ENGLISH LANGUAGE AND SCIENCE

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Abstract.

Here attention is drawn to possible problems arising from an inaccurate use of the English language in science. It is noted that such misuse may lead to incorrect public understanding of some common notions in science today.

Introduction.

It is becoming increasingly worrying to note the decline of usage of correct English in so many areas of life. Possibly most worrying is the decline in such areas as the Law (at least in England) and Science; - two areas where people might have thought accuracy of language to have been of crucial importance especially in relation to legal issues. In England, as in many countries, there is a presumption of 'innocent until proven guilty' enshrined in the law. However, in recent years it has become customary when a complaint is made to 'believe the victim'. Firstly, the use of the word 'victim' is inaccurate because at this point the person is merely a complainant . However, the bigger issue is that, if the complaint is made against another person, this policy of 'believing' implies immediately that the person against whom the complaint has been made is guilty! It follows that there is no longer a presumption of innocence until proven guilty and so alters all attitudes in any subsequent investigation. This realization of the inaccurate – even sloppy – use of English in an area such as the law makes one begin to examine its use in science and immediately concerns begin to emerge.

However, when it comes to science, the misuse of language is not so clear cut as in the legal situation discussed. The problem will, therefore, be addressed via several examples which could cause a measure of confusion both to the all trusting public and, in one sense more importantly, to students.

Inaccurate Use of Language in Science.

In many GCSE examinations in physics, chemistry and geography students are normally made fully aware of what are, and are not, officially regarded as being such renewable sources. The problem arises if the student has not been made aware of the official designation and is fully competent in the English language because whether or not geothermal energy is renewable will present a real problem. Such a student will realize that, once the decay has occurred and the resulting energy given off, it cannot be replaced and he will draw the conclusion that such a source is not renewable – except, of course, in exactly the same way that coal (for example) might be termed a renewable source. According to conventional doctrine, however, such a student would be incorrect! The problem here lies with the use of the word 'renewable' and also with the apparent lack of realization that basic thermodynamics tells us that 'energy may neither be created nor destroyed, merely changed from one form to another'. It might be noted also that, as far as this example is concerned, if the word 'renewable' is taken to have its literal meaning then this example might be seen to imply a violation of the Second Law of Thermodynamics since it would seem that energy had been used to do work but had been replaced. The actual word 'renewable' simply doesn't explain accurately the meaning that it is intended to convey and, as is shown here, could even be felt complicit in suggesting a violation of a well-tried basic law of physics.. In a 1996 article [1], George Cole used the word 'regenerative' instead and, although there are possible objections to this choice, it is a much better one than 'renewable' which can so easily be misunderstood.

Another series of words often used in various areas of physics which is often misunderstood is the 'speed of light'. This is something referred to frequently by people in the media who convince the public that it is a constant and often lay the origin of this claim at Einstein's door. However, Einstein actually asserted that the speed of light *in vacuum* is constant and this is a point which has been explained very clearly by Santilli [2]. In this book, Santilli points out that:-

"Among the various cases of interior systems, a most important one is the propagation of light within physical media described by the law we learn in high school

$$C = c/n \tag{1}$$

where c is the speed of light in vacuum and n is the familiar index of refraction.
As an illustration, it is known that, for the case of water, light propagates at a speed much smaller than the speed in vacuum and approximately given by the value

$$\mathrm{C} = \mathrm{c/n} = 2\mathrm{c}/3 < c, \quad n = 3/2 > 1$$

It is equally known that electrons can propagate in water at speeds bigger than the local speed of light, and actually approaching the speed of light in vacuum. In fact, the propagation of electrons faster than the local speed of light is responsible for the blueish light, called Cerenkov light, that can be seen in the pools of nuclear reactors.
Finally, it is also well known that special relativity was built to describe the propagation of light in vacuum, and, certainly not within physical media. In fact, the setting of a massive particle travelling faster than the local speed of light is in violation of the basic axioms of special relativity."

This quote sums up the position concerning the term 'speed of light' extremely well and serves as further illustration of the fact that far more care needs to be taken in science with the English language than is presently the case. Certainly this is one case where a great many members of the general public have been led astray from the truth. Of course, the whole question of whether or not the speed of light could be exceeded is another linked issue but one which has been reviewed at length already. [3]

Ensuing thoughts on 'black holes'

It was John Michell [4] who, in 1784, first derived an expression, using Newtonian mechanics, for the ratio of the mass to the radius of a spherical body having an escape speed equal to, or greater than, the speed of light,

$$\frac{M}{r} \geq \frac{c^2}{2G} = 6.7 \times 10^{26} kg/m \tag{2}.$$

where M is the mass of the body, r its radius, c the speed of light in vacuum and G the universal constant of gravitation.
It should be noted here that, although the idea of light possessing a finite speed was known at Michell's time, that speed was not regarded as an ultimate speed. The notion of an ultimate speed, if indeed such a speed truly exists in nature, only surfaced with the emergence of the special theory of relativity. However, it was towards the middle of the last century that the modern idea of a relativistic black hole appeared. This latter object actually arose as a physical explanation of a singularity apparently occurring in the Schwarzschild solution to the field equations of general relativity [5]. It is interesting to note that this singularity occurs when the ratio of the mass to the radius (or, in this case, the radius of the so-called event horizon) formally satisfies the same relation as that deduced by Michell. This idea of a 'black hole' (but probably better termed, as suggested originally by McCrea, a dark body), as a body from which nothing can escape – not even light has proved an extremely popular topic of uninformed conversation, and has become especially beloved by science fiction writers. However, the modern notion, as distinct from the original idea of Michell, faces several problems. Possibly the most problematic is the fact that, in Schwarzschild's original article [6]. this crucial singularity does not appear. In fact, the form of the 'Schwarzschild solution' appearing in so many texts is one resulting from use of a co-ordinate system different from the spherical polar co-ordinates so meticulously used by Schwarzschild himself. Hence, the crucial singularity is completely dependent for its existence on the system of co-ordinates used and so cannot possibly have any physical significance assigned to it; it is purely a product of the co-ordinate system adopted. A further problem facing the idea is simply that Einstein himself, often referred to by some as the 'father of black holes', went to great lengths, in an article of 1939 [7], to show that the mentioned singularity had no physical significance. It is interesting to note that neither Einstein nor Schwarzschild claimed the offending singularity to have any physical significance, but their strongly held opinions have been over-ruled to the extent that, somewhat ironically, not only is Einstein credited with being the father of black holes, but the uncharged, non-rotating black hole is commonly termed a Schwarzschild black hole

It seems a somewhat crucial point is omitted frequently when discussing black holes and that is that the Michell more accurately called dark body is derived by examining a possible extreme situation of a genuine physical star but the black hole derived via relativistic theory is an attempt to assign a physical meaning to a mathematical singularity. As far as the second possibility is concerned, it is not unreasonable to search for physical support for such an idea but it must be remembered that, normally in mathematics, a singularity is seen as somewhere that a theory breaks down. However, as far as use of language is concerned, it might be asked to which of the speeds of light is reference being made when discussing either black holes or Michell's dark body? It seems that must be the speed of light in vacuum as that is the one integral in special relativity. However, since, as has been illustrated above, the speed of light itself is not a constant, it should be made clear if the speed of light in vacuum is the one of interest in a particular situation – otherwise confusion could arise for any uninitiated interested investigator.

Some further thoughts.

All of the above discussion has been based on a number of assumptions – firstly that there is an ultimate speed and secondly that that speed is the speed of light in vacuum. However, the possibility of speeds greater than that of light in vacuum has been mentioned already [3] and has also been found predicted elsewhere [8] . This, of course, raises several interesting possibilities immediately but it seems that it may be felt appropriate here to consider its relevance to the question of black holes and, indeed to that of Michell's dark bodies. One question here is 'What value is to be assigned to the speed of light when it is the escape speed in either of these two cases?' It might be remembered that the light will be passing through some medium, so should the refractive index of that medium be involved? This is obviously a reasonable question to ask whether or not the speed of light in vacuum is an ultimate speed but, if it isn't, further issues arise for future consideration and one of these would be an examination of the range of validity of special relativity. This latter point would become relevant whether the traditional route to deriving the equations associated with special relativity was followed – that is, via the use of the Lorentz transformation – or the alternative one pioneered by Wesley which used as its starting point the experimentally verifiable result that energy and mass are related via the well-known equation

$$E = mc^2.$$

Conclusion.

The examples discussed above might seem trivial but, unfortunately, might be seen to indicate a trend towards some carelessness in the use of language. To be in any way truly useful, science must be exact or at least as exact as circumstances allow – although it has to be recognized that, for example whenever statistical arguments are employed, a degree of latitude will appear and should be acknowledged.. Hence, the use of correct language is a real must as that is an area where circumstances allow complete accuracy. It might be worth remembering also that it is always important to remember any restrictions imposed in the derivation of useful results and to ensure that they are satisfied when making use of those results. It was in 1968 that it was pointed out that, when considering particle-number fluctuations, the two well-known expressions for the mean-square relative fluctuation in number of particles are equivalent only when the pressure, P, is a definite function of both the number of particles, N, and the volume, V. Hence, if P is a function of N but not of V, the two expressions are not equivalent and care must be taken to use the correct one. [9]

References.

[1] G. H. A. Cole, 1996, in *Entropy and Entropy Generation*, ed. J. S. Shiner, Kluwer Academic Publishers, Dordrecht

[2] R. M. Santilli, 2006, *Isodual Theory of Antimatter*, Springer, Dordrecht

[3] D. J. Farrell & J. Dunning-Davies in *Astrophysics, Neutron Stars and Galaxy Clusters,* ed. Louis V. Ross, Nova Science Publishers Inc., New York

[4] J. Michell, 1784, Phil. Trans. R. Soc.**74**, 35

[5] for an explanation of this assertion see J. Dunning-Davies, 2007, *Exploding a Myth,* Horwood Publishing Ltd., Chichester

[6] K. Schwaezschild, 1916, Sitzungsberische der Königlich Preussischen Akademie der Wissenschaften zu Berlin, Phys-Math. Klasse 189

[7] A. Einstein, 1939, Annals of Mathematics, **40**, 922

[8] J. Dunning-Davies & R. L. Norman, 2020, J. Mod. Phys. **11**, 1361

[9] J. Dunning-Davies, 1968, Il Nuovo Cimento, **57**, 315