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A proposed experiment on absorber theory

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Abstract. As distinct from conventional electrodynamics in which the advanced potential solution of Maxwell's equations is rejected on causal grounds, absorber theory allows the possibility of a mixture of advanced and retarded radiation, dependent on cosmological boundary conditions.

In a recent experiment Partridge attempted to detect advanced effects by introducing a local absorber, but it was maintained by Pegg that, because a static absorber was used, only a null result was possible. In this paper we give the theory and a brief outline of an experiment which uses a time-asymmetric chopper absorber to alter the boundary conditions and thus the ratio of the advanced to retarded components in the mixture, provided this is non-zero initially, leading to possibly detectable effects.

1. Introduction

It is well known that Maxwell's differential equations are time-symmetric and hence lead to an advanced potential solution as well as the normal retarded potential solution. In conventional electrodynamics the advanced potential solution is discarded on causal or thermodynamic grounds. In the Wheeler–Feynman absorber theory, on the other hand, as interpreted and developed by Hogarth (1962), Narlikar (1962), and Hoyle and Narlikar (1964), it is the cosmological boundary conditions which determine the final solution. For a fully retarded potential to be the only solution of Maxwell's equations two conditions must be satisfied, firstly the universe must be a complete absorber of retarded radiation and secondly it must not completely absorb advanced radiation. Of the better known cosmologies only the steady-state theory seems to satisfy these conditions. Current measurements, however, such as that of the deceleration parameter, indicate that it is more likely that the universe approximates a closed model. It is unlikely that such a basically time-symmetric model would satisfy both the above two conditions (Roe 1969), or the inverse conditions which lead to a fully advanced solution. This leaves a definite possibility that, if absorber theory is correct, the radiation emitted from a source contains a mixture of retarded and advanced potentials.

In the widespread interpretation of absorber theory which we are adopting, the term 'source' is used to describe any potential emitter of electromagnetic radiation, such as an oscillating charge, or an excited atom. When a source emits retarded radiation, the field from the source propagates into the future, that is, its effect is detectable after emission, until it finally interacts with an absorber. For a perfect absorber the field from the source is reduced to zero on the side of the absorber opposite to that of the source. The observable effect of this process is that energy is transferred from the source to the absorber. If the source were to emit advanced radiation, the field would be detectable before emission and interaction with an absorber would produce an observable energy gain at the source at the expense of the energy of the absorber. A source which emits an equal mixture of retarded and advanced radiation suffers no net energy loss or gain. An unequal mixture would produce a gain or loss of energy dependent on the amount of the retarded and advanced radiation in the mixture.

Everyday experience dictates that the retarded part of the mixture, which is associated with spontaneous emission, must be dominant. Any spontaneous absorption probability, which would be associated with the advanced component, must be small. Under these circumstances spontaneous absorption could only compete with spontaneous emission at very low temperatures where most of the lower energy states are filled. An interesting speculation is that the equilibrium temperature is about 3 K. Then the apparent black-body retarded radiation coming isotropically from the universe would actually be advanced radiation being emitted into the universe from the source. The possibility of a link between the 3 K radiation and advanced effects has also been mentioned by Gold (see Partridge 1973).

Partridge (1973) attempted to alter the amount of retarded radiation emitted from a source by introducing a local absorber, and then looked for a change in the power requirements of the source. For reasons given by Pegg (1973b) however, based on the normal interpretation of absorber theory, the technique used by Partridge could give only a null result. In this paper we give the theory of an experiment at present in preparation in which it is hoped to measure, or set an upper limit on, the amount of the advanced field in the mixture.

2. Theory

We write the total field at a source as the mixture $AF_{\mathrm{r}}+BF_{\mathrm{a}}$, where the subscripts refer to retarded and advanced potentials. From Narlikar (1962) we have

$$A+B = 1 \tag{1}$$

$$A = \frac{1-p}{(1-p)+(1-f)} \tag{2}$$

where p and f are the absorption factors for the past and future parts of the universe. These can be complex if necessary to account for any phase shift. The net radiation reaction, that which removes power from the source, is $(Af-Bp)R$ where R is the reaction for a purely retarded field ($A = 1$). From (1) and (2) this expression reduces to $(2A-1)R$.

Clearly, time-symmetric boundary conditions, which would yield $f = p$, give $A = B = \frac{1}{2}$. Common experience demands $A \simeq 1$ and $B \ll A$. From (2) this implies the asymmetry $1-f \ll 1-p$. The proposed experiment involves changing the ratio $A:B$ by introducing a local absorber which will alter the ratio $(1-f):(1-p)$. Supposing that the local absorber can give an absorption factor h_{r} for a retarded ray and a different factor h_{a} for the corresponding advanced ray, we then have, following the method outlined by Pegg (1973a, b), on including the local absorber,

$$f = h_{\mathrm{r}}+(1-h_{\mathrm{r}})f_{\mathrm{u}} \tag{3}$$

$$p = h_{\mathrm{a}}+(1-h_{\mathrm{a}})p_{\mathrm{u}} \tag{4}$$

where f_u and p_u pertain to the universe outside the absorber. Substitution of (3) and (4) into (2) gives

$$A = \frac{1-p_u}{(1-p_u)+(1-f_u)(1-h_r)/(1-h_a)}. \tag{5}$$

We see that to alter A and thus alter the power loss from the source we need $h_r \neq h_a$. This is the reason why a local static absorber, as used by Partridge, has no affect on A. Also it accounts for the fact that other local absorbers at rest relative to the source, such as the laboratory walls or the earth itself, do not influence the rate at which the source loses energy. For example the measurement of the lifetime of an excited state will be independent of whether the experiment is carried out in space or underground.

From (5) we can alter A by increasing or decreasing the ratio $(1-h_r)/(1-h_a)$. Since $1-f_u \ll 1-p_u$ the effect of making this ratio smaller, that is by absorption of the retarded but not the advanced ray, will have only a minor effect on A. A far more promising technique is to absorb the advanced ray and not the retarded ray ($h_a \simeq 1$, $h_r \simeq 0$). Then if we can make h_a of the order of magnitude of f_u, we can substantially alter A and the power transfer from the source. In effect, this is making up to some extent for the lack of absorption of advanced radiation by the universe in comparison with the absorption of retarded radiation.

3. Proposed experiment

The proposed experiment involves the use of two chopper absorbers, one very close to the source with absorption factor h_1 while absorbing, and one with factor h_2 some distance away. A chopper is a device which absorbs and transmits radiation periodically in time. Examples are shutters, either mechanical or electro-optical, which can be opened and closed, and rotating toothed wheels. In figure 1 the times during which a chopper is absorbing are represented by lines, and the times it is transmitting by gaps. In this configuration the choppers have equal frequencies but a difference in phase such that advanced rays emitted during t_1 are absorbed with $h_a = h_2$, but the corresponding retarded rays are transmitted ($h_r = 0$). Advanced rays emitted during t_2 are

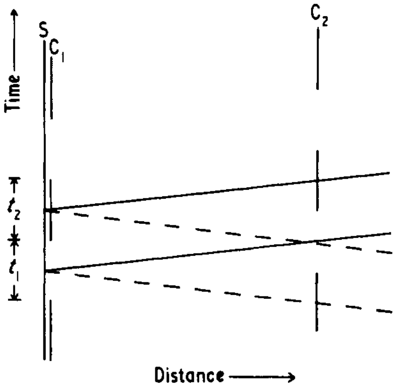

Figure 1. Two-dimensional cross section of the world lines of a source S and two choppers C_1 and C_2. The full oblique lines represent retarded rays, and the broken lines advanced rays.

absorbed with $h_a = h_1$, and for the corresponding retarded rays $h_r = h_1 + (1-h_1)h_2$. From (5) we have that during t_1

$$A_1 = \frac{1-p_u}{(1-p_u)+(1-f_u)/(1-h_2)} \tag{6}$$

and during t_2

$$A_2 = \frac{1-p_u}{(1-p_u)+(1-f_u)(1-h_2)}. \tag{7}$$

For $1-f_u \ll 1-p_u$, $A_2 \simeq 1$ irrespective of the value of $h_2 < 1$, but provided we make h_2 a significant fraction of f_u, A_1 will differ appreciably from unity. The power being transferred from the source will thus oscillate at the chopping frequency.

4. Practical considerations

Because local stationary absorbers have no effect on A, most of the reasons for Partridge's choice of a microwave source do not apply. We therefore have chosen to use a laser which produces a narrow beam suitable for chopping. For an extraneous local absorber to have any effect, its absorptive properties must alter in a systematic way in the time scale s/c where s is the distance of the absorber from the source. The only local absorber which might do this would be the galaxy and even this is fairly unlikely. We shall, however, beam the laser perpendicular to the plane of the galaxy to avoid this small possibility.

Although a pair of rotating mechanical choppers would have very large absorption factors, their inherent frequency limit would necessitate a large separation distance, which in turn would require high quality optics to maintain a sufficiently narrow beam. In the initial experiments, therefore, we are using crystal beam rotators between crossed polarizers as choppers. Since A determines both the source power loss and the average amount of power which can be transferred to a detector, that is, the power in the beam, we have immediately two possible methods for measuring the variation in A.

The first method involves measuring the power input to the laser, and this would correspond to the technique used by Partridge. A variation of this method might involve monitoring the light emitted through the sides of the laser. It is to be noted from (6) and (7) that the value of h_1 has no effect on A, so the first chopper could be removed, leaving in principle a simple experiment involving only one chopper. The value of h_2 could be modulated at a convenient low frequency and a corresponding variation sought in the power to the laser. One difficulty involves the possibility of retarded radiation reflected back into the laser affecting the rate equations sufficiently to mask the effect sought. This could be reduced by a slight misalignment of the chopper, enough to ensure that over the large distance involved the main reflected beams miss the laser. Further, an estimate of the magnitude of this and other extraneous effects could be found by doubling the chopping frequency. Then for every retarded ray which is absorbed by the chopper, the corresponding advanced ray is also absorbed, giving no change in A and so zero signal arising from the presence of advanced radiation. A more satisfactory approach, however, is simply to insert a static absorber between the laser and the chopper. The static absorber would have no effect on the value of A, but would optically isolate the laser from the chopper in terms of the conventional retarded radiation theory. Under these circumstances a positive result would be quite convincing evidence of the existence of advanced radiation. The disadvantage of this simple experiment, however, lies in the uncertainty in the correspondence between the power input to the laser and the value of A, making any quantitative estimate very difficult.

The method we propose to use involves retaining the first chopper and monitoring the power in the beam by a photo-electric device as the maximum absorption of the second chopper is varied. The resultant signal should be a square wave, the amplitude of which, for h_1 sufficiently close to unity, depends on h_2. It is not difficult to show that even with the minimum values of $1-h_1$ and $1-h_2$ as large as $\frac{1}{30}$, obtainable from simple crossed polarizers, a ratio of $B:A$ of the order of 10^{-4} would produce an easily measurable change in the square wave amplitude of the order of 1%. In terms of photon numbers, which are proportional to energy, this would imply the existence of 1 advanced photon for every 10^8 retarded photons.

5. Conclusion

For the reasons pointed out by Partridge (1973) an experiment such as this will have significance even in the event of a null result provided a reliable upper estimate of this null is obtainable. Assuming absorber theory is correct, this will place an experimental limit on the ratio $(1-p_u)/(1-f_u)$ for the universe. Any proposed cosmological model should give a result within this limit. Alternatively if no reasonable model can be found within this limit, then the results will be an argument against absorber theory. On the other hand, regarding the far more exciting possibility, a positive result would have such far-reaching consequences on our ideas of the unidirectionality of time and causality that we feel that the experiment justifies a large amount of effort, even if no conclusive result is obtained for years.

The experiment at present being set up by the authors should be regarded as of a preliminary nature only. It is expected, in the absence of a positive result, to set a limit on the ratio of advanced to retarded photons of 10^{-8} initially, and then 10^{-12} with further modifications involving the use of a single chopper and gated detector. By publishing the principle of the experiment at this stage, we hope to evoke widespread criticism and comment before committing considerable resources to the further search for advanced photons by this method.

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