

Perseverance di Mars



Penjelajahan *in situ*
dikendalikan dari jauh

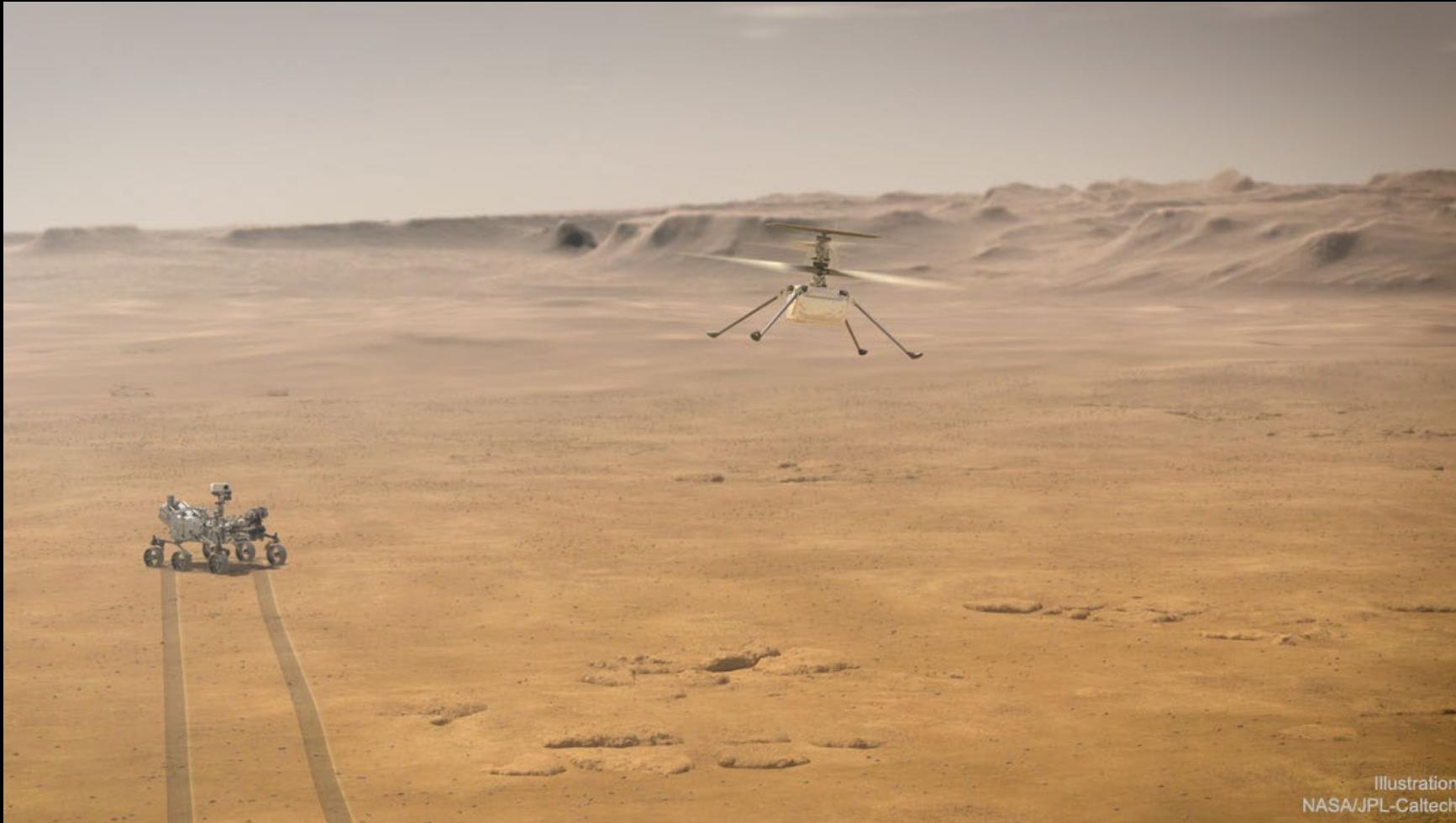
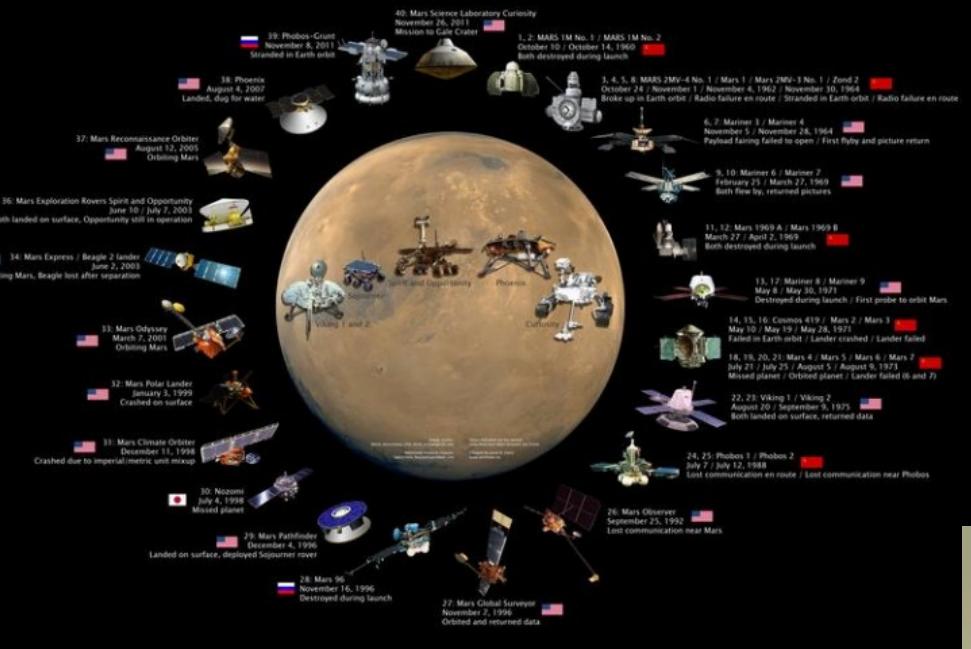
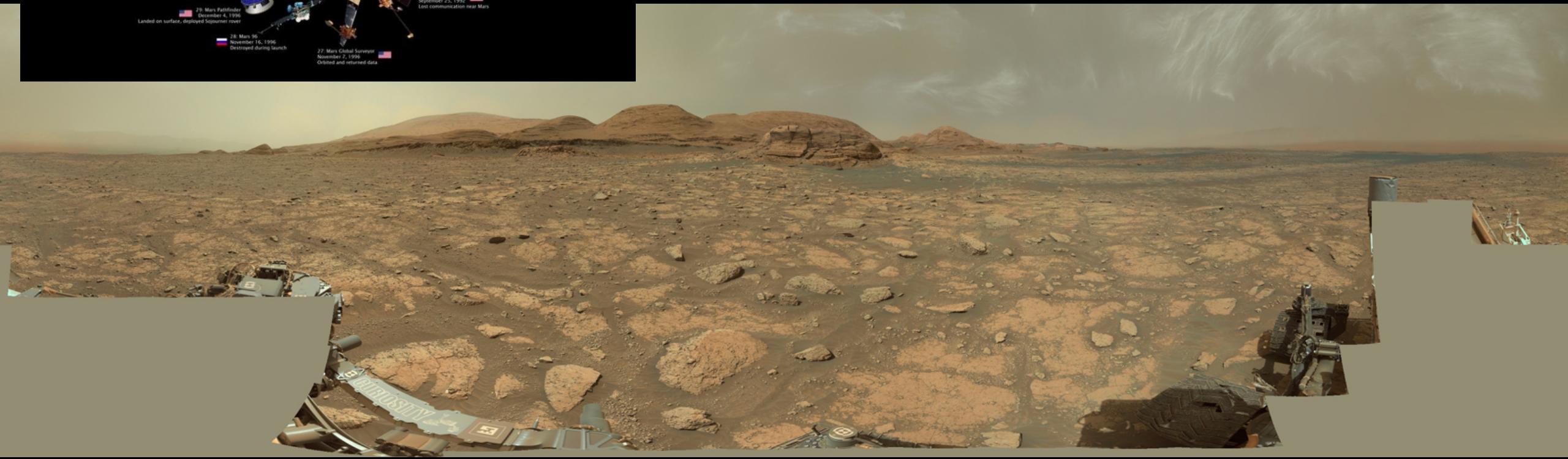


Illustration
NASA/JPL-Caltech

Mars Exploration Family Portrait



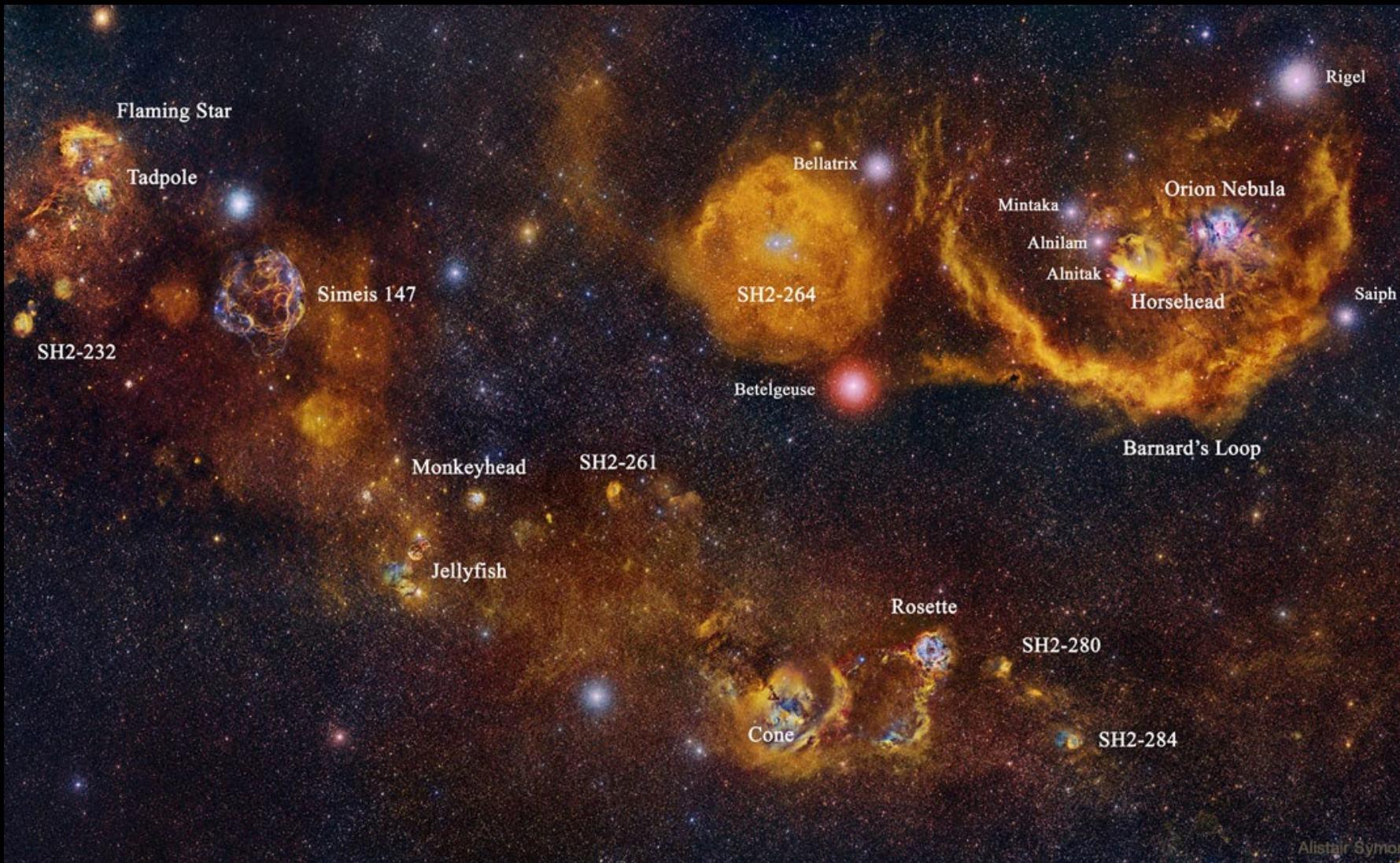
Curiosity di Mars 2011-2012



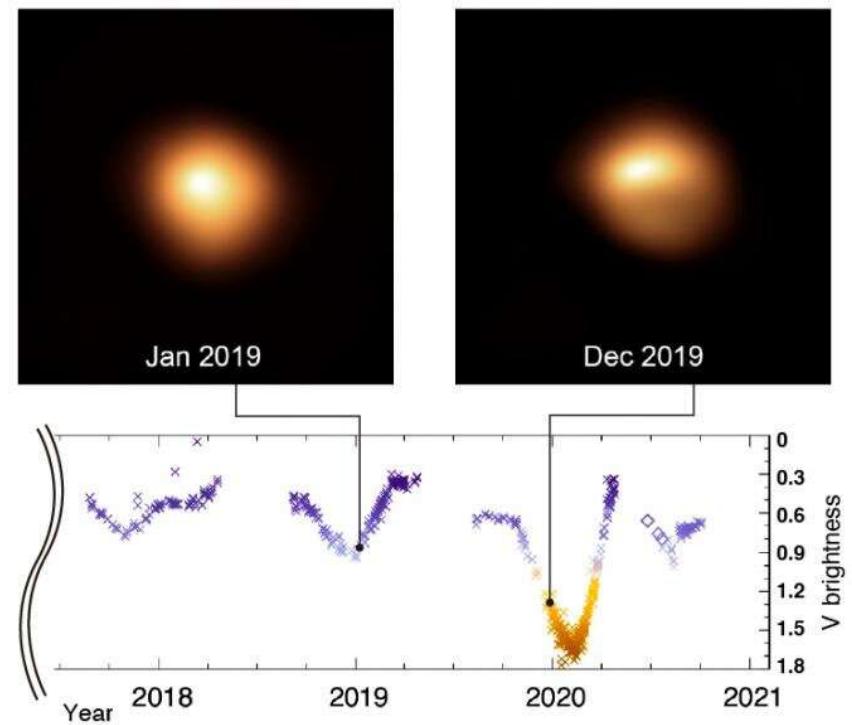
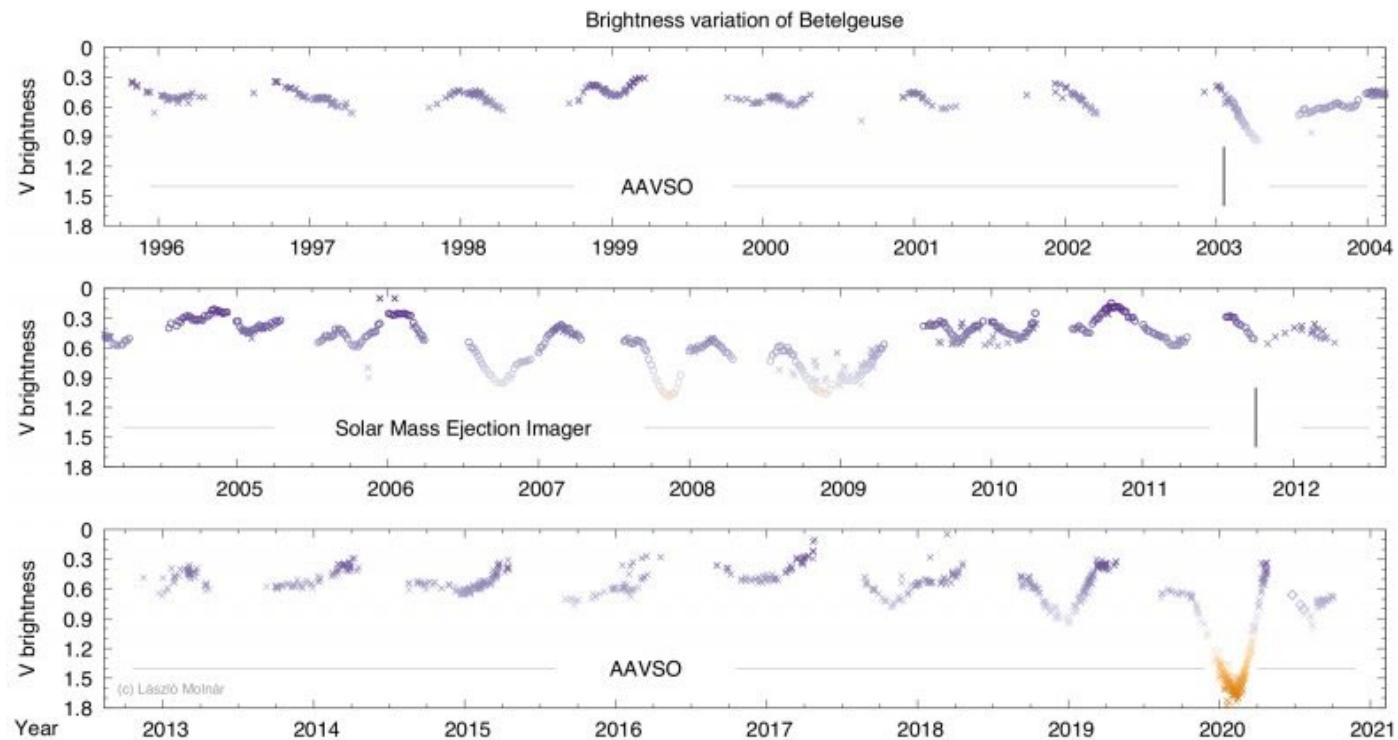


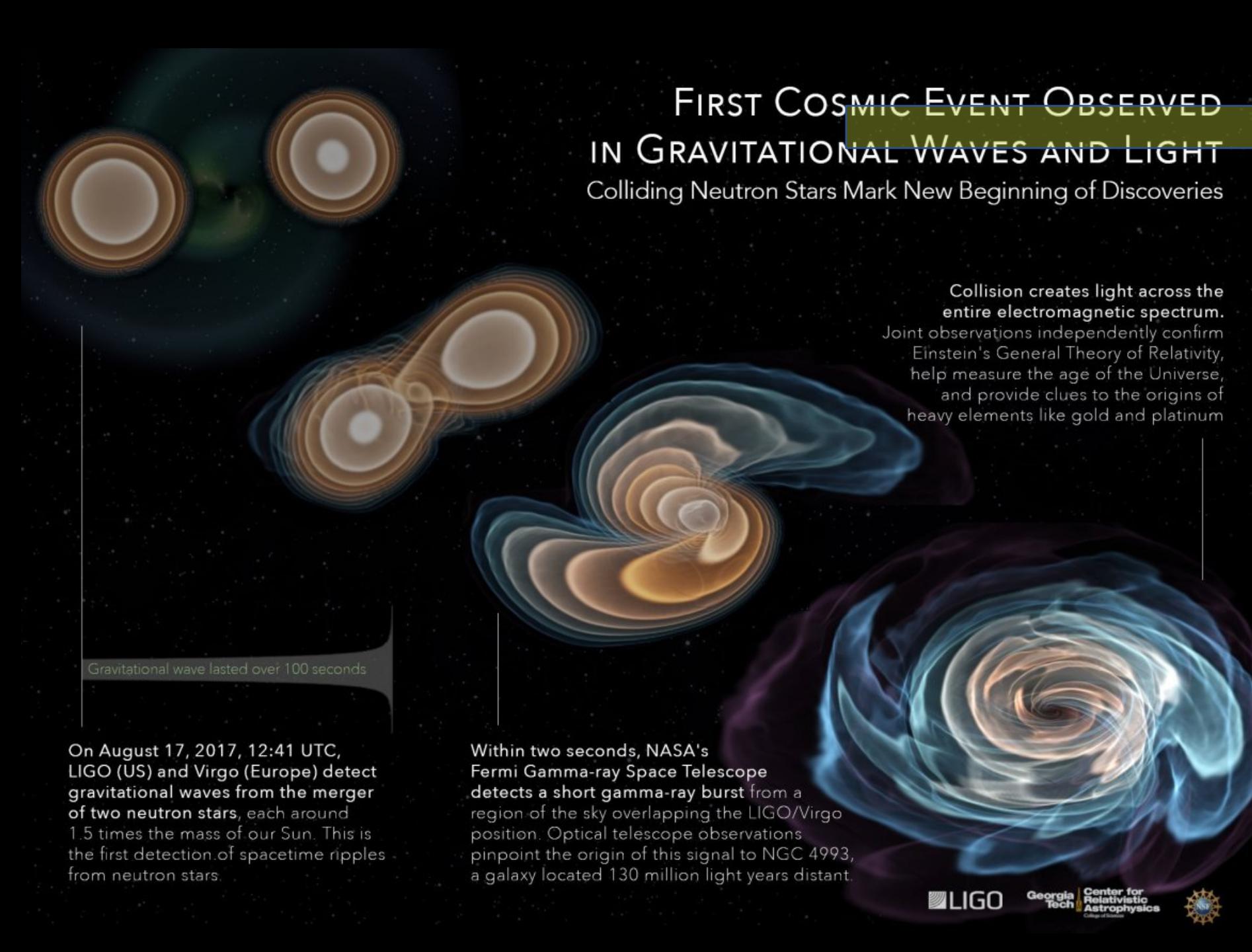
Mars
pada arah Taurus

Rasi Orion dan sekitarnya



Betelgeuse meredup? Apa yang terjadi?





FIRST COSMIC EVENT OBSERVED IN GRAVITATIONAL WAVES AND LIGHT

Colliding Neutron Stars Mark New Beginning of Discoveries

Collision creates light across the entire electromagnetic spectrum. Joint observations independently confirm Einstein's General Theory of Relativity, help measure the age of the Universe, and provide clues to the origins of heavy elements like gold and platinum

Gravitational wave lasted over 100 seconds

On August 17, 2017, 12:41 UTC, LIGO (US) and Virgo (Europe) detect gravitational waves from the merger of two neutron stars, each around 1.5 times the mass of our Sun. This is the first detection of spacetime ripples from neutron stars.

Within two seconds, NASA's Fermi Gamma-ray Space Telescope detects a short gamma-ray burst from a region of the sky overlapping the LIGO/Virgo position. Optical telescope observations pinpoint the origin of this signal to NGC 4993, a galaxy located 130 million light years distant.

Merging
pasangan
objek kompak

Bintang neutron – Bintang neutron
Bintang neutron – Lubang Hitam
Lubang Hitam – Lubang Hitam



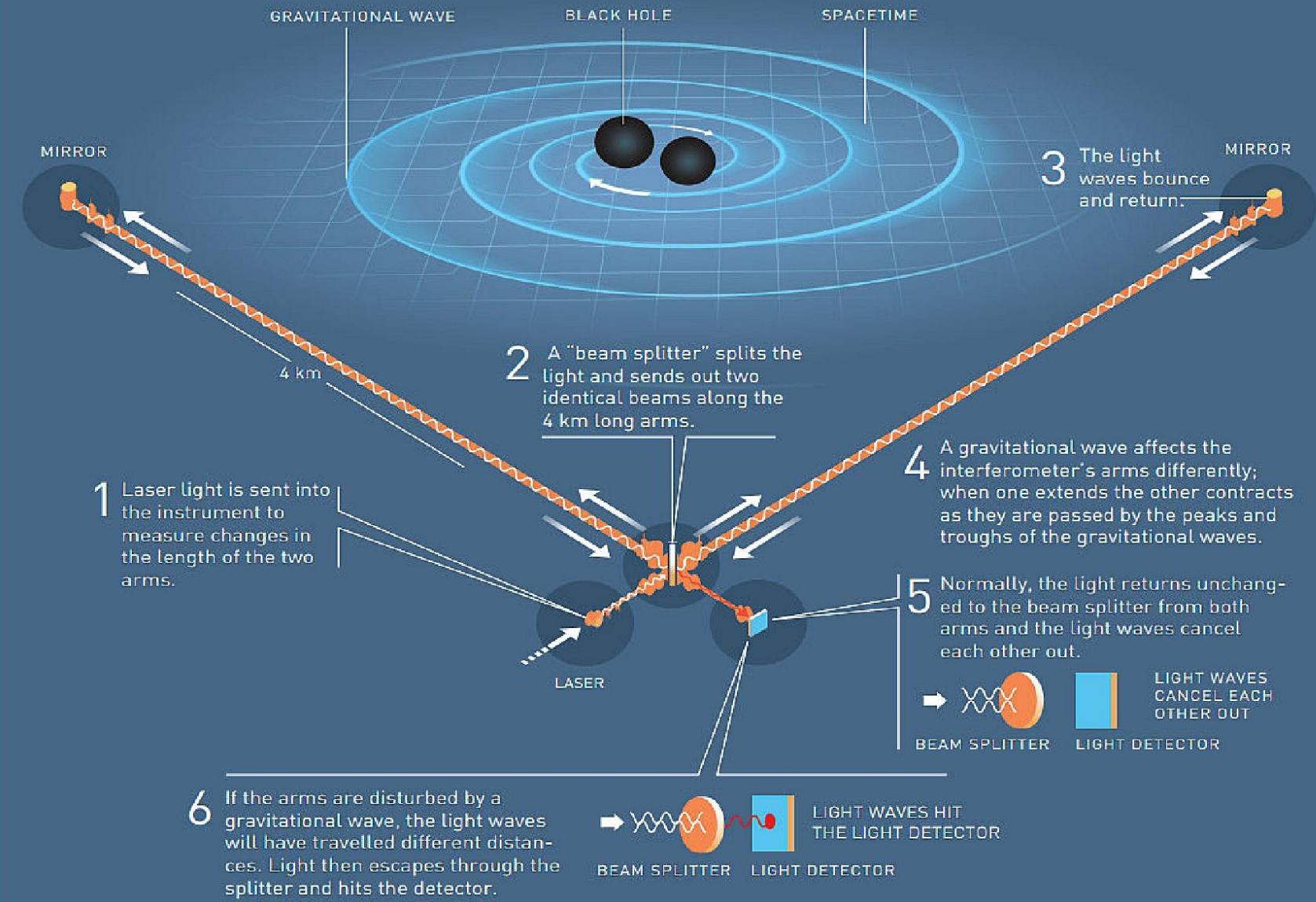
Gelombang Gravitasi

Jendela Baru ke Alam Semesta



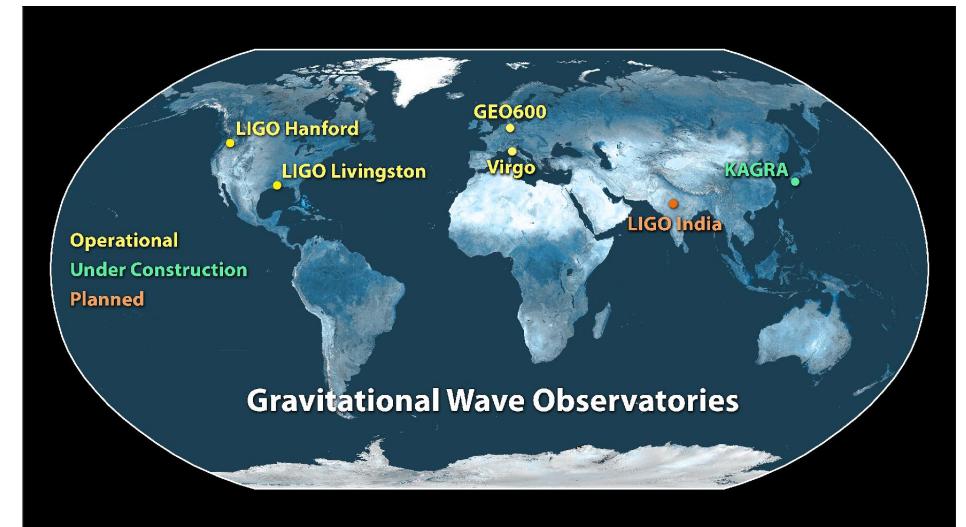
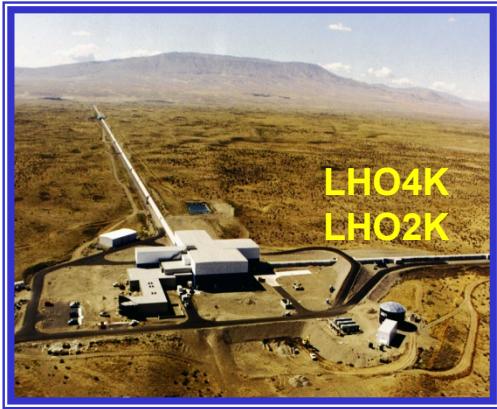
Kurir baru informasi fisis
melengkapi foton
sebagai kurir elektromagnetik

LIGO – A GIGANTIC INTERFEROMETER

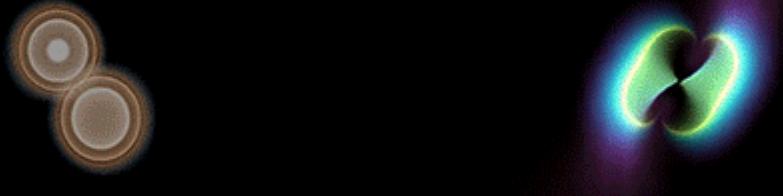


Cara kerja
detektor
gelombang gravitasi

LIGO, VIRGO, GEO, GEO, TAMA ...

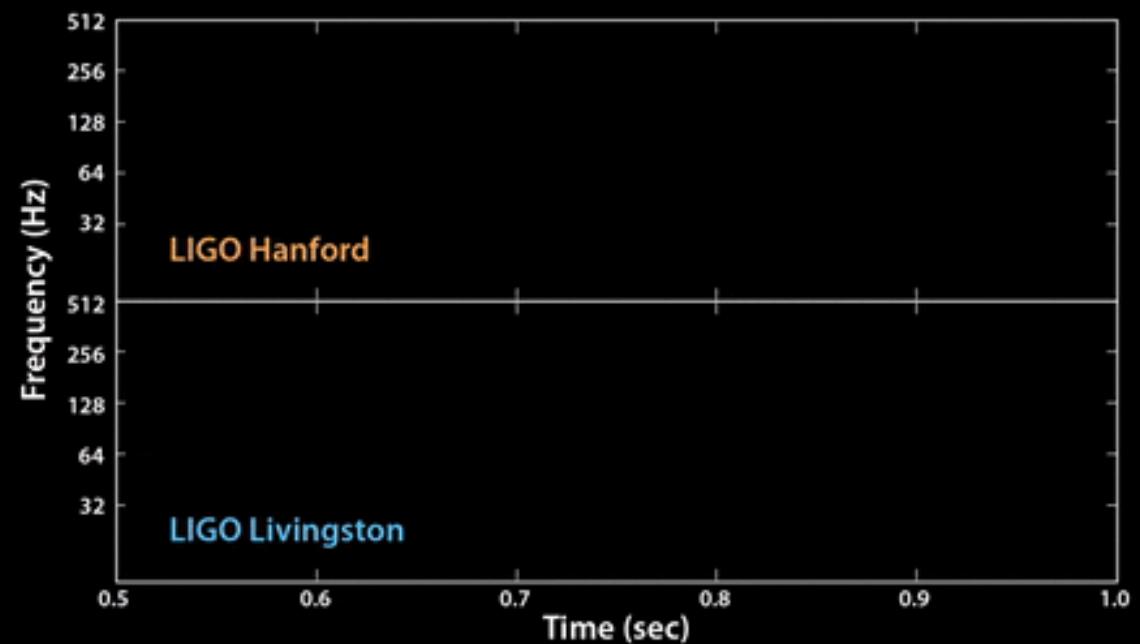


GW170817: The Merger of Two Neutron Stars



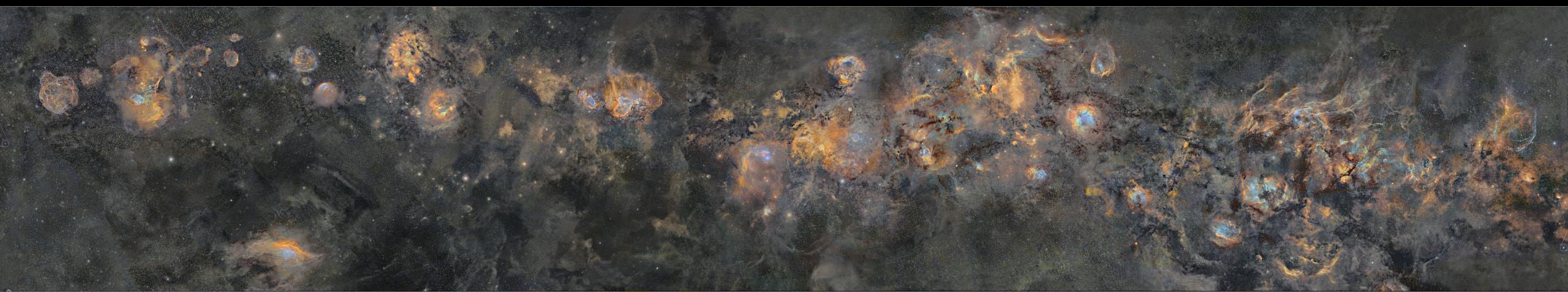
Georgia Tech

Deteksi Gelombang Gravitasi



Galaksi penuh bintang, gas panas, gas dingin, debu

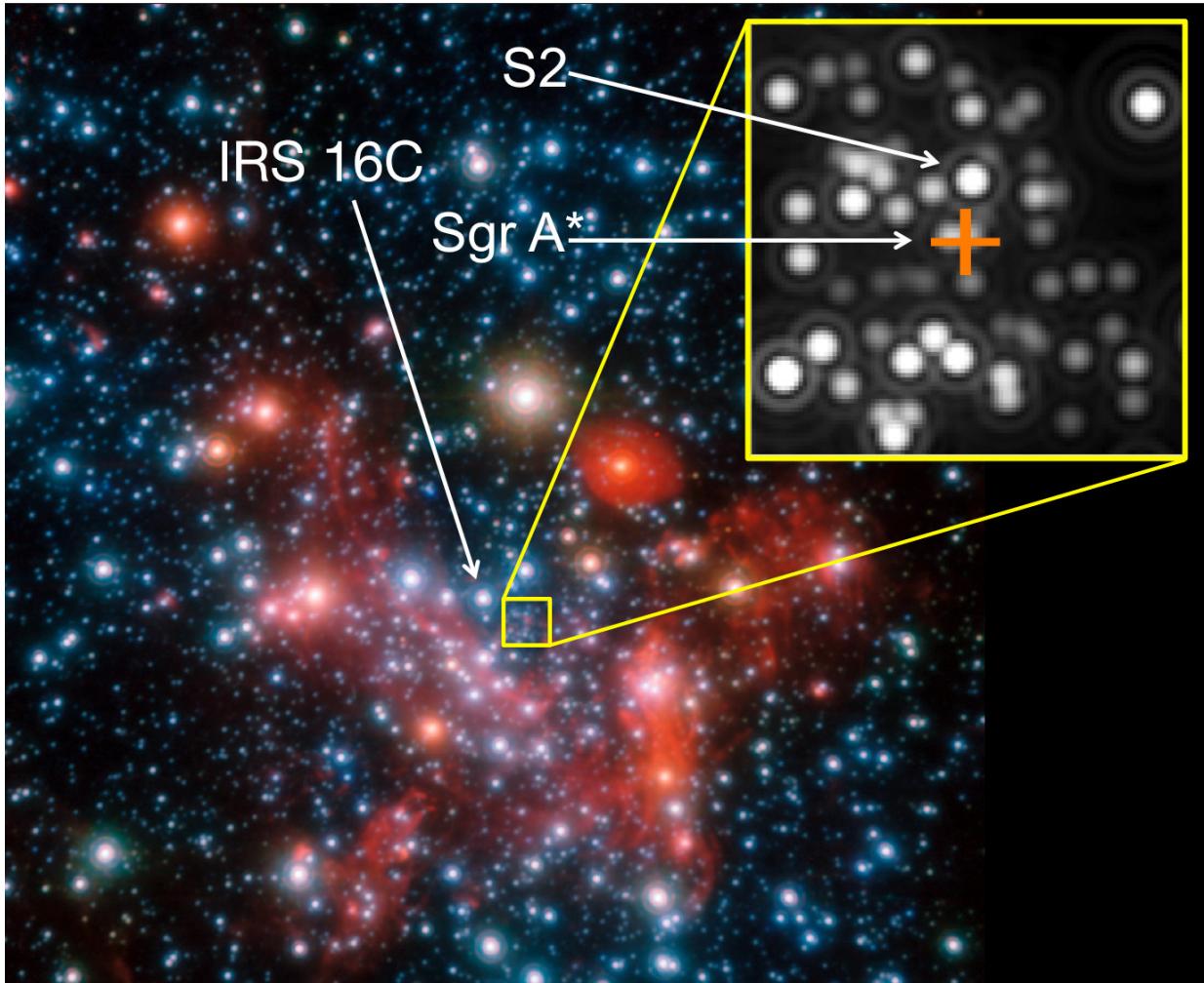
Milky Way: foto dengan total waktu eksposure 1250 jam



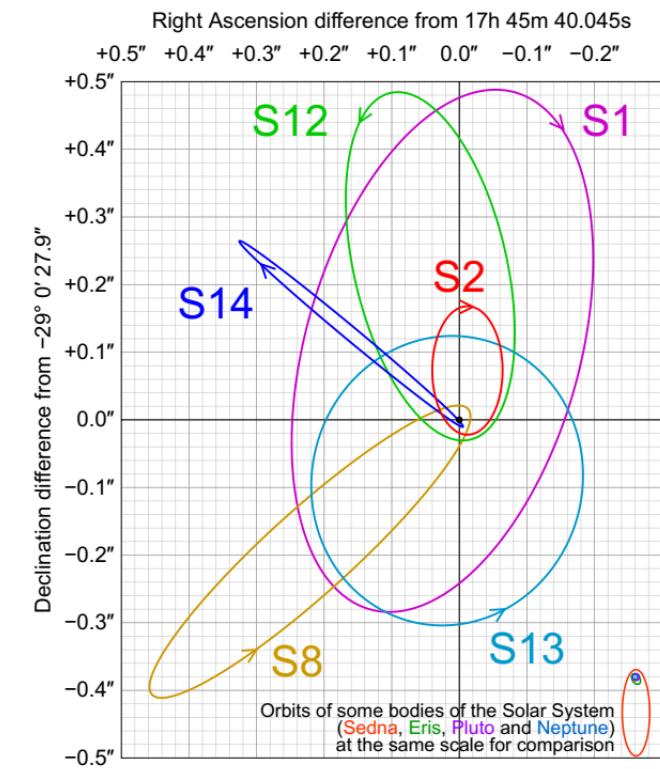
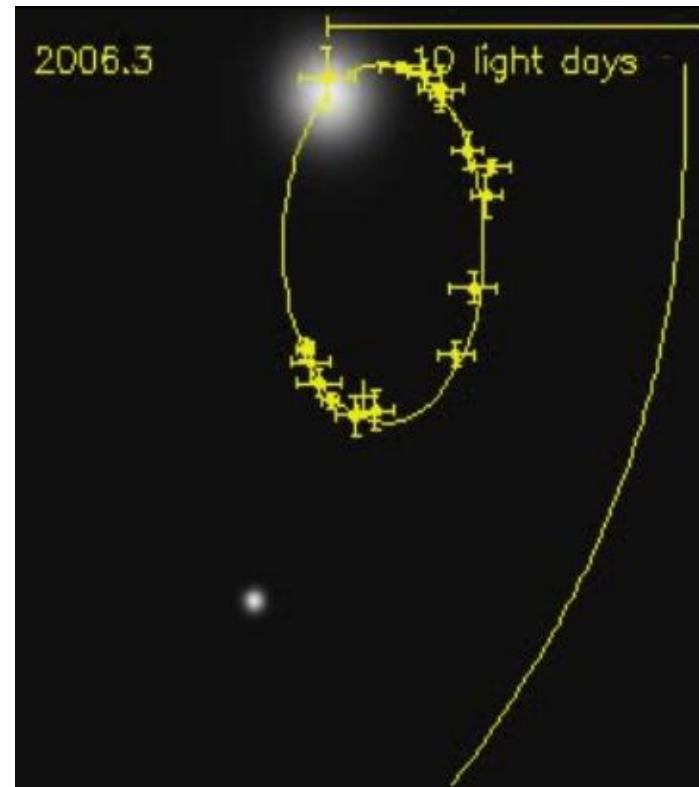
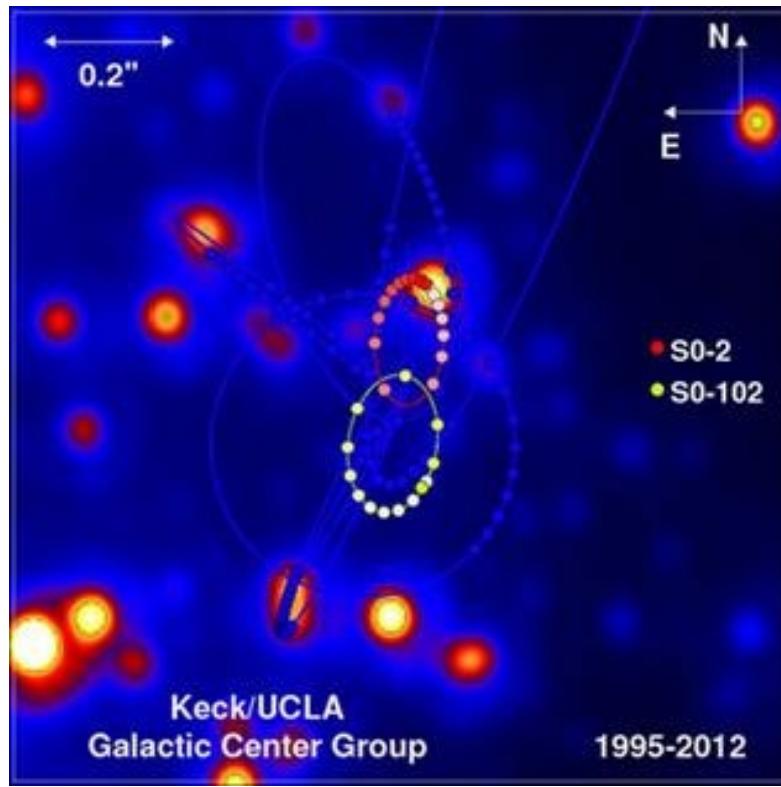
125 degrees of sky from Taurus to Cygnus, photography and processing by J-P Metsavainio 2009 -2021

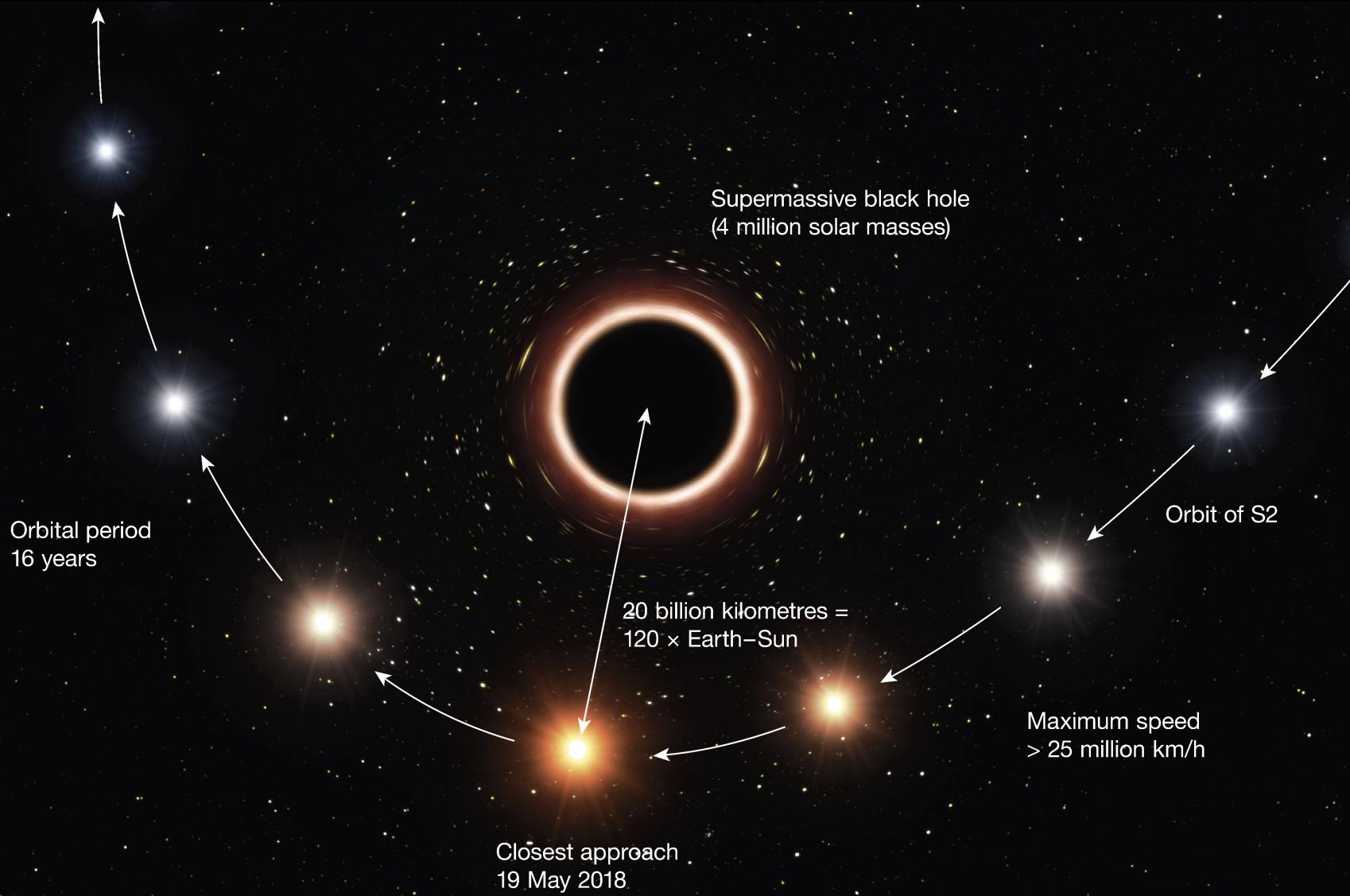
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Metsavainio, 2021



Lubang Hitam Maharaksasa di Pusat Galaksi Bima Sakti





Akurasi prediksi
posisi dan
kecepatan orbit
Nobel Prize 2020



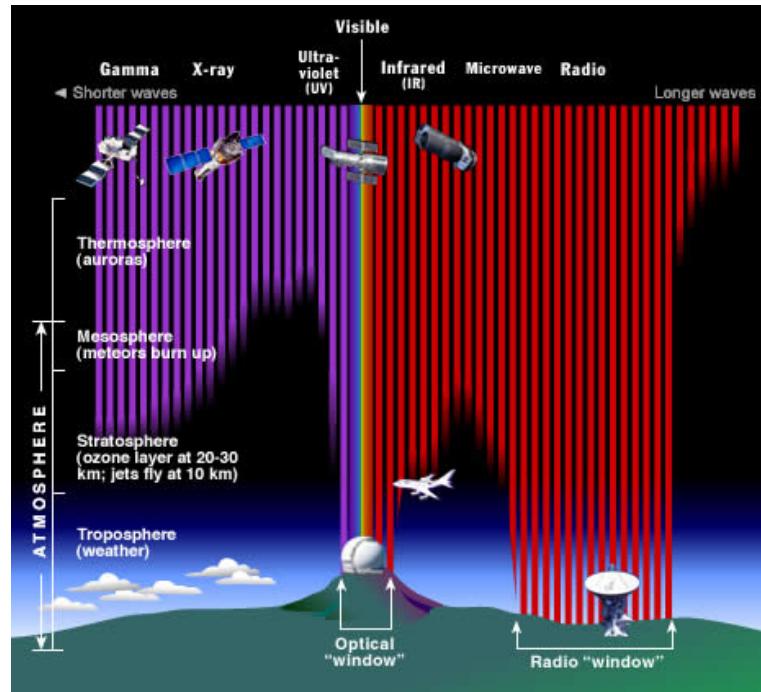
Galaksi M87
di Gugus Galaksi Virgo



12 ribu tahun cahaya

M87
Chandra
X-ray

Chandra: Teleskop sinar-X



Pengamatan radiasi elektromagnetik pada berbagai frekuensi



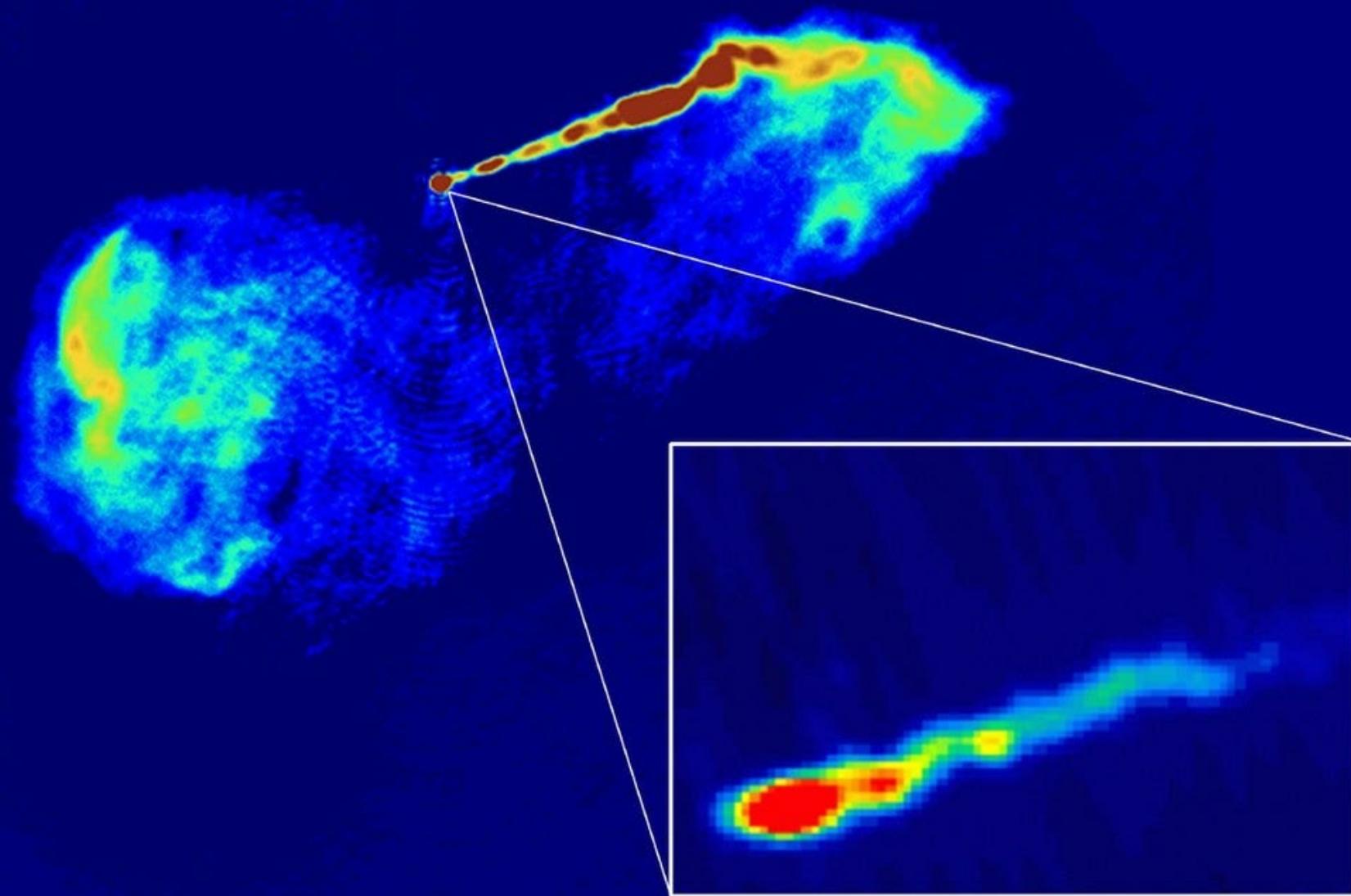
Narrabri, Australia



Arecibo, Puerto Rico



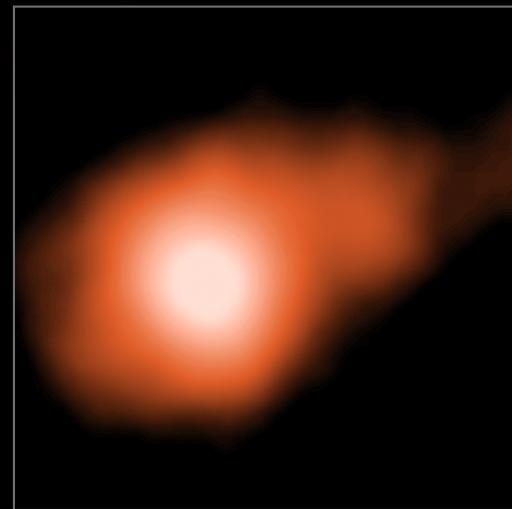
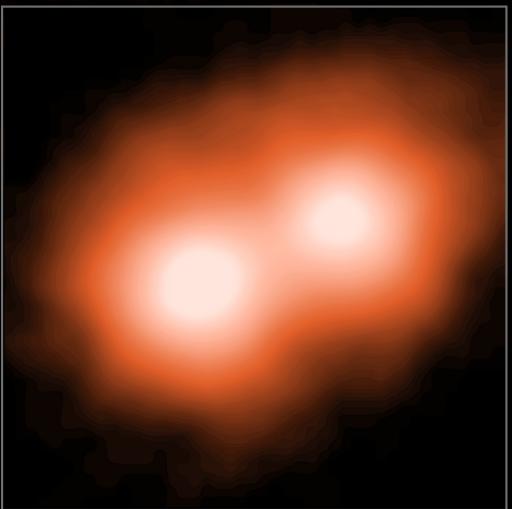
FAST, RR China



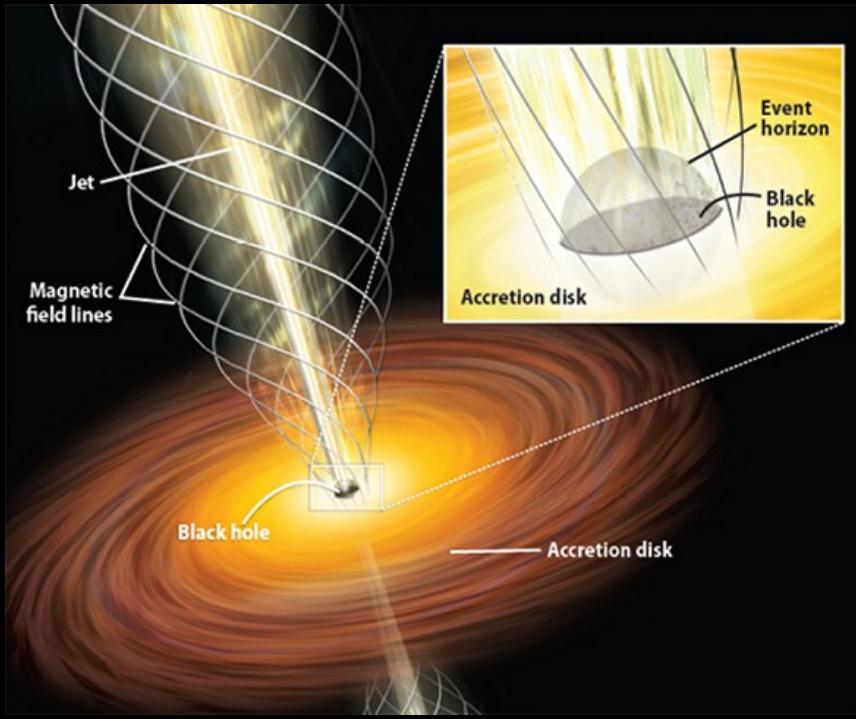
M87
VLA
radio

WIDE FIELD

800 tahun cahaya



M87
Chandra
X-ray



Simulasi komputer
Daerah dekat *event horizon*

Lubang hitam menarik semua di sekitarnya
dan menjadi dynamo mahakuat





Medan magnet
melilit seputar
lubang hitam





M87
EHT

EHT Collaboration