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GRAVITATIONAL WAVE DETECTION: WHAT IS NEW

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RESUMEN

La búsqueda de la detección de ondas gravitacionales ha sido uno de los desafíos tecnológicos más difíciles a los que se han enfrentado jamás los físicos experimentales y los ingenieros. A pesar de los resultados nulos obtenidos hasta la fecha después de cuatro años de búsqueda, la comunidad involucrada en ésta área ha ido creciendo. Una de las principales razones de esto es que la primera detección de ondas gravitacionales y la observación regular de ellas son de las metas más importantes para el comienzo de este milenio. Ellas probarán uno de los fundamentos de la física, la teoría de la relatividad general de Einstein y abrirá una nueva ventana para la observación del universo, lo cual, seguramente causará una revolución en nuestra comprensión de la física y la astrofísica. En esta charla daré un reporte actualizado acerca de todos los detectores relevantes (interferómetros, barras, esferas, radio telescopios y satélites CMB) en operación, ó actualización y los que están en construcción o en proyecto. En particular hablaré con más detalle acerca del detector brasileiro Schenberg.

ABSTRACT

The quest for gravitational wave detection has been one of the toughest technological challenges ever faced by experimental physicists and engineers. Despite the null results to date, after four decades of research, the community involved in this area is continuously growing. One of the main reasons for this is because the first gravitational wave detection and the regular observation of gravitational waves are among the most important scientific goals for the beginning of this millennium. They will test one of the foundations of physics, Einstein's theory of general relativity, and will open a new window for the observation of the universe, which certainly will cause a revolution in our knowledge of physics and astrophysics. In this talk I will give an updated report about the status of all relevant detectors (interferometers, bars, spheres, radio-telescopes, and CMB satellites), in operation, going to an upgrading, under construction, or still as projects. In particular, I will give details about the Brazilian Schenberg detector.

Key Words: gravitational waves — instrumentation: detectors

1. GRAVITATIONAL WAVES: DO THEY REALLY EXIST?

In 1916, Einstein himself proved from his theory of General Relativity that gravitational waves should exist. These gravitational waves, caused by the accelerated movements of masses, would be distortions of the spacetime, travelling through the Universe at the speed of light.

According to Einstein's theory of General Relativity, these waves have two independent polarizations, named plus and cross, in the plane perpendicular to the direction of the wave propagation. Any wave polarization (linear, circular, and elliptical) can be decomposed in these two fundamental polarizations by a combination of their amplitudes and phases.

However, one may ask: Do they really exist? Because, after half a century of theoretical debate (from 1916 to 1965) and more than four decades (from 1965 to 2010) of observational search, a direct detection has yet to be confirmed.

Some good observational evidence, although indirect, comes from a few pulsar binary systems, such as the PSR 1913+16 discovered by Taylor and Hulse. These systems present decay in their orbital periods that can only be explained by energy removed from their orbital motion by the emission of gravitational waves. It is an indirect observation, because the waves are not directly detected, but rather an effect (orbital energy loss) caused by their emission.

Why haven't they been detected yet? The reason is because they are hard to detect.

So, why are they so hard to detect? It is because they have very tiny amplitudes.

The amplitude of $h = \delta L/L < 10^{-19}$, which is ten thousand times smaller than the diameter of a proton, is only expected to be observed for a gravitational "tsunami wave".

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