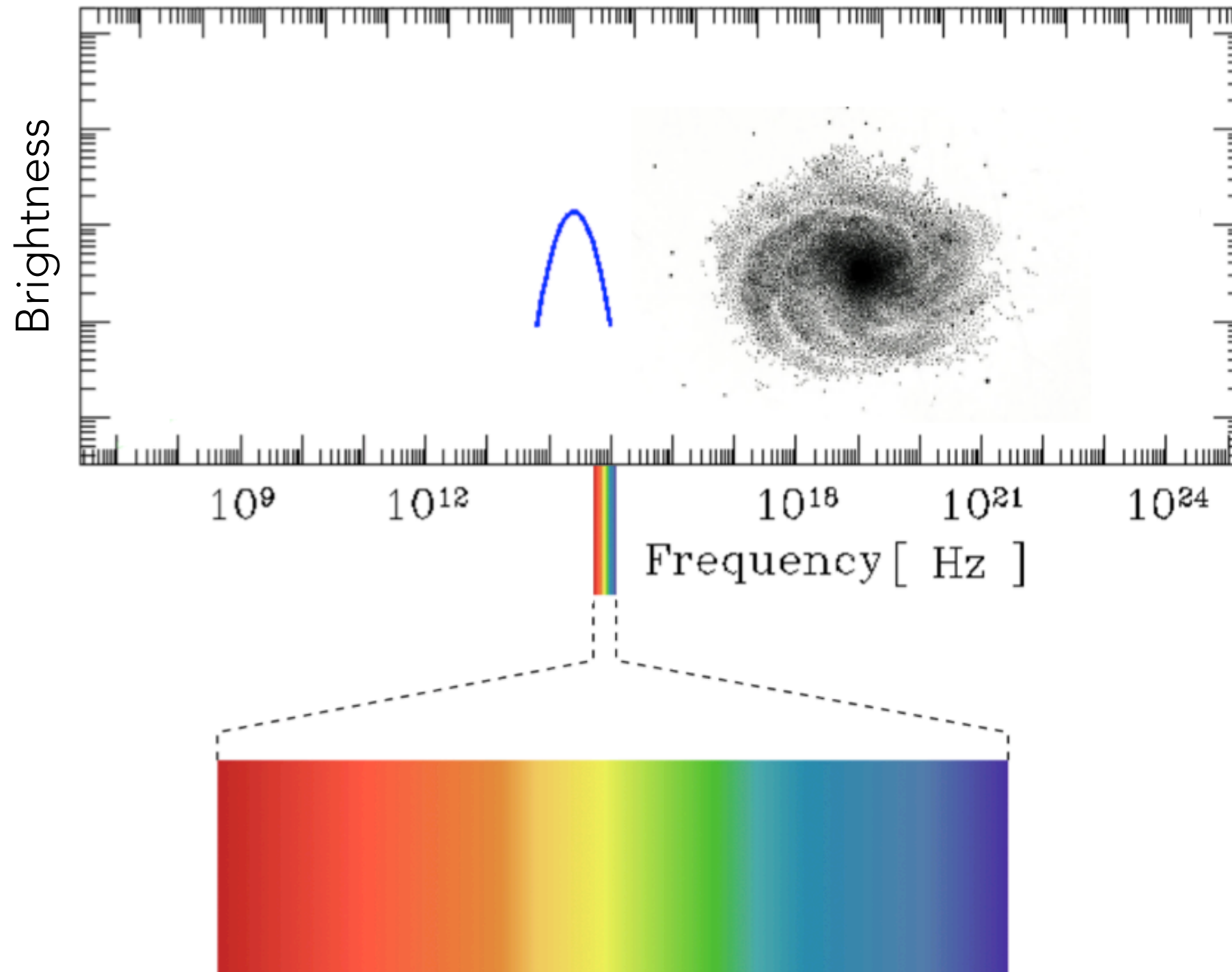
How Bright is it?



ELECTROMAGNETIC SPECTRUM

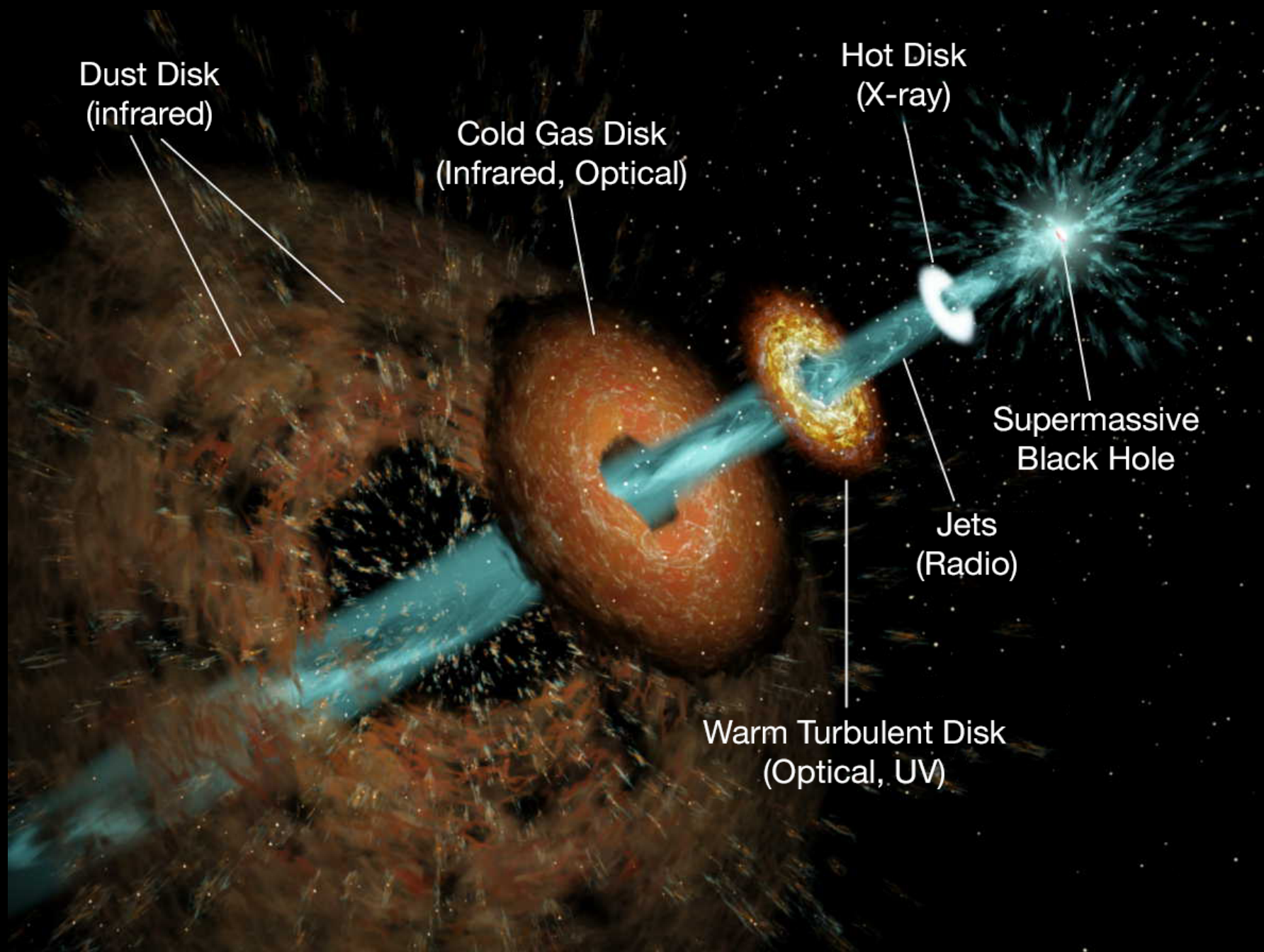


QUASAR 3C 273 SPECTRUM



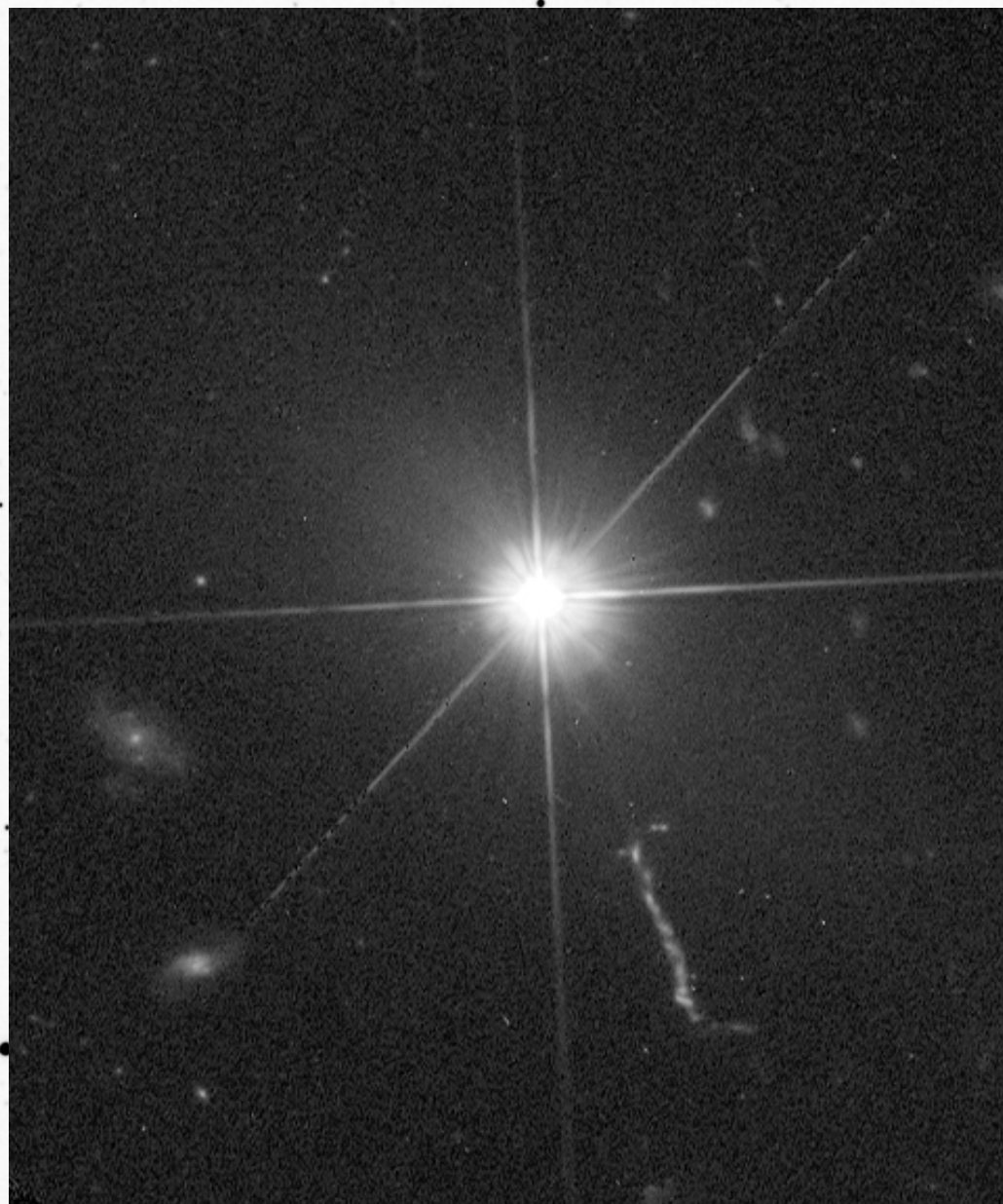
Black Holes

Where does the light come from?

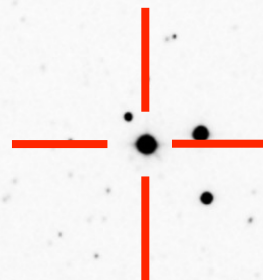


- Gravity causes material to spiral inward towards the black hole
- Frictional forces compress and raise the temperature of the material causing the emission of light ranging from X-rays to infrared
- Particles accelerated to speeds approaching that of light and emerge from the poles as radio jets

QUASAR 3C 273

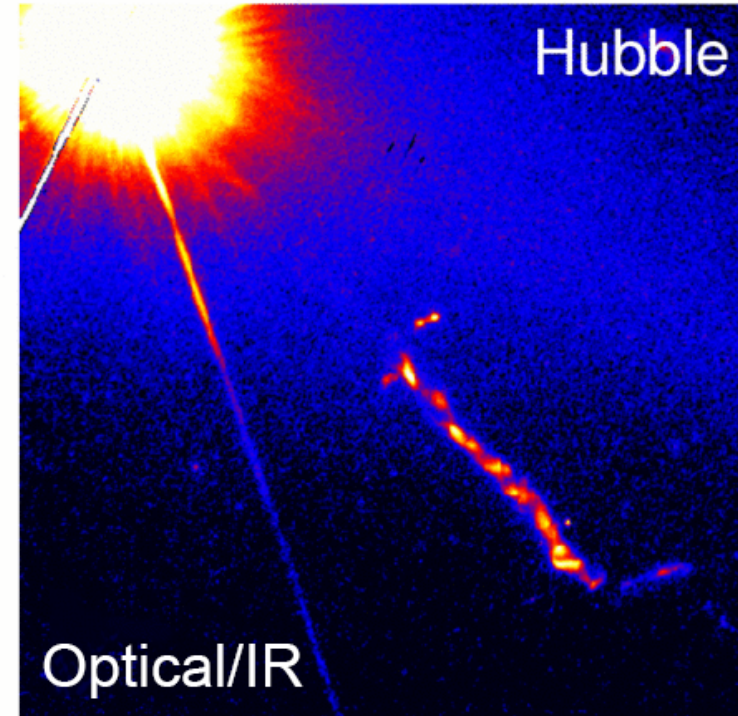
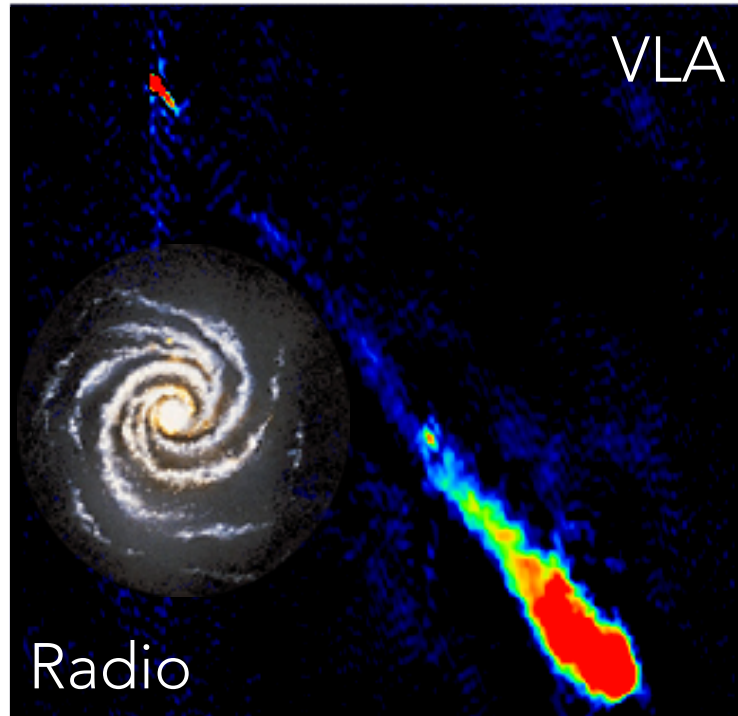


3C 348 in the constellation Hercules



QUASAR 3C 273 RADIO JET

~2 x longer than
distance across
Milky Way



I USE THESE BAD BOYS...

Hubble

**25
Years!**

**12
Years!**

Spitzer

Magellan

Chandra

Herschel

VLA

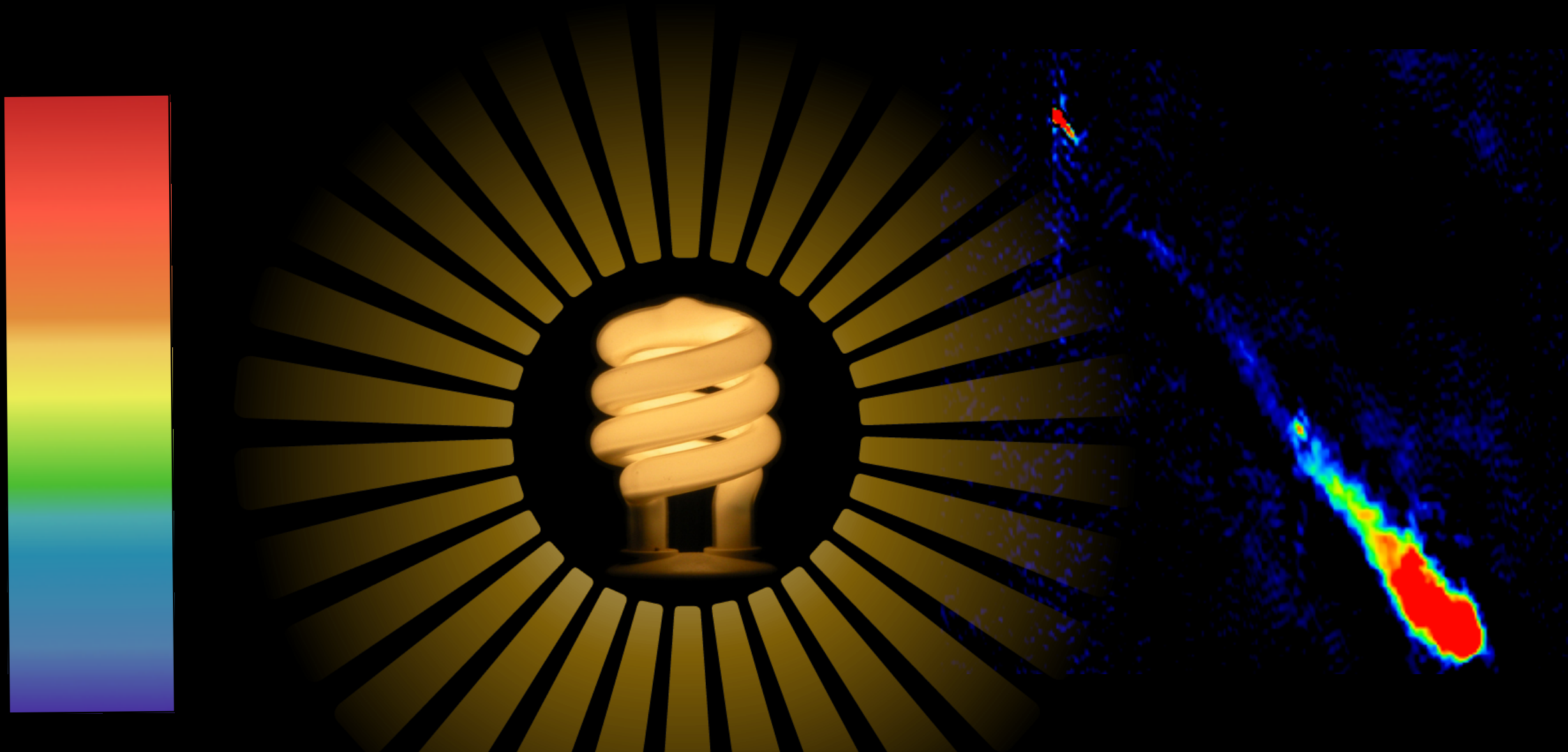
SPITZER CALENDAR



<http://goo.gl/n7lvD6>

**QR CODE
SCAN ME!**

CAN BLACK HOLES SHINE?



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

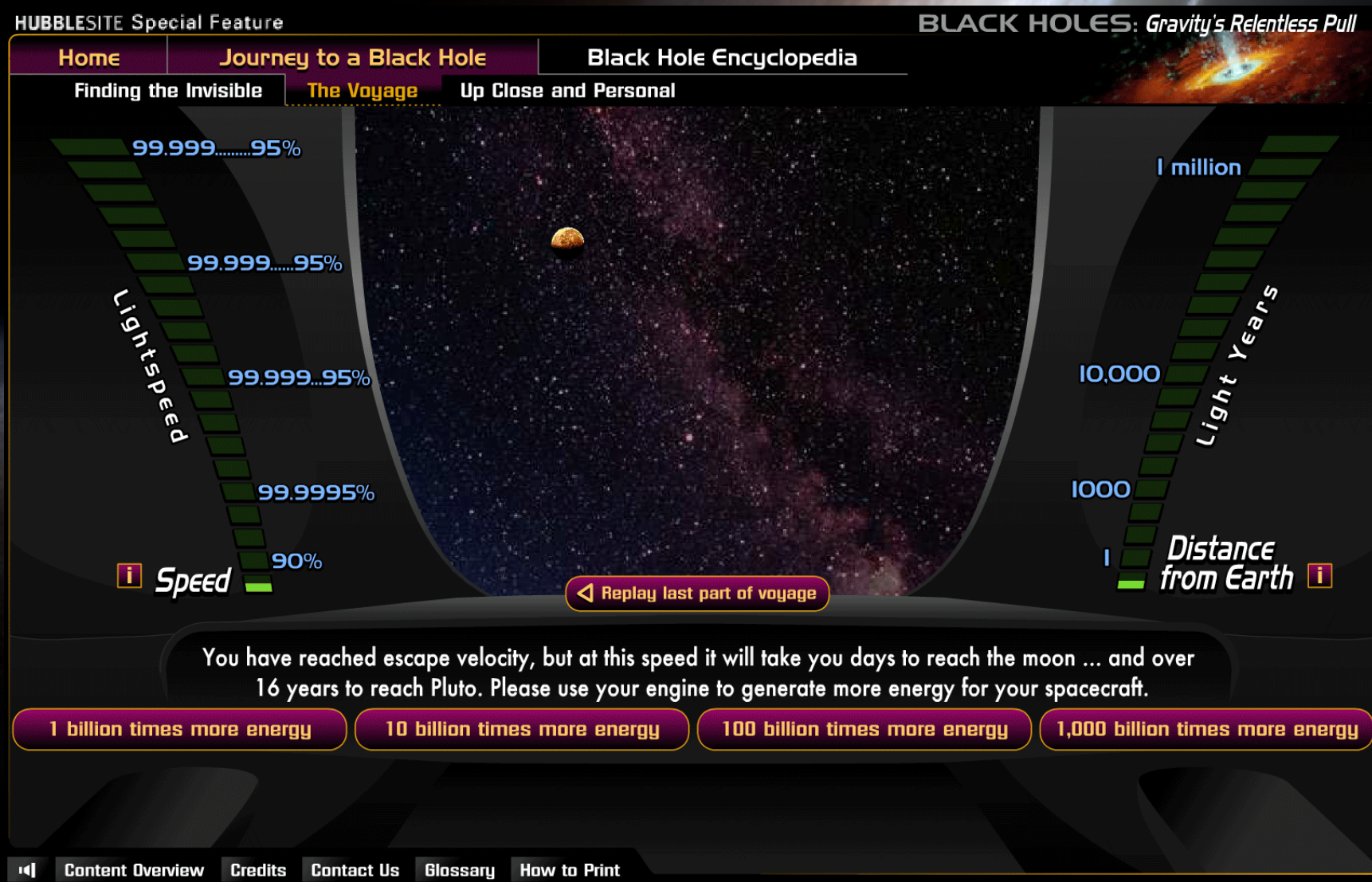


THANK YOU!

Want to learn more?

QR CODE
SCAN ME!

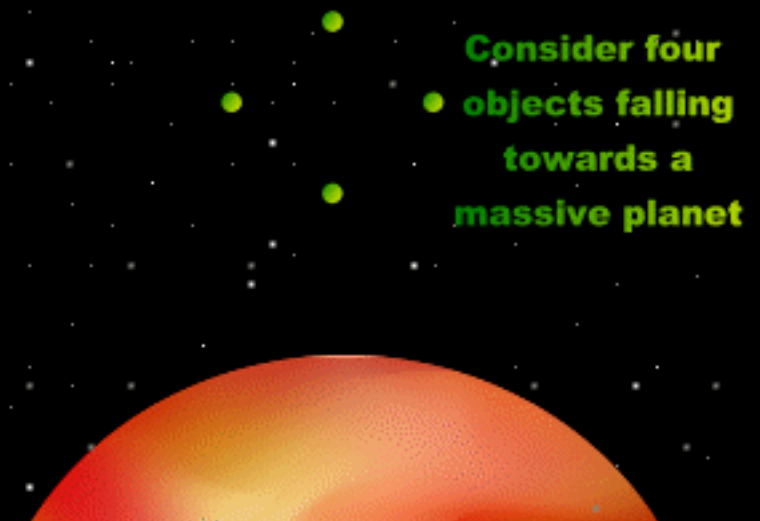
<http://hubblesite.org>



WHAT IS SPAGHETTIFICATION?



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,



BLACK HOLE