“The Utilization of High-Frequency Gravitational Waves for Global Communications”

By Robert M L Baker, Jr. and Bonnie Sue Baker

Peer-review First Referee’s Comments:

The paper presents highly innovative techniques and applications of gravitational waves that will have exceptional benefits to mankind, on par with the discovery of radio communications and lasers or even more. This paper deserves maximum attention. In a single sentence the paper says: "these (previous) methods for generating GWs are unsatisfactory", which is true. This small sentence cannot be removed. To improve the paper the sentence should be expanded to one or more chapters of unacceptable lenght in order to explain why. The author made the correct choice to cite a reference article. This observation explains a 9 in h.-Presentation. The paper can be accepted as is. Specific comments follow:

1) I understand that a proper electromagnetic excitation for the double helix must be a **circularly polarized** http://en.wikipedia.org/wiki/Circular_polarization EM wave, produced by a http://en.wikipedia.org/wiki/Helical_antenna or phased and crossed dipoles http://sv1bsx.50webs.com/antenna-pol/polarization.html . Please tell something about that in the paper.

2a) Most important: If the authors are considering couples composed of far away masses. In this case in order to be able to move in reciprocal synchronization, each element of the couple could be electrically charged; it is not necessery to use MEMS, I understand that those particles could be ions in a plasma. Maybe I can understand the double helix system (far away masses) if the MEMS are piezo-rods connecting the two "ideal" helixes. The center of mass and center of inertia is the axis of the two helixes. In this case the rods need **not** be electrically charged and the size of the elementary emitting system is the distance between the two helixes **exactly like** the author discusses. Each rod must change shape from I to S under em excitation.

For instance:
Fig 4 "MEMS pair, one on each ribbon " change to something like "MEMS axis connecting the two ribbons"

2b) Alternatively the authors can keep the description of the system **as is**, in this case I understand that the size of the emitting system is the size of the MEMS, that is "much smaller" than the distance between the two ribbons. We do not have far away masses. This is **not** a limitation, in fact to operate at 2.5GHz the MEMS must be very small, and the general rule is that the maximum GW output power per kg of material is proportional to frequency provided that a suitable arrangement of many discrete sources is made. The **double helix** certainly is one of them (I think that **it is the optimal arrangement**).

I believe that if these two points will be clarified, this will be an improvement in the manuscript

3) Here I comment on the following:

“…There have been other challenges to HFGW communications based upon the mistaken belief that GW generators or transmitters can only be designed using spinning rods or the effect proved by Gertsenshtein in 1962 and analyzed by Eardley in 2008 in the JASON report (SR-08-506)., Both of these methods for generating GWs are unsatisfactory and produce negligible GW power…”

Comment: the formalism of the spinning rod (and spinning masses) (Example: http://elfweb.mine.nu/Me/CV/Projects/incl/GW/GW.html) is the only “formula” that is proven to work in the “real world” according to Hulse and Taylor. The formula applied to vibrations in the solid state and other clever configurations should give valid results. This formula is better tested than the equations that

regulate the functions of interferometers and other detectors (see attached paper to understand the situation). The spinning rod (and the spinning mass) formula confirms that going high frequency increases the power emitted. Therefore **everything is fine regarding this formula.**

Spinning point masses:

$$\dot{E} = -\frac{32G}{5c^5}\left(\frac{m_1 m_2}{m_1+m_2}\right)^2 r^4\omega^6. \qquad (37)$$

Equal masses:

$$P = \frac{8G}{5c^5} m^2 r^4 \omega^6$$

For rotating objects, the centripetal force is:

$$F = mr\omega^2$$

If we choose to keep our system at the limit for the structural integrity of the selected material, F is a constant, let's choose force units in order to have 1 for this limiting constant. Let's also choose suitable units to have m=1 and r=1. Therefore splitting our system in two identical smaller systems each defined by:

m_{split}=½ m and r_{split}= ½ r.

we have from the centripetal force limiting formula $\omega_{split}=2\omega$

Using these changes in the quadrupole formula for equal masses and considering that we obtain two systems that we drive coherently.

$$P = \frac{8G}{5c^5} m^2 r^4 \omega^6$$

$$Psplit = 2\frac{8G}{5c^5}\left(m/2\right)^2\left(r/2\right)^4\left(2\omega\right)^6$$

$$Psplit = 2\frac{\frac{8G}{5c^5}\left(m\right)^2\left(r\right)^4\left(\omega\right)^6}{4*16/64} = P*2$$

Therefore starting with a given mass (and volume) of a preferred emitting material and cleverly rearranging in order to keep it at the limit of mechanical structural integrity, the power emitted is proportional to the frequency, that in turn **requires to arrange the given mass into the largest number of MEMS that technology allows..** That is why **the authors have a good approach**, derived from "tested" formulas. **Equation (1) is therefore absolutely correct.**

The **simpler jerk formulation** allows the study of many more emitting systems and **the double helix approach is extremely interesting regarding output power.**

In conclusion**, I recommend publication** of this interesting and pioneering paper.

Peer-review Second Referee's Comments:

The present reviewer's approach was to compare the authors' approach to that of the Dehnen and Romero-Borja (DRB) paper that the author's reference. The use of Eq. (1) of the author's MS for $2r$ (or in the DRB case b) or a = 0.00001 m for the two cases (1) νGW = 3 GHz and P = 0.48 attowatts and (2) ν = 1300 GHz and P = 210 attowatts, yields Δfi = 8.704 mN and 0.4201 mN, respectively. It is difficult to compare with MS under consideration since DRB do not consider the energizing power, but the square root of frequency difference would increase the 0.4201 N Δfi to 0.4201x(1300/3)1/2 = 8.745 mN, which is only a factor of 8.745/8.704 = 1.0047 or about half of a percent different. Thus the simplified, engineering author's approach gives results that are quite close to the more complete GR approach of Dehnen and Romero-Borja even over quite different frequency ranges.

Although the candor of the authors in utilizing the conservative two-Newton delta force is appreciated – there is probably a larger power for their HFGW generator than they compute, The power is no doubt somewhere between the number of FBAR force elements squared (conservatively utilized by the authors) and the number of FBAR force elements cubed (utilizing full superradiance). Test of the apparatus when it is finally fabricated will no doubt result in a HFGW power in excess of that estimated by the authors.

The present reviewer found typographical errors that were noted in the manuscript, and these should be corrected. Otherwise the MS is strongly recommended for publication.