

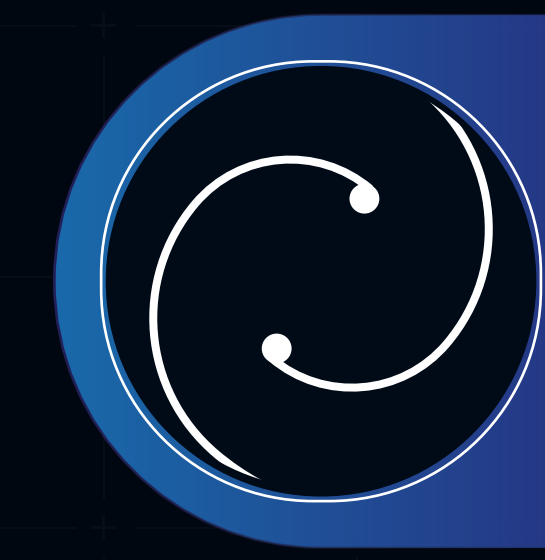
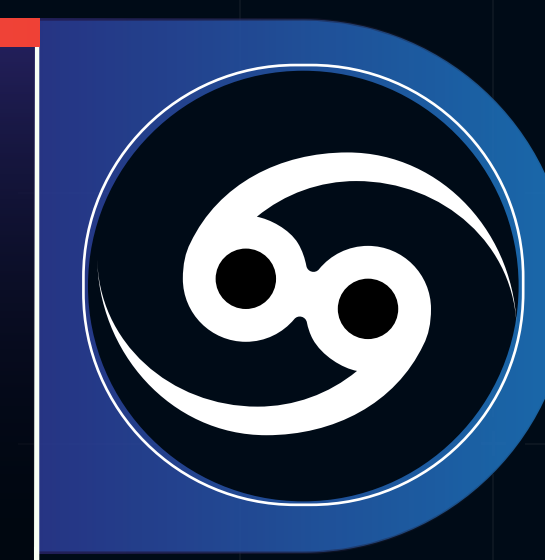
THE GRAVITATIONAL WAVE SPECTRUM

Gravitational waves are ripples in space-time traveling at light speed. They're created when massive objects accelerate. Different phenomena produce ripples with wavelengths ranging from a few miles to larger than the observable universe. The general range of waves from some sources are shown here. Merging objects emit ever shorter wavelengths as they spiral inward. Pairs of stellar-mass objects include combinations of black holes, neutron stars, and white dwarfs.

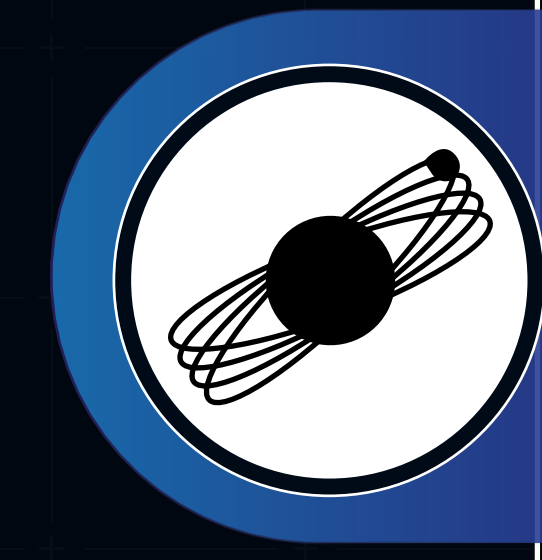
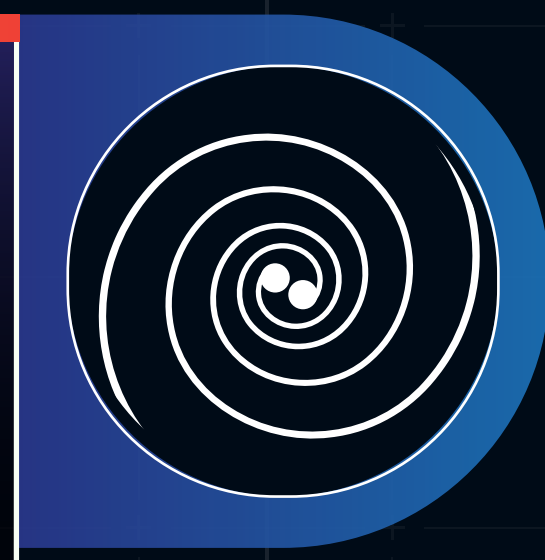
Scientists need different detectors to explore these wavelengths, from human-made facilities on the ground and in space to galaxy-sized pulsar timing arrays – sets of rapidly rotating neutron stars monitored for changes. Details in the cosmic microwave background (CMB), the oldest light in the universe, can reveal gravitational waves generated less than a trillionth trillionth of a second after the big bang.



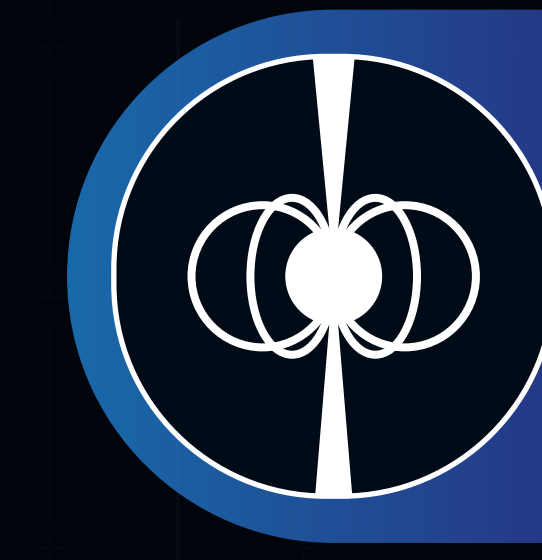
SUPERMASSIVE BLACK HOLE PAIRS



CLOSE PAIRS OF STELLAR-MASS OBJECTS



MIXED PAIRS OF SUPERMASSIVE & STELLAR-MASS BLACK HOLES



PULSARS & SUPERNOVAE



BIG BANG

VIRGO SUPERCLUSTER SIZE
1.15 SEXTILLION MILES

TO ANDROMEDA GALAXY
15 QUINTILLION MILES

MILKY WAY SIZE
620 QUADRILLION MILES

TO PROXIMA CENTAURI
25 TRILLION MILES

SUN TO PLUTO
4 BILLION MILES

SUN TO EARTH
93 MILLION MILES

EARTH SIZE
8,000 MILES

HALLEY'S COMET MEAN SIZE
7 MILES

SEXTILLIONS

QUINTILLIONS

QUADRILLIONS

TRILLIONS

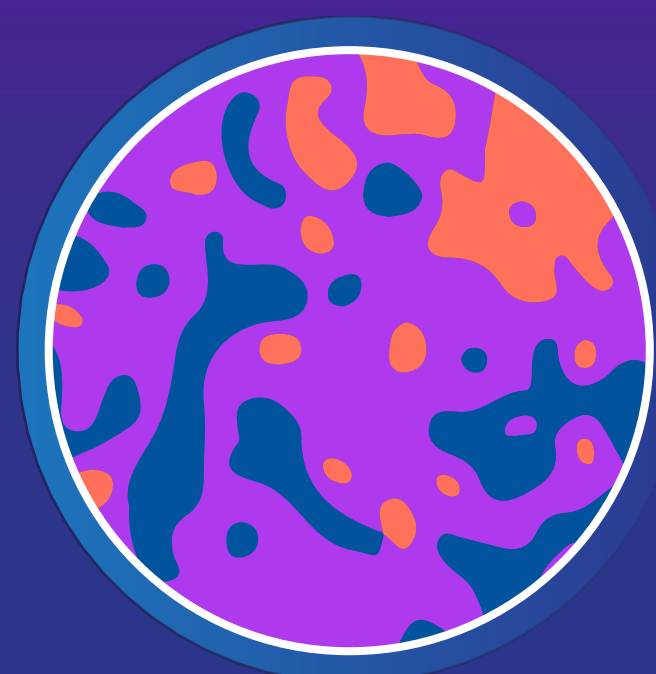
BILLIONS

MILLIONS

THOUSANDS

WAVELENGTH (MILES)

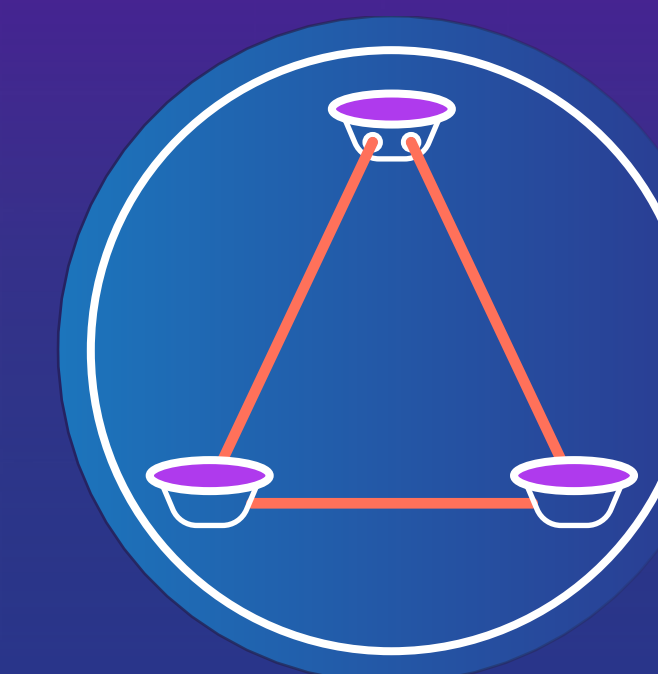
C M B



P U L S A R
T I M I N G
A R R A Y S



S P A C E - B A S E D
D E T E C T O R S



T E R R E S T R I A L
D E T E C T O R S

