BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, Inc.
UPTON, L.I., N.Y.   REFER:
TEL. YAPHANK 4-6262

DEPARTMENT OF
PHYSICS

Dec. 5, 1964

Dear Fiza,

I thought I would wait a few days to answer your letter to discuss in more detail the physics part of it, but on better thinking I prefer to discuss today the unphysical shut + write a second letter as soon as possible after having completely understood your idea.

First of all thank you very much for your long letter which relieved me of my doubts about yours a your family health. I'm sorry to hear Yusuf has not been well + hope he will soon improve: please give him our best wishes with special greetings from Luca a Alessandro.

And now to our businesses. Of course I never told Brahm that I wanted to enlist his help for the paper: he has probably imagined the whole thing in his anxiety to work on this problem. As a

matter of fact I saw very little of him since you left mostly because I find increasingly difficult to understand what he says. He usually calls me to announce that he has just sent a paper to the physical review: now he has finished a paper on weak interactions which you & I will receive soon, where in a long footnote, which he read me over the phone, he mentions some of the work we did during the Summer. I must say I don't care too much what he does or does not mention.

You have probably seen the letter by Feynman Gell-Mann & Zweig where they discuss the algebra of $U(6) \otimes U(6)$, the one we discussed in the summer: This I think drove Brahm almost mad but I don't think there is any harm in letting other people discover some of the things we know. And now to your work: as I said I haven't completely understood it though in these two days I have been able to reconstruct part of it & discover analogies with what I had been doing. I am awaiting for your manuscript to make sure I have understood correctly your point of view & then I will write a more detailed letter

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It seems however to me that this work should
be published by you alone since you have done
essentially all of it. This I say not because I do not
agree with it — in fact from what I understood I
believe it is correct — but I don't think it would
be proper for me to sign a paper to which I have
contributed very little. I think there are several other
things we can do together when we meet: some of the
work I have done during this time might be of some
interest & could be used if we decide to write
a paper on the interaction between mesons & quarks.

I have studied some of the some features of
the static interaction & I believe I understand the meaning
of the SU_6 invariance for this very special case.

*actually
I believe
we need
U_6*

You have probably noticed that the number of
papers that have been written on the SU_6.
almost everybody seems to be convinced the idea
is correct though nobody understands how it

can work. From your letter I do not quite understand if you have a Lagrangian invariant under the full group, I mean the group G_6 which I believe one needs if the interaction is to be invariant.

I cannot tell you right now whether I will be able to accept your kind invitation to come to Ankara; let me however thank you very much for it & tell you that my uncertainty comes from the difficulty I have in leaving Pisa soon after my arrival. I hope I'll be able to write to you about this before Christmas. In case I can't come I hope you can manage to come to Pisa: I believe a meeting at this stage is almost necessary.
We have decided to stay here a few more weeks, till the middle of January: would it be possible for you to come in February?

Goodbye now. Regards to Suha & love to Yusuf from all the children. To you my warmest congratulations for your work (which of course I won't mention to anyone) & à bientôt

Yours ever

Luigi

P. S. Just as I was mailing this letter

I receive a letter from Inoue with

the official invitation to Ankara.

Will you please thank him very much &

tell him I will write as soon as

possible.

　　　To both you & Inoue many

many thanks

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December 10, 1964

Dear Feza,

I have received a couple of hours ago your paper which looks to me very good. I haven't yet read it completely because I wanted to check your work with what I did during these last few days since I received your letter + made some previous work.

Let me first of all tell you a few general things

1. Your explicit construction of the generators of the little group is very beautiful

2. The explicit construction of a conserved third order tensor is a real tour de force which I think is very important. After all we were right in claiming the existence

of a curl-free axial vector.

3. The gauge transformation is beautiful too and I'm sure can be made space-time dependent.

Before proceeding I have a difficulty. I fail to see how you derive the C.R. for the $W_{\alpha 2}$ (Eq. 3.18). I had calculated them & they are not the same as yours, and therefore they are not the C.R. for an angular momentum. I have objects which satisfy these C.R. but they are not the $W_{\alpha\beta}$; instead they are, I believe

$$L_{\alpha\beta} = W_{\alpha\beta} + \frac{1}{2} E_{\alpha\beta\sigma\sigma} W_{\rho\sigma}$$

I enclose a copy of some pages from my ~~to~~ note book so you can compare $_{\wedge}$. I suspect that your $W_{\alpha\beta}$ (by the way

$$W_{\alpha\beta}^{Survey} = -2 W_{\alpha\beta}^{Rochet})$$

contains only the first terms of my table p. 10 of the note book. ~~Indeed~~ This I think is incorrect since from $W_{\alpha\beta} \sim E_{\alpha\beta\lambda\mu} W_{\lambda} P_{\mu}$

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given α, β, χ & μ can take two values

I don't think this is a dramatic difficulty
but the point must certainly be straightened out.
If I am right there should be also a similar
modification in the definition of the conserved
quantity $H_{\lambda\mu\nu}$ or perhaps only on the
integral over d^3x of its 4-th component.

I don't want to wait to mail this letter till I have
digested the whole paper. Rather I would like to
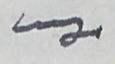raise now two practical points.

1. As I said in my previous letter I think you
should publish this paper alone since you did
almost all the work. I will send you soon
a few comments about it which you may or
may not ~~then~~ consider relevant. At any rate
I wait for your word whether to send the
paper to N. Cimento or have a preprint
typed of it for provisional circulation.

2. I think that it would be appropriate

that before leaving I should give a seminar on this work of course by presenting it as 'yours'. This may be necessary in view of the attempts which are made by several people to give proofs of the work we started during the Summer. If you think this is appropriate I could do it in a seminar I will give at N.Y.U on Jan. 7. Let me know please your point of view.

It looks now rather likely that I could come to Ankara at the beginning of February but I will write something definite before the end of next week.

I close now to mail. Best regards to Suha with all best wishes from all of us for a merry Christmas. Again many thanks for your paper

Yours

Dec 18 /1964

Dear Feza,

thank you for your letter of Dec 10.
I prefer to answer without waiting for the
manuscript of the new section because I don't
want to slow down our correspondence.

1. I still do not understand your commutations
   (3.18) These are necessary to identify $W_{\alpha\beta}$ with
   the generators of an SU_2 but according to
   my calculations they are not satisfied.
   The operators I defined in my letter and in
   my notes

   $$L_{\alpha\beta} = -2\left(W_{\alpha\beta} + \tfrac{i}{2}\, \varepsilon_{\alpha\beta\lambda\mu}\, W_{\lambda\mu}\right)$$

   satisfy the correct C.R. but have the
   great disadvantage of not being skew-hermitian.

Though they obey the algebra of SU_2 they
cannot be used to generate the group SU_2
since they cannot be used in the form

$$e^{i W_{\alpha\beta} L_{\alpha\beta}}$$

2. In view of the number of papers being published
on the relativistic version of SU_6 I think the
best thing would be for you to publish a
letter in P.L. or P.R.L which in my opinion
should contain only a small part of your
paper. If I may venture to give a suggestion
the letter should contain

   (i) Def of the op $W_{\alpha\beta}$

   (ii) Their commutation relations (?...)

   (iii) Their expression in terms of $H_{\alpha\beta\gamma}$

   (iv) Their combination with the F_A to form $U(6)$

   (v) Expression of $H_{\alpha\beta\gamma}$ for the spin ½ particle.

   (v) Invariance of the free L under the transf. (6.18)

3. I am totally happy about your calling
the $W_{\alpha\beta}$ (assuming they have the right C.R
(3.18)) the generators of the little group.
Indeed it seems to me your $W_{\alpha\beta}$ are more

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general since they are defined for any momentum
whereas a transf. of the LG is usually
defined by

$$L p = p$$

i.e. a transf. which leaves invariant a given
momentum p, not all p's.

4. I gave a seminar in Princeton last Tuesday:
since I had seen the day before Gell-Mann's paper
I decided it would be better at the end of the
seminar to mention briefly your work in order
that people know that your working actively.
I gave no details, but what I said was very
well received & I think served the purpose it
was intended for.

After the seminar I had a long conversation
with Bargman & Whightman to whom I
gave more details about your work. It was
Bargman who pointed out the difficulty
in the using my L_{ap} (see 1. above).

5. If I may presume to discuss a pure personal
matter I would like to point out that I do not
believe Bram realizes that what he now does
is not entirely proper. I think he has no ill
feeling towards you (or me): his behaviour comes
from a certain lack of 'delicatesse' & an enormous
ambition. I agree however with you that his
paper is very bad: everyone thinks the same

6. Thank you for your kind assistance in having my
name on the paper. I really did not do enough work
& as you see I am only slowing down the publication
with my difficulties (see 1. above). Go ahead therefore:
when we shall meet there will still be work to do together.
I want to make clear however that my reluctance to
have my name on the paper does not come from any
disagreement (except formula 3.18) with it's content
but solely from moral considerations.

7. I am still waiting for an answer from Pisa. I will
let you know my plans as soon as I hear from
them.

Goodbye now: to you all our best wishes for a
merry Xmas & a very happy & healthy new Year

Yours ever

Luigi

P.S.   I forgot to mention one more point:

8.   There are two reasons which make me think
the symmetry group is $U(6)$
(i).   In order to get a spin - unitary spin
independent potential of the form

$$V(r) \frac{1}{4} (1 + \vec{\sigma}_1 \cdot \vec{\sigma}_2)(\frac{1}{6} + F_4' F_4^2)$$

(an obvious generalization of the Majorana
potential $V(r) \frac{1}{4}(1+\vec{\sigma}_1\cdot\vec{\sigma}_2)(1+\vec{\tau}_1\cdot\vec{\tau}_2))$ one
needs 36 mesons with equal masses.
The vector mesons must be coupled
both to the current & to the magnetic
moment, the coupling constants being the same
(apart from a factor $1/\mu$). If you are
interested in the details of the argument I
can send it to you.

(ii) If one wants that both the current
densities & the charges satisfy the same
algebra this must be the algebra of U_6.

It is the argument that we discussed during the summer so probably you know it already. There is finally a third argument, an experimental one, namely the existence of η'(958) with J = 0⁻. It is there & can not be dismissed. If my argument (i) is valid relativistically then the mass 958 MeV is quite reasonable.

l. a.

I will send you two preprints by Gell-Mann

Feza Gürsey Arşivi

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