Gravitational Wave Detectors on the Earth and in the Heavens

Prof. Dr. Karsten Danzmann

Institut für Atom- und Molekülphysik Universität Hannover
and
Max-Planck-Institut für Quantenoptik
Außenstelle Hannover
Callinstr. 38, D 30167 Hannover, Germany
Fax: +49 511 762 2784
e-mail: kvd@mpq.mpg.de

Gravitational waves have been predicted more than 80 years ago by Einstein as a con sequence of his Theory of General Relativity. Although gravitational waves have not yet been seen directly, their indirect influence can be observed in the binary pulsar PSR 1913+16. This binary's two neutron stars are spiralling together at just the rate predicted by gravitational radiation reaction.

Gravitational waves, once observed, promise us a radically new view of the universe. Electromagnetic waves are incoherent superpositions of emission from individual electrons, atoms or molecules in low-density regions. But gravitational waves will tell us about the coherent motion of huge amounts of massenergy and the vibrating, nonlinear spacetime curvature itself.

Several kilometersize laser interferometric gravitational wave detectors are now under construction in the US and Europe (LIGO, VIRGO, GEO). It is expected that in the first few years of the next millenium a worldwide network of ground-based detectors will begin routine observations of gravitational waves in the high-frequency band between 1 Hz and 10 kHz, aiming at sources such as coalescing binaries or supernovae.

The low-frequency band from 1 Hz down to less than a milli-Hertz is populated by waves emitted by sources as diverse as supermassive black holes at large red-shifts to short period binaries in our own galaxy. This band will never be observable on the ground due to the unshieldable background of Newtonian gravity gradients on earth. This is the domain of detectors flown in space. The European Space Agency (ESA) has just recently selected a spaceborne laser interferometric gravitational wave detector (LISA) as one of the cornerstone missions in its future Horizon 2000 Plus program.

This talk will give an overview of current efforts and future plans for gravitational wave detection on the ground as well as in space.