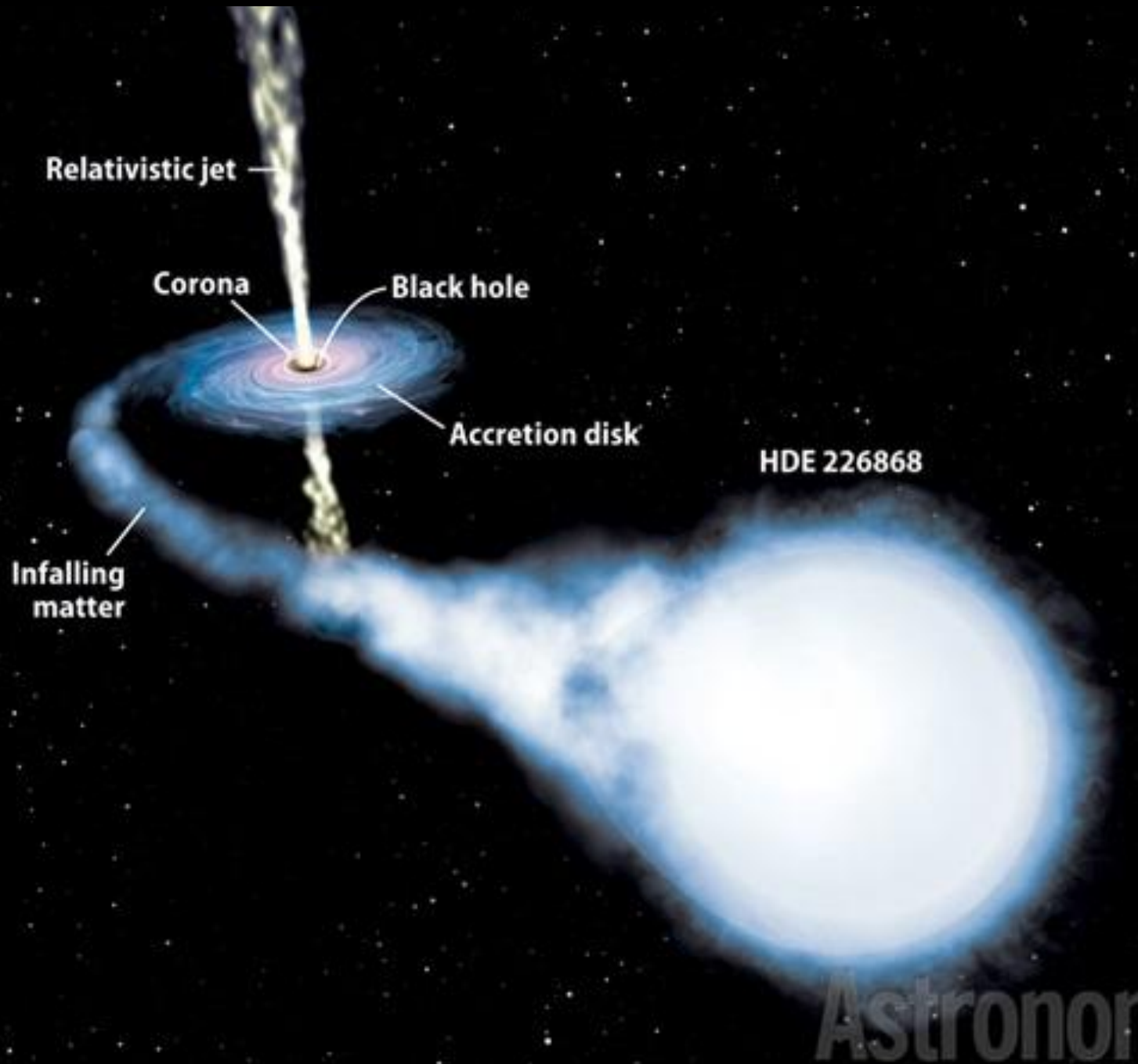




Black Holes
Ethan Partington
Wayne State Planetarium



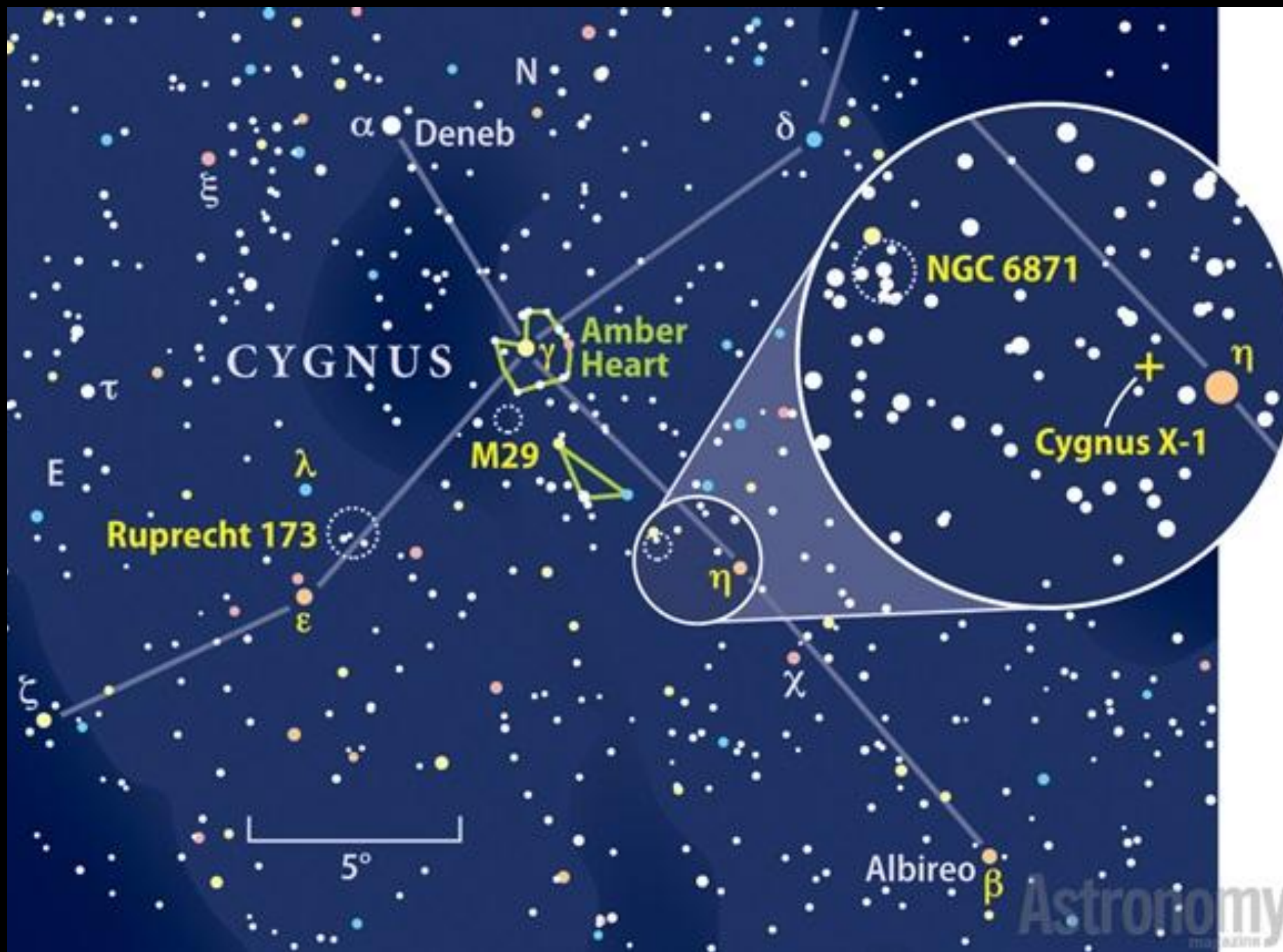
Cygnus X-1

Discovered 1964 (X-ray Source)
Confirmed black hole 1971
(Observation of binary companion)

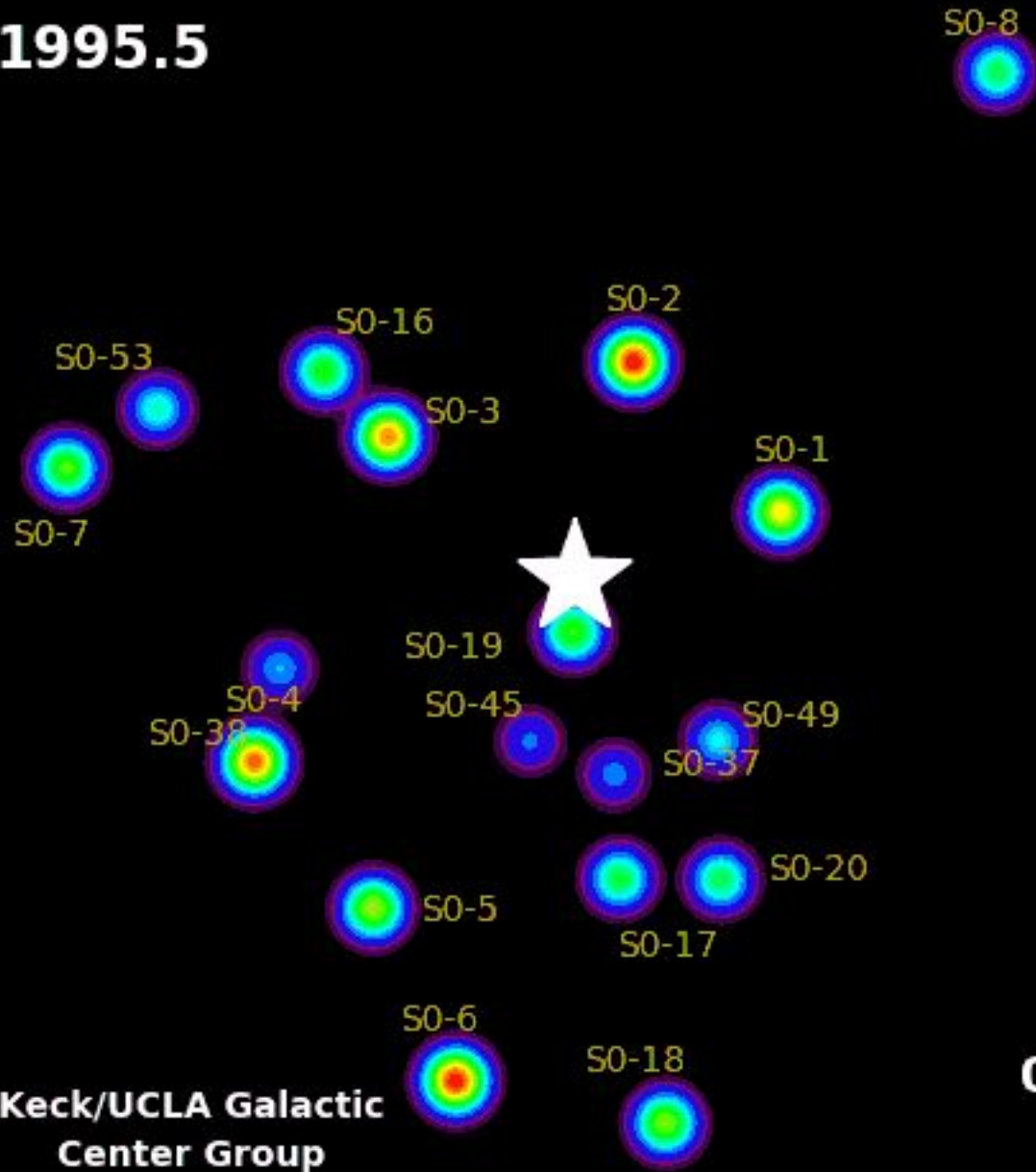
Distance: 6,000 ly away

Mass: $14.8 M_{\odot}$

($1 M_{\odot} = 1.99 \times 10^{30} \text{ kg}$)



1995.5



Sagittarius A*

Discovered 1931 (Radio Source)

Confirmed black hole 2018

(Motion of central stars and
gas - Won 2020 Nobel Prize!)

Distance: 26,700 ly away

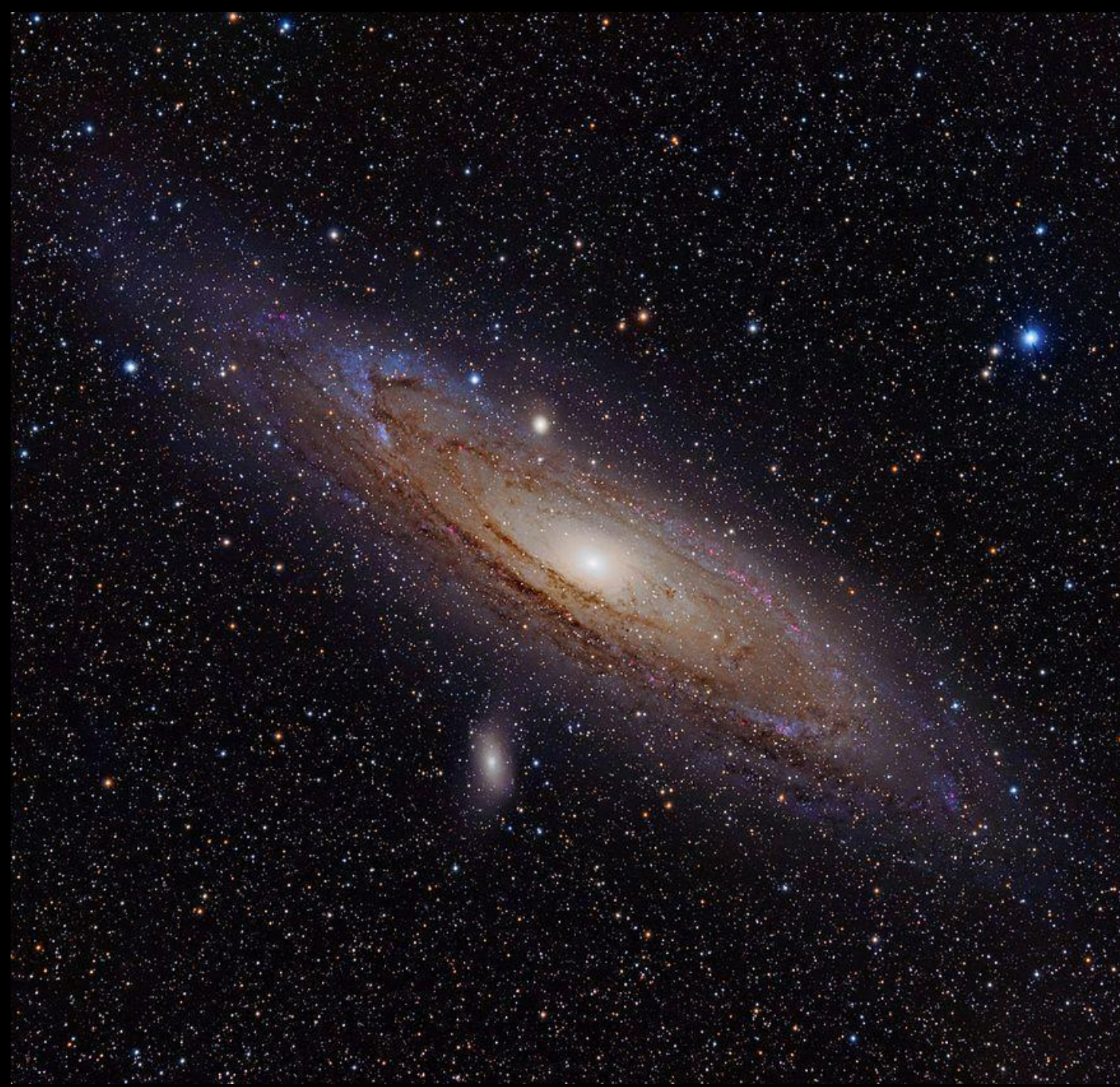
Mass: 2.6 million M_{\odot}

The Teapot
of Sagittarius

Sun

Galactic
center





Andromeda Galactic Center

First recorded 964 AD

Confirmed black hole 1984

(Motion of central stars)

Distance: 2.5 million ly away

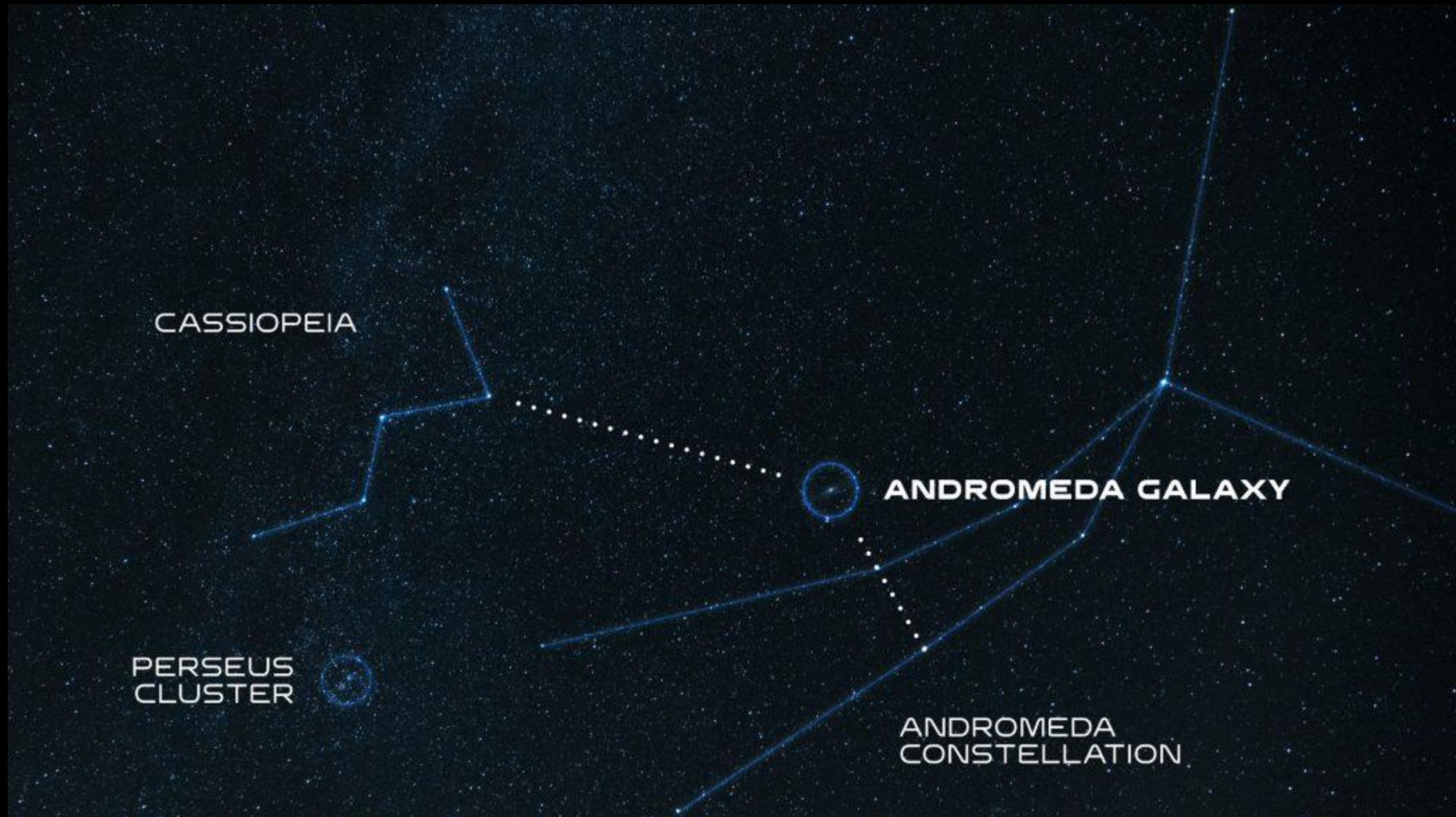
Mass: 110-230 million M_{\odot}

CASSIOPEIA

PERSEUS
CLUSTER

ANDROMEDA GALAXY

ANDROMEDA
CONSTELLATION





M87 Galactic Center

Discovered 1781 (Nebulous feature)

Confirmed black hole 1978

(Motion of central stars)

Photographed 2019

Distance: 53.5 million ly away

Mass: 6.5 billion M_{\odot}

Event Horizon Telescope Array



Arcturus

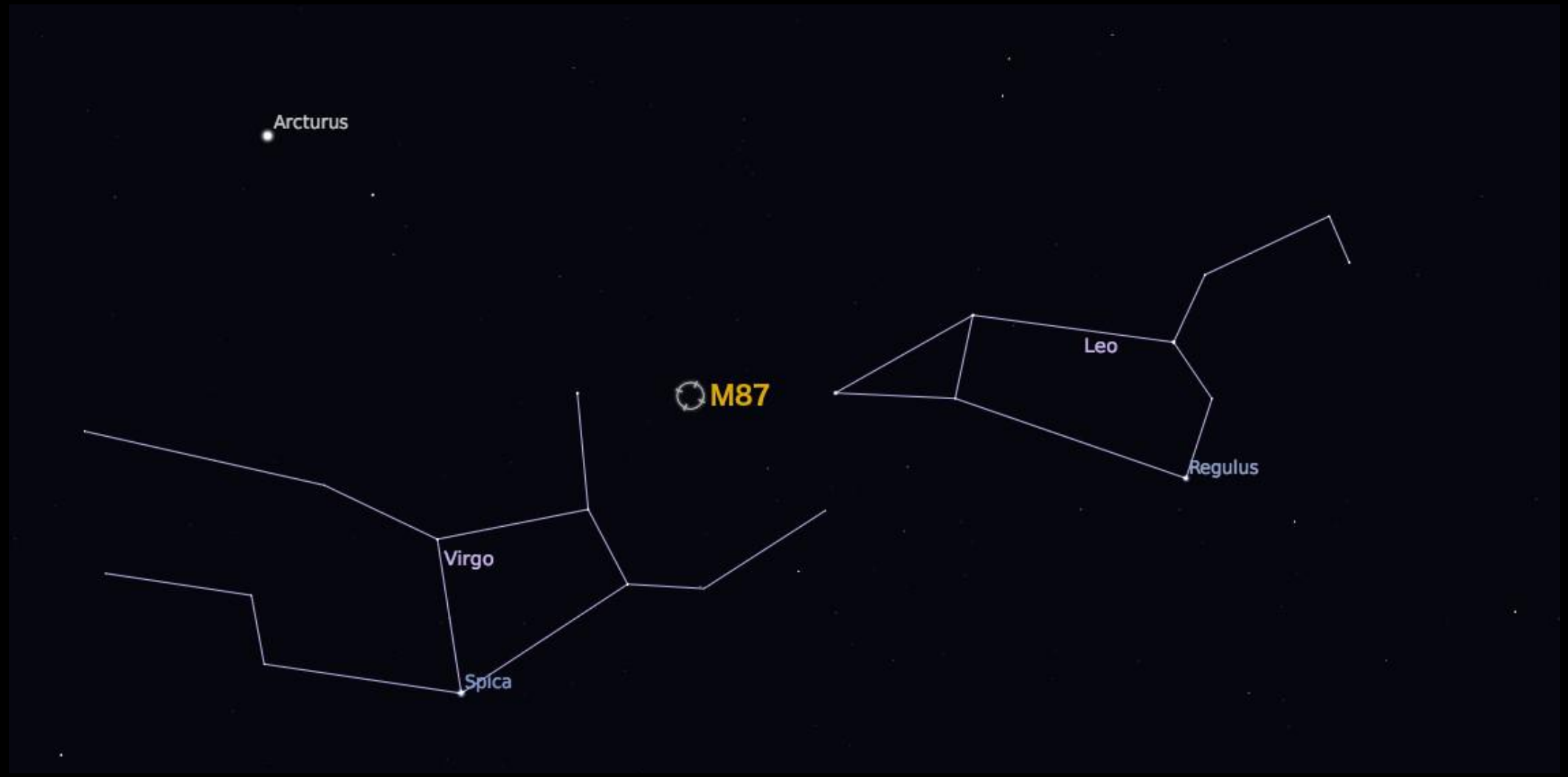
M87

Virgo

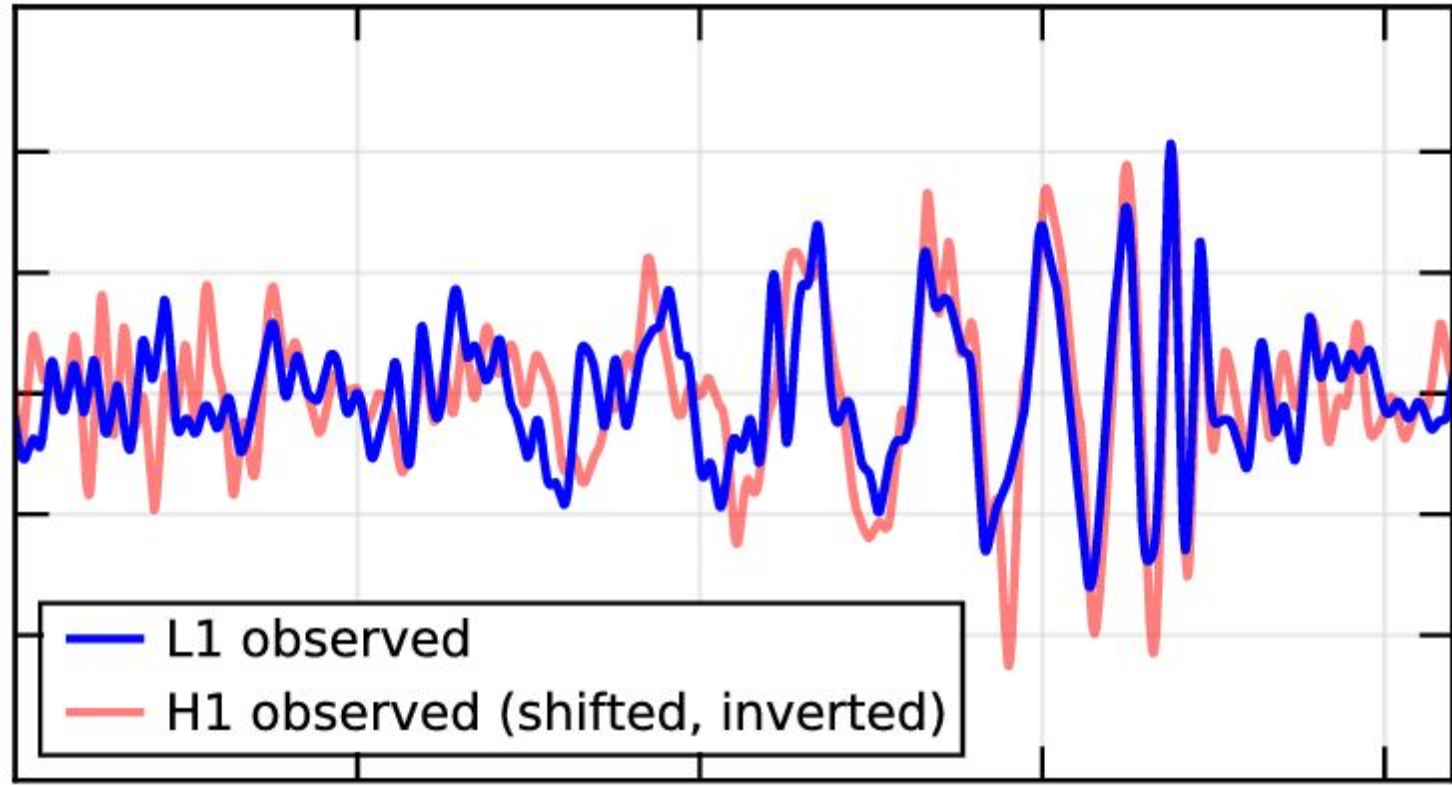
Spica

Leo

Regulus



Livingston, Louisiana (L1)



GW150914

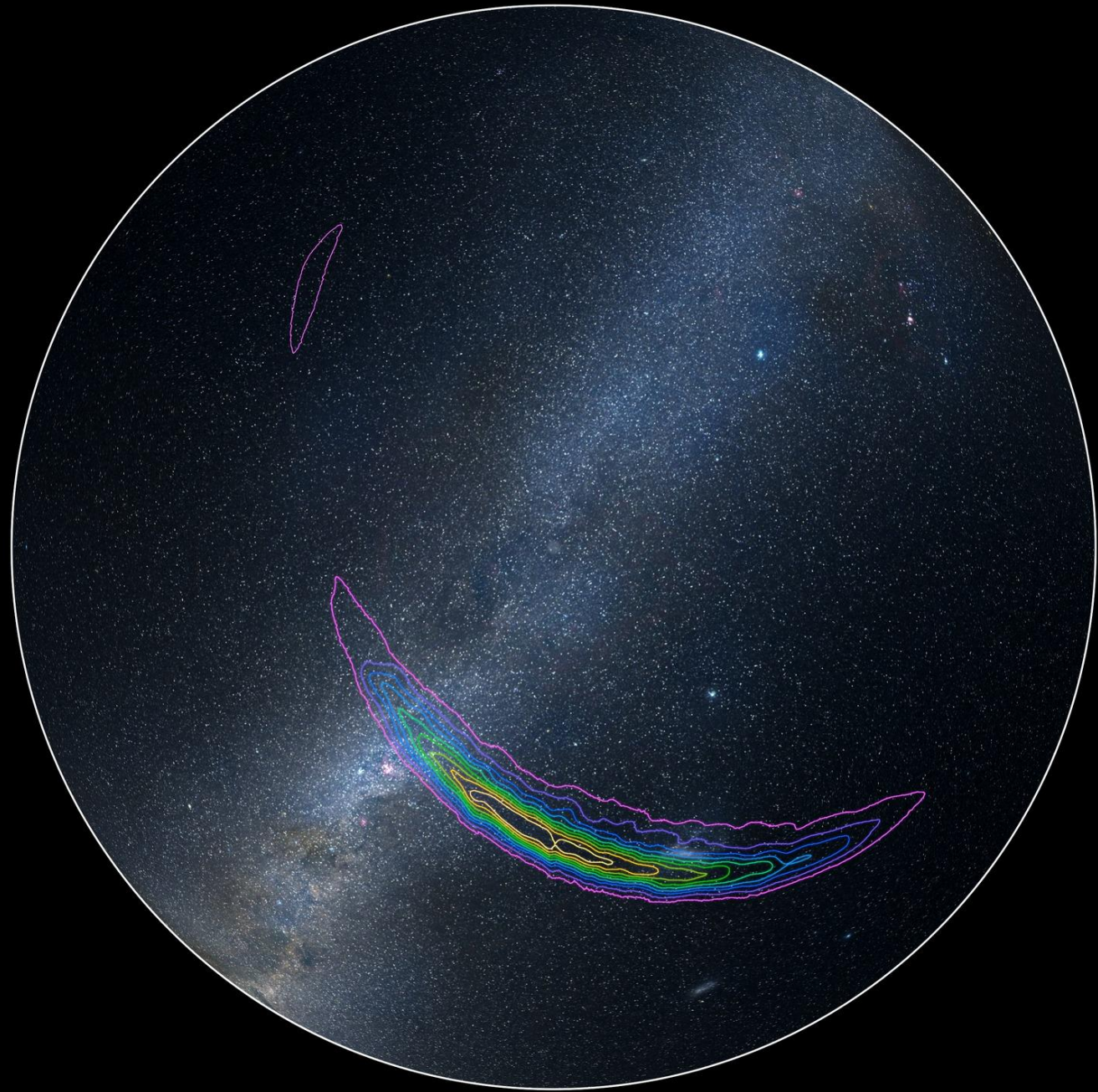
Discovered 2015

Confirmed black hole 2015

(Numerical relativity
simulations)

Distance: 800-1800 million ly away

Mass: $36+29 M_{\odot}$



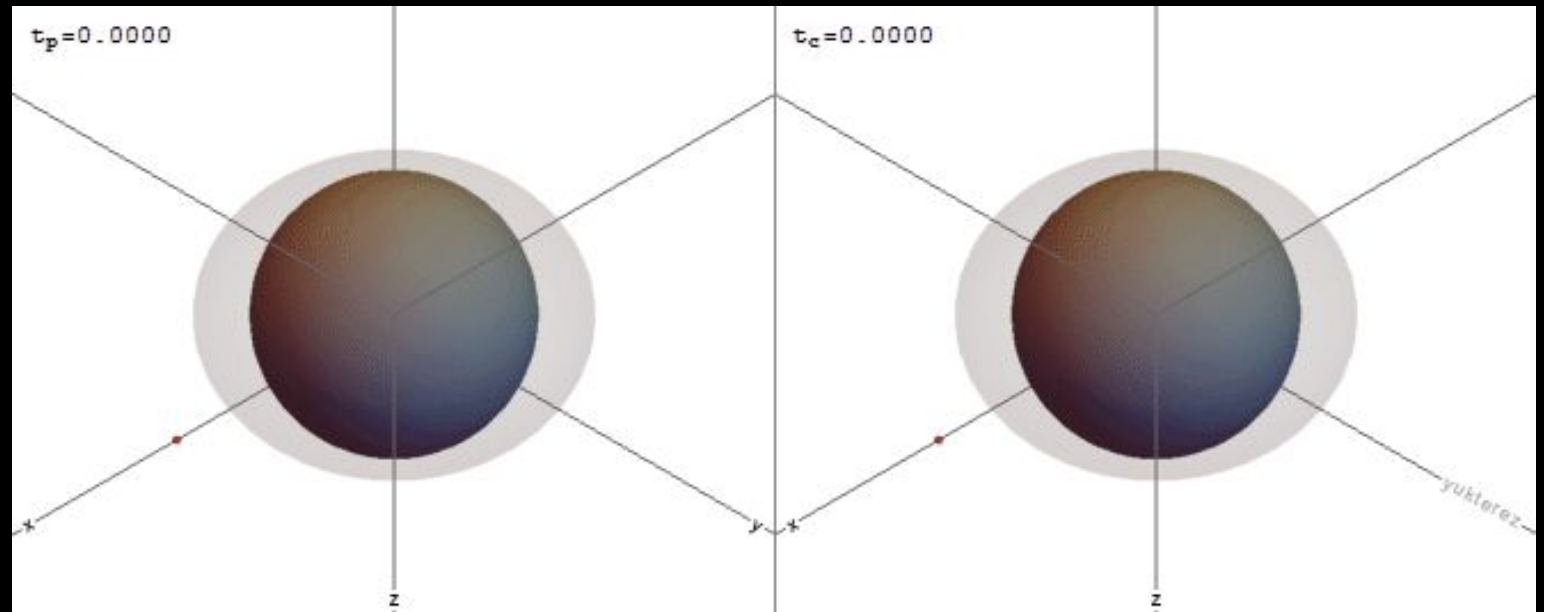
What happens as you approach a black hole?

Gravitational Time Dilation

Gravitational field strength affects the flow of time

As you get closer, you'd appear to slow down to an observer

From your perspective, the observer appears to age very quickly



By Yukterez - kerr.yukterez.net

What happens as you approach a black hole?

Spaghettification

Gravitational field strength increases when objects are close together

As you cross the event horizon, the distance between your head and your feet creates a significant difference in gravitational force

This causes your body to become stretched by gravity, like spaghetti



Bonus: Milkdromeda Merger

ETA: 4.5 billion years















