



Einstein@Home Volunteer Project



*Searching for gravitational waves from
stars and black holes*

Einstein@Home Goal

Searching for gravitational waves

Einstein@Home Scientific Research

(<http://einsteinathome.org>)

The Einstein@Home Project

Einstein revolutionized our understanding of the universe and set the course for physics research in the twentieth century. Now, 50 years after his death and 100 years after his Special Theory of Relativity was published, we have the chance to confirm one of Einstein's most important predictions. But we need your help – read on to find out why you should get involved.

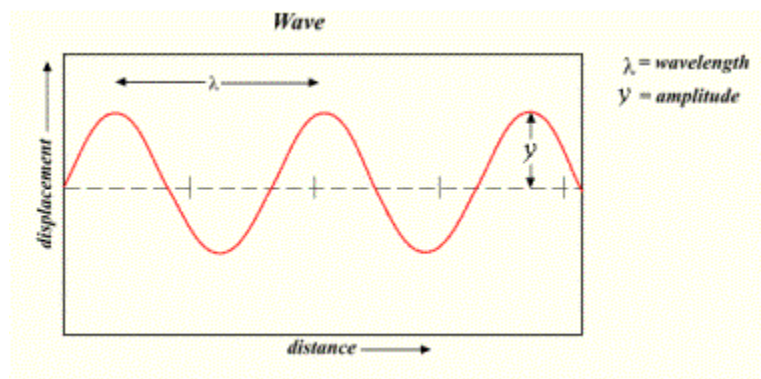
Einstein suggested that we live in a universe full of gravitational waves. He proposed that exploding stars, colliding black holes and other violent events create waves that alter space and time. We have not detected these waves yet because it requires tools sensitive enough to measure very small effects. It's like trying to detect a change in the distance from the earth to the sun equal to the width of an atom.

Technology has caught up with Einstein's prediction. We now have detectors sensitive enough to see these waves. Two of them, the [Laser Interferometer Gravitational Wave Observatory \(LIGO\)](#) in the United States and [GEO 600](#) in Germany, are working together to find gravitational waves from stars and black holes. These experiments require enormous amounts of data to be processed, so the LIGO group created Einstein@Home.

How will data be analyzed on my computer?

The two LIGO detectors and GEO 600 each have their own large collection of data. In order to sort through all of this data and find gravitational wave signals, the data has to be broken into small sets that can be processed by individual computers.

Each computer gets data corresponding to a specific area of sky and a specific time interval. Each computer also gets a model of what scientists think a pulsar signal from that part of the sky should look like in the data. Pulsar signals are expected to be sine waves, like the one shown below.



A sine wave is the graph of the equation $y = \sin x$. A sine wave has the same amplitude (distance from centerline to the top of a peak) and wavelength (distance from peak to peak) over time.

**LIGO Hanford Observatory (LHO)**

Hanford, Washington, USA, (N 46.45°, W 119.41°)
consisting of two interferometers, one with 4km arms (H1) and one with 2km arms (H2).

**LIGO Livingston Observatory (LLO)**

Livingston, Louisiana, USA, (N 30.56°, W 90.77°)
consisting of one interferometer with 4km arms (L1).

**GEO600**

Hanover, Germany, (N 52.24°, E 9.81°)
consisting of one interferometer with 600m arms.

If your system clock is set to the correct time, the detectors will be shown in proper relation to the stars. They move around the celestial sphere once in 24 hours.

Pulsars and Supernovae Remnants

Pulsars and Supernovae are shown on the sky because scientists believe they emit gravitational waves. The purple dots on the celestial sphere mark the locations of [pulsars*](#) that have already been detected. These are clustered in the plane of our galaxy, the Milky Way, and are mostly near the center of the galaxy. They are likely sources of gravitational waves.

Dark red dots mark the locations of [supernova remnants**](#). These are also concentrated near the center of the galaxy. Supernovae remnants can leave behind pulsars or spinning neutron stars that may produce gravitational waves.

Area being processed

The area of sky being processed on your computer is shown as a small moving circle with a cross drawn through it. The coordinates for this location are given in the lower right-hand corner of the screen. You should see this marker move as the search progresses.

* Pulsar: A dense, rapidly rotating star that emits pulses of light.

** Supernova remnants: What is left after a heavy star violently explodes.

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Project Specific System Requirements – (Einstein@home website)

- 20 MB of free disk space
- 64 MB of RAM
- 233MHz processor