MACQUARIE UNIVERSITY ART GALLERY
LIGHT YEARS AHEAD EXHIBITION

CAN BLACK HOLES SHINE?

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11TH MAY 2016

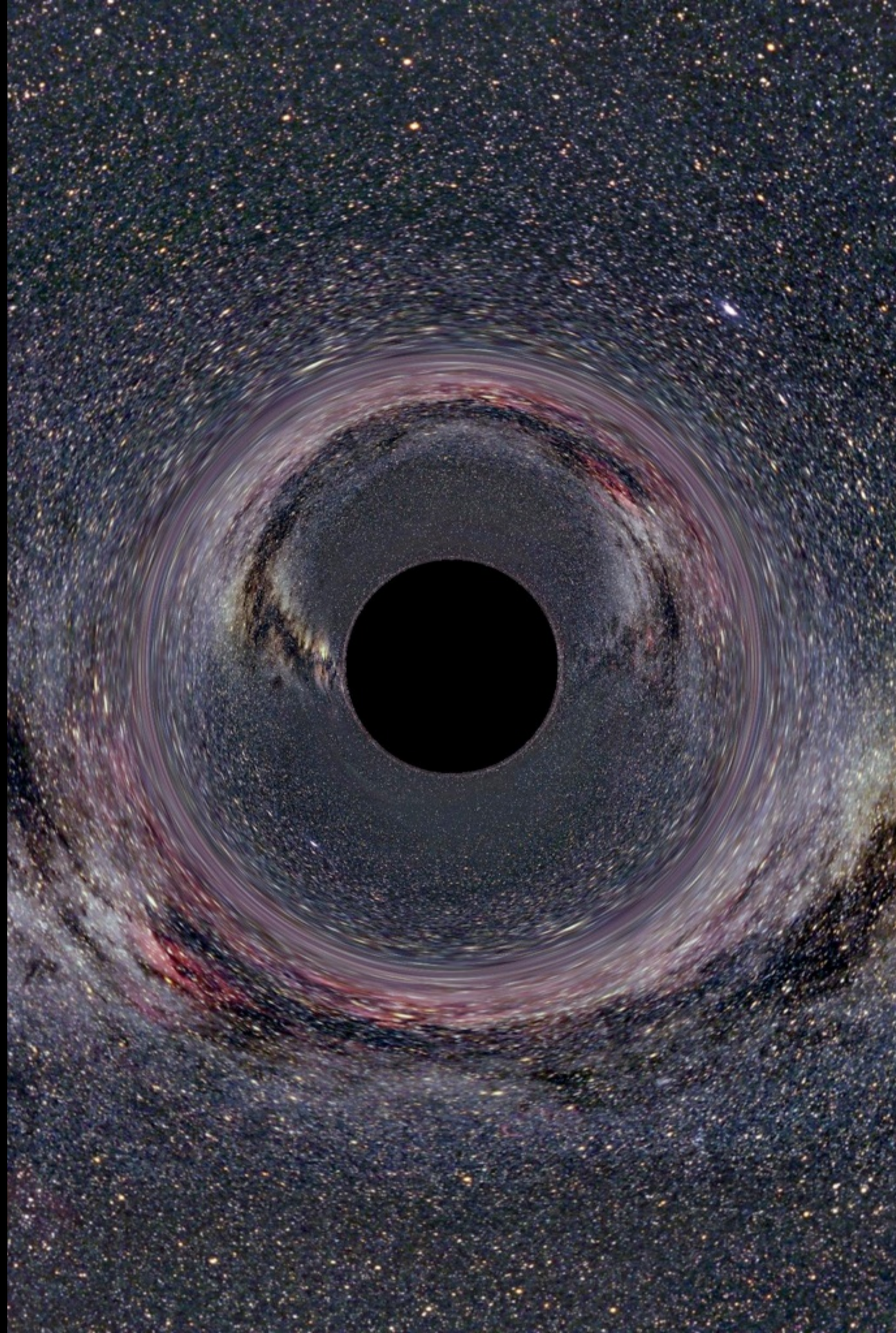
Australian Government
Department of Industry and Science

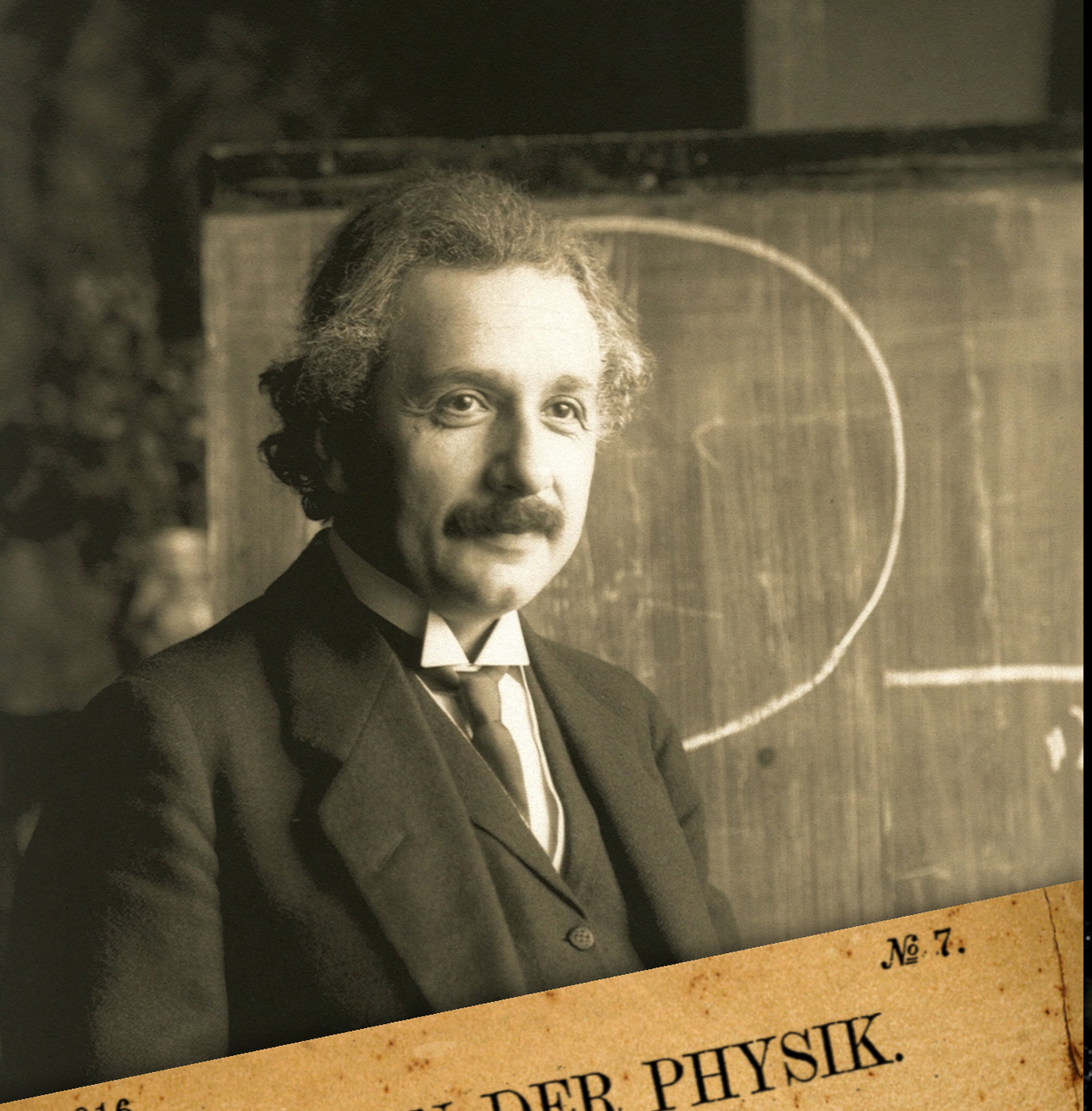
AAO

MACQUARIE University
SYDNEY·AUSTRALIA

TIMELINE OF BLACK HOLES

- 1916: Einstein's Theory of General Relativity
- 1919: Eddington's solar eclipse experiment
- 1967: Wheeler coins the term "black hole"
- 2002: The Milky Way's lurking monster
- Today: What do we know and how do we find them?





№ 7.

1916.

ANNALEN DER PHYSIK.

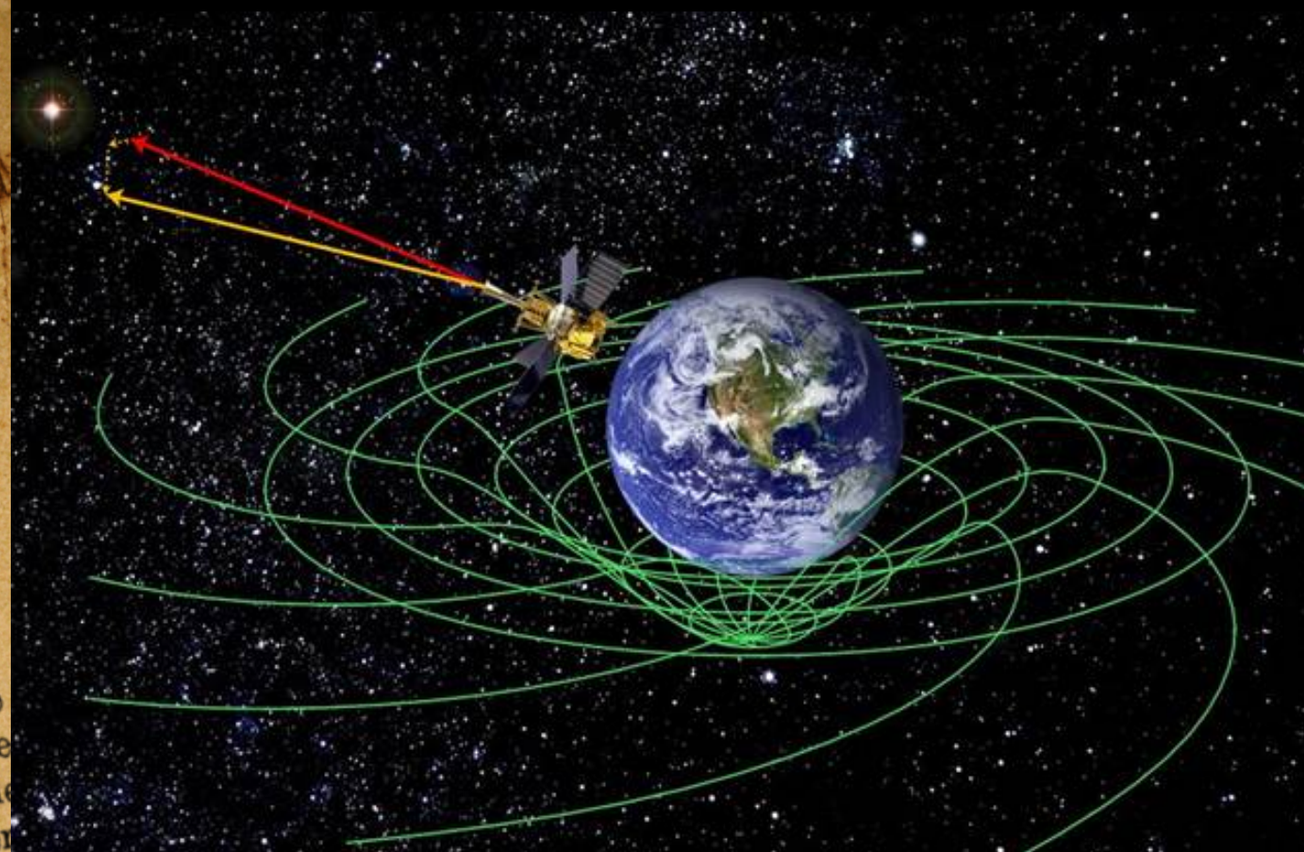
VIERTE FOLGE. BAND 49.

1. *Die Grundlage*
der allgemeinen Relativitätstheorie;
von A. Einstein.

Die im nachfolgenden dargelegte Theorie bildet die denk-
weitgehendste Verallgemeinerung der heute allgemein als
rie" bezeichneten Theorie; die letztere nenne
idung von der ersteren „spezielle
kannt voraus. Die

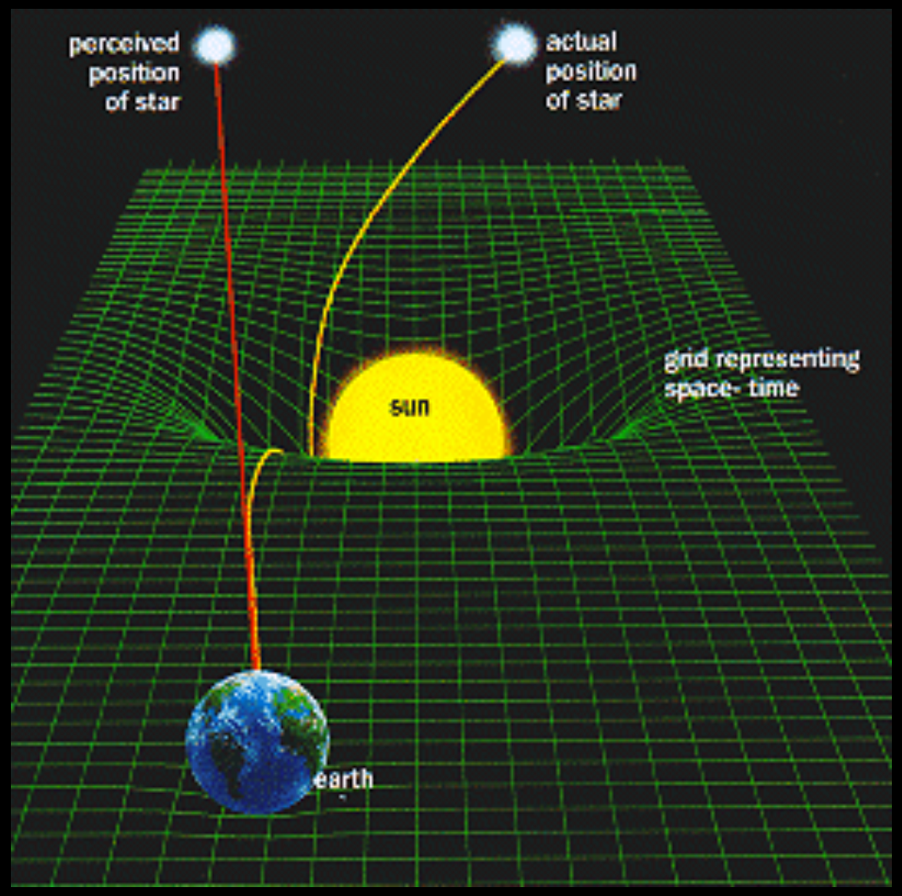
1916: Albert Einstein's General Relativity

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



- 1919: Eddington's solar eclipse experiment

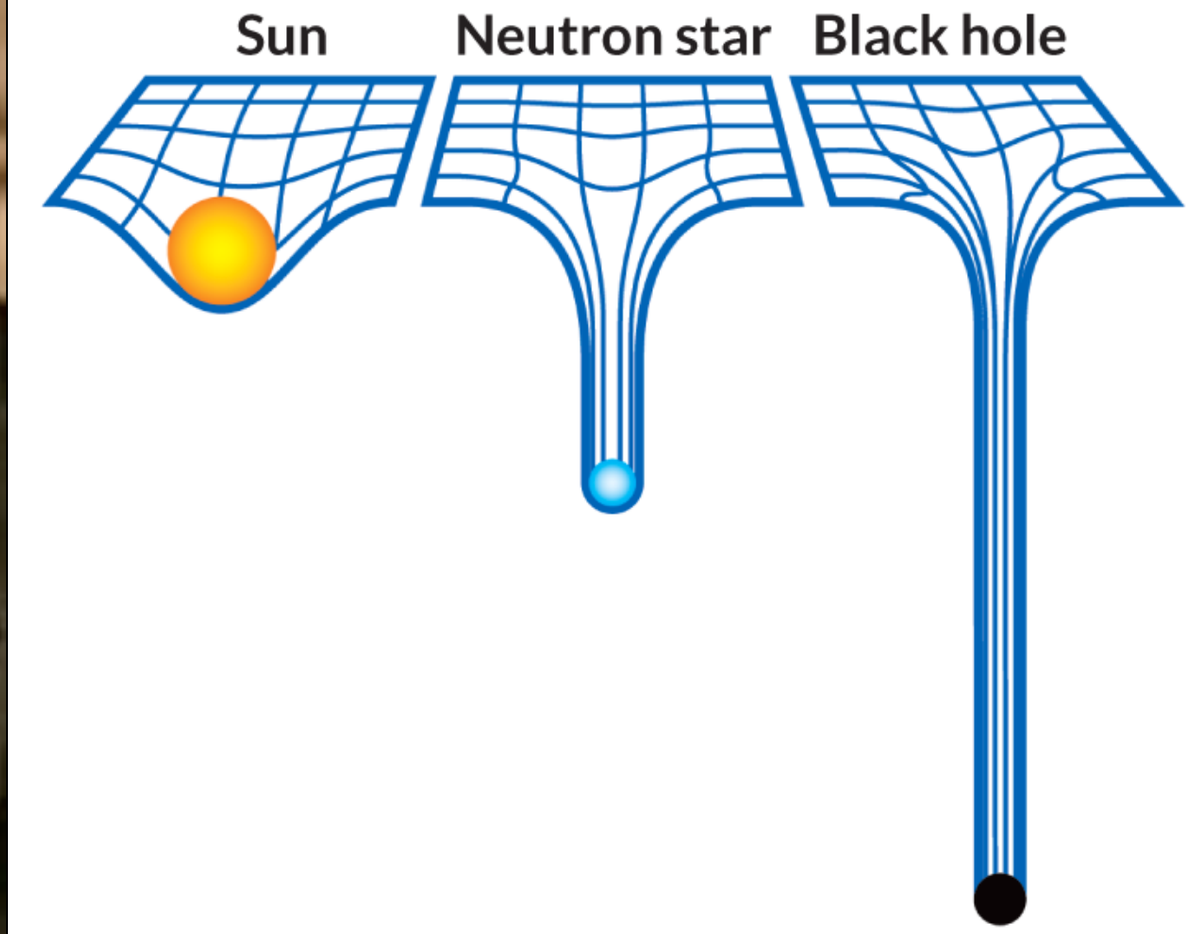
Eddington photographed positions of stars near the Sun to **test Einstein's prediction** of warped space around massive objects



AN UNIMAGINABLY DENSE REGION WHERE SPACE IS CURVED TO SUCH EXTREMES 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"

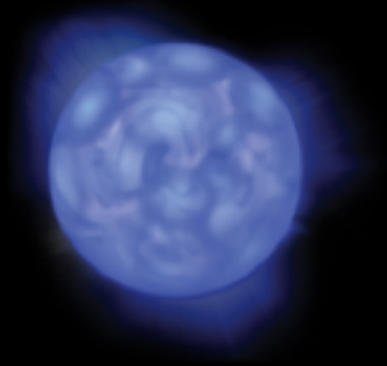


BIRTH OF A BLACK HOLE

LOW TO AVERAGE MASS STAR

WHITE DWARF

LARGE MASS STAR



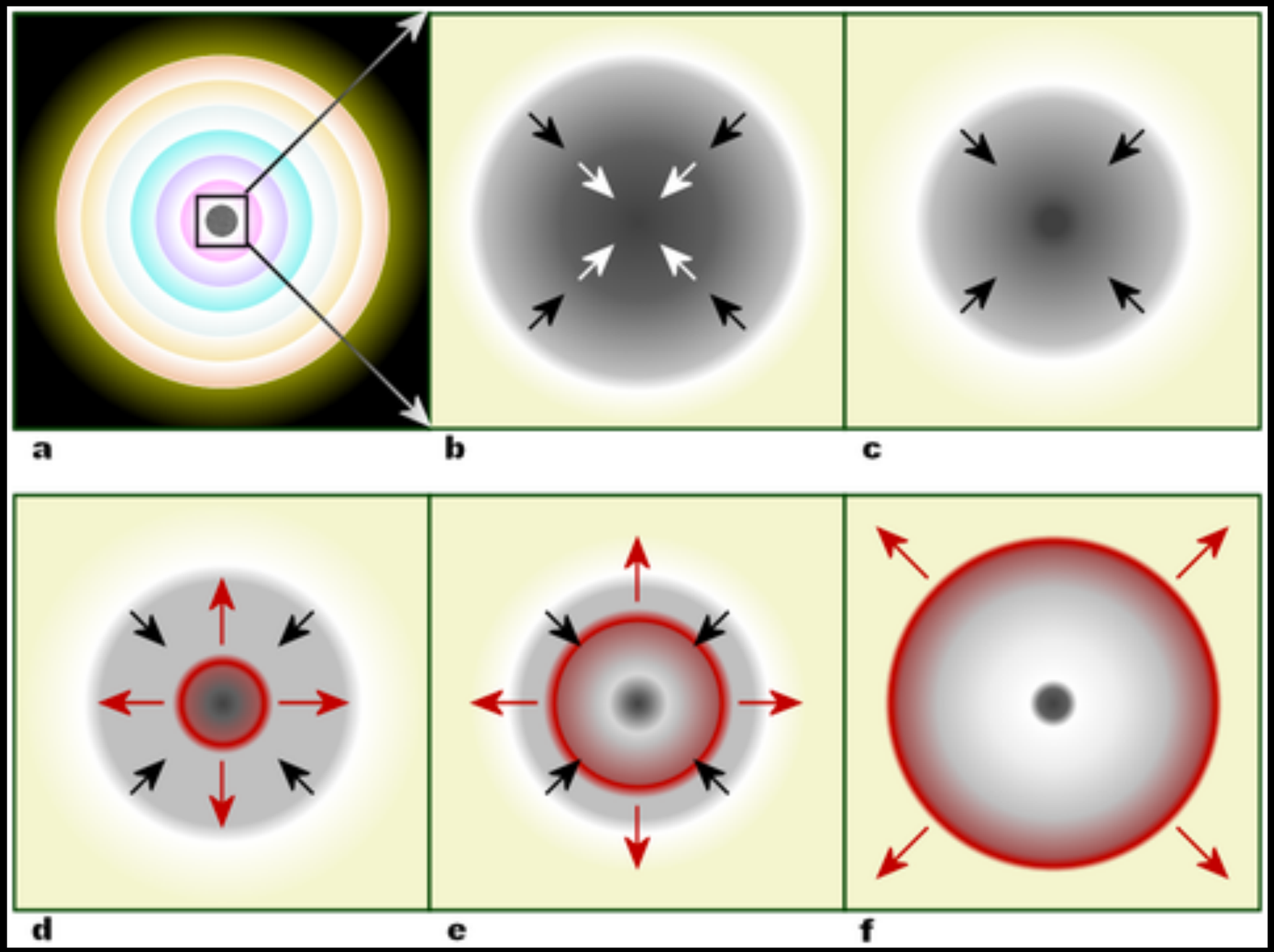
NEUTRON STAR

VERY LARGE MASS STAR

BLACK HOLE

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

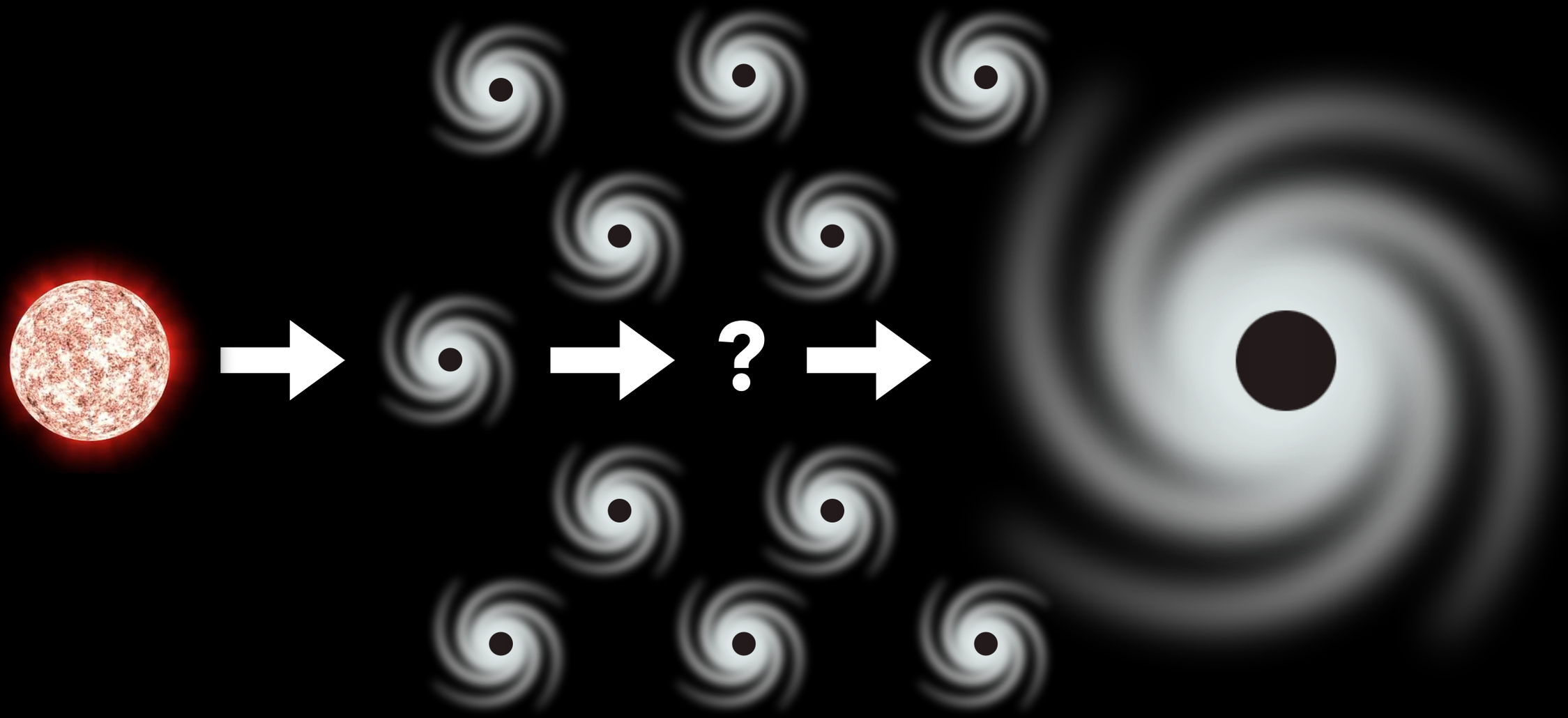
BIRTH OF A BLACK HOLE



BIRTH OF A BLACK HOLE

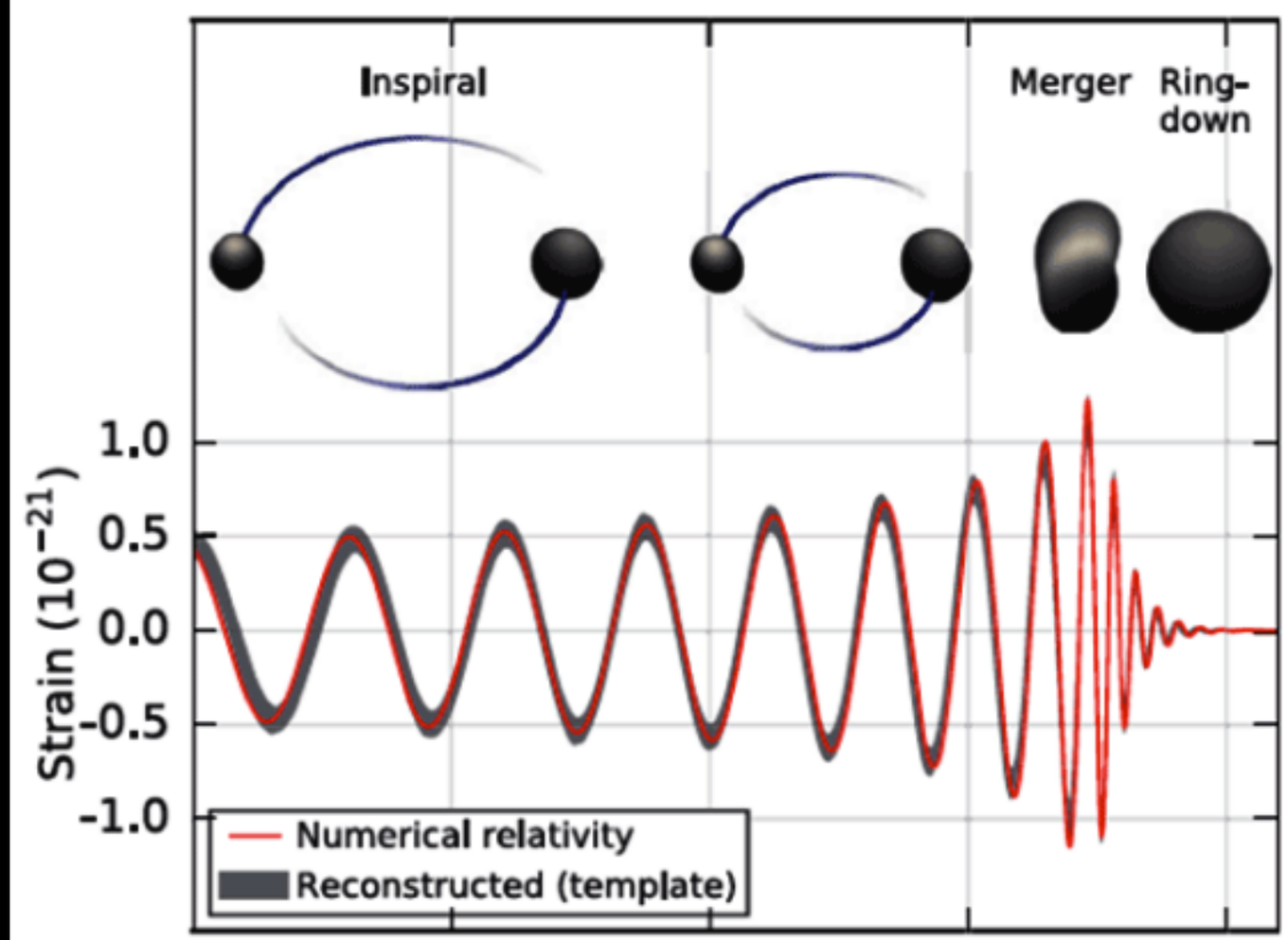
BLACK HOLE TYPES

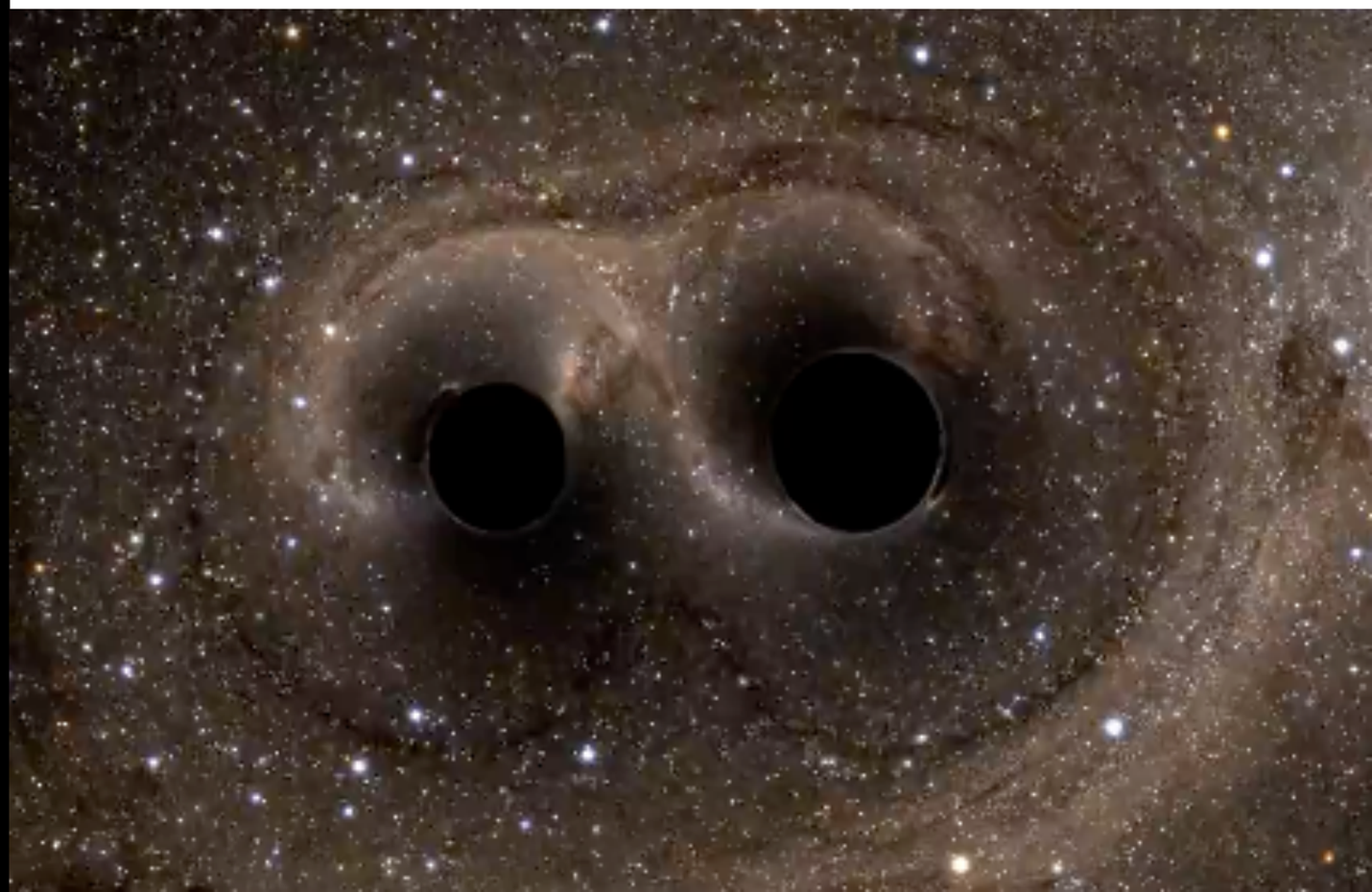
- Stellar-mass: black holes with 3 to 20 times the mass of our own Sun
- Supermassive: black holes with millions to billions of times the mass of our own Sun

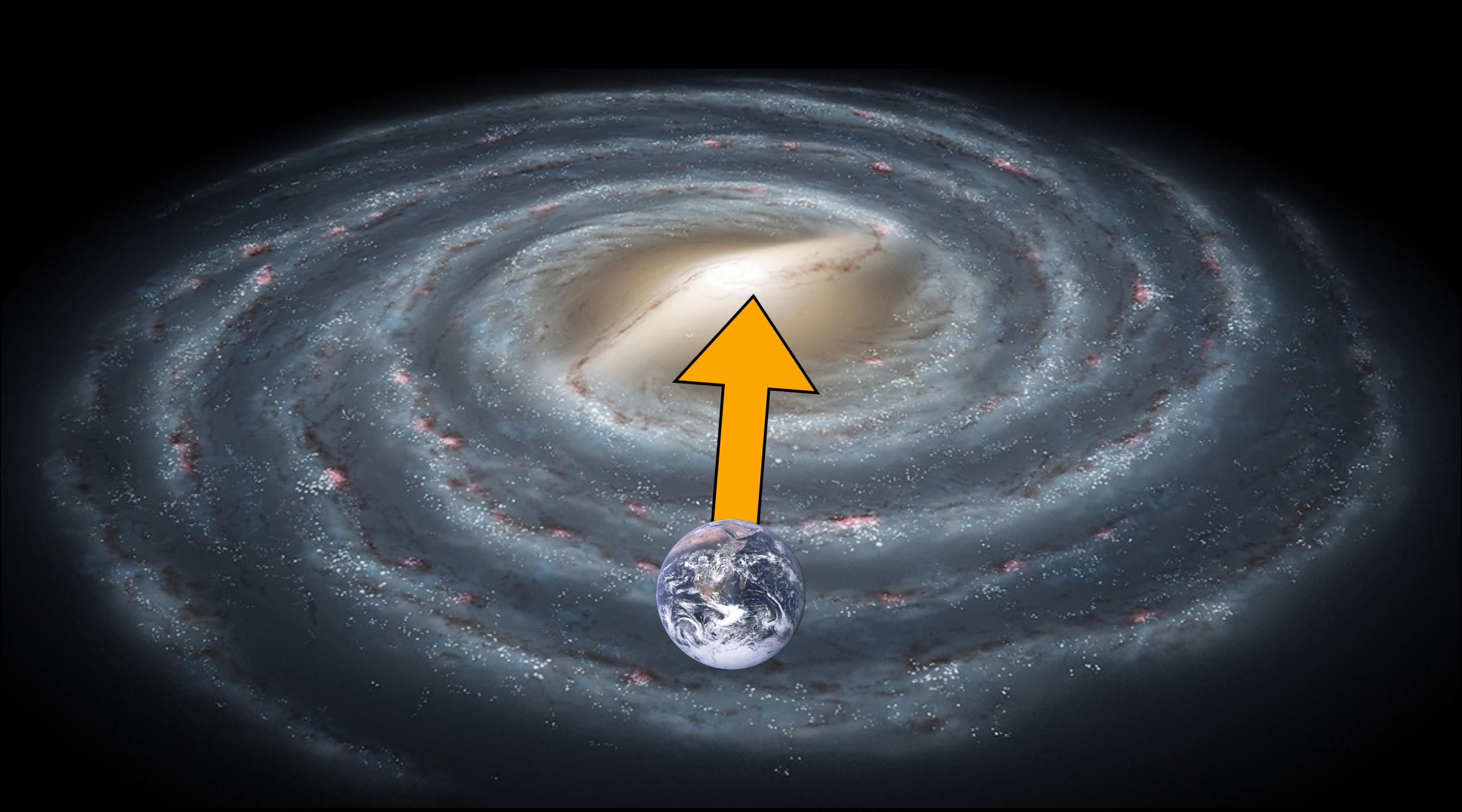


Gravitational Waves!

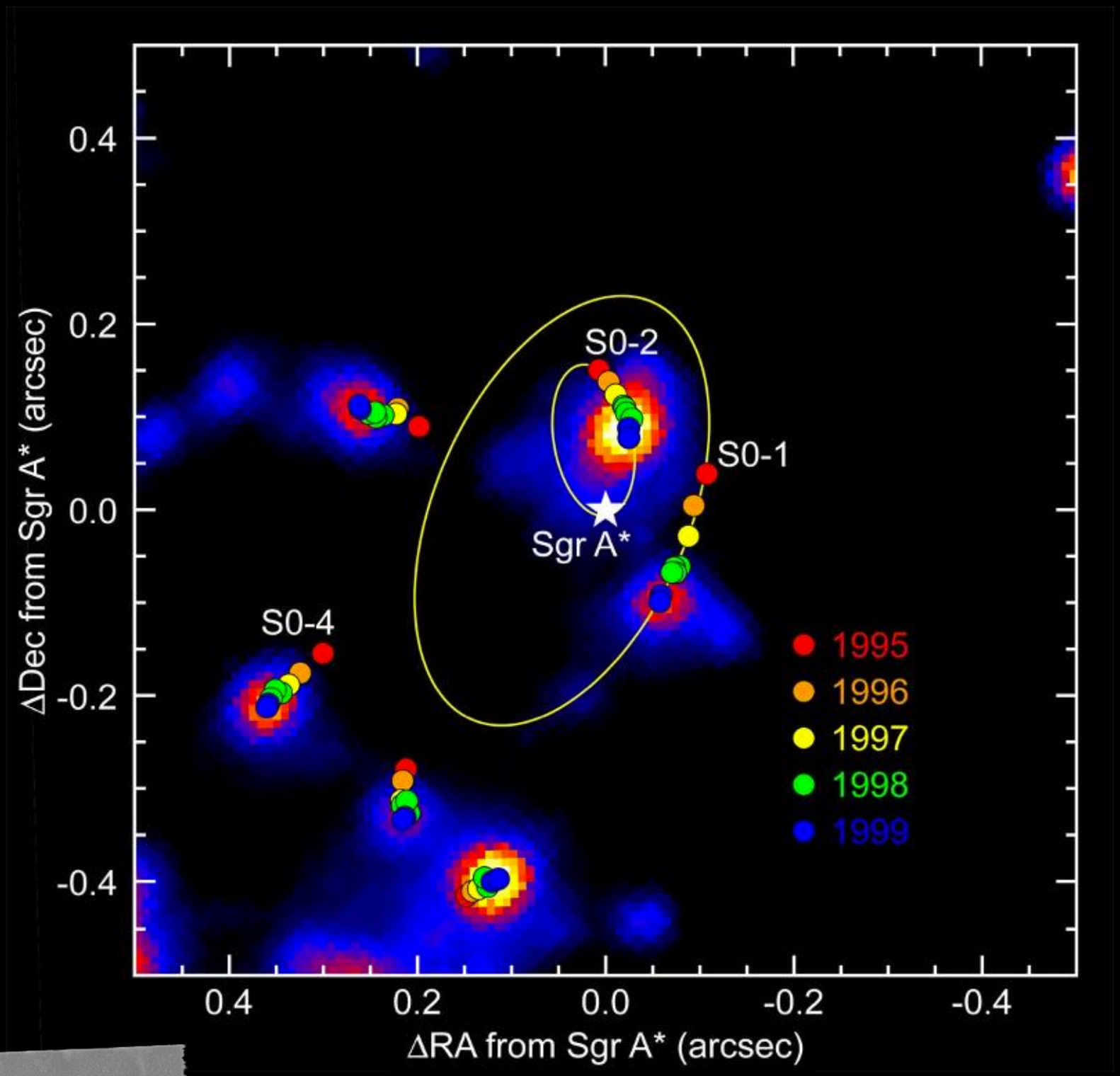
- Two massive black holes merging
- 36 and 28 times the mass of the Sun
- Estimated 1.3 billion light years away
- Combined mass of the final black hole is 62 solar masses
- 3 Suns worth of mass was lost in gravitational wave energy





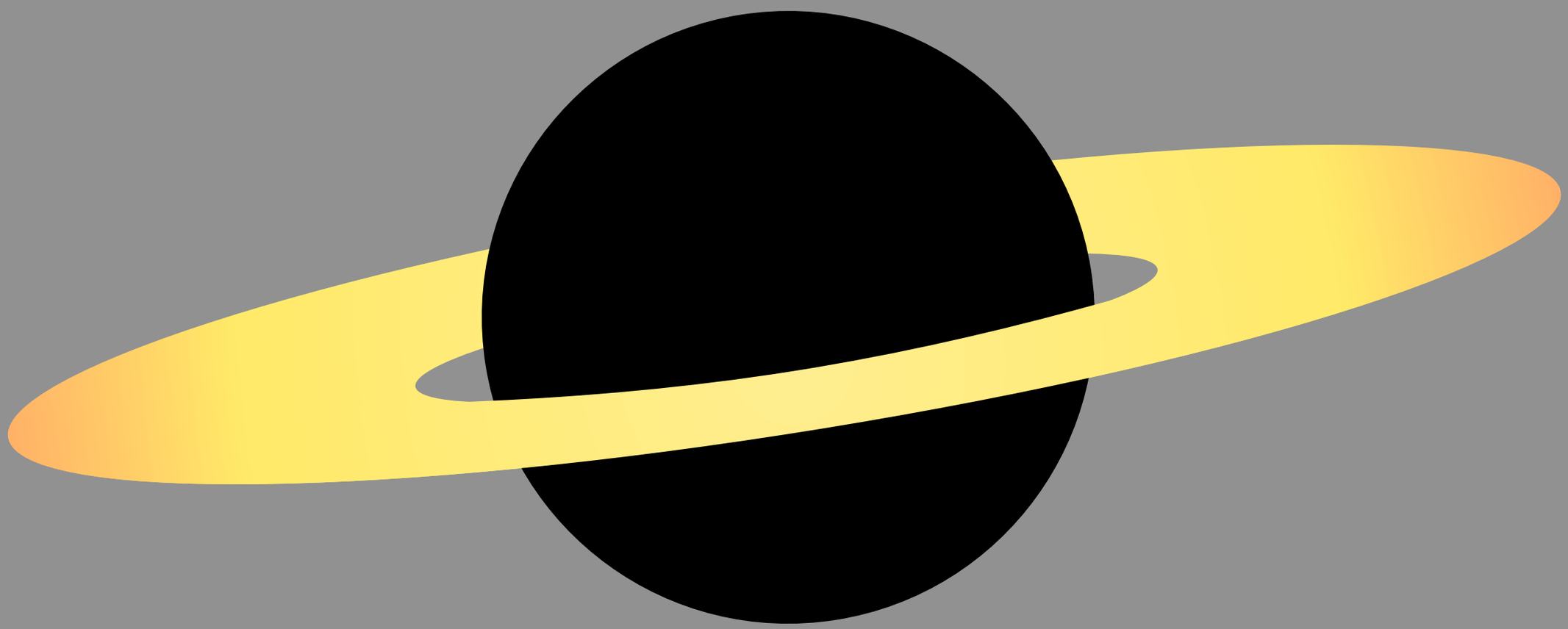


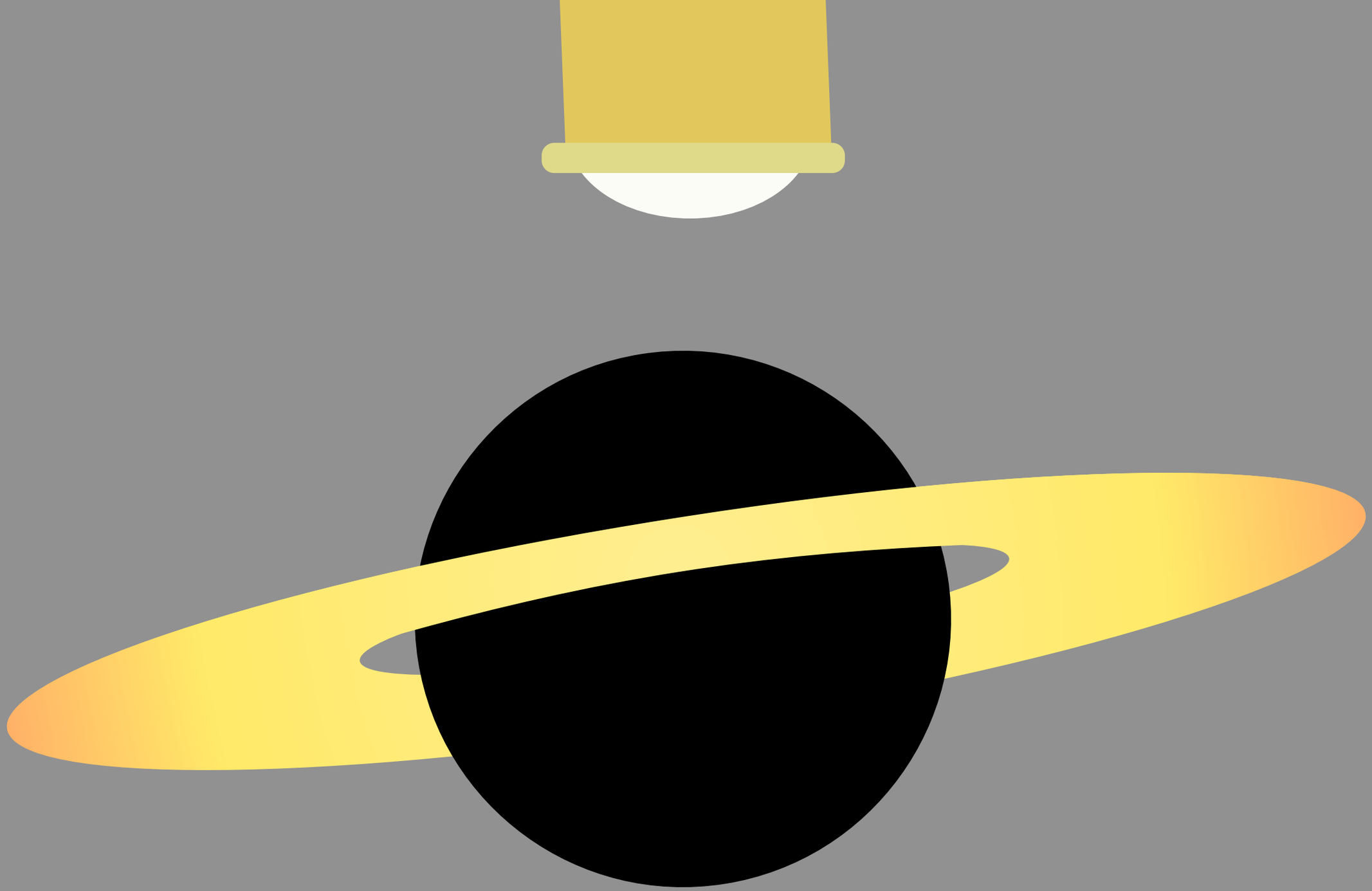
2002: The Milky Way's Lurking Monster

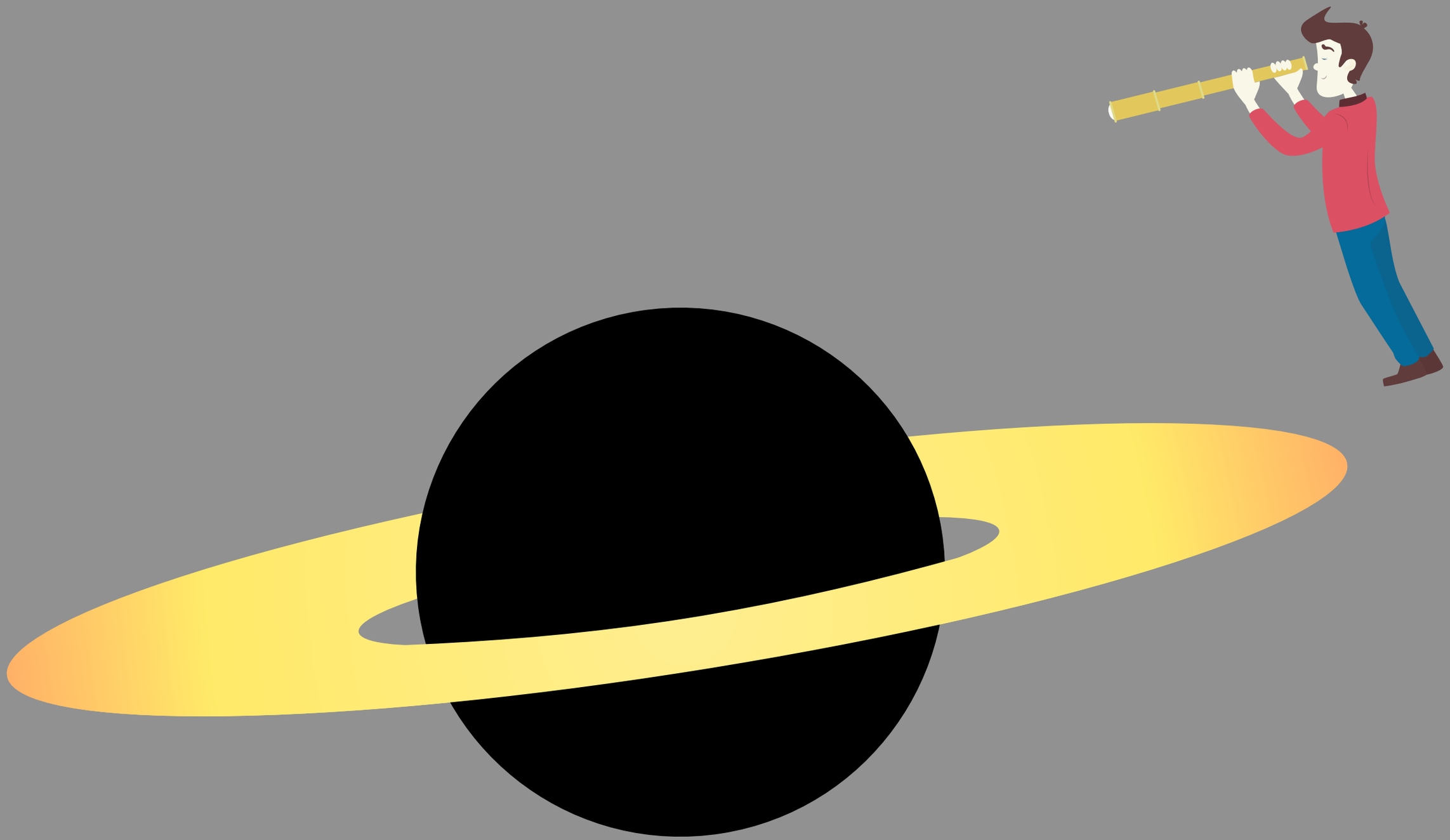


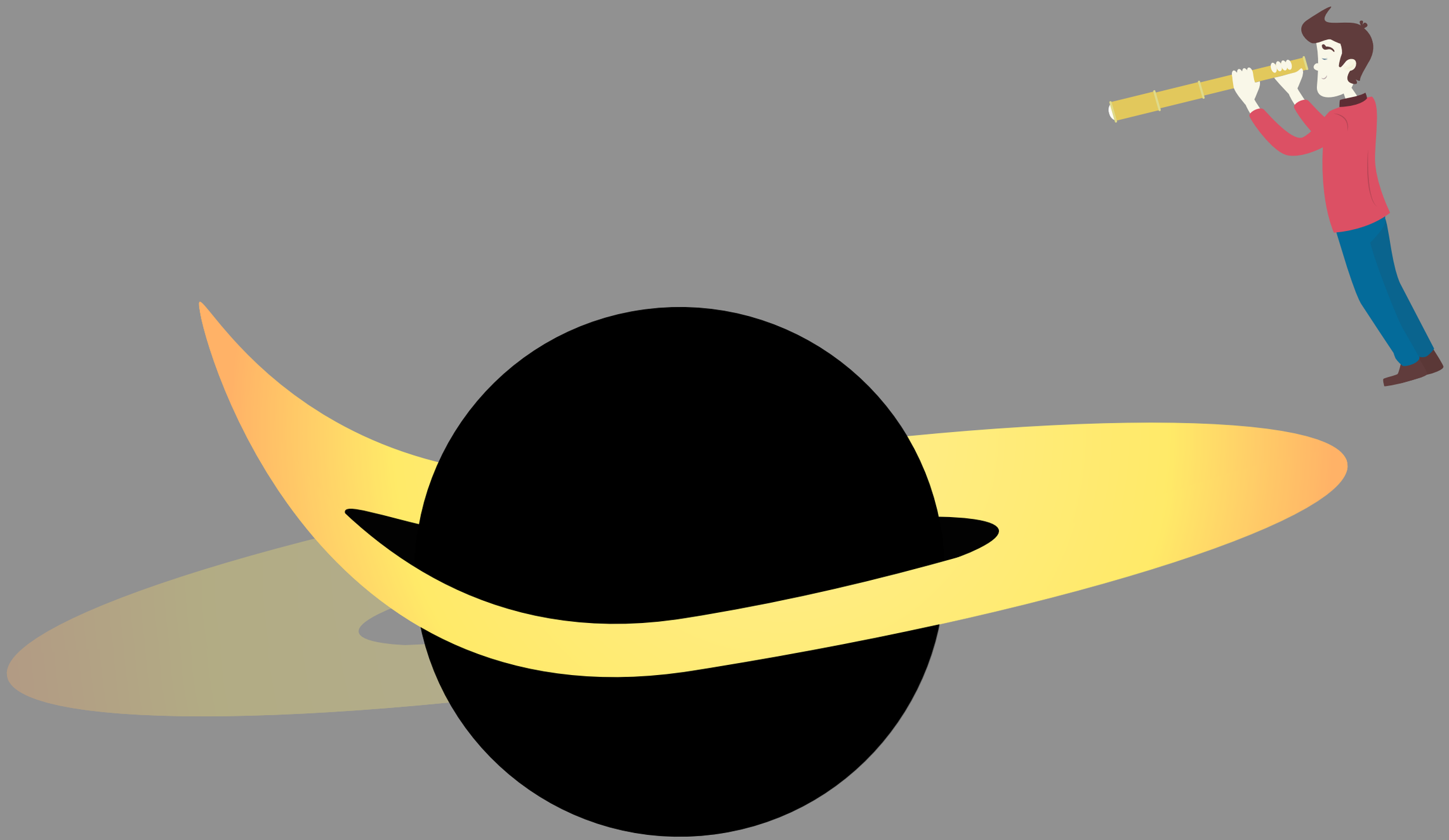
2002: The Milky Way's Lurking Monster

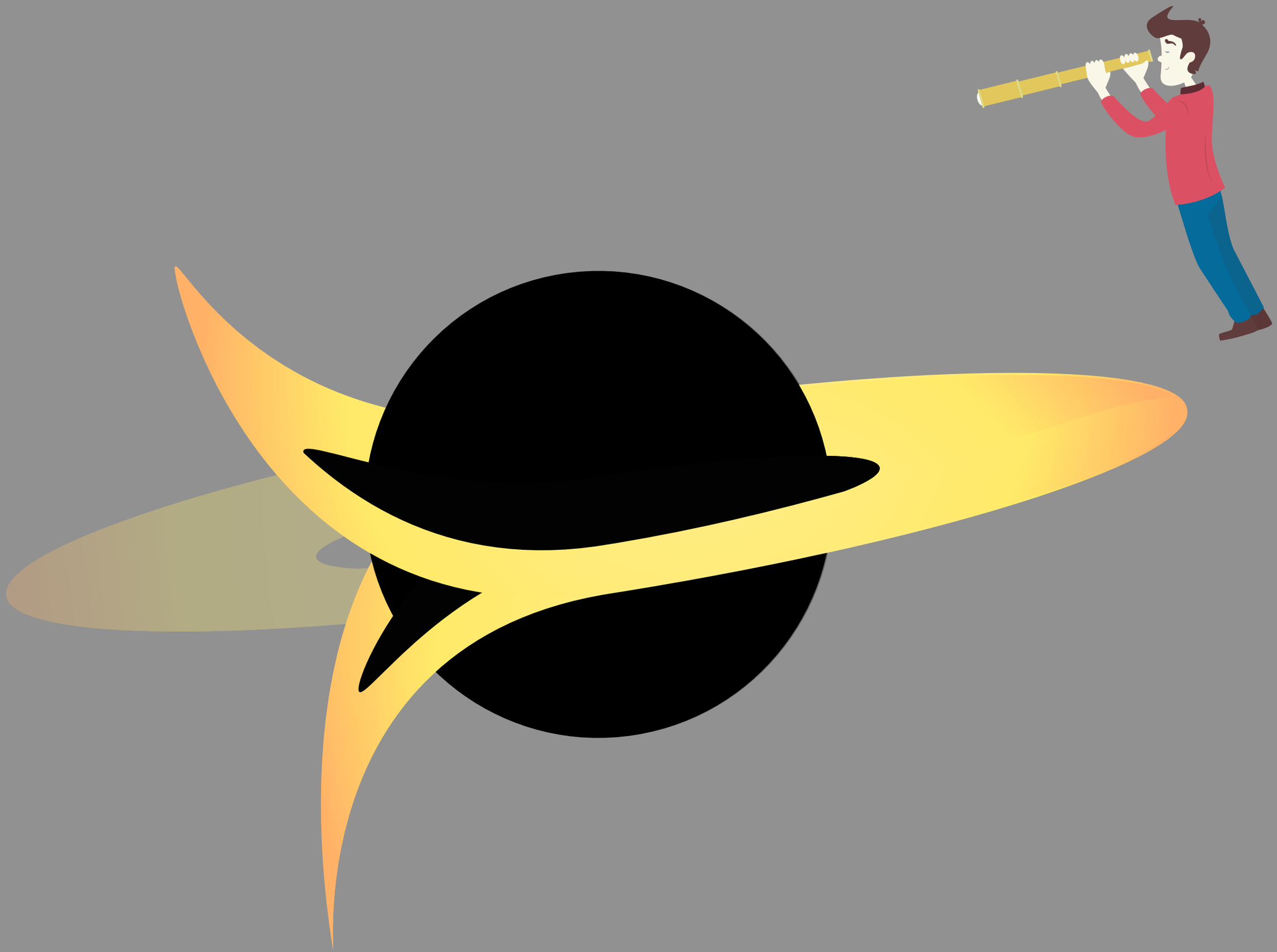

INTERSTELLAR
NASA







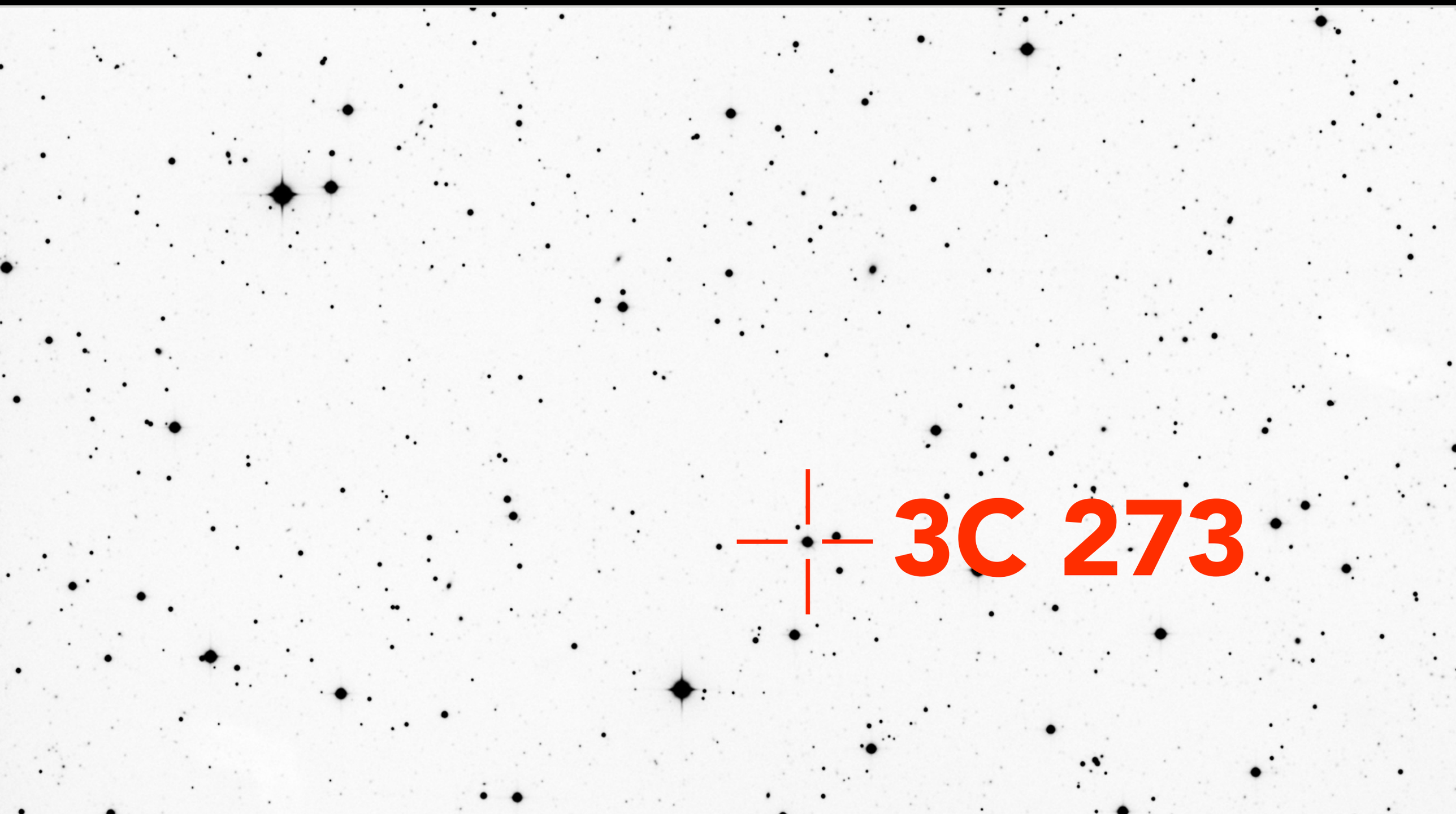





INTERSTELLAR
NASA

Black Holes

How do we find them?



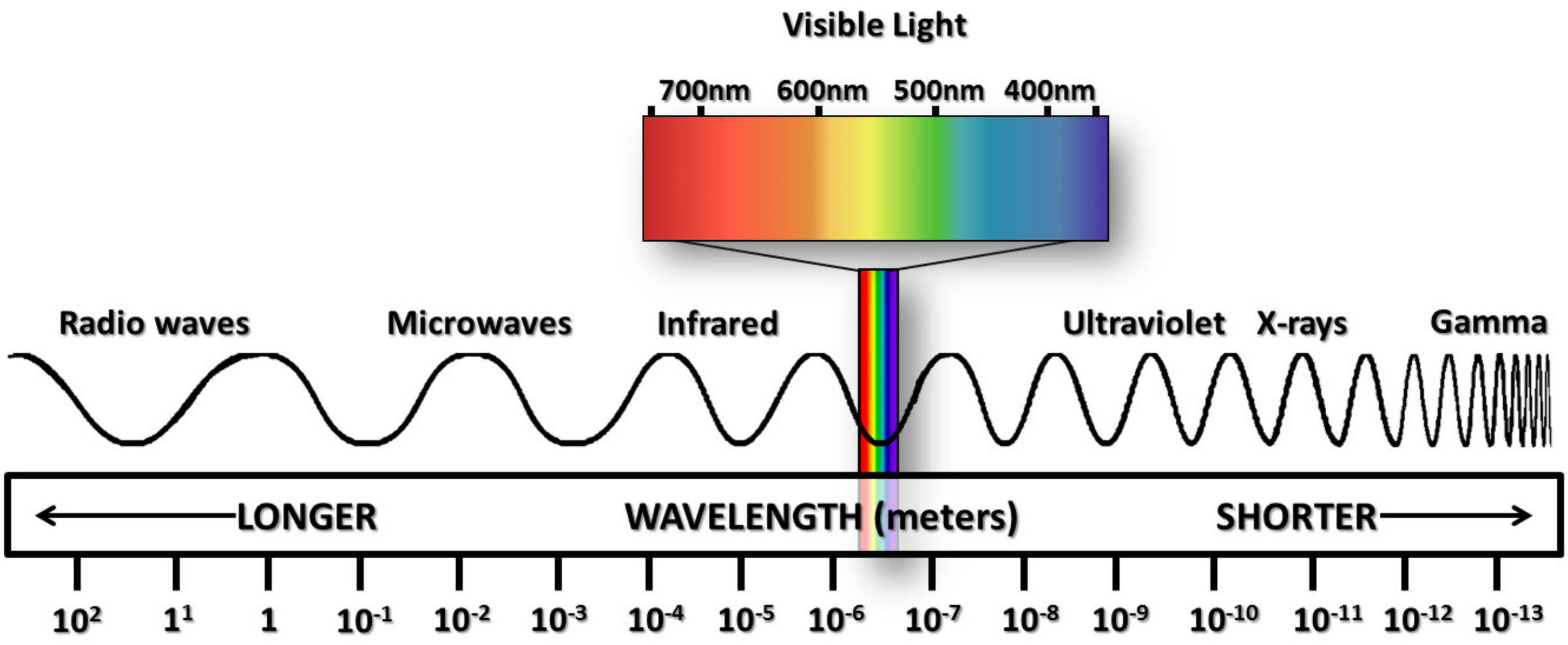
QUASAR 3C 273

- 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)

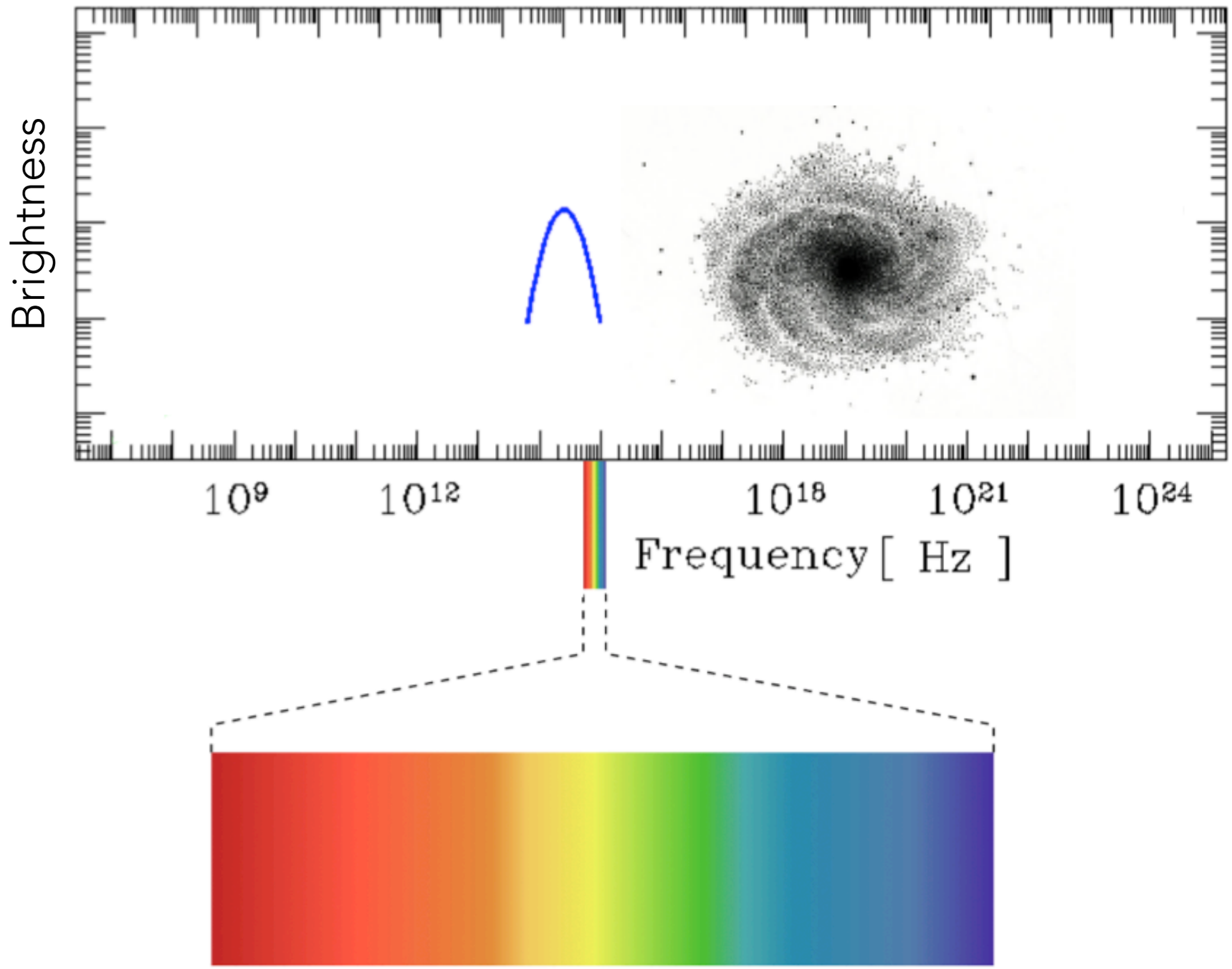
How Bright is it?

4 TRILLION TIMES BRIGHTER THAN THE SUN!

ELECTROMAGNETIC SPECTRUM

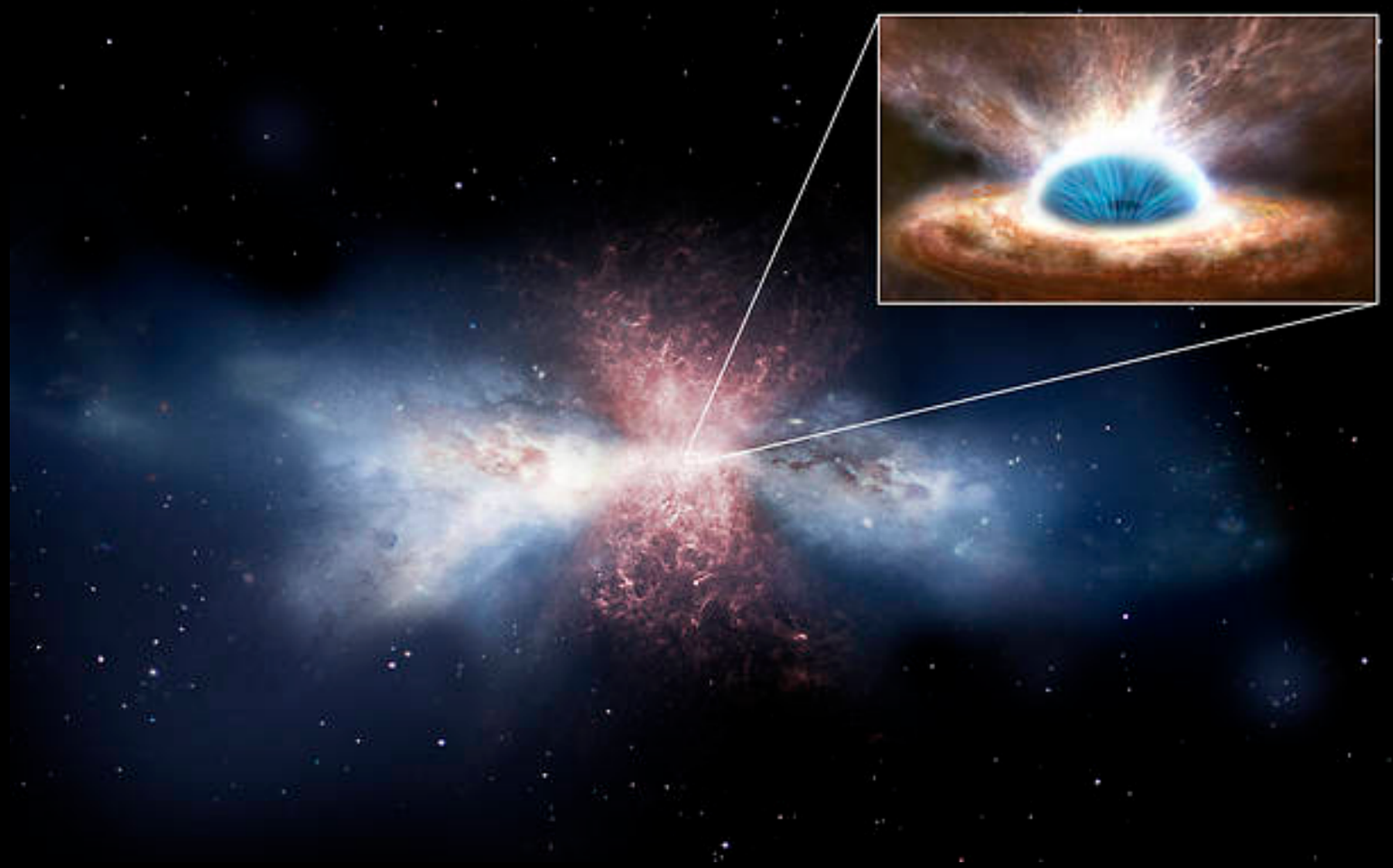


QUASAR 3C 273 SPECTRUM



Black Holes

Where does the light come from?

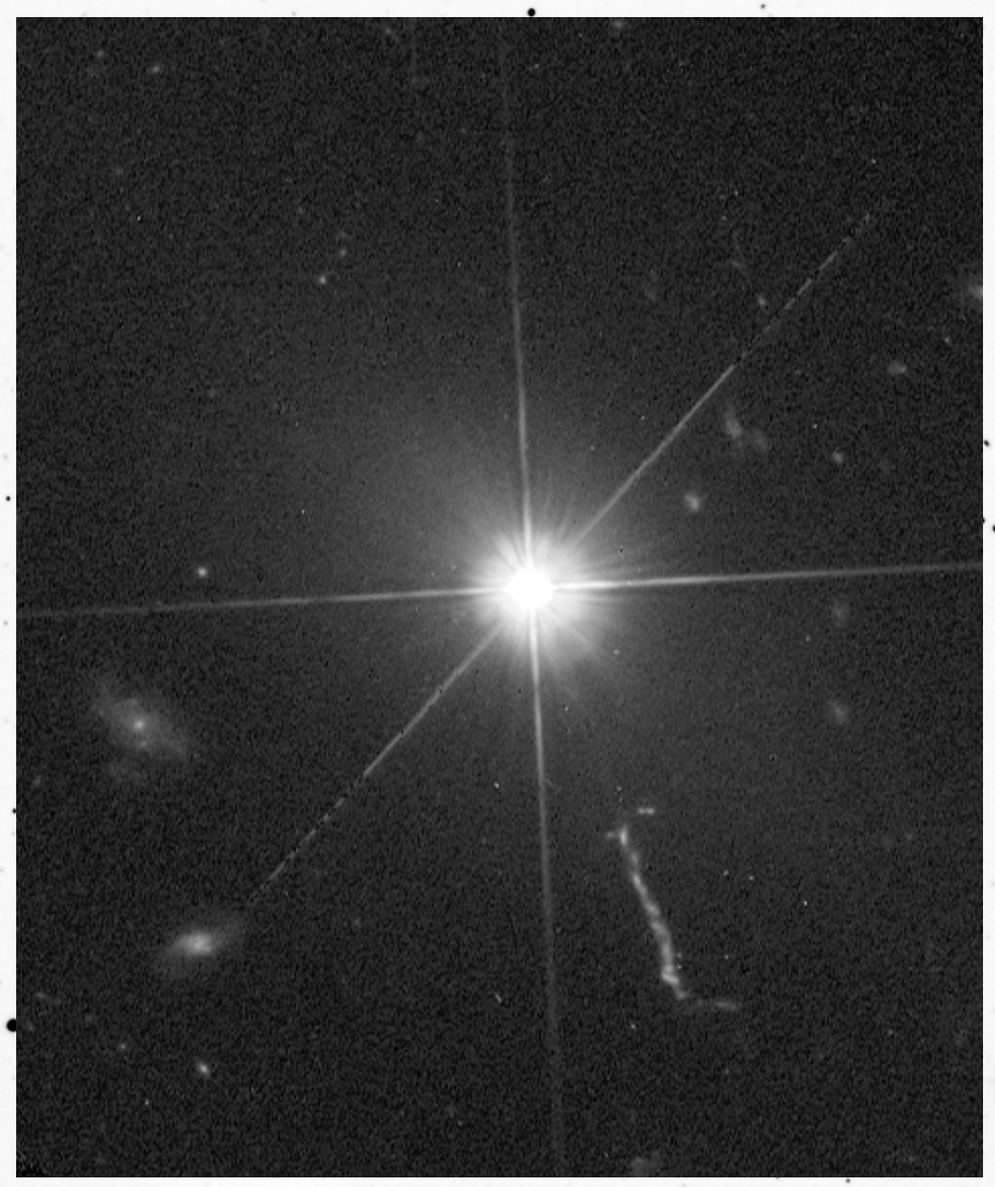


- Gravity causes material to spiral inward towards the black hole

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

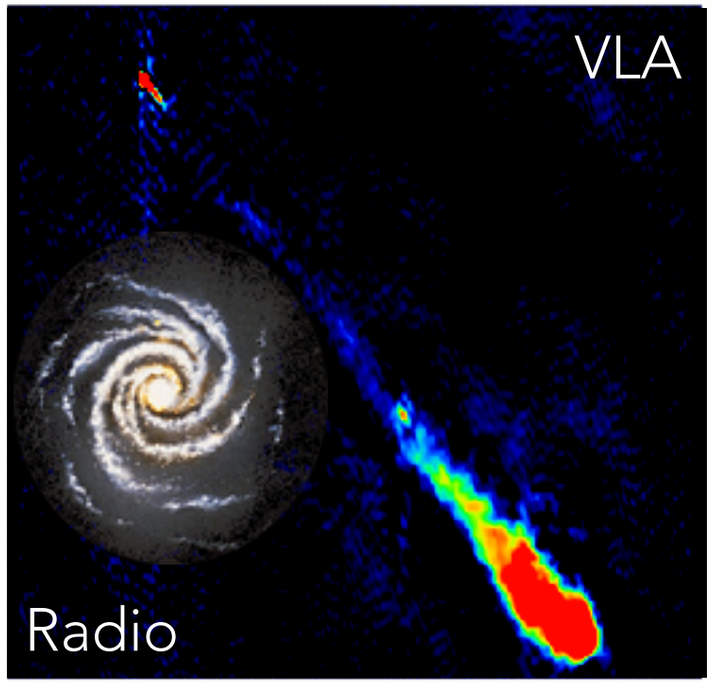
QUASAR 3C 273

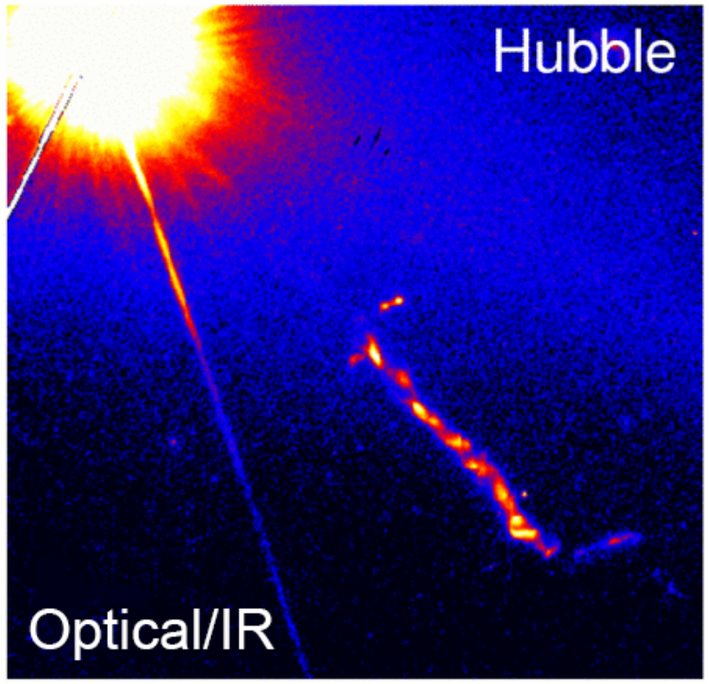


3C 348 in the constellation Hercules

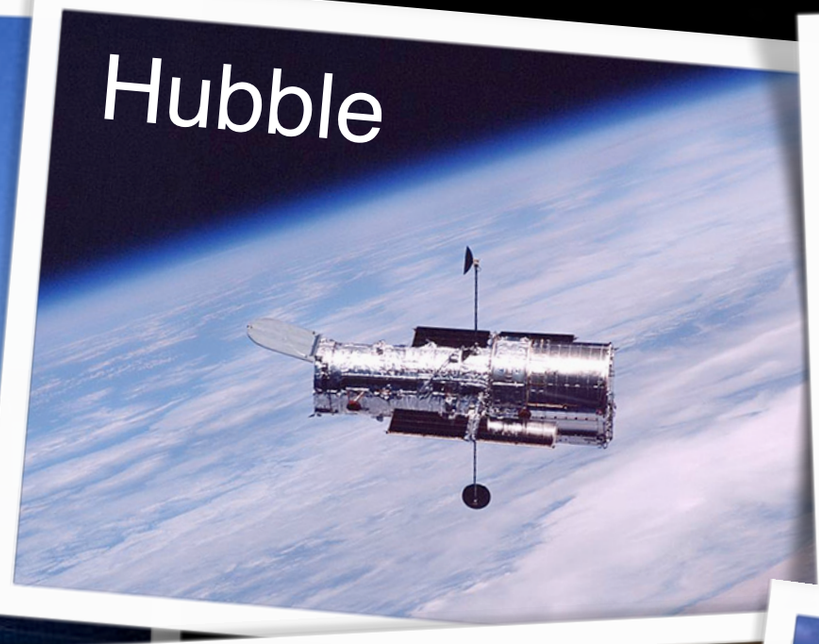
QUASAR 3C 273 RADIO JET

~2 X LONGER MILKY WAY






Magellan


Hubble

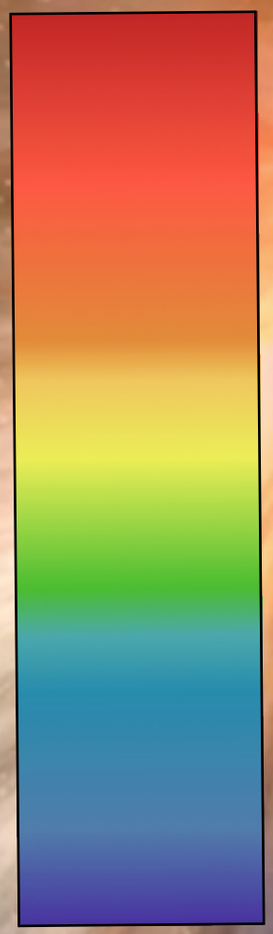

Spitzer

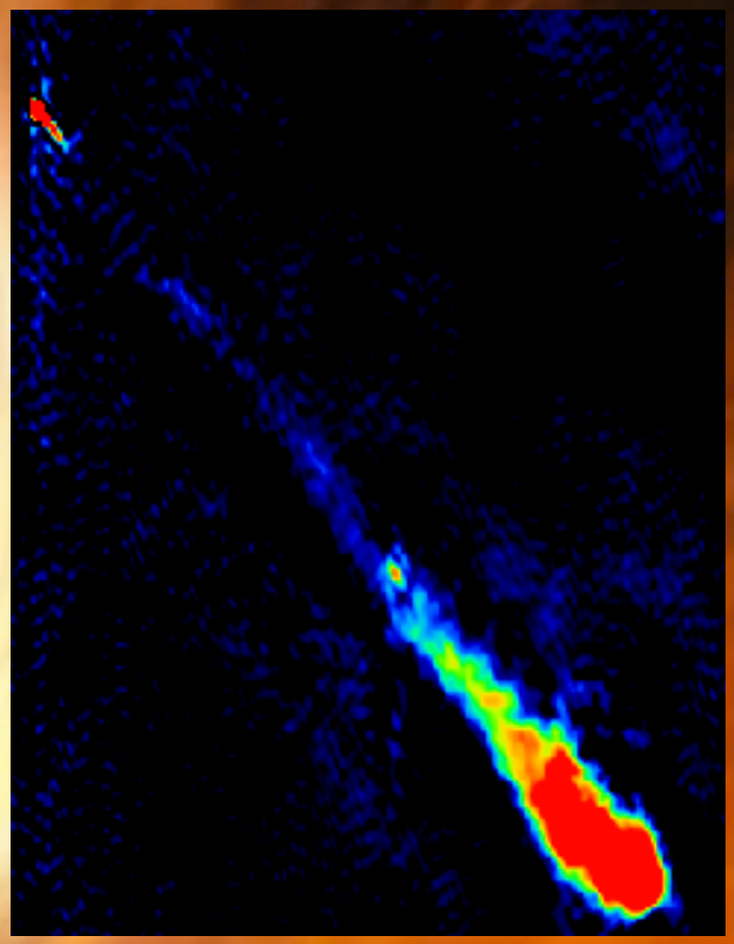

Chandra


Herschel


VLA

BLACK HOLES ILLUMINATE





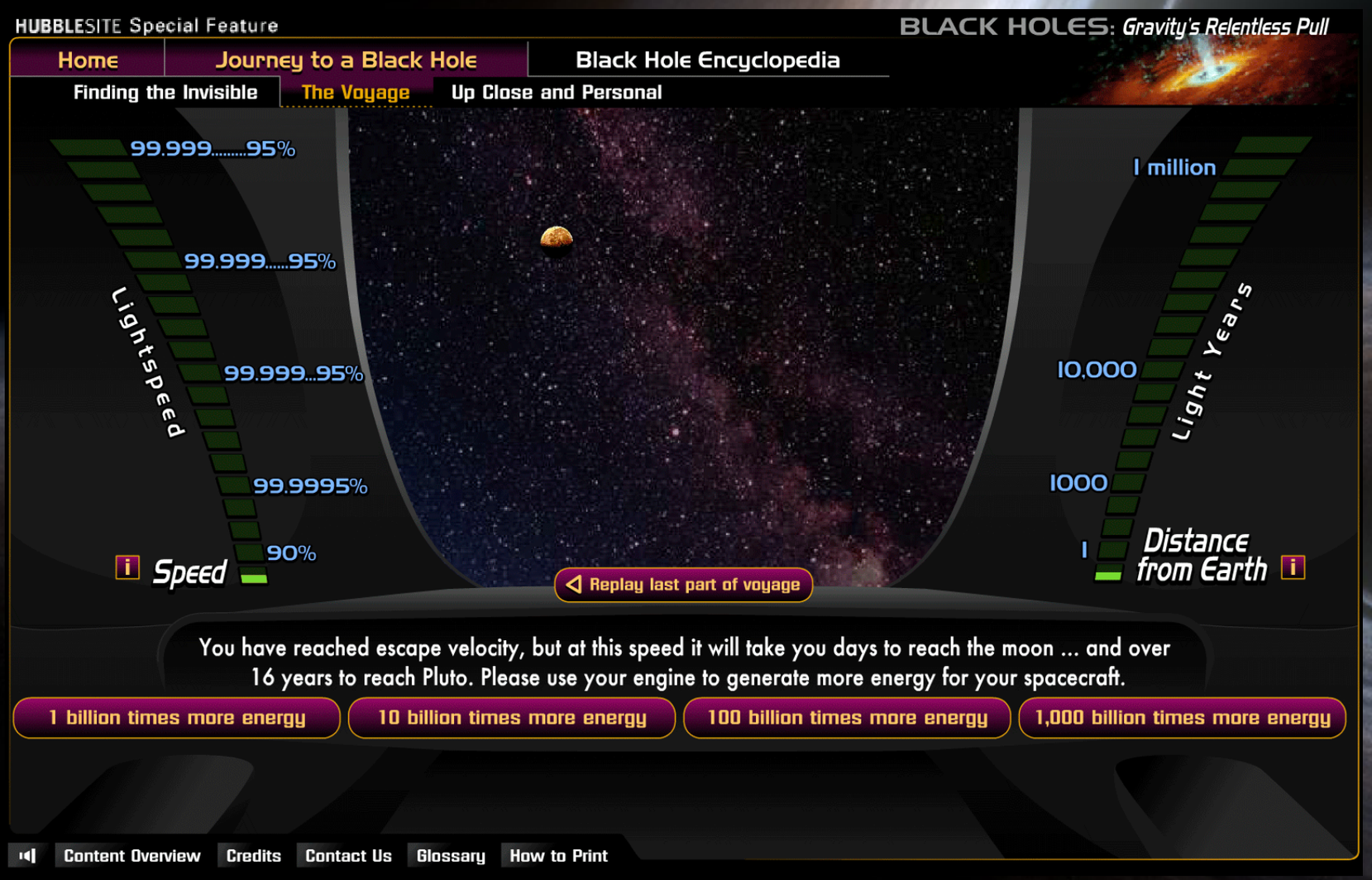
4 TRILLION TIMES BRIGHTER THAN THE SUN!

THANK YOU!

Want to learn more?

QR CODE SCAN ME!

http://hubblesite.org



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