More on gravity waves

R. L. Garwin, and J. Weber

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The error attributed to Amaldi was introduced by our staff in the process of editing the original tape-recorded interview and not caught in proof.

EDITOR

More on gravity waves

Joseph Weber's reply to my letter in December 1974 (pages 9, 11) in no way addresses my claim "that the Maryland group has published no credible evidence at all for their claim of detection of gravitational radiation." He states "My first-hand knowledge is based entirely on other data including real-time counting and pen-and-ink records," but this evidence has not been published. Q.E.D.

Weber brings my own experiments into discussion,[1,2,3] but these have nothing at all to do with the point of my letter. Indeed, the reader may judge the correctness of our conclusions shown graphically in figure 3 of reference 3,—that one month of data for our 480-kg bar show conclusively the absence of pulses intense enough to have been detected with good efficiency by Weber,[4] assuming that his published events were indeed gravitational waves.

I shall not reply to Weber's innuendo, but I must respond to two criticisms he makes of our experiments:

1) That our equation 2 (reference 2) cannot be correct "because the detector relaxation time is not contained in it,"[4] and

2) that "Garwin apparently overlooked the great importance of temperature control or automatic tracking of his cylinder with a reference oscillator."

Briefly, Weber seems to have misread our papers:

1) Equation 2 calculated P_{fa}, the "probability of false alarm"[2] (in one antenna). The *rate* of false alarms was calculated in the next paragraph[2] as

$$r_d = (P_{fa})^2/\tau_E$$

where τ_E is precisely the detector (energy) relaxation time.

2) In fact, our published results are insensitive to frequency offset of the reference oscillator or to temperature drift of the bar because for each data block (3 min[1] or 455 sec[3]) "Each data block is then processed by a computer which first computes the autocorrelation function and from it the decrement δ of the bar ($\delta = \pi\tau f_0/Q$) and its offset $(f_0 - f_B)$. These data are then used to predict from each pair of amplitudes [a vector $\mathbf{v}(t_n)$ in the phase plane] the amplitudes of the next point τ seconds later,

$$\mathbf{v}^*(t_n + \tau) \equiv \mathbf{v}(t_n) \exp(-\delta)$$

after obvious corrections for frequency offset."[1]

Indeed, the effect of any imperfection of compensation is *included* in the measured system noise temperature T_e of 29.2 K[1] or 18.5 K.[3] James L. Levine has reviewed the computation for a typical 4-hr stretch of the data[3] and finds that the contribution to T_e from this source was 4×10^{-2}K. The details are available to anyone writing the author.

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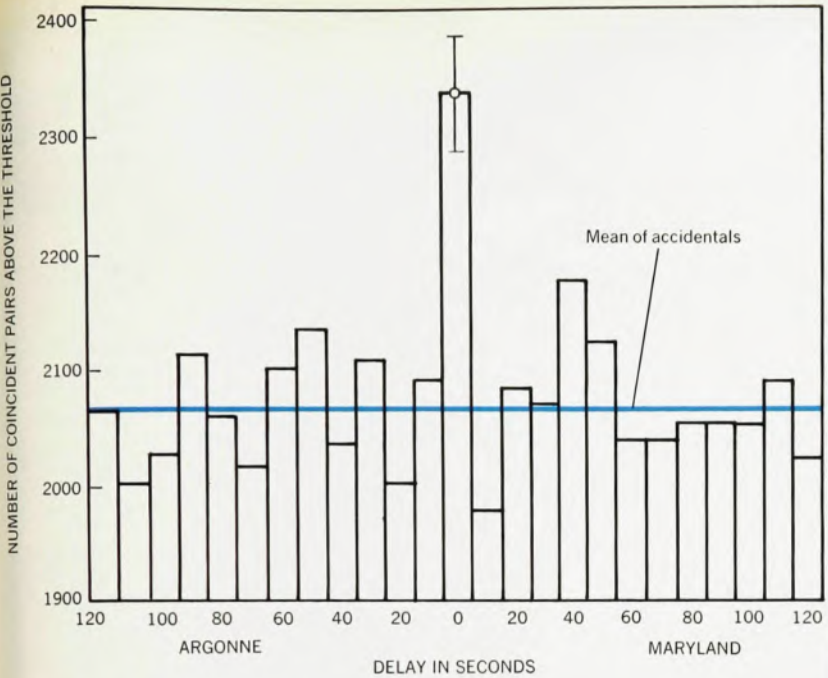
WEBER RESPONDS: Real-time counting data were sent to Richard Garwin in a letter dated 8 February 1974.

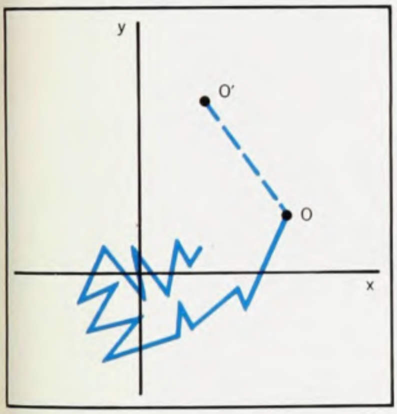
It is regrettable that Garwin continued to publish incorrect information about Maryland experiments after submission of his earlier letter in PHYSICS TODAY.

In the 23 September 1974 *Physical Review Letters* (page 797), Garwin states that a Maryland computing error "was shown to account for essentially all of the zero delay excess events on a four day tape . . ." Figure 1 is a histogram for this four-day tape. The computing was checked by three independent scientists. The zero-delay excess is 5.7 standard deviations.

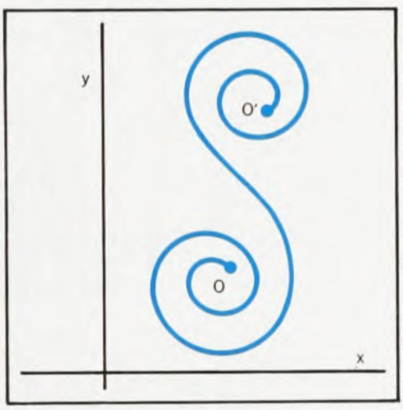
It is also regrettable that Garwin's clever instrumentation gives poor sensitivity. The experiments search for excitation of the normal mode of an elastic solid, by gravitational waves. Two



Histogram for Maryland–Argonne 4-day tape 217. Figure 1



Brownian motion of antenna. Figure 2



Response for swept frequency. Figure 3

variables of the normal mode are its amplitude ρ and its phase ϕ. The electronics output consists of variables x and y related to ρ and ϕ by

$$x = \rho \cos \phi; y = \rho \sin \phi$$

Maryland experiments made use of an energy algorithm based on changes of $x^2 + y^2$, that is $\Delta (x^2 + y^2)$. Consider figure 2. The antenna mode undergoes Brownian motion, which corresponds to a random walk of the point x, y. This energy algorithm gives no response unless change $00'$ is primarily in the radial direction. Garwin assumed therefore that he would obtain greater sensitivity if he employed an amplitude algorithm based on the expression

$$(\Delta x)^2 + (\Delta y)^2$$

responsive to $00'$ in any direction. Expected increased sensitivity of his amplitude algorithm led Garwin to use a much smaller mass than that used at Maryland. Furthermore he abandoned the well established technique of a two-detector coincidence experiment.

Garwin's results were negative. Maryland experiments using the larger mass and both algorithms simultaneously show, for a recent 2½ month period, a larger event rate for the energy algorithm. An explanation suggested by our brilliant student Gustave Rydbeck is that the pulses are longer than Garwin thought, and they frequency sweep through the detector bandwidth, giving the spirals shown in figure 3. The result is to give some radial displacement for most signals, and a higher detection efficiency in comparison with similar displacements associated with heat-bath excitation.

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Garwin's use of too small a mass, together with an algorithm tailored to signals having different spectral character than most of the ones we observe, account for his negative results. Garwin did overlook the importance of temperature control. Two effects are involved. Failure to control temperature produces excess noise because the cylinder is not in equilibrium, and this excess noise cannot be removed by Garwin's computer program. A second effect is that the cylinder drift relative to a reference oscillator produces a large phase-modulation background, and this can be removed, by computer-program corrections discussed by Garwin.

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Nuclear club

Your recent article "Nuclear Proliferation—30 Years after Hiroshima" (July, page 23) had some very interesting visual depictions of the growth of "The Nuclear Club." Unfortunately, they all indicate the Mideast as being non-nuclear now and in the immediate future. In fact, Israel has had nuclear reactors for some years and Egypt is in the process of getting one, while Iran, Saudi Arabia and others of the oil-rich Arabic States are standing in line to purchase reactor technology.

Since the Mideast is also a politically unstable area, which conceivably could be a tinderbox for a holocaust, ignoring this area in the visual presentations appears to be misleading.

ELLIOT WHEELER
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THE AUTHOR COMMENTS: In my view, you are quite correct in your criticism of the visual depictions of the "nuclear club" illustrating my article in July. My own listing of the nuclear club would include Israel today, and certainly Iran, Egypt and possibly Saudi Arabia in 1980.

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Correction

June, page 88—The Committee on Science Education for the General Public should have been identified as a joint committee of both the American Association of Physics Teachers and The American Physical Society and not solely a committee of the APS. □