Eddington's Number, the Mass of the Universe and the Unification of Gravitation and Electromagnetism.

By

Richard M. Blaber.

Abstract.

It is easy to show how Eddington's number (the number of protons and electrons in the Universe) and the mass of the Universe are related to the gravitational fine-structure constant, and how, via the postulate of a 'gravito-electric' current, all three may permit the unification of gravitation with electromagnetism and *vice versa*.

Keywords: Eddington's number; gravitational fine-structure constant; mass of the observable Universe; 'gravito-electric' current; unification of gravitation and electromagnetism.

Declaration re conflict of interest: The author declares he has no conflict(s) of interest, and has received no funding for his research from any source(s), public, private or voluntary sector.

Contact email address: richardblaber1956@gmail.com; ORCID ID: 0000-0003-0326-4469.

(1). Introduction.

In two recent papers (Blaber, publication pending [1,2]) the present author has outlined an argument which may be broadly summarised thus: Eddington's number (Eddington, 1938, XI, pp.170-186 [3]), which is the total number of protons in the observable Universe, and is equal to the total number of electrons in our Universe, in order to ensure it is electrically neutral, may be taken to be equal to the square of the reciprocal of the gravitational fine-structure constant, α_G (Davies, 1982, Table 3, p.39 [4]). This constant is the gravitational analogue of the fine-structure constant, $\alpha = e^2/4\pi\varepsilon_0\hbar c$, and is equal to $Gm_p^2/\hbar c$. Its reciprocal is equal to $(M_p/m_p)^2$, where M_p is the Planck mass, given by $(\hbar c/G)^{½}$.

(2). Development of the Argument.

It follows, of course, that the square of this reciprocal is $(M_p/m_p)^4 = 2.8667569 \times 10^{76}$, which we may take to be Eddington's number, N_E. If we then multiply that by the ratio m_p^2/m_e, we obtain a value for the mass of the observable Universe, M:

$$M = N_E m_p^2/m_e = M_P^4/m_p^2 m_e = M_P^2/\alpha_G m_e = 8.80435 \times 10^{52} \text{ kg} . \tag{1}$$

The current age of the Universe, t_0, as determined empirically by Aghanim *et al* (2020, Table 1, p.7 [5]), is ~13.8 billion years. The time it would take light to traverse the Schwarzschild radius, R_S, of a black hole with mass M is given by:

$$t_S = R_S/c = 2GM/c^3 = 2\hbar^2/Gm_p^2 m_e c = 13.83134 \text{ billion years} . \tag{2}$$

This suggests that our Universe is, in fact, a black hole, with $t_0 < t_S$, and a maximum remaining expansion-time of no more than ~313.4 million years, and – given its entropy, determined by the Bekenstein-Hawking equation (Bekenstein, 2008 [6]) – probably considerably less (Blaber, [2], op.cit.). For advocates of black-hole cosmology, see references in [2].

(3). Implications for Unification of Forces.

The gravitational fine-structure constant features in an equation the present author has proposed (Blaber, op.cit. [1]) in relation to the unification of gravitation and electromagnetism, where he argues that such unification requires the existence of a 'gravito-electric' current:

$$I_G = (m_p^2 c/\hbar).|(G/\mu_0)^{½}| = (m_p^2/\mu_0\hbar).|(G/\varepsilon_0)^{½}| = 5.79613 \times 10^{-14}\text{ A} . \tag{3}$$

This would be related to the fundamental electric charge, *e*, by e/I_G = 2.76422 × 10^{-6} s, and its inverse, 361.7657 kHz, corresponding to a wavelength of 828.6923 m.

The magnetic force induced between two of these currents would be equal to:

$$F_m = \mu_0 I_G^2 = Gm_p^4c^2/\hbar^2 = 4.2217 \times 10^{-33}\text{ N} . \tag{4}$$

The smallest force ever measured in an experiment is 42 yoctonewtons – that is, 4.2 × 10^{-23} N – at the Lawrence Berkeley National Laboratory in California in 2014 (Yarris, 2014 [7]; Schreppler *et al*, 2014 [8]). This is, of course, ten orders of magnitude larger than the force given by equation (4).

(4). Conclusion.

To summarise: if the argument presented above, and in [1] and [2] is correct, the cosmos is an enormous black hole, and we, as observers, are at the centre of it. We can dismiss the so-called 'Copernican' or 'cosmological' principle (Barrow, 1989 [9] and refs. therein), for the following simple reason: he cites Milne (1935 [10]),

> **'Not only the laws of nature, but also the events that occur in nature, the world itself, must appear the same to all observers, wherever they may be.'**

This provokes an obvious question: *What* observers? We are in no position to *assume* there are any other observers apart from ourselves, here on Earth, although we can *speculate* about their possible existence. The Search for Extraterrestrial Intelligence (SETI) has been operating for many years now, but has provided no evidence of radio-possessing intelligent life elsewhere in the Universe, tending to confirm the so-

called Fermi 'Paradox' (Drake, 2011 [11]; Wright, 2022 [12]; Armstrong and Sandberg, 2013 [13] – these authors noteworthy because they disagree with the present one about the feasibility of intergalactic space-travel). Nor are we in any position to say how the Universe would look from a position remote from Earth – say the Andromeda Galaxy – because that is 2.2 million light-years away, and we can never get there (but see [13]), in order to see for ourselves.
The likelihood is, in fact, that any putative advanced technological 'civilisations' such as our own may well end up doing what our own threatens to do to itself, well before it becomes capable of interstellar spaceflight, let alone the intergalactic variety – namely, destroy themselves, by one means or another, through their own folly. It is a melancholy thought – but one which we must confront, if we seek to preserve our species, and ensure it has a future.

REFERENCES.

[1] Blaber, R.M., 'The Possible Existence of a "Gravito-Electric Current,' *Journal of Modern and Applied Physics (J. Mod. Appl. Phy.)*, publication pending.

[2] Blaber, R.M., 'The Mass of the Observable Universe on the Basis of its Age in Black-Hole Cosmology,' *J. Mod. Appl. Phy.*, publication pending.

[3] Eddington, A.S. (1939), *The Philosophy of Physical Science: Tarner Lectures 1938*, Cambridge: Cambridge University Press (CUP), ISBN: 978-1-107-63034-5, pbk. (2012).

[4] Davies, P.C.W. (1982), *The Accidental Universe*, Cambridge: CUP, ISBN: 0-521-28692-1, pbk.

[5] Aghanim, N. *et al*, '*Planck* 2018 results: VI. Cosmological parameters,' *Astronomy and Astrophysics* **641(A6)**, 67pp., 11th September 2020 (online), DOI: 10.1051/0004-6361/201833910, https://www.aanda.org/articles/aa/pdf/2020/09/aa33910-18.pdf.

[6] Bekenstein, J.D., ‘Bekenstein-Hawking entropy,’ *Scholarpedia* **3(10):7375**, 2008, DOI: 10.4249/scholarpedia.7375, http://www.scholarpedia.org/article/Bekenstein-Hawking_entropy.

[7] Yarris, L., ‘Not Much Force: Berkeley Researchers Detect Smallest Force Ever Measured,’ *News From Berkeley Lab*, 26th June 2014, https://newscenter.lbl.gov/2014/06/26/smallest-force-ever-measured/.

[8] Schreppler, S. *et al*, ‘Optically measuring force near the standard quantum limit,’ *Science* **344(6191):1486-1489**, 27th June 2014, DOI: 10.1126/science.1249850, abstract & refs. only at: https://www.science.org/doi/10.1126/science.1249850.

[9] Barrow, J.D., ‘What is the principal evidence for the cosmological principle?’, *Quarterly Journal of the Royal Astronomical Society* **30:163-167**, June 1989, ISSN: 0035-8738,
BibCode: 1989QJRAS..30..163B,
https://articles.adsabs.harvard.edu/pdf/1989QJRAS..30..163B.

[10] Milne, E.A. (1935), *Relativity, Gravitation and World Structure*, The International Series of Monographs on Physics, ed. Fowler, R.H. & Kapitza, P., Oxford: The Clarendon Press, https://ia802603.us.archive.org/17/items/dli.ernet.7948/7948-Relativity%20Gravitation%20And%20World%20-%20Structure.pdf.

[11] Drake, F., ‘The search for extra-terrestrial intelligence,’ *Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences* **369(1936):633-643**, 13th February 2011, DOI: 10.1098/rsta.2010.0282, https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=a7a6d6dc3bc8a82e757ed47d315c55661c5f1e37.

[12] Wright, J.T., ‘SETI in 2020,’ *Acta Astronautica* **190:24-29**, January 2022, DOI: 10.1016/j.actastro.2021.09.024, abstract, extracts & refs. only at:

https://www.sciencedirect.com/science/article/abs/pii/S0094576521005105.

[13] Armstrong, S. & Sandberg, A., 'Eternity in six hours: Intergalactic spreading of intelligent life and sharpening the Fermi paradox,' *Acta Astronautica* **89:1-13**, 10th April 2013, DOI: 10.1016/j.actaastro.2013.04.002, https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=157979edf2671c28217a293c7136e4b204f409b1.