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January 18, 1965

Dr. Feza Gursey
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Dear Feza:

Thanks so much for your frank letter and your good wishes. I would like to make a number of equally frank comments. No doubt we both have the view of Andrew Jackson when he said, "I intend to ask for nothing that is not clearly right and to submit to nothing that is clearly wrong."

1) Let me begin with the question that from the very start has been most dear to you, that of relativistic invariance. First, I do not agree (as you say I do) with Sakita that $SU(6)$ can be defined only in the non relativistic limit. There is a difference between a theory that is non-relativistic and a theory that can make unique predictions to order v/c . Observe that the v/c in question is an off the mass shell velocity in a three point function. This lack of uniqueness beyond the first order in v/c exists equally in the effective vertex of a photon-electron system. And of course you will not believe that I think for this reason that that theory is non-relativistic. What is important for $SU(6)$ is that one can make physical predictions even though one does not claim to know the form factors which, it is crucial to observe, are \approx constant + $O[(\frac{v}{c})^2]$ near (but off!) the mass shell (in the brick wall frame, for definiteness).

Secondly, it is indeed true that the kinetic energy violates $SU(6)$ in a Lagrangian field theory. In fact, we appear to disagree on the need for a distinction between field theory on the one hand, effective vertex and S-matrix theory on the other, in as far as $SU(6)$ is concerned. Let me add to this the

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following. On Jan. 7, Luigi gave a good and clear seminar at NYU in which he talked about the algebra which you and he have constructed. I have no doubt that this algebra is right. The point is, it seems to me, what one wishes to conclude from the existence of this algebra. I do not wish to comment further in this direction. When your time is ripe you will let me and others know what your findings are in the form of a document on which you wish to stand. This Beg and I have done. In the sequel which will be ready soon, we discuss the problems in great generality. This work has been done with care. If you believe we are incorrect, you will have the chance to say where and why.

(Incidentally, our paper I was done and sent out before Gell-Mann's work came out. His style is questionable. Why Zweig? Because he talked of 35 and 56 with his axes. The point which is not fully appreciated by many is that this game is exciting because it goes beyond representations into dynamics.)

Against this background let me comment on some other questions, notably on the questions which, you say, you had suggested and started. I have taken extreme care in regard to acknowledgement and have on many occasions gone through the pre-history with Beg (with whom, in confidence, I had to discuss your last letter). For example, in regard to the induced terms, we have discussed the sentence about it in our (=GPR) paper. We (=BP) have not referred to it because the sentence is substantively incorrect. I have told both Beg and Lee of your remark, made right after you had thought of induced terms, that one can calculate the magnetic moment. Well, one can calculate it, but this has nothing to do with induced terms. In fact, if you believe in relativistic invariance the way you do, you cannot possibly get our answer, because, it seems to me, you cannot agree to the remarks on field theory made in our letter, which to us are as important as the numbers are.

Again, regarding the weak interactions, I have gone with Beg over the detailed notes which we jointly made. The well known footnote 18 seemed timely and there you were you acknowledged, as was fit and proper, and with which I am glad you agree.

Regarding the role of a massless pseudoscalar field as explanation for the Fitch effect (suggested by me) and its identification with the cosmological field (suggested by you), I shall be glad to discuss this further. However, I do not feel I want to take the initiative in reopening this problem. I shall

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let the matter drop unless and until you express a desire to continue. (I hope you will in due course.)

In conclusion, I have a sense of true gratitude toward Luigi and you for the things we shared. I would understand it if this were mutual. However, I accept no thanks for having pushed anybody. I gave you courage, yes, but I did not push. You recall that we were expecting at any moment a paper by Gell-Mann on the subject, so those thanks should go to him.

It is my hope that this exchange of letters may prove that two friends can have different views and need not be good collaborators due to different outlooks. I look forward at any time to further correspondence, either substantive scientific or personal or both. And, incidentally, your invitation still stands. In a roundabout way I heard that you three have had more than your share of illnesses and accidents. I hope things are better now and want to ask you to give my love to Souha and Youssouf.

Yours,

A handwritten signature in cursive script that reads "A. Pais". The signature is written in dark ink and is positioned above a horizontal line that extends to the right.

A. Pais

AP/kss

A. Pais
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