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THE ORIGINAL ALEXANDER EXPERIMENT FROM 1957 ON ANOMALONS AND THE SECOND LAW OF THERMODYNAMICS

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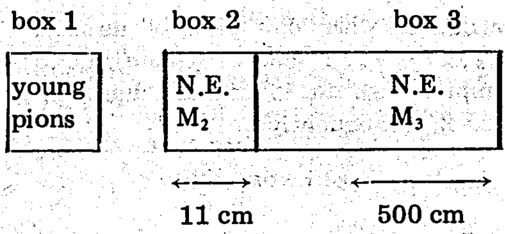
2) The average energy liberated in nuclear interactions by "young" and "old" pions is the same, i.e. energy conservation holds.

3) A pion is completely characterized by stating that the object is a pion with a known total momentum. Present day physics does not know any inherent difference between a "young" and "old" pion.

4) All experimental evidence from bubble-chambers and the construction and operation of pion-beams in high-energy laboratories shows, that the electromagnetic interaction of pions does not show any difference between "young" and "old" pions. The curvature of a pion is constant in a constant magnetic field, starting from the point-of-creation of the pion down to many meters flight path, provided we neglect such obvious effects as slowing down due to passage through bulk matter, etc.
Using these four assumptions, we carry out the following gedankenexperiment:



N.E. — nuclear emulsion
M_2 — Mass in box 2

$M_2 < M_3$

Box 1 is filled with "young" pions with E = 100 MeV, the total momentum of every pion is directed towards box.2. Boxes 2 and 3 are filled with nuclear emulsion, they are thermally isolated against the surroundings and thermally isolated from each other. At the start, boxes 2 and 3 have the identical temperature T_0. Now, all "young" pions from box 1 are forced to enter at first box 2 and then, in case a pion survives, it enters box 3. (In this gedankenexperiment the experimentators are so smart, as to force all pions this way. But when the reader has trouble in imaginating such an experiment, well, he can consider concentric shells around box 1 instead).
No pions are allowed to leave boxes 2,3. After all "young" pions have come to rest and vanished in boxes 2, 3, we observe temperature increases as follows:

in box 2 : from $T_0 \rightarrow T_2$
in box 3 : from $T_0 \rightarrow T_3$.

As approx. 2/3 of all pions have interacted in box 2, which is much smaller than box 3, it is observed : $T_2 > T_3$.

After this, the thermal isolation between boxes 2 and 3 is taken away and thermal equilibrium is established between them at T_4. Now it holds:

$$T_2 > T_4 > T_3 > T_0 . \tag{3}$$

During the thermal equilibration, the following heat was transfered from box 2 to box 3:

$$Q_y = c_p \cdot M_2 (T_2 - T_4) \qquad c_p - \text{specific heat} \tag{4}$$

and the entropy increased as follows:

$$\Delta S_y = c_p \cdot \ln \frac{T_2}{T_3} > 0. \tag{5}$$

Then an identical experiment is carried out with ”old” pions of the same energy. We have to replace $T_2 \to T_5$, $T_3 \to T_6$. T_0 and T_4 remain, due to the experimental lay-out and assumption (2). But in this case, due to increased Λ_0, less pions interact in box 2, consequently:

$$T_2 > T_5 , \text{ and } T_3 < T_6 .$$

After thermal equilibration, the following heat has been flowing from box 2 to box 3:

$$Q_0 = c_p \cdot M_2 \cdot (T_5 - T_4) \tag{6}$$

and the entropy increased as follows ($T_5 > T_4 > T_6 > T_0$):

$$\Delta S_0 = c_p \cdot \ln \frac{T_5}{T_6} > 0.$$

As $T_2 > T_5$ and $T_6 > T_3$, we must state:

$$\Delta S_y > \Delta S_0 .$$

The Second Law of Thermodynamics requests, that starting with a UNIQUE situation, as defined by the four assumptions given, and carrying out a UNIQUELY defined experiment, one must end up with a UNIQUE situation at the end. In this gedankenexperiment we don't.

The system starting with ”young” pions leads to a situation with a lower entropy (before thermal equilibration), than a system starting with ”old” pions.

Now one has the following options:

1) the Second Law of Thermodynamics does not always hold,

or

2) one of the four assumptions given is incorrect,

or

3) the authors of this note have made a gedankenmistake.

At this stage, the authors cannot decide. But it is conceivable, that the Second Law of Thermodynamics still holds and our assumption (3) — i.e. ”a pion is always a pion” — is incorrect: There may be a difference between a ”young” and ”old” pion, even when no such difference can be observed in electromagnetic experiments. It might be interesting to note, that the principle of having a difference between ”young” and ”old” pions may have already been seen visionary by L. Szillard in 1929, when he published an article about: ”Über die Entropieverminderung in einem thermodynamischen System bei Eingriffen intelligenter Wesen”[7]. This basis idea was revitalized somewhat modified in a recent paper[6]. There one tried to suggest this ansatz as an attempt to explain possibly all ANOMALON experiments. Some of these last experiments[8] are of a more indirect type, as they use radiochemical techniques. However, their experimental evidences defy any attempt to be understood on the basis of physics known to the authors — and this for about one decade.

In summary, we state that all ANOMALON phenomena are observed strictly only on the level of nuclear interactions, not on the level of electromagnetic interactions. Anomalons may be connected to a state of lower entropy (or higher ”information” content) than the normal nuclear state. The difference between an ”old” and ”young” pion (of the same total momentum) would then be their different content of what may be called ”information” (or negative entropy). The ”young” pion would carry just more ”information” — and this leads to be observed reduced mean-free-path Λ_y. Further experimental work should shed light on the question, whether this ansatz is of any use or not. In particular, it seems mandatory to try to reproduce the Alexander experiment[2] and other direct ”proanomalon” experiments, as summarized in Ref.6. Finally, it might be interesting to note that the possible generalisation of the ”information” concept has recently been discussed by Stonier[9].

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