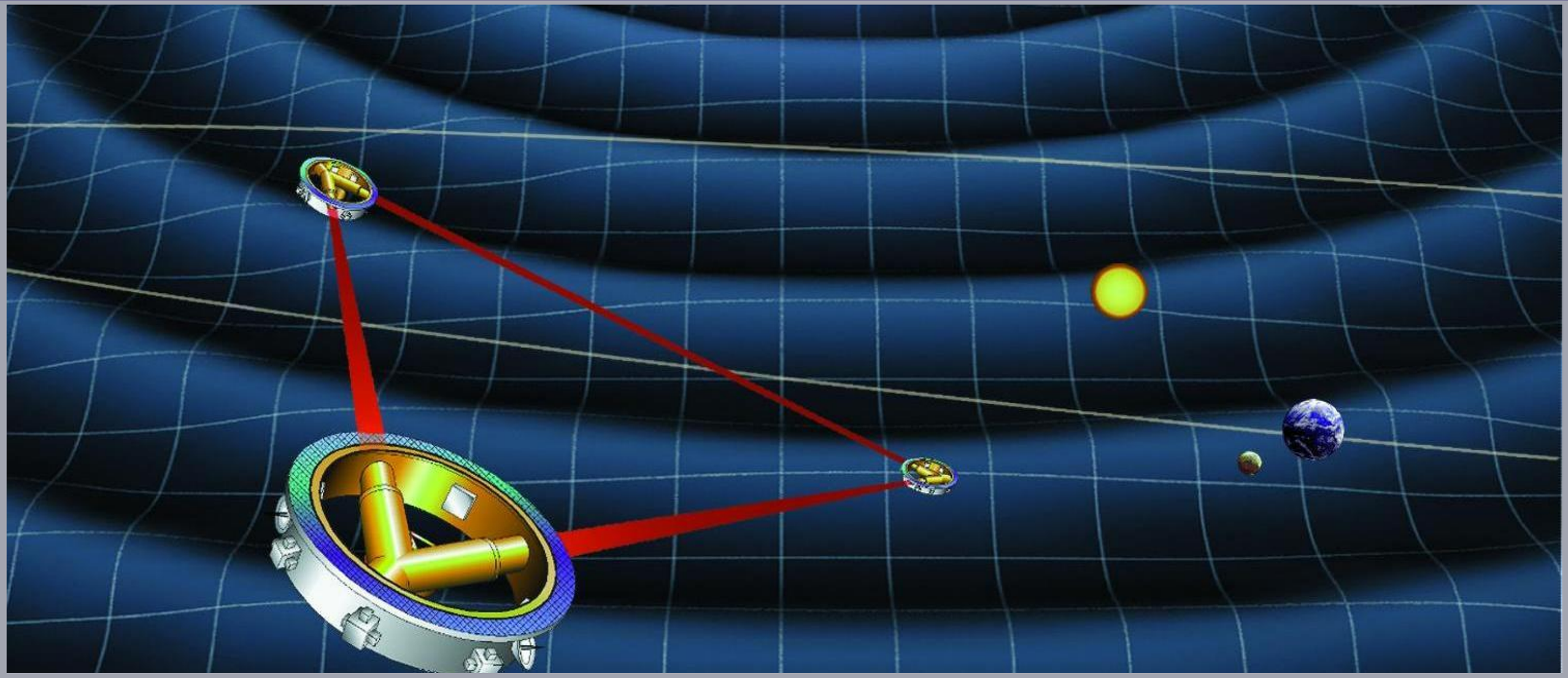
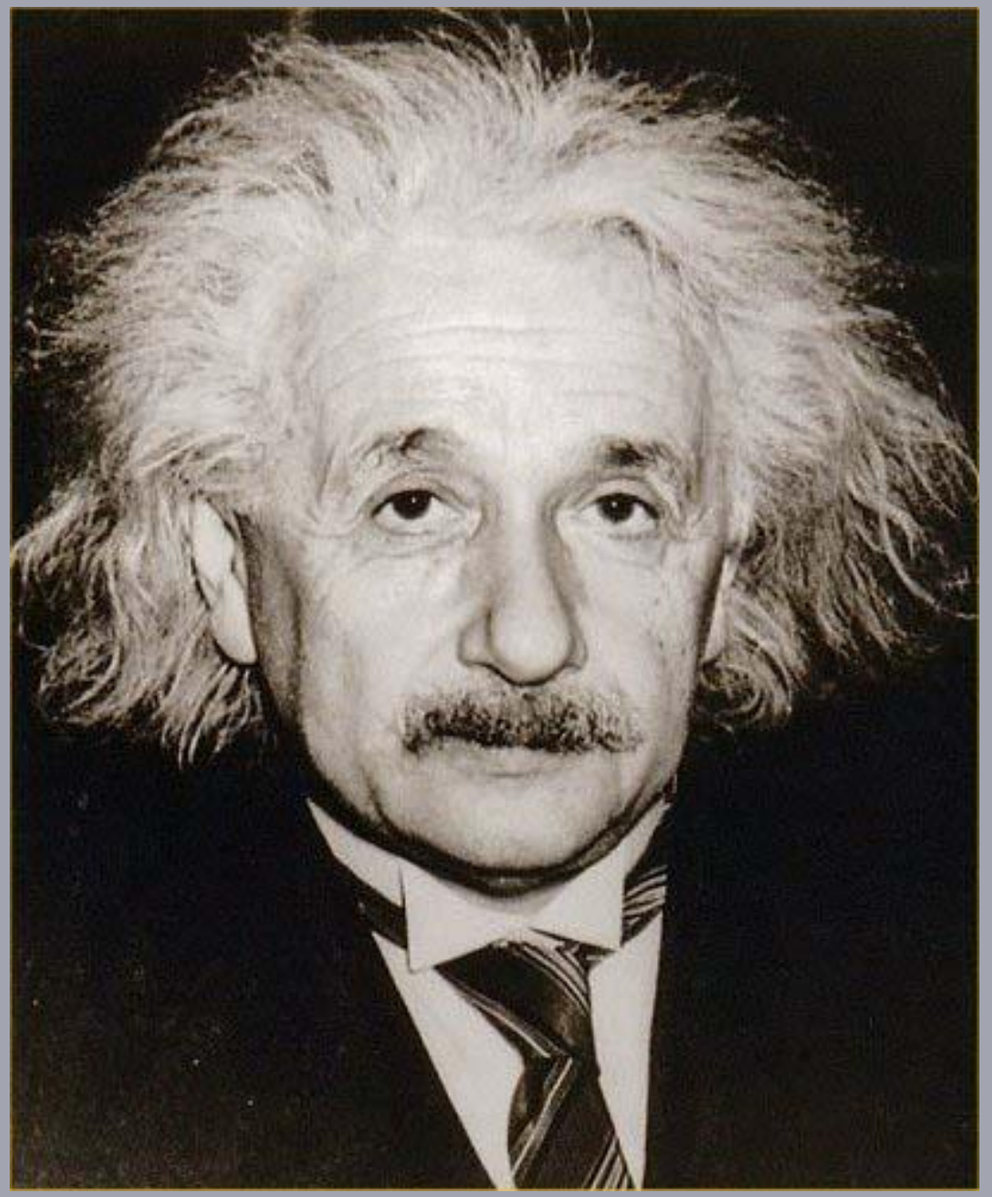
Gravitational Waves:

Space-Based Detection

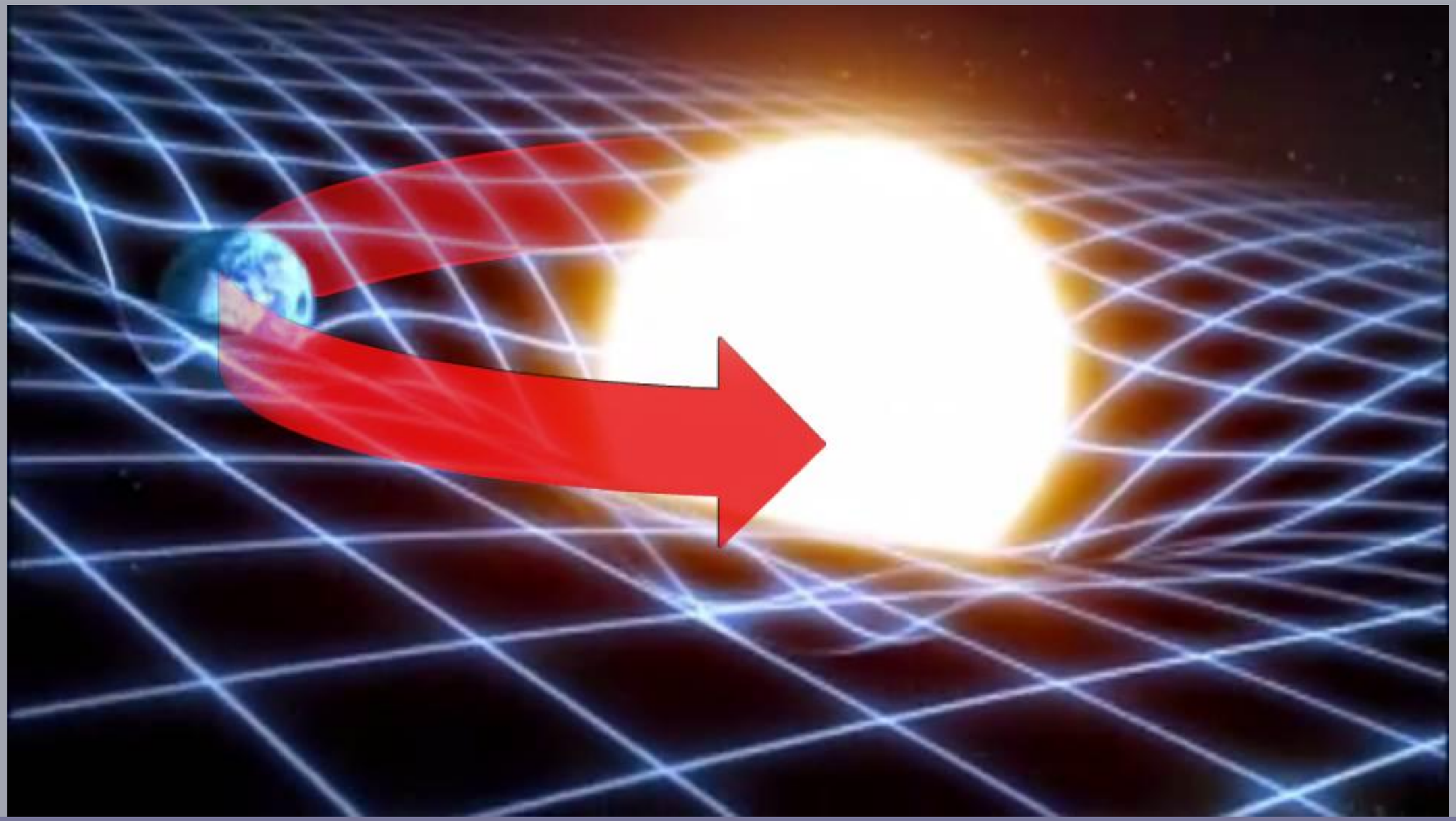
Christopher Berry



Gravity

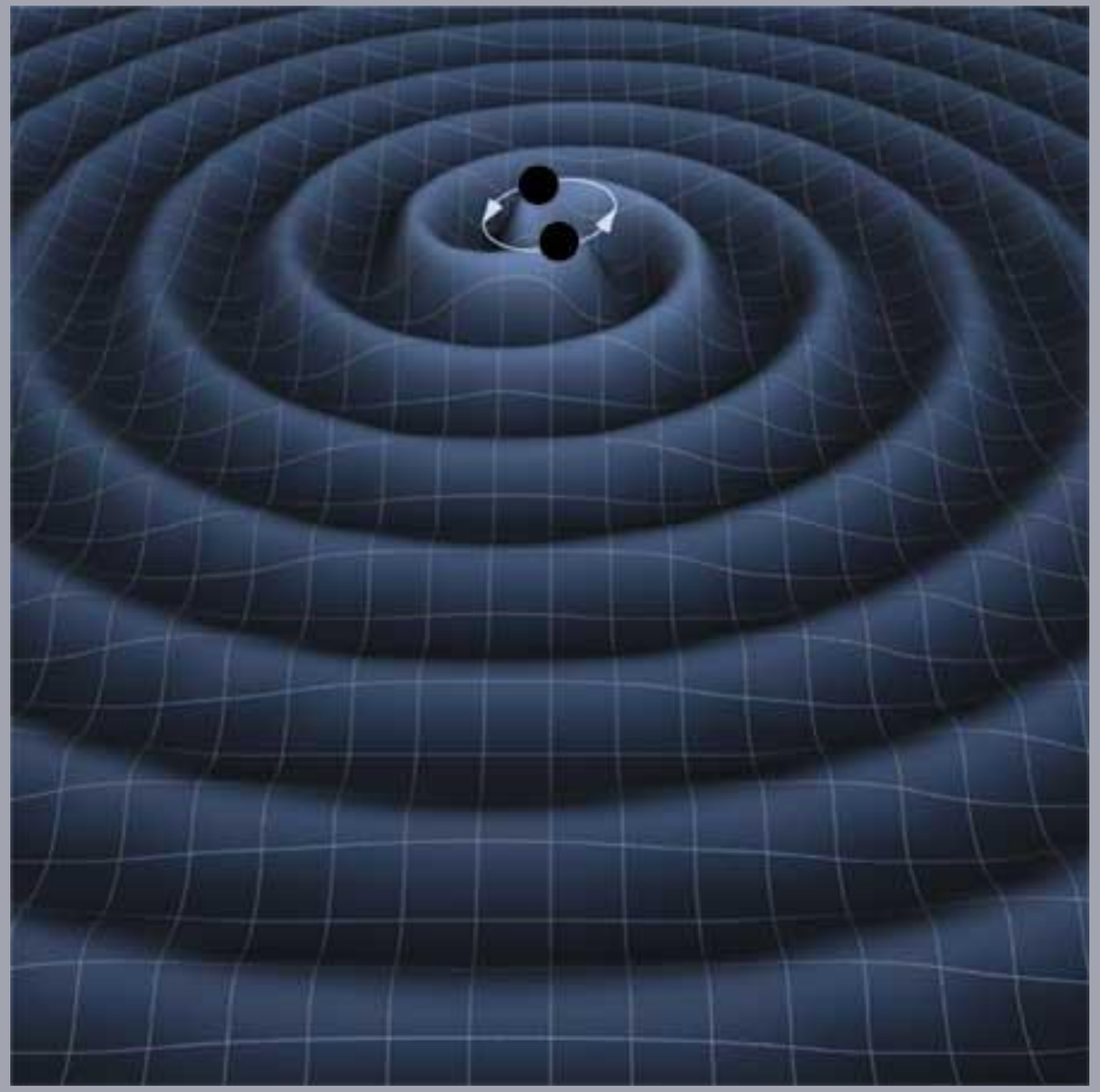


Gravitation



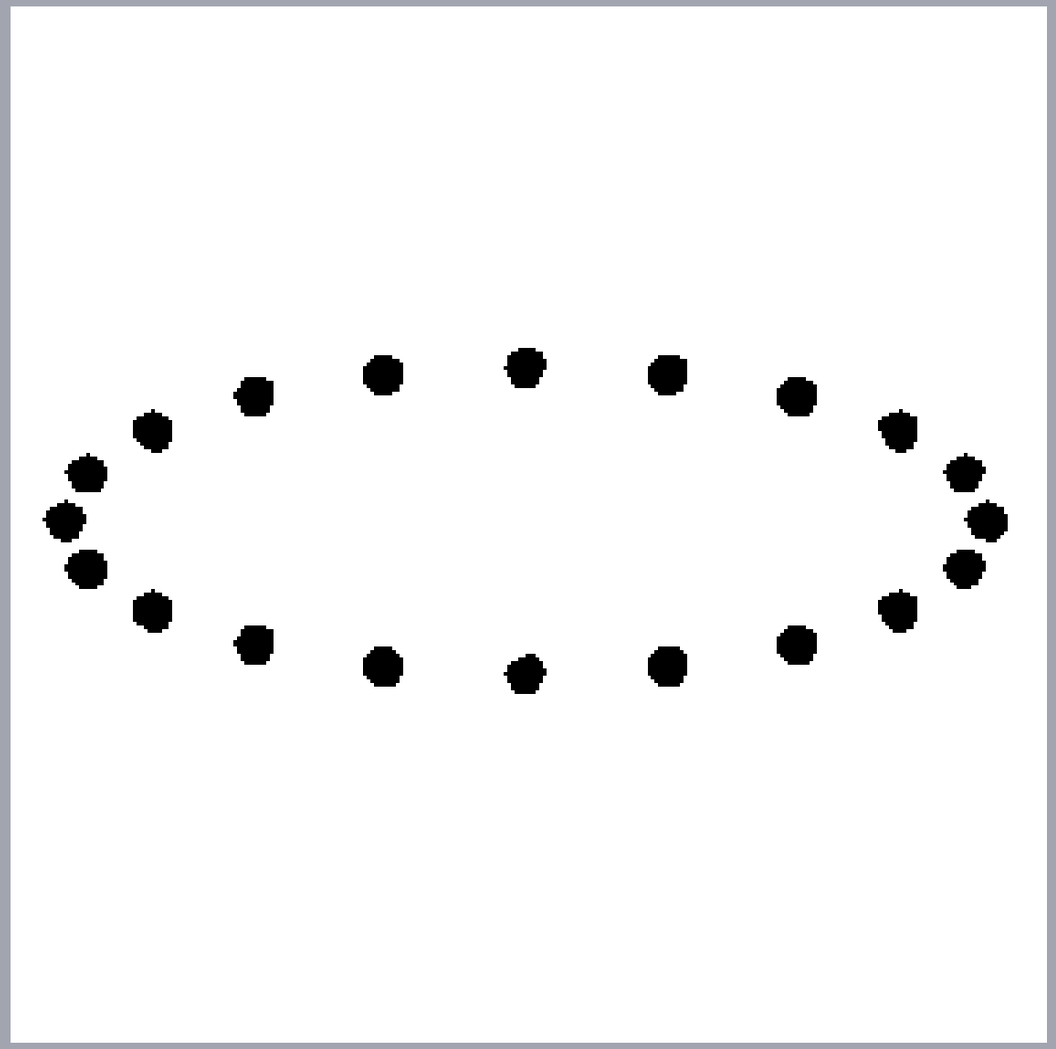
Credit: WGBH Boston

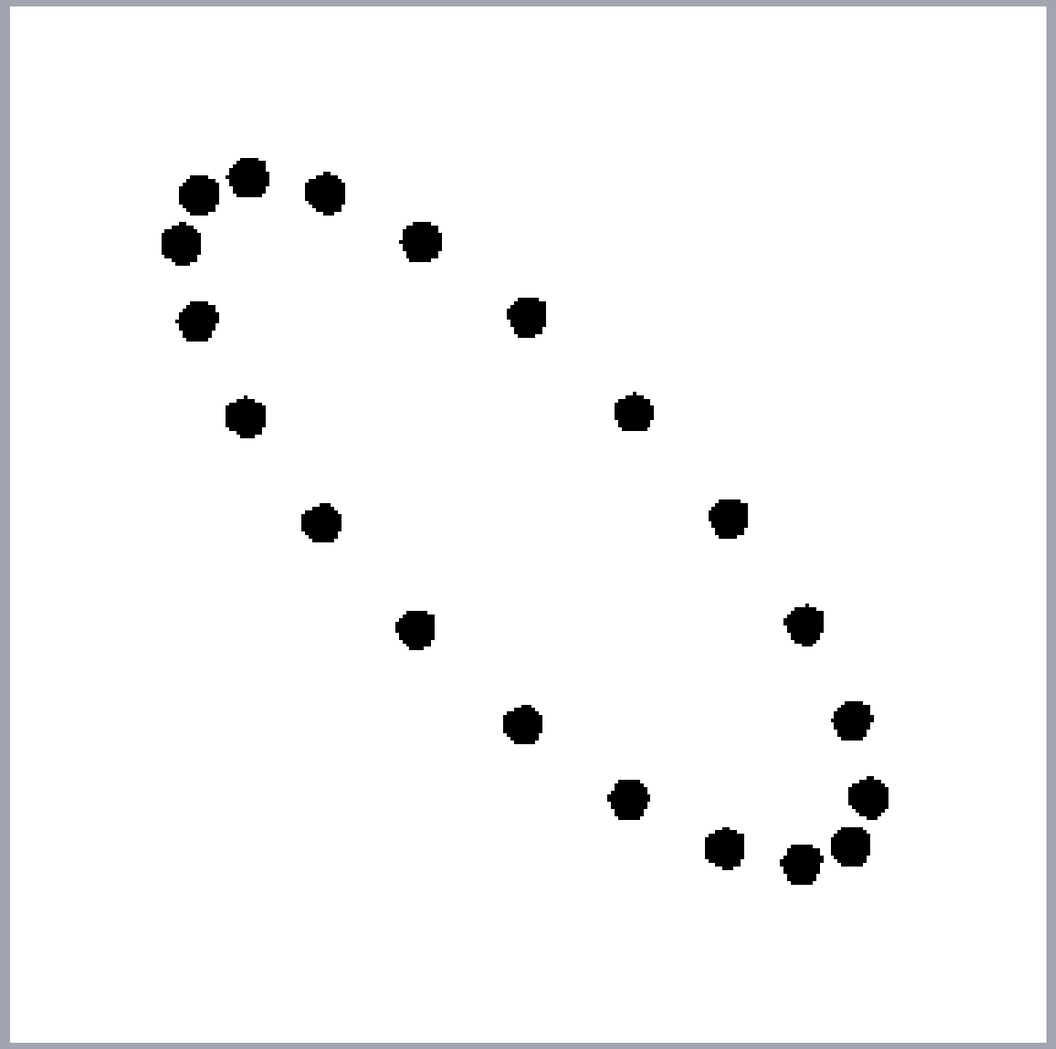
Gravitational waves



Credit: T. Carnahan

Gravitational waves

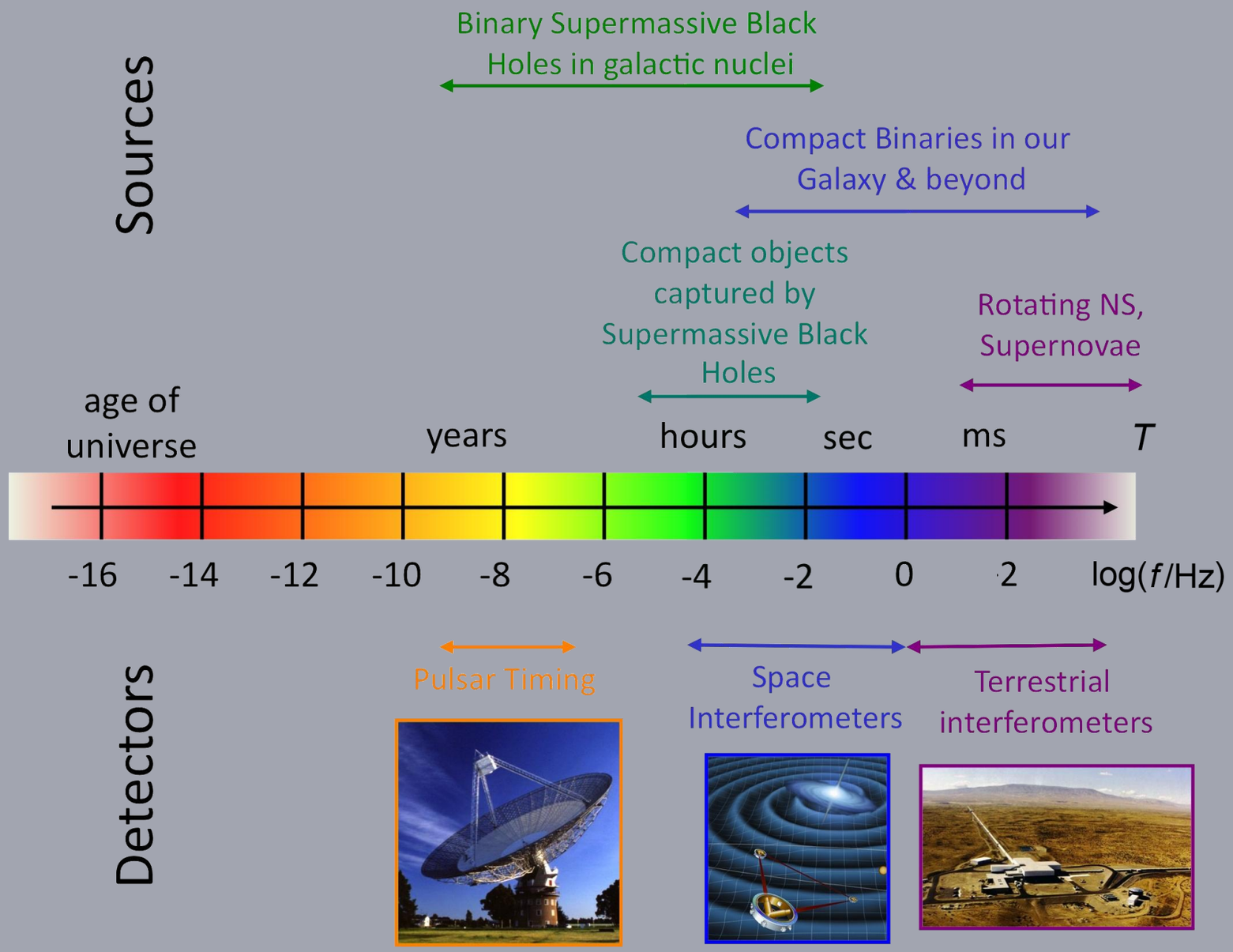




Detectors

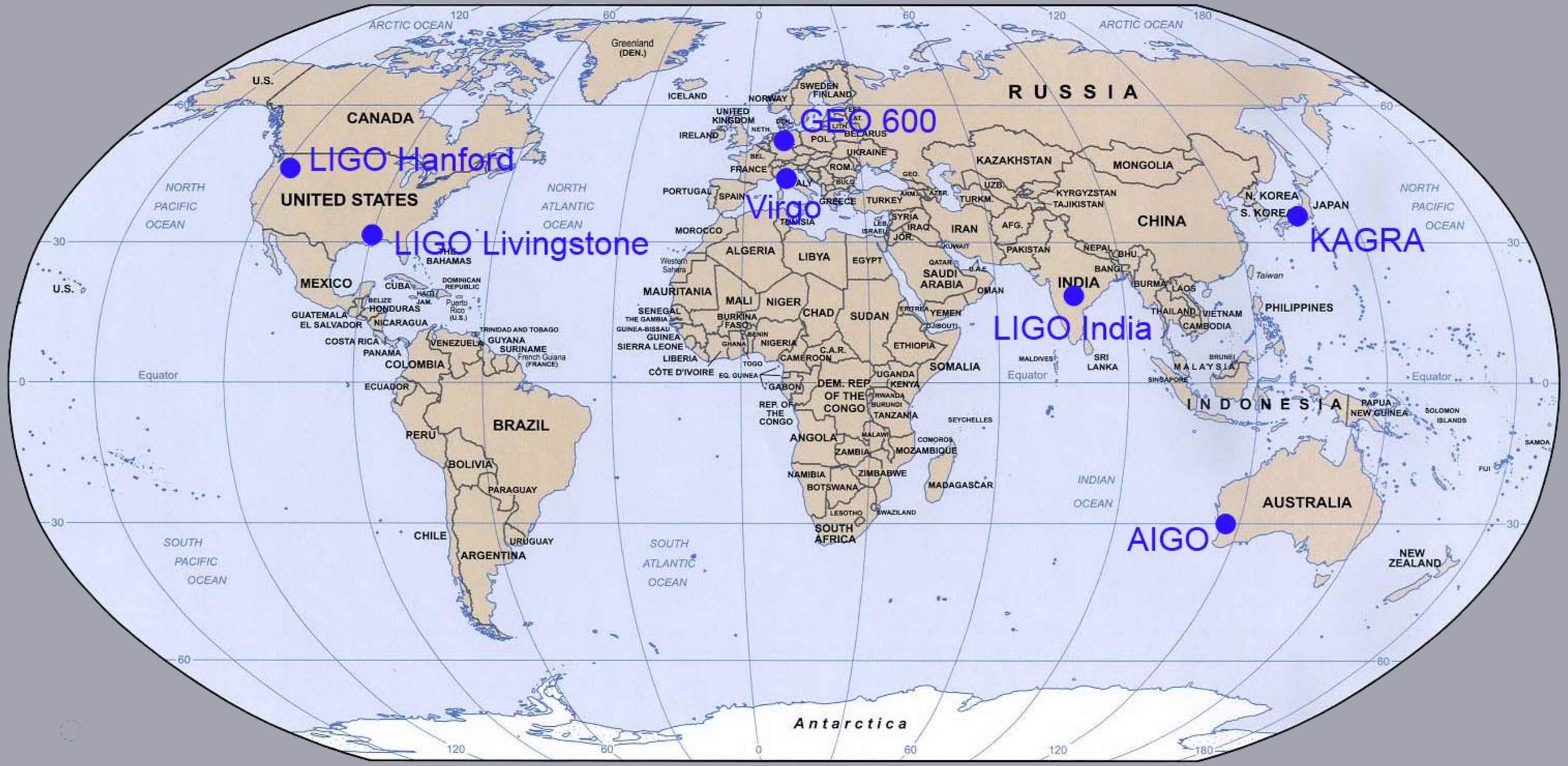
Credit: LIGO, Caltech, NSF

Spectrum

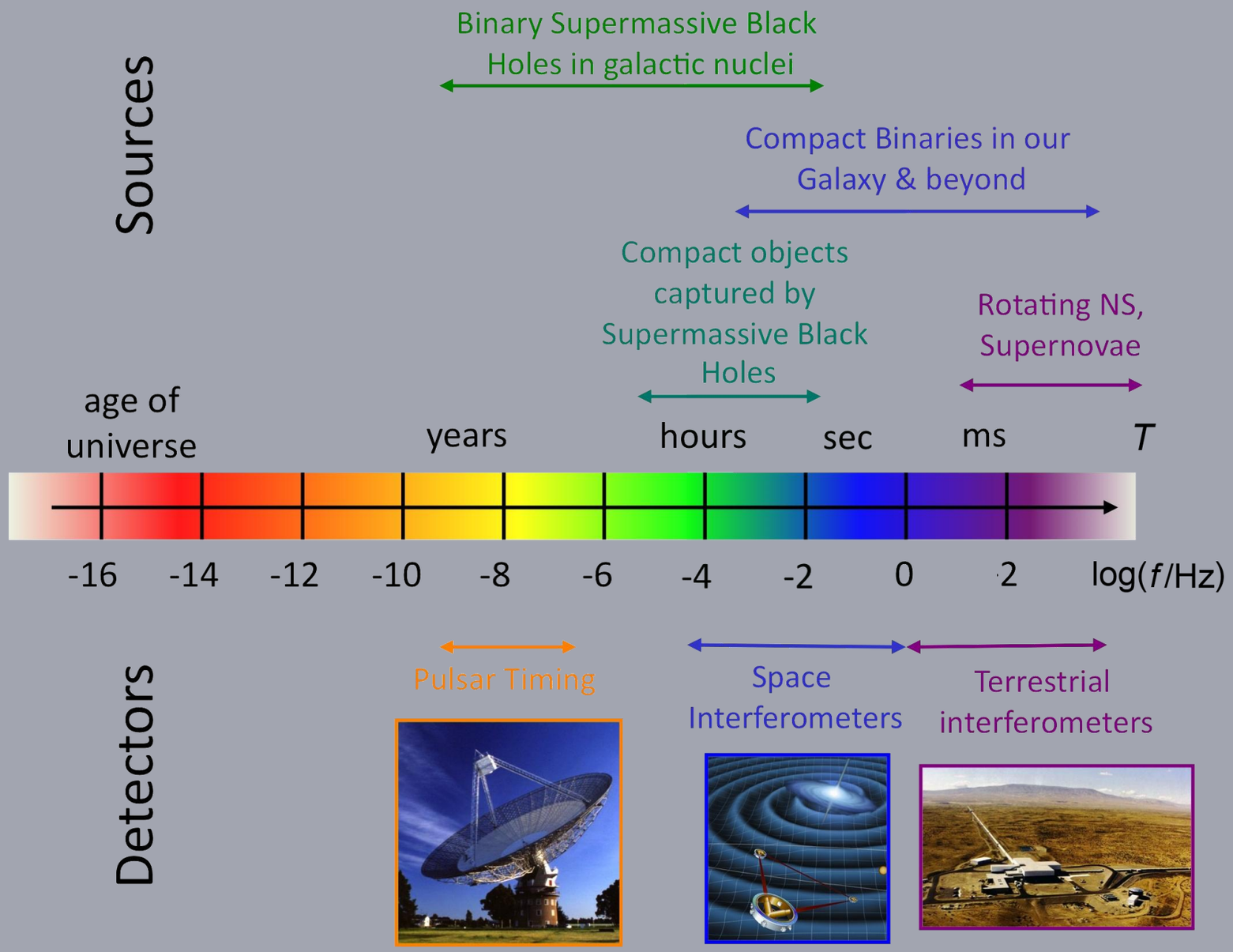


Credit: NASA

Ground-based detectors

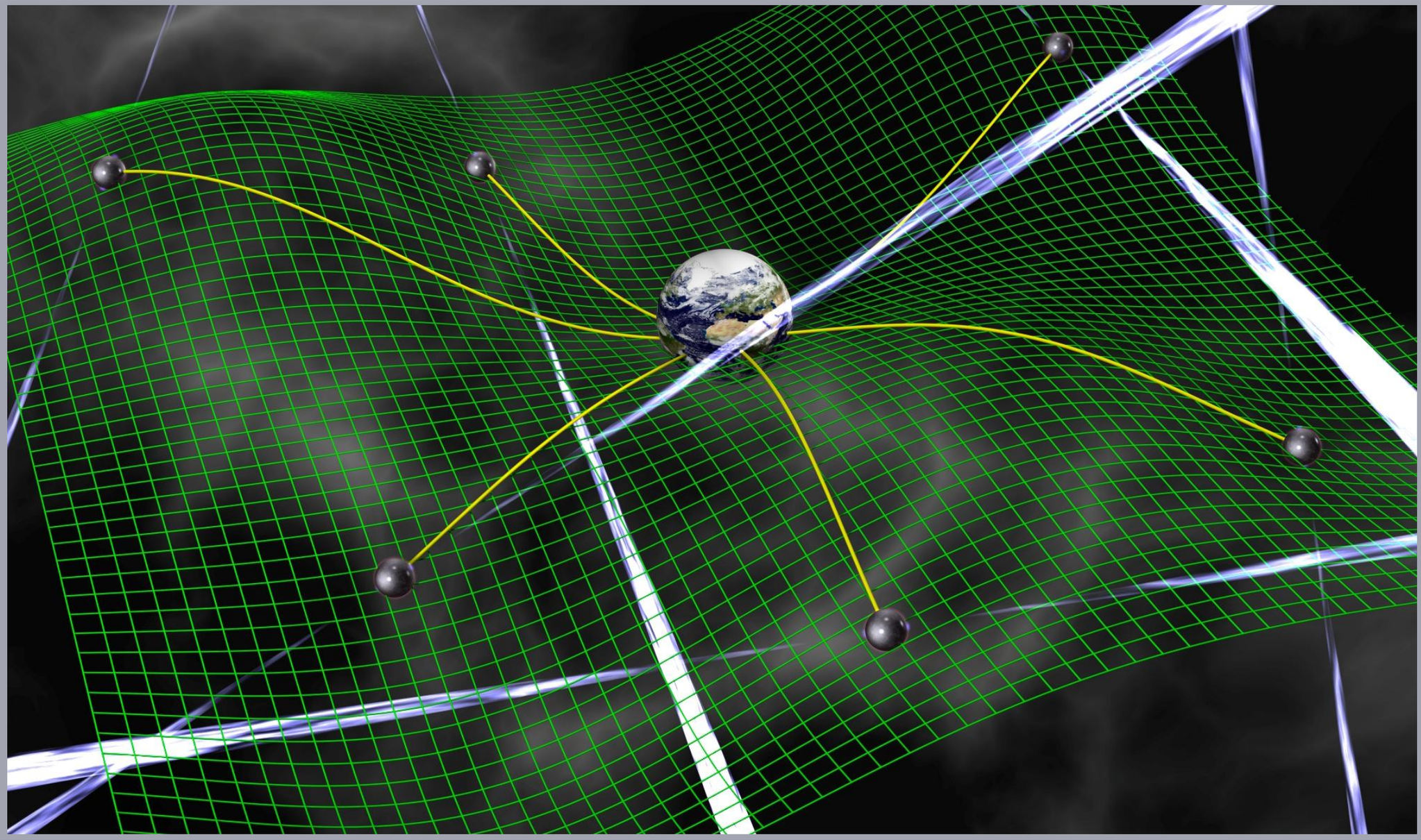


Spectrum



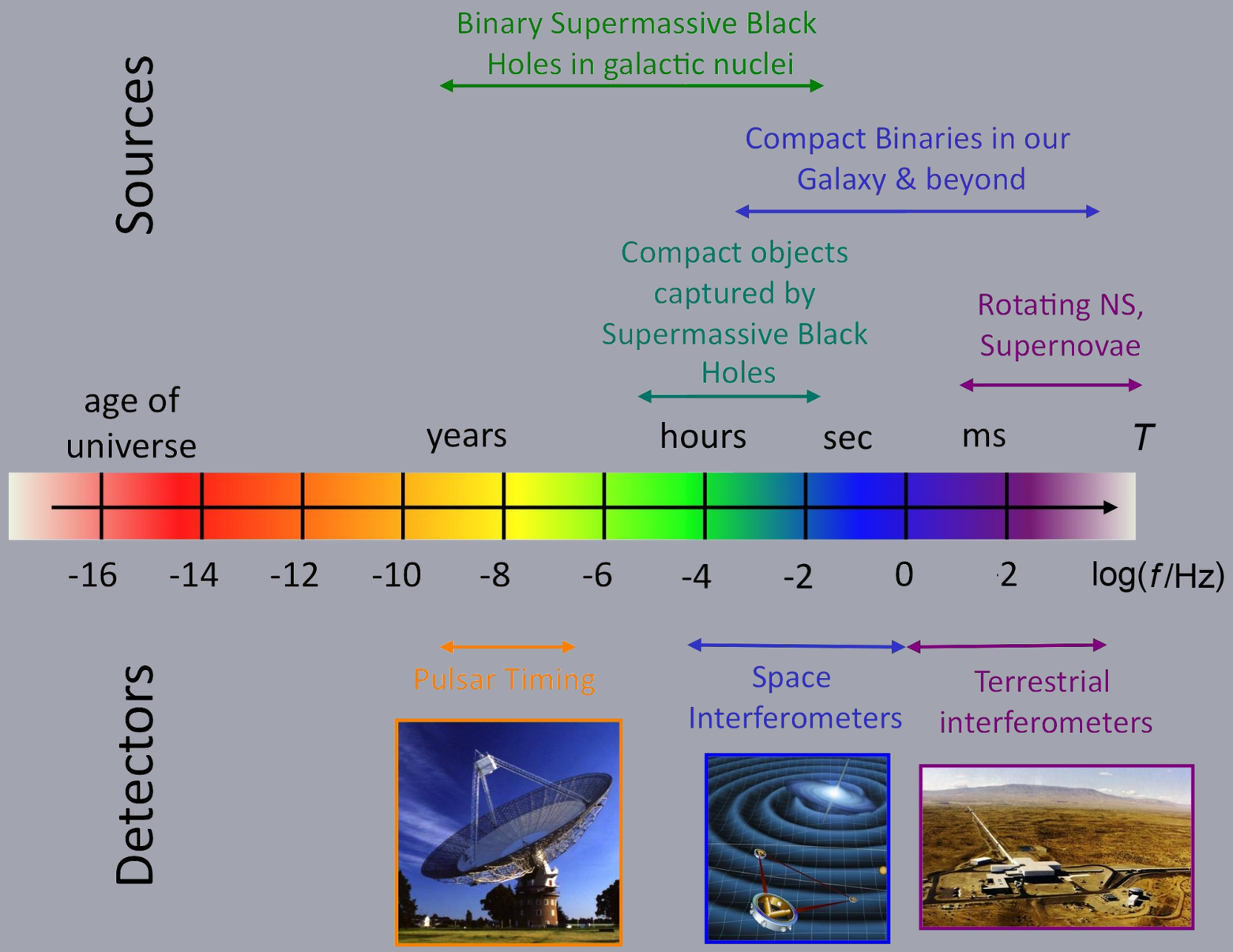
Credit: NASA

Pulsar timing array



Credit: David Champion

Spectrum

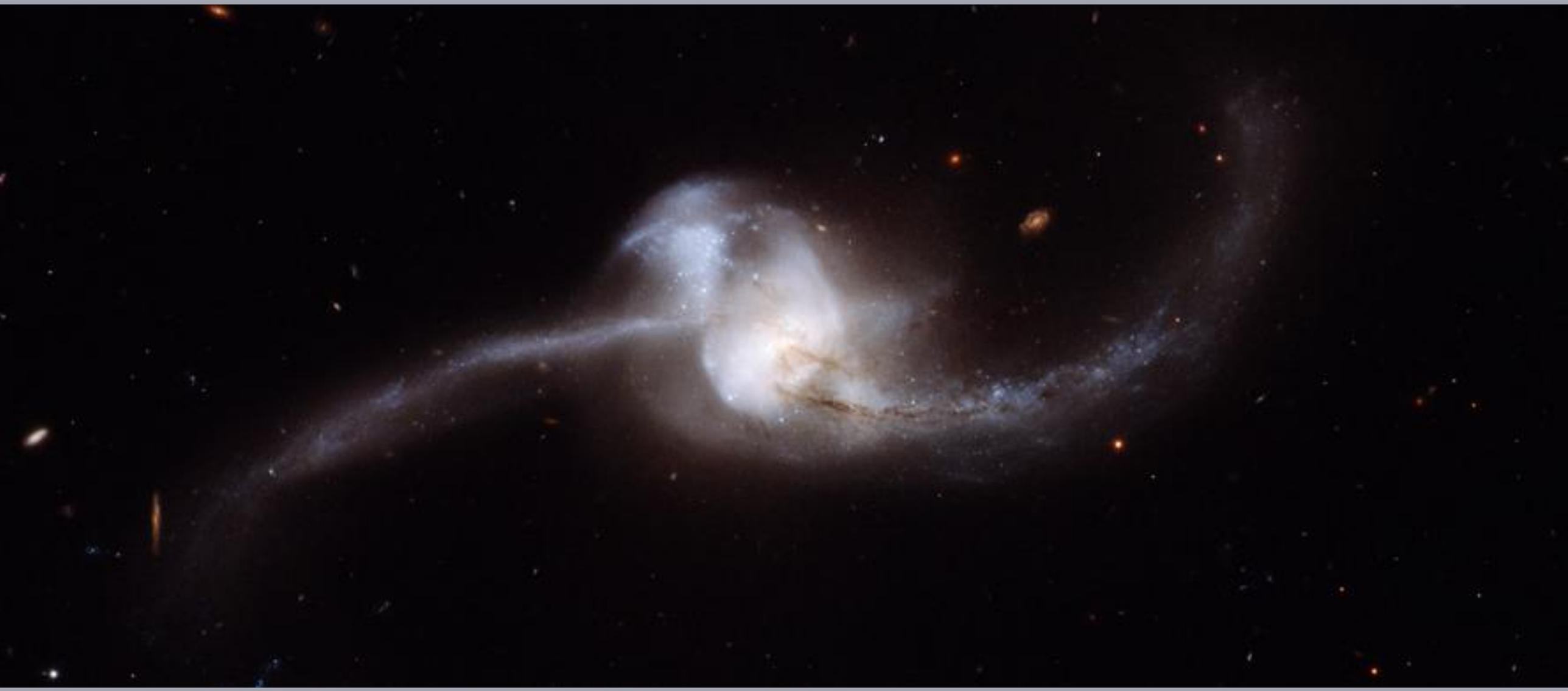


Credit: NASA

Supermassive black holes

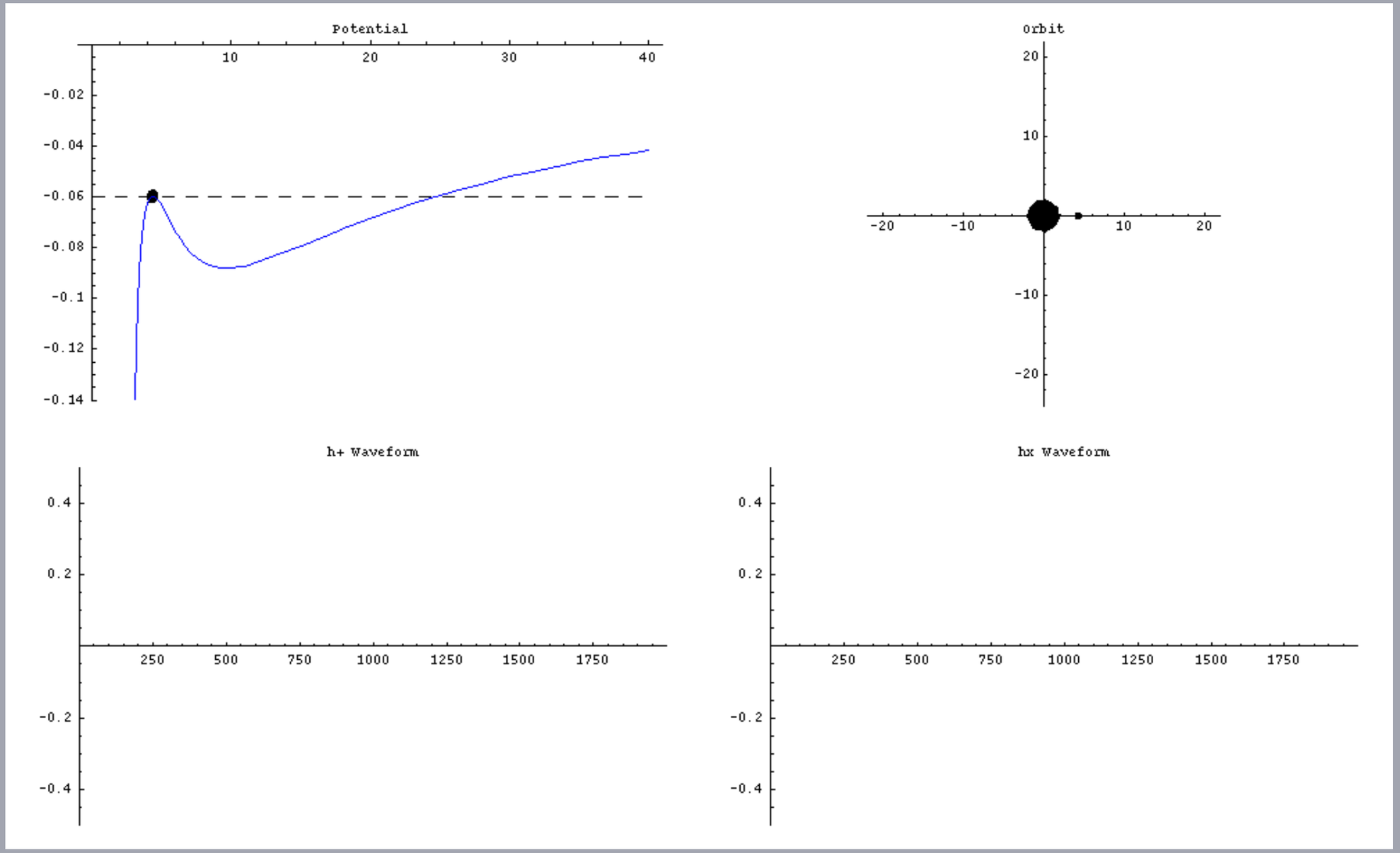
Credit: ESO/
S. Gillessen and
B. Gilli

Mergers



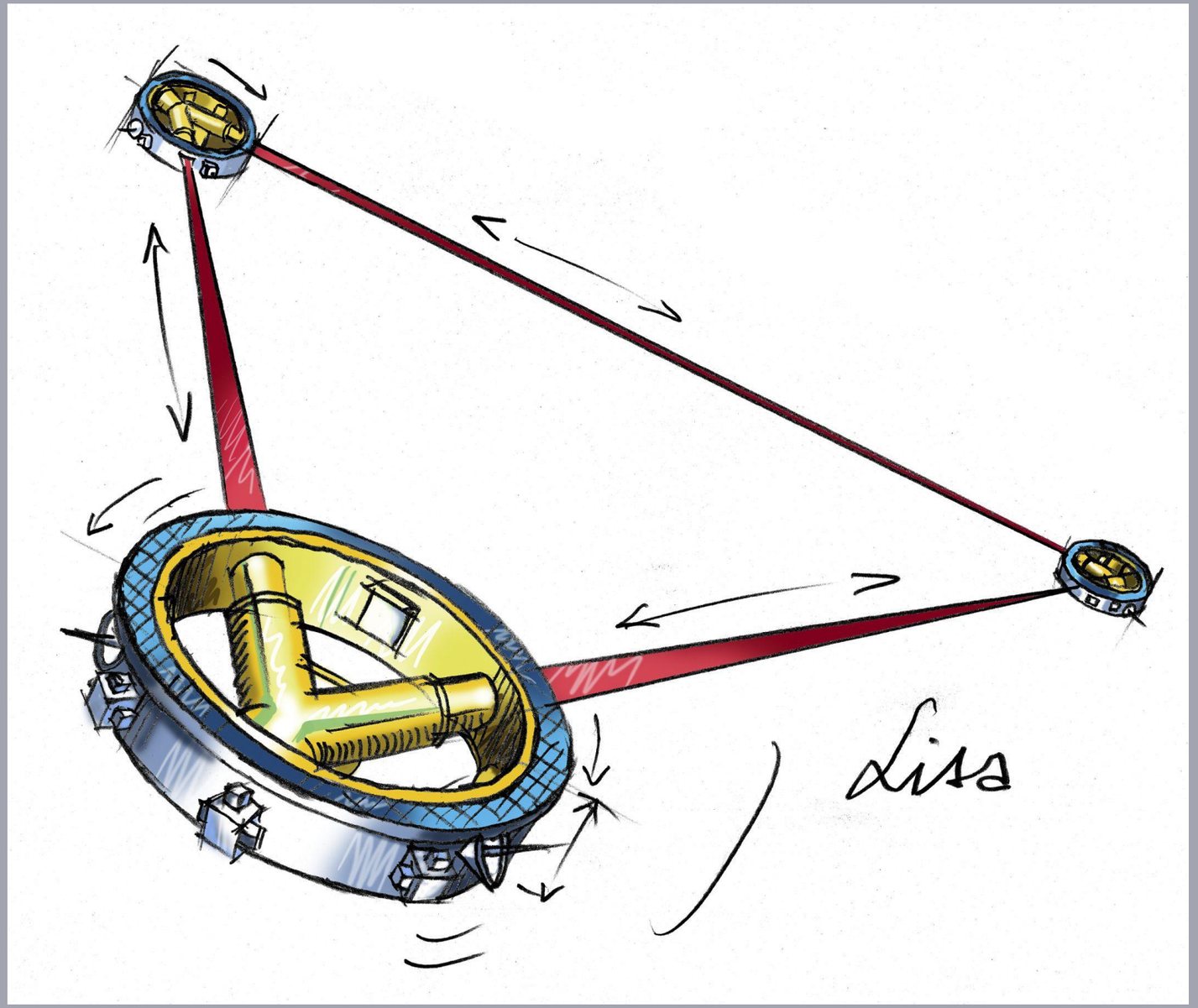
Credit: NASA, ESA and A. Evans

Extreme-mass-ratio events



Credit: J. Gair

Space-based detector



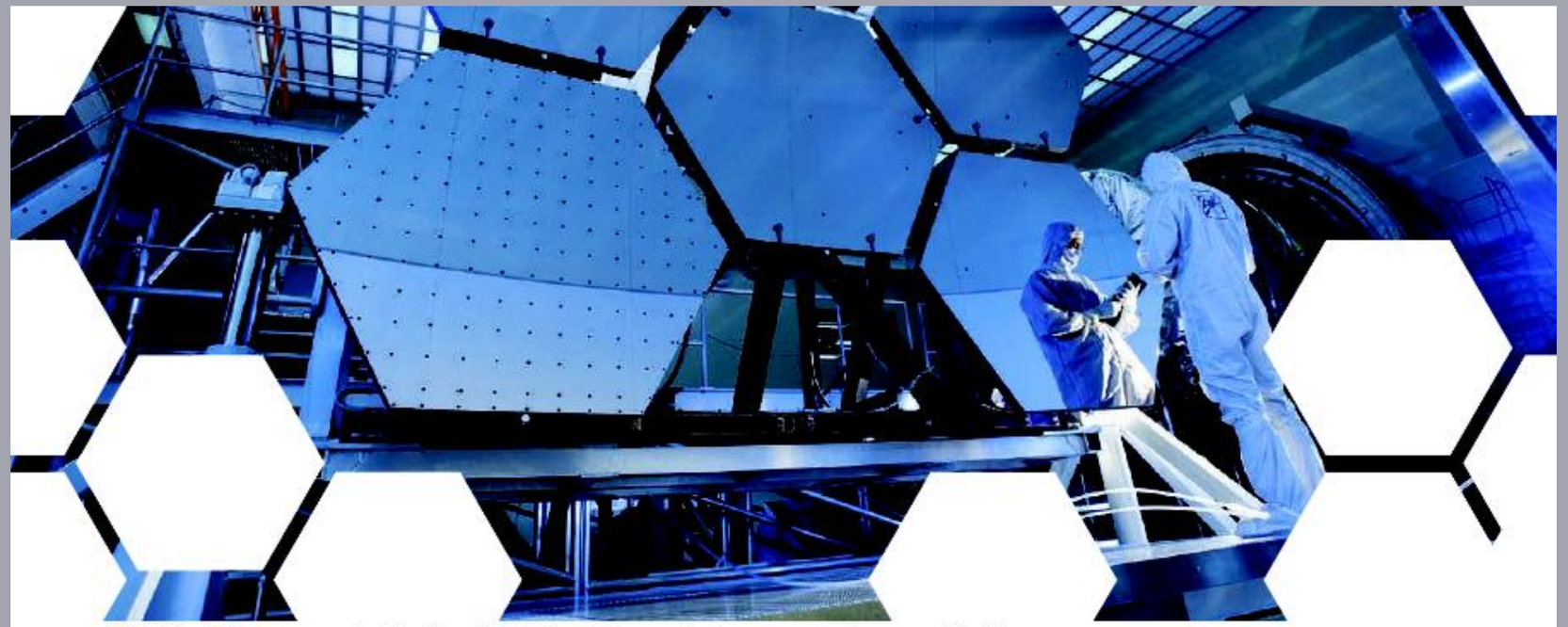
Laser Interferometer Space Antenna

(LISA)

LISA history

1974	First discussions in US
1984	Laser Antenna for Gravitational-wave Observations in Space (NASA)
1993	LISA proposed for ESA's Horizon 2000 study
1996	Chosen as ESA cornerstone mission (launch 2017-2023)
1997	Joint NASA-ESA design (launch 2005-2010)
2000	US Decadal Review: LISA ranked 2nd
2001	LISA Pathfinder begins
2004	Formal NASA-ESA agreement (launch 2012-2013)
2010	US Decadal Review: LISA ranked 3rd (launch 2017-2023)
2011	NASA pulls out. ESA continues with New Gravitational-wave Observatory (launch 2022-2023)

What went wrong?



A NASA technician prepares six of the James Webb Space Telescope's mirror segments for cryogenic testing.

THE TELESCOPE THAT ATE ASTRONOMY

NASA's next-generation space observatory promises to open new windows on the Universe — but its cost could close many more.

BY LEE BILLINGS

It has to work — for astronomers, there is no plan B. NASA's James Webb Space Telescope (JWST), scheduled to launch in 2014, is

the JWST — named after the administrator who guided NASA through the development of the Apollo missions — fails, the progress of astronomy could be set back by a generation.

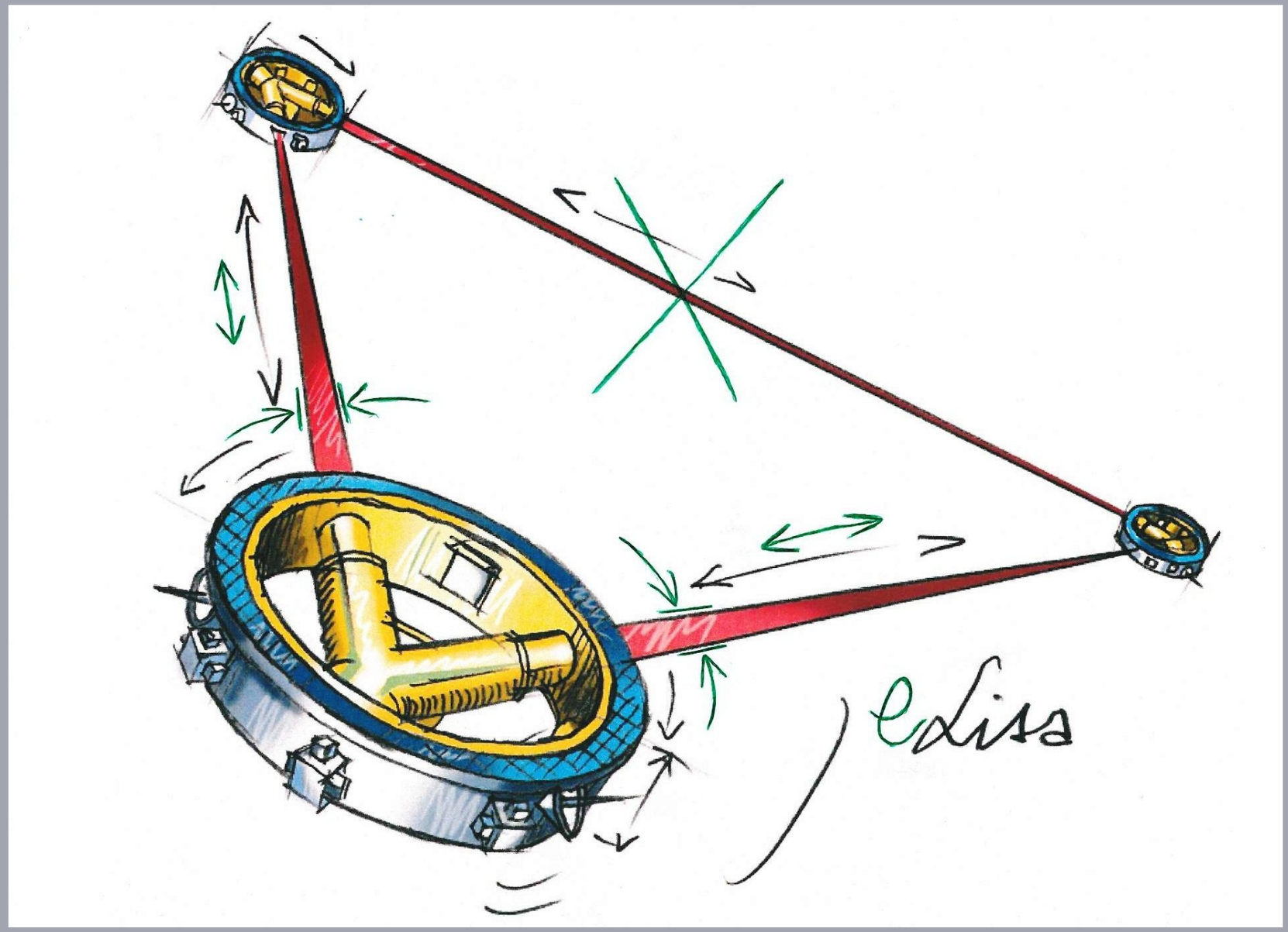
HAM/E. GIVEN

Credit: Nature

NGO/eLISA

evolved
Laser
Interferometer
Space
Antenna

(eLISA)



LISA history

1974	First discussions in US
1984	Laser Antenna for Gravitational-wave Observations in Space (NASA)
1993	LISA proposed for ESA's Horizon 2000 study
1996	Chosen as ESA cornerstone mission (launch 2017-2023)
1997	Joint NASA-ESA design (launch 2005-2010)
2000	US Decadal Review: LISA ranked 2nd
2001	LISA Pathfinder begins
2004	Formal NASA-ESA agreement (launch 2012-2013)
2010	US Decadal Review: LISA ranked 3rd (launch 2017-2023)
2011	NASA pulls out. ESA continues with New Gravitational-wave Observatory (launch 2022-2023)
2012	ESA chooses JUICE for L1 mission.
2013	???

Prospects

Despite not being selected, NGO was unanimously ranked 1st by ESA's scientific review committee in terms of:

- Scientific interest
- Strategic value for science
- Strategic value for the projects in Europe

LISA Pathfinder still funded, and scheduled for launch in 2014.

LISA Pathfinder

Credit:
Astrium

Prospects

Despite not being selected, NGO was unanimously ranked 1st by ESA's scientific review committee in terms of:

- Scientific interest
- Strategic value for science
- Strategic value for the projects in Europe

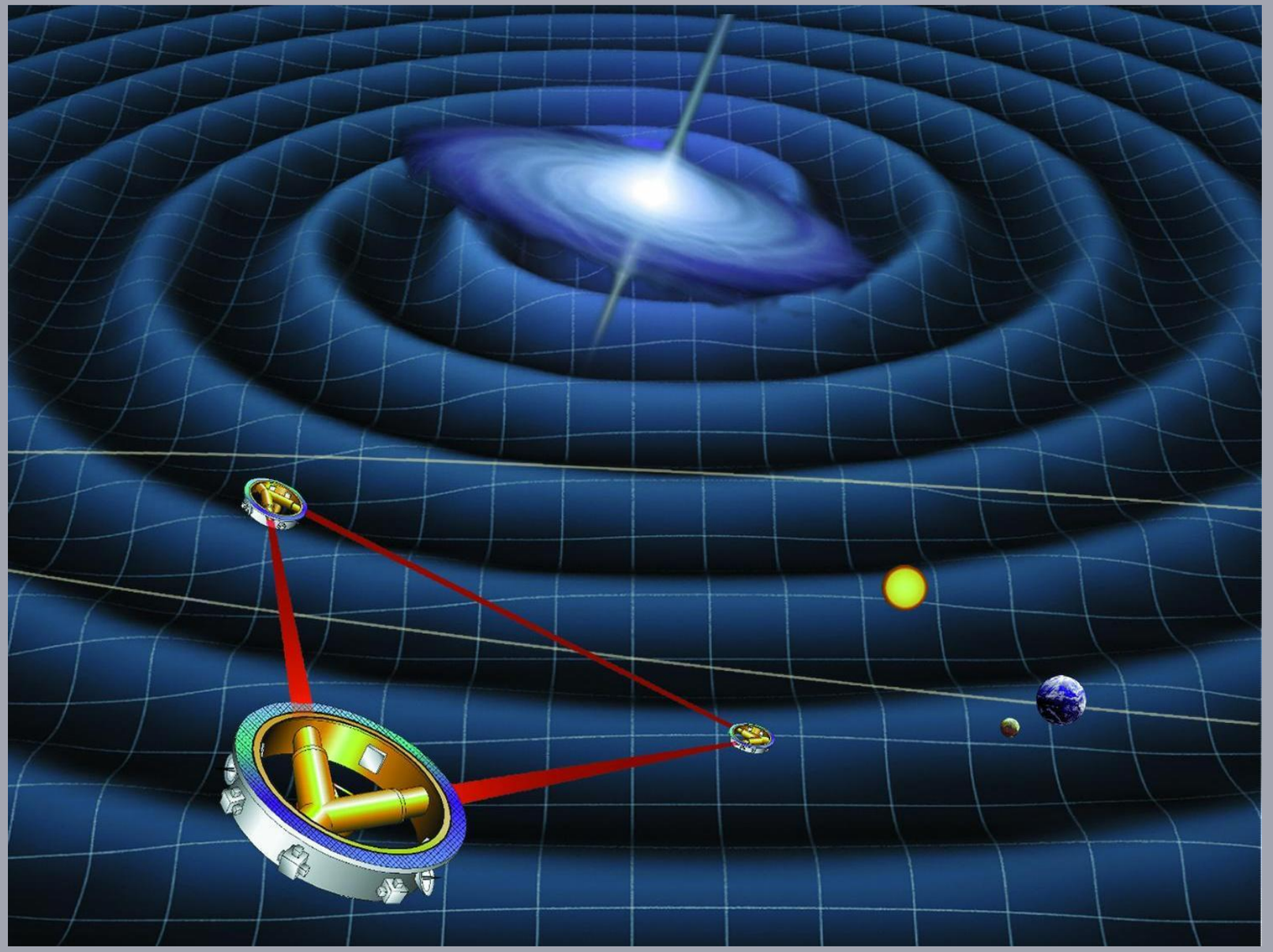
LISA Pathfinder still funded, and scheduled for launch in 2014.

Chinese potentially willing to contribute to an ESA mission.

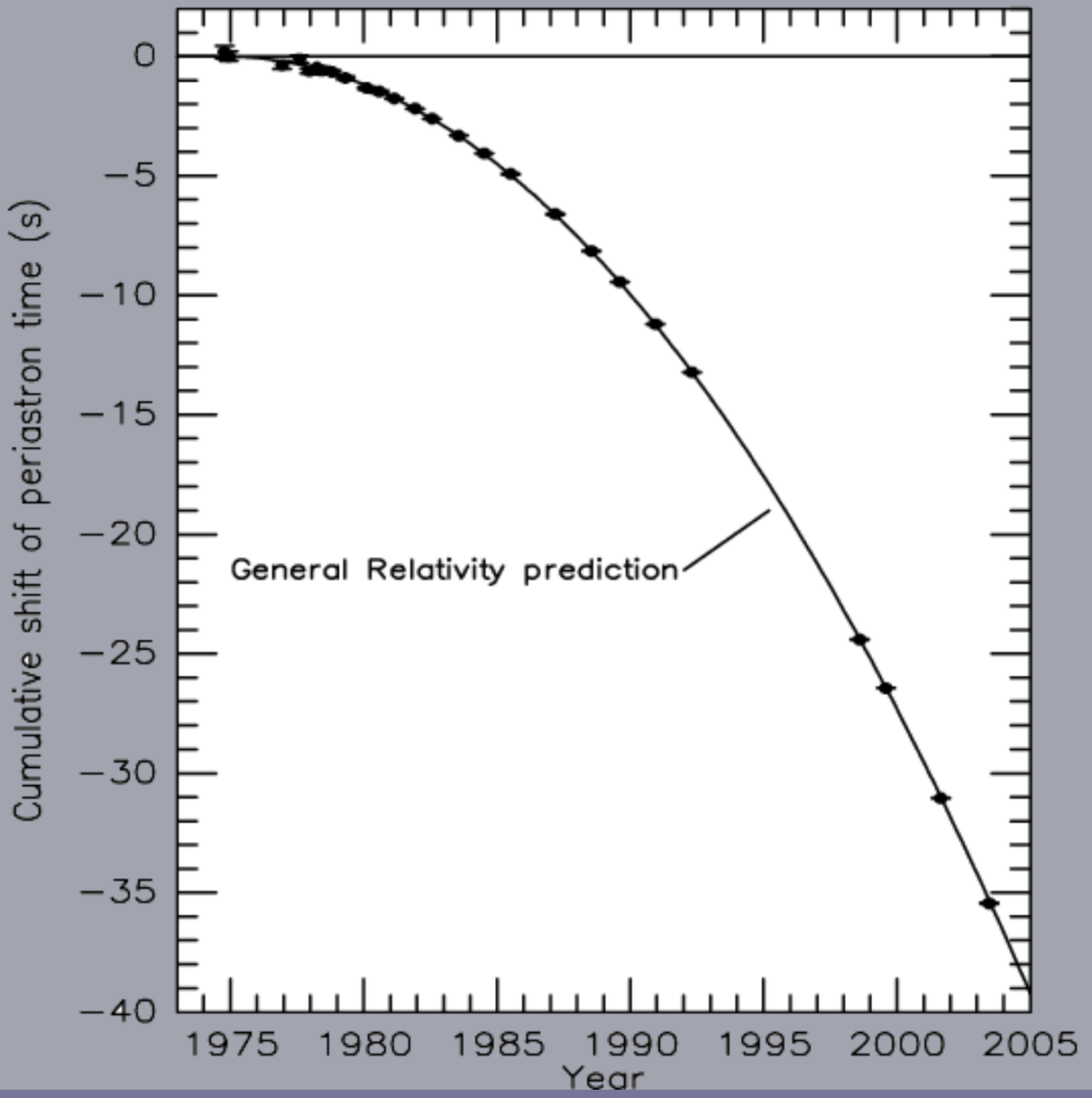
Old friends or new?

Credit: Freaking News

Gravitational waves in space?

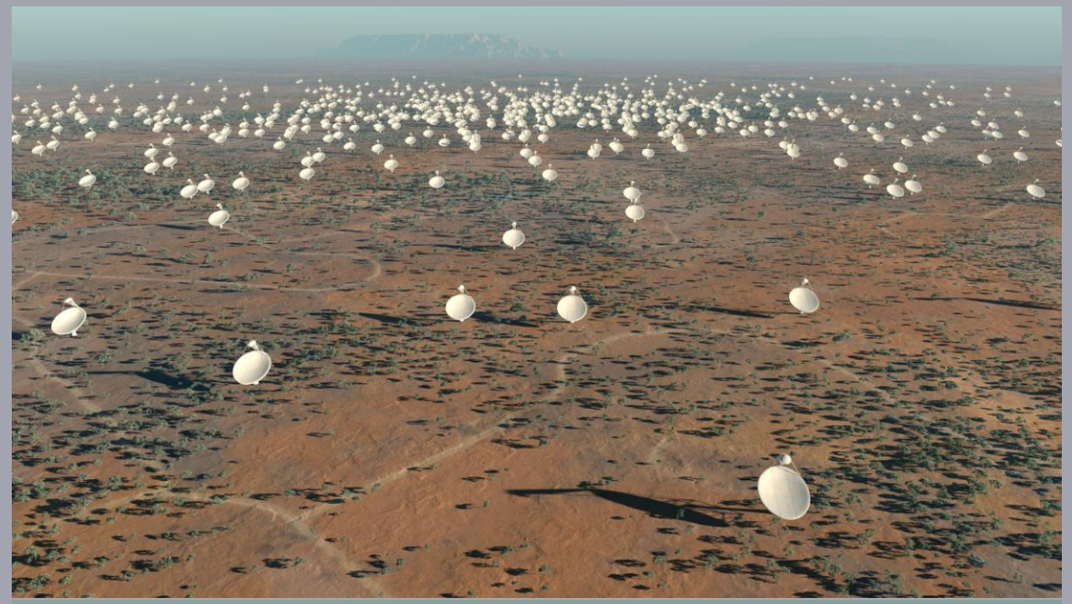


Binary Pulsar



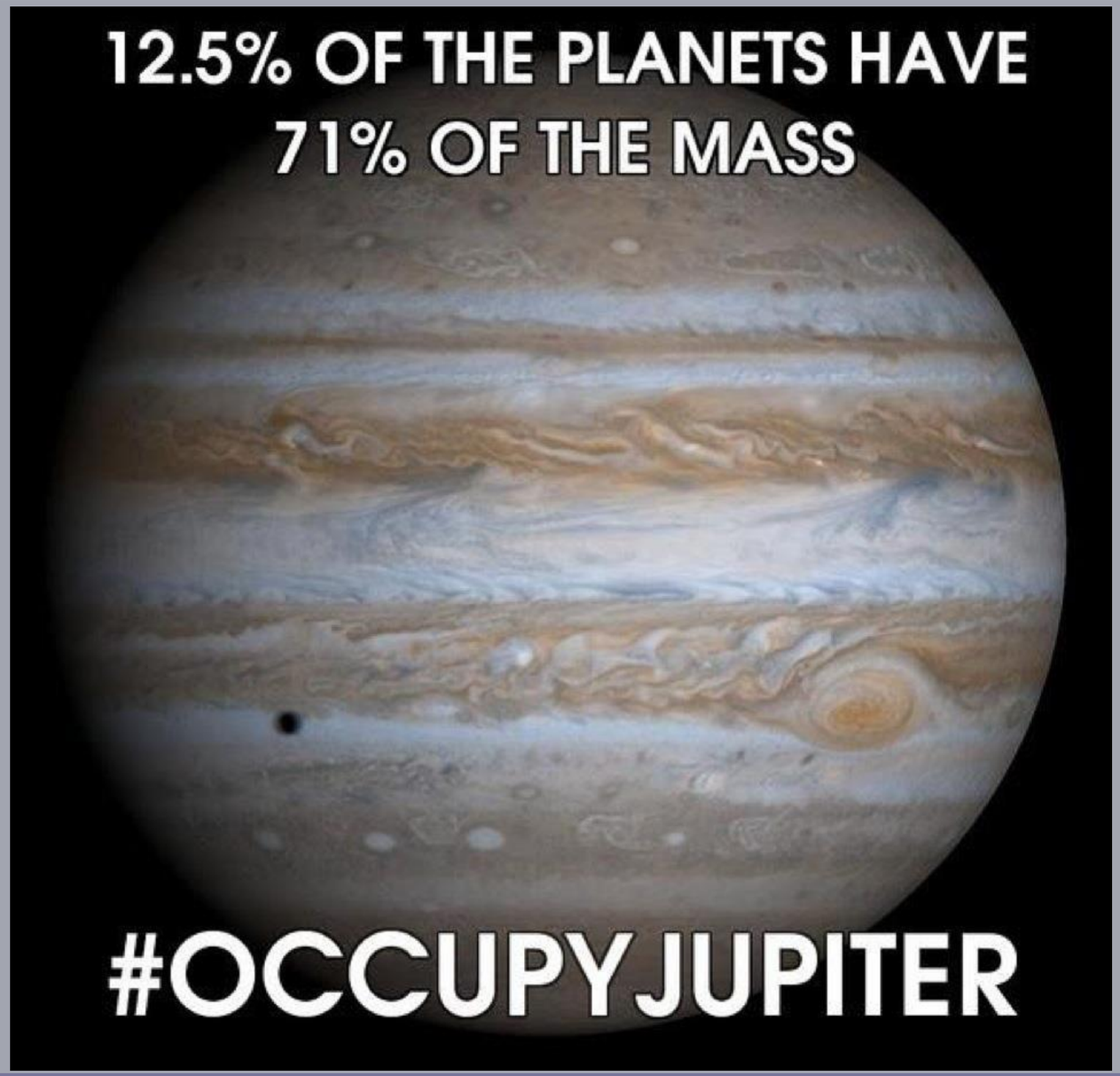
Credit:
Weisberg &
Taylor

Square Kilometre Array



Credit: SKA Organisation/ Swinburne Astronomy

JUICE



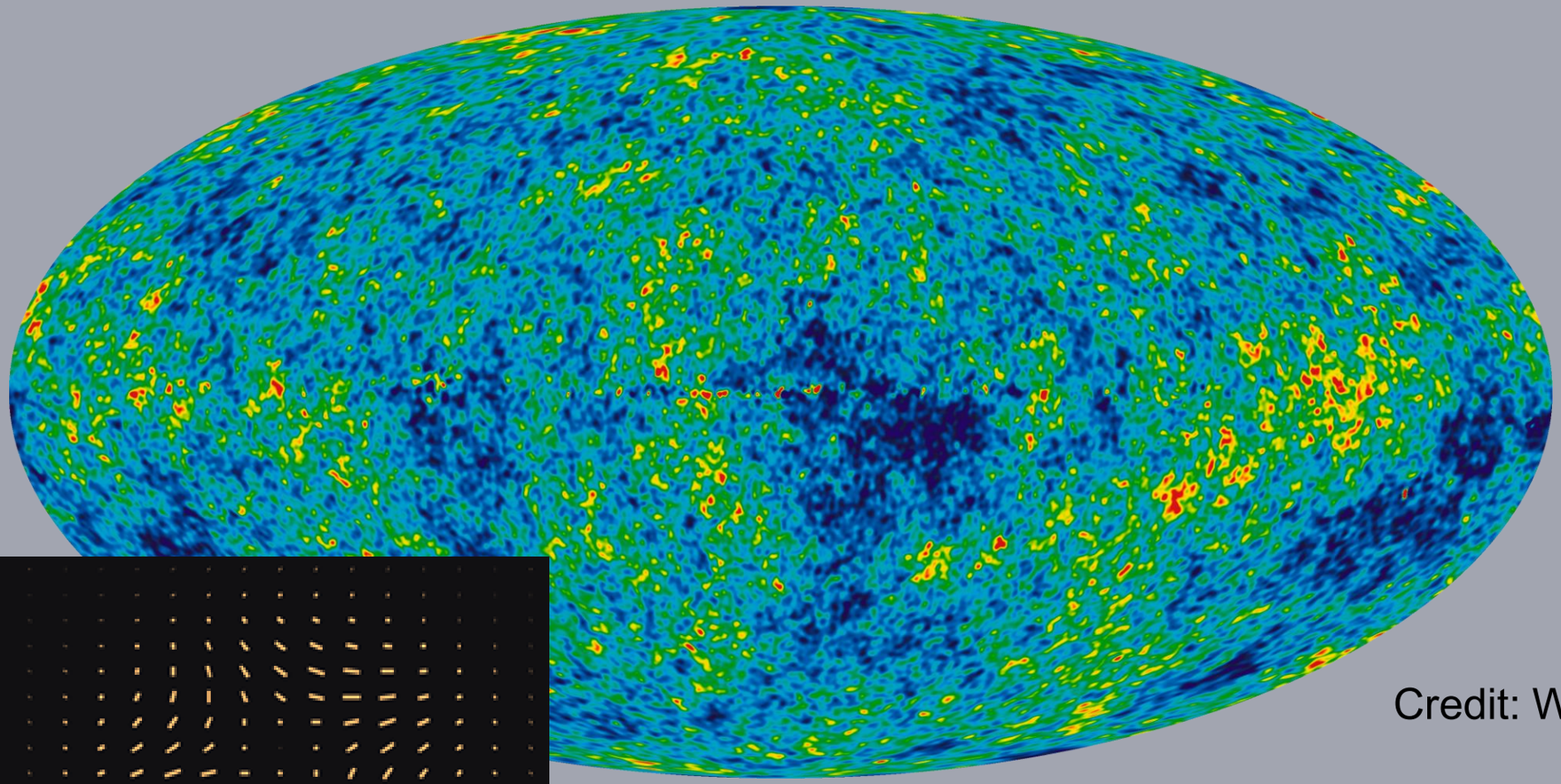
No-hair Conjecture

Black hole properties:

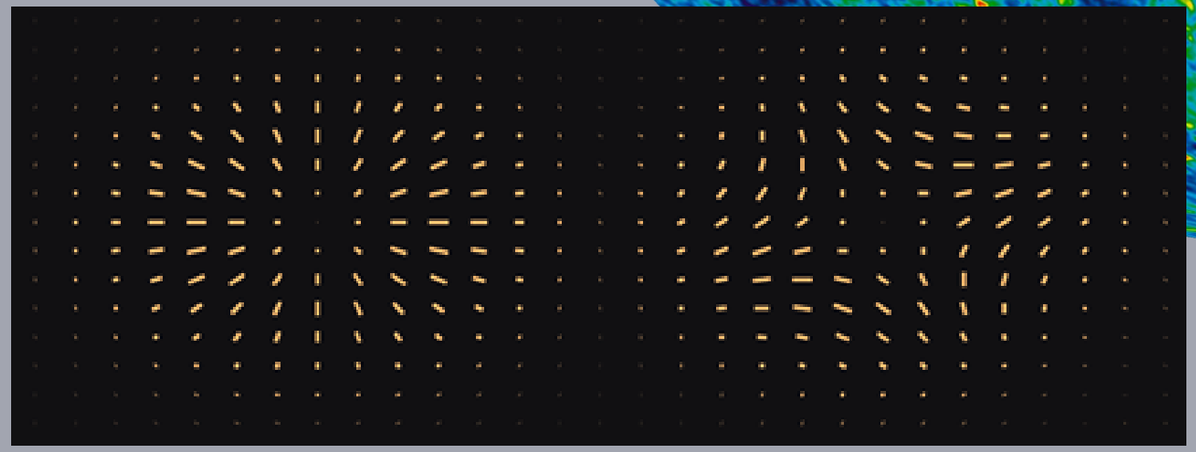
1. Mass
2. Spin
3. Charge (ignorable)

No other hair!

Cosmic Microwave Background



Credit: WMAP



Credit: B-Pol