# LOGOS SCIENCE FEATURE: GRAVITY WAVES

## by Robert W. Bly

*"...Gravity, taken so for granted, is really something eerie, Messianic, extrasensory in Earth's mindbody..."*

—Thomas Pynchon in **Gravity's Rainbow**

*"Everybody accepts the notion of gravitational radiation. The controversy comes in 'How strong are these waves?'."*

—Dr. David H. Douglass, Jr., Ph.D.

Everybody living on this planet is familiar with the effects of gravity. You drop an apple, and it falls toward the ground. We know gravity is an attractive force. Now, if we drop this apple in a tub of water, we see that the water is disturbed, and waves are generated along its surface. We are all familiar with the phenomenon of waves. But few of us ever think of gravity in terms of waves, when in fact gravity is manifested as a wave, as well as a force.

There is a useful analogy occurring between gravity and electricity which makes it easier for us to accept, or at least understand, the notion of gravity waves. One type of electricity is static electricity, which deals with stationary charged particles. If you rub a comb through your hair, for example, it will become charged and will pick up little bits of paper. If we are dealing with two point charges, the force between them will be inversely proportional to the square of the distance between them, and directly proportional to the product of their charges.

The gravitational force is the analog of the static electric force, the only difference being that two masses will always attract each other, while like and unlike charges will attract, but two like charges will *repel* each other. Like the electric force, the gravitational force is inversely proportional to the square of the distance between the masses. It is directly proportional to the product of the two masses. The electric force is by far the stronger of the two forces.

Another aspect of electricity deals with waves. If charged particles accelerate, electromagnetic waves are radiated from a source, let us say from an antenna. A wave is anything which propogates with a well defined velocity. In the case of electromagnetic waves this velocity is the velocity of light. These waves carry energy and momentum which can be transferred to objects in their path. If the wave from our antenna is a radio wave, it transmits energy which is converted into sound waves when it crosses the path of a radio.

Static electricity has its analog in gravity, so why shouldn't electromagnetic waves? And it turns out that this is just the case. To produce a gravity wave, you need two or more accelerating masses. Now, this can be achieved with just one body, as long as some portion of the mass distribution is accelerating with respect to the center of mass of the body. A wave is then radiated, which propogates outward with a velocity equal to that of light. The velocity of light is about one hundred and eighty six thousand miles per second.

This wave, like its electromagnetic counterpart, does not require a medium in which to travel - it can propogate in a vacuum. The gravity wave carries energy, which it can transmit to bodies in its path. This results in motion of the bodies bombarded by these waves.

The reader may be starting to think, "Yes, this is all very interesting, but it's a lot of nonsense. I've never seen the effects of any gravity waves!" And you are right, the effects of these waves have probably never been observed by anyone on this planet. But, as you shall see in a few paragraphs, people are trying to see them.

The planet Earth does not generate any gravity waves itself, even though it is in constant motion. Any sphere possesses properties of symmetry, and you need a geometry other than spherical in order to produce gravity waves. The Earth is very nearly transparent to gravity waves; they pass right through it as if it weren't there at all, like sunlight through a windowpane.

The gravitational radiation that is produced by other sources is, however, of a very small magnitude. Recently, Professor Joseph Weber at Maryland claimed to have detected gravity waves with his instruments. Dr. David Douglass, Professor of Physics at the University of Rochester, repeated Weber's experiments using a similiar gravity detector, and did not find any evidence of gravity waves. Several other researches obtained the same results as the U of R researches, and Dr. Douglass says that "...most people believe that we have in fact disproved Weber's claims."[1]

Failure to detect gravity waves does not mean they do not exist, and scientists are not now claiming this. The experiments just tell the physicists that the waves they are looking for are weaker than they had anticipated.

The waves the scientists tried to detect were "bursts" of gravity waves from exploding stars. In these explosions, much of the star's mass is converted to energy and radiated as the waves. In order for waves of the magnitude Weber claims to have seen to have been generated, between fifty to one hundred solar masses daily would have to be converted to energy. A solar mass is roughly equivalent to three thousand trillion tons of matter, and the energy equivalent of this mass can be calculated from the well known equation of Einstein, E equals mass times the speed of light squared. Astronomers report that the amount of mass actually converted to energy is nowhere near the amount indicated by Weber, so observable fact contradicts Weber's claim, and supports the conclusions of Dr. Douglass.

Just as a mass distribution is required to generate a gravity wave, so is one needed to detect such a wave. Dr. Douglass used a large aluminum cylinder. If a wave passes through the cylinder, the ends should oscillate with respect to the middle. The wave amplitude is described in terms of the ratio of the displacement of one of the cylinder's ends, and the length of the cylinder. This ratio is known in physics as the strain, hence the gravitational field is a strain field. The detector is sensitive to a displacement of about a hundredth of the diameter of the nucleus. In three years of research, Douglass found no gravity waves. Says Douglass, "You might think of a gravity wave detector as a very sensitive bell just waiting to be rung...Although a gravity wave won't interact very long with that bell, the desirable property would be to have the bell ring, or oscillate for hours or days."[2]

The concept of a gravity wave is not at all a new one. It goes back to Einstein, and was part of his original Theory of General Relativity. And just as relativity, strange as it may seem to the layman, is accepted without question by most modern physicists, so too is the gravity wave. Gravitational radiation is "...just part of physics that should exist," says Dr. Douglass.[1] Douglass has finished his series of experiments with the Weber type apparatus, and is in the process of constructing a new gravity wave detector.

The new detector will be about a million times more sensitive than the one used by Weber, so hopefully it will be able to show positive evidence of gravitational radiation. This detector involves giant artificially grown sapphires (see Fig. 1). These crystals, unlike natural ones, are very large and, more importantly, are without flaws. When and if they interact with a gravity wave, they should oscillate for a long period of time, perhaps for days, giving scientists a better chance to study the phenomenon.[2] This is probably the most unusual use found for these costly artificial gems yet.

Silicon may also be used for such single-crystal detectors. Silicon is the material used in integrated circuits in such devices as pocket calculators and transistor radios. The silicon crystals are in the shape of cylinders, with diameters of up to six inches. Researchers at this university recently had one eighteen inches in length; lengths of up to four feet may be possible.

The concept of gravity has been with us since Newton allegedly got beaned by a falling apple. It is something that we take for granted, for we have all seen the falling apple or what have you knock someone in the head. The concept of gravity waves has been with us since Einstein, and while physicists accept and indeed insist upon it, they are going to have to verify the theory experimentally before the layman accepts it. Only when the sapphire detector is moved by a gravity wave, when *that* apple hits us in the head, will we be able to appreciate the fascinating concept of gravity waves.

References:

[1]Most of the information in this article is the result of an interview with Dr. David Douglass. I thank him for his time and patience.

[2]From an article in the *Boston Globe,* December 20, 1976.

Figure 1

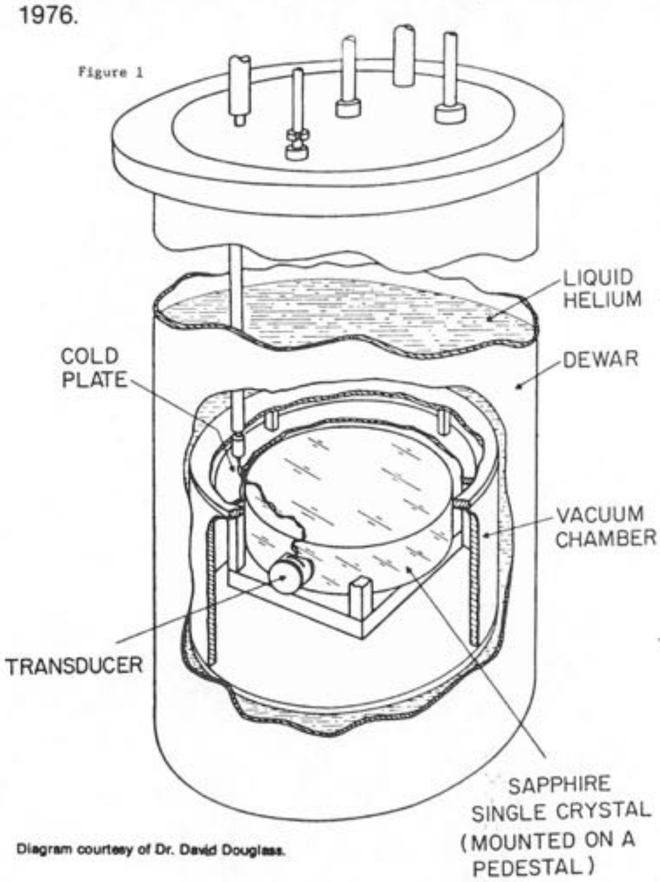


Diagram courtesy of Dr. David Douglass.