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Atomic fission

I feel I must write with regard to what must be science fiction (Electromagnetically induced atomic fission) in your January issue. There are, I feel, a few comments which should be made.

The claim half-way down p.16 that the electron and proton both appear to have the same physical diameter and no discernible internal structure is not correct. Although classical e.m. theory gives an estimate of electron and proton radius as approximately 2.8×10^{-15}m, experiments have failed to determine a size for the electron, an upper bound on size being set by current machine limitation at 10^{-18}m. The proton, however, can be considered to be 10^{-15}m across, but unlike the electron, does show internal structure.

The first hint of this structure came with the identification of the delta resonance at Brookhaven National Laboratory in the US in 1953 and marked the start of what became very strong evidence that protons consist of more fundamental particles now called quarks.

In the light of this, the suggestion that the "ether" can only withstand a finite electric field intensity equal to that which exists at the surface of Carl Adams' equally sized electron and proton is baseless, as the two particles do, in fact, have drastically different sizes.

The claim half-way down column 1 of p17 that the strong interaction was never observed or measured is also incorrect. Particle scattering studies have determined both that it exists and that it is some two orders of magnitude stronger than the longer range Coulomb interaction.

Finally, consider the frequency of a source of e.m. radiation capable of inducing fission. The critical energy of fission for uranium isotopes is around 5.5MeV. To approach this electromagnetically would require a gamma-ray "laser" to pump the nucleus into fission. Considering the difficulty of secrecy associated with the development of the X-ray laser for the SDI programme, I would enjoy reading a detailed article on Carl Adams' "precisely tuned and oriented e.m. wave" generator to achieve fission, since this device alone is clearly at the forefront of technology.

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Carl Adams' January article on 'Electromagnetically induced Atomic Fission' is ahead of its time: – by just three months! Filling in some of the numerical details which he felt might be too complex for EWW readers, nuclei from actinium to uranium and beyond show systematic shape oscillations with excitation energies of some 40 keV, corresponding to frequencies of some 10^{10}GHz, well beyond the range of familiar sources of electromagnetic radiation. The wavelength of radiation of this frequency is about 3×10^{-11}m, or some 3000 times the nuclear radius, so that one has all the difficulties normally associated with using a receiving aerial array (the nucleus) whose linear dimensions are much smaller than the wavelength of the exciting radiation. Such oscillations can however be excited by a pulse of electromagnetic radiation, provided by a close (but not too close) encounter with a proton or alpha particle with an energy of a few MeV. Afterwards all these nuclei, even those which can undergo spontaneous fission, simply re-emit the radiation within a fraction of a microsecond of absorbing it. If Mr Adams hopes to speed up the decay of a lighter radioactive nucleus the problems become even more daunting.

Resonance excitation of nuclei by electromagnetic radiation has been observed, and Mössbauer's explanation of the unexpectedly large yields from Fe-57 won him a Nobel prize, but once again the nucleus which has absorbed the radiation simply waits for a while and then spits it out again. However the Prize categories may yet be extended to include Science Fiction.

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Relativity and engineering

As a professional engineer, I enjoy reading the articles and correspondence you publish which express unconventional views on relativity theory and on other aspects of physics in general. Yours is the only publication prepared to offer a forum for such "non-conformist" views, and while most of the contributions contain fallacious arguments, they nevertheless serve a thought-provoking as well as an entertaining purpose. I hope you will continue with this policy.

However, lest any of your readers may have been misled into believing that the Special Theory of Relativity is erroneous and only survives through an Establishment "cover-up", it should perhaps be pointed out that the formulae of the Lorentz Transformation are in regular use by engineers who design equipment involving high particle velocities. The fact that application of these formulae results in equipments that actually function as intended may not constitute an adequate "proof" for philosophers, but it is good enough for practical engineers who earn their living in these fields.

Examples of equipment whose design in influenced by the relativistic increase in mass of a fast-moving particle include high-power klystrons, travelling-wave tubes, microwave gyrotrons, particle accelerators for medical and other uses, and free-electron lasers. These devices all involve the dynamics of fast-moving particles (usually electrons) in their interactions with the electric and magnetic fields of beam-focussing and trajectory-management arrangements, and it is therefore essential to use the relativistic correction to particle mass if the design is to be successful. That the devices in question need not be particularly exotic can be appreciated by noting that even the common-place colour television tube, operating at 25 kV, accelerates electrons to about 30% of the speed of light. This results in a relativistic mass increase of about 5% – an increase which is entirely "real" to a practical engineer.

An even more striking demonstration of the engineering reality of Relativity – and one which I believe will have particular appeal to many of your readers – is provided by the NAVSTAR satellite navigation system. Very briefly, this system comprises 18 satellites in nearly-circular inclined orbits whose radii is about 27,000 kilometres and whose orbital period is 12 hours. Each satellite carries a highly-accurate atomic clock and broadcasts digitally-coded time signals on carrier frequencies of 1,575 and 1,228 MHz; four satellites are normally "visible" from any terrestrial location at any time. The terrestrial platform (ship, aircraft, etc.) carries a receiving system which is "locked-on" to the four visible satellites, and which measures the arrival time of each of their four time signals with respect to its own, not so accurate, clock. These four time-delay measurements are combined with ephemeris data (also broadcast by the satellites) to set up four simultaneous equations in four unknowns, which are solved by the receiving system's computer. The resulting outputs are the platform's position in three dimensions (latitude, longitude, and height) together with the necessary correction to the receiver clock to re-align it to satellite time. Positional accuracy has been quoted as 18 metres r.m.s., and time accuracy as 35 nanoseconds.

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The achievement of this remarkable degree of accuracy required the system designers to take due account of relativistic time-dilation arising from a satellite's orbital velocity of about 4 km/s. Small though the effect is, it results in the satellite's clock losing about 350 nanoseconds per hour, which corresponds to a build-up of positional error of the order of 100 metres per hour. In order to compensate for this effect, the satellite's clock would have to be set before launch to run 350 nanoseconds per hour fast with respect to standard time.

However, there is also an even more important effect; General Relativity predicts that clocks run more slowly in a gravitational field. Since the satellite is 27,000 km from the centre of the Earth, whereas the Earth's surface is only 6,400 km away, the satellite is in a weaker gravitational field and its clock therefore runs *faster* than it did prior to launch. The two effects are therefore in opposite directions, but General Relativity predominates in this particular case, and calculation shows that the net effect is that the satellite clock runs fast to an extent that would result in an error growing at a rate of about 500 metres per hour. The atomic clock is therefore deliberately built to run slow by the amount calculated by the relativistic formulae, so that it keeps correct time after the satellite is positioned in its orbit.

It can therefore be seen that although there may still be scope for deeper philosophical debate, Relativity is now firmly established in engineering as a practical design tool.

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Recent articles in *EEW* have sought to undermine the foundations of Special Relativity by seeking some error in the mathematical reasoning upon which it is based. As was pointed out by Harald Nordensen, many years ago, the epistemological basis for Einstein's theories is unsound and contains the unconscious acceptance of classical time in its attempts to prove the necessity for a new definition.

There is, however, a further reason to doubt the soundness of Einstein's model, and it may be illustrated by the following thought experiment.

A relativistic physicist decides to test the theory of Special Relativity by sending a clock to Alpha Centauri and back. This will, he assures his acolytes, finally prove the case for the slowing of time under accelerated conditions. It will be a simple matter to compare the elapsed time shown on the returned clock with the time kept in our Galilean locality. As he recognises the importance of accuracy to the success of the experiment, he approaches the best horologist in the world and commissions him to manufacture a timekeeper equal to the task.

The horologist agrees but, as he has little faith in the prognostications of mathematical physicists, he decides to make a timekeeper that will be immune to the effects of relativistic junketing. He has read 'Relativity' and is well aware of the prediction by Einstein, that as the clock's velocity increases, the mass of its balance wheel will also increase.

"If this is so", he reasons, "Then neglecting the second order effects due to the increased mass of the balance spring," (he is a most careful and thorough analyst). "And assuming that the losses in the system are unchanged, being a function of the oscillating systems velocity only, then the amplitude of oscillation must increase. The quality factor of the oscillator, 'Q' is proportional to $\omega M/r$ so that as the mass of the balance increases, the angular velocity will decrease in inverse proportion to the square root of the difference in mass while the Q will increase in direct proportion."

As the amplitude of oscillation increases, he needs a compensating effect to maintain the clock's period constant, therefore, he pins up the balance spring so as to make the balance spring combination faster in the longer arcs. Thus, the increasing spring constant with increasing amplitude will compensate for the increasing mass and the ratio K/M will be kept constant.

The physicist pronounces the clock satisfactory, and with due white coated ceremony it is placed aboard the Alpha Centauri spacecraft, then launched on its way.

Many years later, the spacecraft returns and the now aged physicist, supported by his remaining acolytes, carries the timekeeper in triumph to the laboratory for comparison with the master clocks which throughout this long period, have ticked away with uncompromising accuracy.

To their horror, no difference can be found between the travelled clock and the stay at home master clocks. The shock is too much for the aged master and he expires, leaving the bereft acolytes to discover some explanation.

Some curse the clockmaker as incompetent, others embark on the formulation of a mathematical theory of great complexity and rigour to show that the effect of the clock's journey (including necessary relativistic corrections) over the distance to Alpha Centauri and back is such that the hands of both master and slave exactly coincided on its return. Others busily examine the data pertaining to the master clocks and carefully test their accuracy using the best (and most expensive) test equipment available. Some simply went home to beat their wives. Only the clock was right.

The above parable for our times has a further sting in its tale. Even if Special Relativity were not true, the clock would still have shown no error upon its return, assuming that the horologist had completed his task in a competent manner. If the amplitude of oscillation remained constant, then no rate error would result from the non-linearity of the balance spring and no difference would occur in the result of the experiment.

It is therefore impossible to draw any conclusion concerning the validity or non-validity of Special Relativity from an experiment involving what we like to call 'clocks'.

Let one thing be made absolutely clear, as clear as it was to the horologist whose tweezers manipulated the balance spring to such good effect. Clocks do not measure and cannot measure classical time. What we define as clocks are merely oscillating systems whose periodicity is governed by the Galilean values of the parameters at the epoch of observation. As any clockmaker could have told Einstein, the rate of the clock is subject to the influence of the non-linearities inherent in its operation. What Einstein demonstrated was that he had little understanding of how a clock actually functioned.

Otherwise, I shall be forced to assume that relativistic effects are occurring between the lounge and kitchen in my home as, in common with the houses of most other horologists, none of the clocks therein show the same time! I make no excuse for the choice of a balance wheel timekeeper in the above thought experiment; in this I merely follow Einstein who did the same. If it is wished to argue that quantum mechanical clocks are somehow different, that some mysterious linkage exists between the functioning of atomic structure and this derived parameter 'time', then the physicist must show that the conditions which were generated by the horologist in the thought clock cannot possibly apply to atomic mechanics. That is, that no non-linearities or hidden variables are possible within Quantum theory. If he persists that such a view is correct I can only refer him to the sound reasoning of Popper on this subject[2].

If he argues that such a system of parametric compensation is

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impossible or would not function, I shall direct his attention to the Gurney clock in Norwich which was built by Martin Burgess, using the ideas of John Harrison, the 18th century clockmaker.

Harrison's investigations into the stability of timekeepers led him to the perfection of a non-linear model for a clock oscillator with parametric compensation.

There is little evidence in physics that the subjective parameter, 'time' has any importance to the universe. What we call 'time' is the product of our cognitive perception and is governed by the 'clock' inside our heads. It is perhaps, a product of our arrogance that we have chosen that particular facet of our abilities, which set our hominid ancestors apart from all other species on this planet, as a universal governor for the whole cosmos. It was short term cognitive time perception that made Koestler's primaeval man "shudder and see omens at every step."

It will be noticed that the above experiment in no way conflicts with our concepts of causality, although it does have grave consequences for probabilistic theories based on linear algebra. It is closer to Popper's propensity dynamic which allows system behaviour to be influenced by parametic structure.

In that context, if Harrison's ideas had been understood in his lifetime, if the functioning of non-linear systems had been recognised by 19th century physicists as vitally important, then the muddle and misunderstanding described by Popper need never have come about.

References
1. Relativity, Time and Reality – H. Nordensen. Allen and Unwin, 1969.
2. Quantum Mechanics and the Schism in Physic – Karl R. Popper. Hutchinson, 1982.

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Catt's anomaly:

It seems that Dr Catt has once again set up his own version of conventional theory in order to debunk it. Catt's anomaly (*EEW* Sept. 87. p903) isn't, as I will explain. Practical people like myself prefer concrete examples, so I will begin by putting dimensions to his Fig.7. My Fig.1 shows the same strip line with copper conductors 1mm apart, but 1m deep into the paper in order that we can ignore "edge effects": this doesn't matter – you can repeat the sums for narrow strips afterwards with edge effects, or you can use algebraic dimensions, but it will not change the conclusions.

I shall assume a t.e.m. step travelling to the right as he does, and make it 5 volts high. The electric field E is then 5,000 V/m, and the flux density D, or surface change density on the conductor, whichever you like to call it is:

$$D = \epsilon_0 E = 5{,}000 \times 8.854 \times 10^{-12}\text{coul/m}^2$$
$$= 2{,}763 \times 10^{11}\text{electrons/m}^2$$

I have, of course, used the fact that each electron carries a charge of 1.6×10^{-19} coulombs. As the t.e.m. step is travelling at the speed of light, the next metre of strip must gain this same charge in 3.33ns (yes, I agree, 1ft/ns is nicer). Where, Dr Catt asks, do these electrons come from? The answer is that they are already there: copper atoms are 2.28×10^{-10} metres apart (I worked this out from my 0-level chemistry book). According to the conventional theory I was taught, each copper atom contributes one electron to the conduction flow, leaving itself positively charged by the same amount. Before the t.e.m. step arrives, the density of positively charged copper atoms and the electrons they have contributed is the same, so there is no net electric field. Assuming that the copper atoms are arranged on the surface in a square grid, this density is

$$(1/2.28 \times 10^{-10})^2 = 1.92 \times 10^{19}\ \text{electrons/m}^2.$$

This is so huge that we need only increase the existing surface density by 1 part in 70 million in the next 3.3ns to achieve our aims. This will happen if all the electrons in the surface move up a little bit, as shown in my Fig.2. In other words, all the electrons must start travelling to the right, immediately the t.e.m. wave passes them, at 1/70,000,000 of the velocity of light, i.e. about 4 m/s. An electric field so high as to cause flashover would involve a difference from neutrality of only 1 electron in 200,000 surface atoms, so we are never likely to run into trouble with conventional theory.

It is actually better than this, because whoever heard of a strip line one atom thick? If we make the line 0.01mm thick (my Fig. 3), i.e. about 44,000 atoms thick, the average electron drift velocity required is 44,000 times smaller, or about 10^{-4} m/sec, which is what I was taught to expect. Lest anyone point out that current flow in the surface "at these frequencies", I have already dealt with that, since even 4m/s is much less than an electron's velocity. Behind the step, the currents is of course d.c., so one can imagine a transition from the regime of Fig.2 to that of Fig.3. I find the above conventional theory intuitively obvious. Your readers will have to judge whose intuition is best.

I do not wish, in my turn, to debunk Dr Catt's theories; indeed I was designing capacitors for thermonuclear experiments using transmission line theory in 1958, because it seemed the only sensible approach. But it didn't lead me to lose my faith in displacement current: quite the opposite! If you read carefully Drs Catt and Watson's earlier papers in *WW* you will find they contain a mathematical howler, as a result of which displacement current isn't debunked after all. Don't ask me what this howler is; along with many of my colleagues, I find this correspondence very entertaining, and I wouldn't like it to stop. but I will give you a clue. Whenever Dr Catt debunks conventional theory he insists on using a perfect mathematical step. Can you differentiate at a step? Have you ever seen a step? With modern oscilloscopes they always turn out to be ramps.

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Fig. 3

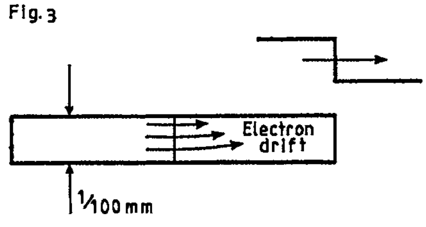

Fig. 1

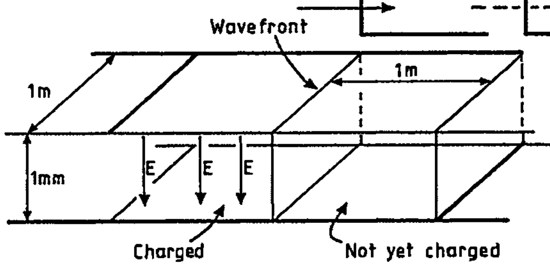

Fig. 2