Omnès Revisited

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Abstract.

Attention is drawn to a newly suggested modification to the matter/antimatter theory advanced by Omnès in 1969. The new suggestion is dependent on the existence of supermassive black holes and is an attempt to invalidate the major objections to that earlier version of the theory. Here it is noted that many of the results derived apply equally well if the massive body involved is a Michell dark body. Mention is also made of the alternative theory advanced in 2006 by Santilli.

Introduction.

Cosmology is a fascinating area of science, not least because, by its very nature, it allows the human mind to speculate and theorise almost at will. It is, after all, basically the study of the structure of the Universe on the largest scale and, although observation plays an important part, cosmological models are descriptions of that Universe in terms of mathematical equations and it is these models which have tended to lead investigations for many years. This has led to the detailed examination of several truly ingenious models, probably the most well-known being the so-called Big Bang model. However, all models have been found to harbour problems and one associated with the Big Bang concerns the apparent lack of antimatter in the present Universe. The question of whether or not there is actual predominance of matter over antimatter is not necessarily a trivial one. In the middle of the last century, Hannes Alfvén and Oskar Klein suggested cosmological models which start with perfect symmetry between matter and antimatter. Subsequently in the theories these two components which comprise the Universe separate into matter-dominated and antimatter-dominated regions. Several objections were raised concerning this theory but an important one involved the manner of separation of the regions of matter and antimatter, since it was understood that even intergalactic space contains a small amount of matter and so galaxies could not be completely separate from antigalaxies. Alfvén [1] did propose a possible mechanism for achieving the required separation but most astrophysicists remained sceptical.

The mechanism proposed by Alfvén was effectively a generalisation of a phenomenon investigated in the 19th century by a German physician, Johann Leidenfrost. It was noted that, if a drop of water is placed on a surface whose temperature is in the region of 100°C, it will evaporate almost immediately. However, if the surface temperature is several hundred degrees, the drop does not boil off immediately; rather it becomes smaller gradually before disappearing completely. The explanation is that, at the higher temperature, as the drop evaporates, a layer of steam forms between the drop and the surface and this layer acts to insulate the drop from the surface so that heat is conveyed from the surface to the drop more slowly. Alfvén's idea was that a similar situation might exist in some circumstances between matter and antimatter.

Another model introduced just a little later in the 1970's by Omnès, Stecker and others had as an initial state a mixture of matter and antimatter separated by a Jordan surface, which is a simple closed curve separating two different components, each of which is fully connected. This state was referred to as an 'emulsion'. However, before too long, these efforts were abandoned because it emerged that separation on the scale of clusters of galaxies was needed to satisfy the then current observations but the model was found unable to demonstrate that coalescence could continue long enough for the accumulation of matter and of antimatter to grow even to the size of galaxies, let alone clusters of galaxies, before separation occurred. The problem of an initial baryon, anti-baryon asymmetry, necessary in today's dominant model to ensure the apparent dominance of matter in the Universe as it is today, remains. The fact is that the existence of an initial imbalance between baryons and anti-baryons is a purely ad hoc assumption. That being so, people have continued to speculate on the presence of antimatter in our Universe, even though the models of Alfvén, Omnès and others have long since been discarded. However, it is possibly of interest to note that, although, as mentioned, Omnès and his co-workers referred to a state as an 'emulsion', at no time did they utilise the properties exhibited by an actual emulsion in their deliberations. It is worth noting these particular properties and contemplating the effects of incorporating them into the model.

Emulsions.

An emulsion is a mixture of two substances which normally wouldn't mix; that is, a mixture of two immiscible substances. One, referred to as the dispersed phase, is dispersed throughout the other, referred to as the continuous phase. Again, emulsions fall into two categories; colloidal emulsions which are stable so that one phase will remain dispersed throughout the other over a period of time, and non-colloidal emulsions which are unstable and in which the two components tend to separate out. On occasions, substances known as emulsifiers may be added to stabilise an emulsion. A very typical example of an unstable emulsion is provided by salad dressing. In this example, as is well known to all, the emulsion will separate out very quickly unless shaken very vigorously. However, for present purposes, this common example is worth bearing in mind as it is an example of an emulsion which illustrates very clearly what an emulsion is, how it looks and how it behaves.

In the original Omnès model, although the term 'emulsion' was used, the situation envisaged was more a mixture of individual blobs of matter and antimatter; there seemed no notion of one phase being dispersed throughout a second phase which remains fully connected. Normally, the two substances forming an emulsion will separate out over time if left undisturbed but the situation in the early universe described by Omnès was certainly not undisturbed, more akin in fact to the situation of a violently shaken salad dressing. However, simply introducing the notion of a genuine emulsion into the discussion cannot, of itself, help in the resolution of the problem of the missing antimatter since no conglomerations of antimatter have been identified in the Universe. Recently, an ingenious suggestion [2] has been advanced in an attempt to rectify this and that suggestion is that what might be termed the cores of black holes are all, both primordial and supermassive black holes, composed of antimatter. With the popular modern notion of a black hole, such a suggestion would mean all the antimatter being hidden from view inside the event horizon of the black hole. Also, considering the sizes of the postulated supermassive black holes, it is relatively easy to see how an equivalence of content of matter and antimatter in the Universe could be achieved; indeed, in the above mentioned article [2] some rough figures are included to support the plausibility of this assertion.

Black hole involvement in the model.

However, what if matter manages to cross the event horizon and come into contact with the antimatter? Obviously, any matter/antimatter contact will result in the annihilation of both but, in the model, the annihilation rate would be slowed down tremendously due to the antimatter being condensed into an extremely small body. Also, this annihilation would occur inside the event horizon and so there need not be any observation of resulting radiation. Further, it is suggested that such annihilation might not proceed too rapidly if a Leidenfrost layer, such as suggested by Alfvén, were to exist inside the event horizon. One further point occasioned by this idea is that such matter/antimatter annihilation could help the gradual evaporation of the black hole without recourse to the possible phenomenon of Hawking radiation, if such evaporation does, in fact, occur as speculated.

In the discussion so far, the role of the event horizon has been simply to prevent evidence of any possible matter/antimatter annihilation being viewed by observers; apart from that possibility, it appears to play no significant part in the model. Event horizons, though, are only part of the notion of a black hole which seems to emerge from the theory of general relativity. In the simplest case of an uncharged, non-rotating black hole, the starting point for discussion of the model is the Schwarzschild solution to the Einstein field equations but, as has been pointed out on numerous occasions [3], the popular version of that solution on which this deduction is based is not actually Schwarzschild's original solution, as is easily verified by referring to his original article and comparing it with the popular version which appears in so many textbooks. Schwarzschild's original solution does not possess the singularity which leads to the idea of a black hole. Hence, serious question marks hang over the modern notion of a black hole, added to which, as again has been pointed out on numerous occasions [3], so far no black hole candidate has satisfied the fundamental inequality to be satisfied by the ratio of its mass to the radius of its event horizon; that is, the inequality

$$M/R \geq c^2/2G = 6.7 \times 10^{26}\mathrm{kg/m}.$$

However, even if the modern notion of a black hole has problems, theoretically the idea put forward by Michell in 1784 [4] and based on purely Newtonian principles is sound. Michell investigated the problem of a body with an escape speed greater than, or equal to, the speed of light. He found that the mass and radius of such a body would satisfy the same inequality as that mentioned above for a black hole as derived from the principles of general relativity. Of course, in Michell's case, *R* represents the actual radius of the body and not the radius of an event horizon. Since the event horizon plays so small a part in the above mentioned model of a balanced matter/antimatter Universe, it would not seem too much of a problem to substitute a Michell dark body instead of a black hole in that model. The term 'dark body' is used more correctly to describe the Michell idea since, as was pointed out by McVittie [5], if such a body exists, it would be simply a very dense body which could be approached and, in fact, viewed from a suitable distance, unlike the modern notion of a black hole. Obviously, this latter comment is in accordance with the usual meaning of a so-called 'escape speed'. It follows that the ideas advanced in the mentioned recent article [2] would hold if the bodies referred to were Michell type dark bodies of the appropriate size rather than conventional black holes since, although such objects wouldn't be hidden behind an event horizon, they would be effectively hidden from view by the very fact that even light would be unable to escape completely from them. Also, as with the suggestion based on black holes advocated in [2], any annihilation occurring would be slowed down to a great degree by the antimatter being condensed into an extremely small compact body. Of course, with no event horizon, if the dark body was composed of antimatter, any annihilation with nearby matter could only be prevented, or the effects slowed down, by the Leidenfrost layer solution as advocated originally by Alfvén. That in itself is no drawback to this modified suggestion since it is such a Leidenfrost layer which proves so important in the model suggested in [2]. It might be commented also that, in the case of a Michell dark body, the visibility referred to above would not mean that photons would reveal the presence of annihilation reactions since such photons would be degraded in energy and would not be what would be expected from annihilation.

Conclusion.

All of the above discussion, at least as far as matter/antimatter is concerned, is basically dependent on the Big Bang model being accepted as fundamentally correct. If it is not, then no immediate argument springs to mind to suggest the existence of antimatter in the Universe, at least not in quantities comparable with the amount of matter actually observed.

Another totally different theory relating to the possible antimatter problem exists though and that is the one due to Santilli [6]. Santilli claims there is no classical theory capable of describing antimatter properly and, having devised a new form of mathematics to cope with the situation, he proceeds to study antimatter via his newly devised isodual mathematics which involves negative-definite units and norms. When represented in this way, all the characteristics of matter change for antimatter, not just the charge. One huge change in thought brought about by this approach is that the photon is not invariant under isoduality or, in other words, within this theory a conjugate particle, the isodual photon, exists. It emerges that this isodual photon possesses different physical characteristics, which might be measured experimentally, when compared with the ordinary photon. It follows that, if true, this would offer a means of distinguishing between faraway matter and antimatter galaxies or, in fact, between any matter and antimatter objects present in our Universe.

Here attention is being drawn to two possible ways of explaining and investigating the apparent matter/antimatter discrepancy in our universe if the Big Bang theory is taken as a starting point for discussions. That due to Santilli has now been in the public domain for a few years but, as far as this author is aware, has not been investigated independently. This new suggestion, comprising a modification of ideas introduced by Omnès some years ago is also in need of further detailed consideration. However, this new suggestion has the advantage of depending on existing ideas, both physical and mathematical, and does seem to offer a genuine solution to a problem which must have been causing concern for standard model advocates. The original ideas of Omnès were ruled out by observations. This modified idea should offer further opportunities to observers to seek proof, one way or the other, of its correctness.

References.

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