

June 19, 1953.

Dear Dr. Meyer :

(or I should have said, Drs. Meyer and Wataghin, since this letter is actually meant for both of you, although for simplicity addressed to one person) -

Since it now appears practically certain that I shall be with you at Sao Paulo from this fall on, I feel that I should start discuss with you our research program. Please consider what I am going to outline here as suggestions, not necessarily as rigid plans. I shall be glad to change them, or to incorporate your ideas, if that will appear advisable; in fact I am asking you for your comments and ideas.

To explain my approach after this introduction, let me dwell for a little on generalia. Of the three major aspects of cosmic ray physics (nuclear, atmospheric, and astrophysics) the main emphasis is still on the first (although it is my heretic view that the third is soon to be even more important). Here it is the high-energy region which, naturally in the time of the big accelerators, moves into the center of interest. On the one hand we can pioneer the work that soon will be taken over by the machines (the 10-100-Bev region), finding out for them where they should look; on the other there are wide fields which they cannot yet hope to approach, and where a host of new phenomena may exist: the "air shower" region of energies above 10^{12} ev.

The main experiment that I suggest to do is, therefore, a continuation and extension of the long-range plans that we have followed at Syracuse for the past two or three years. Reports on two experiments carried out in 1951 and 1952 are now being completed, and I shall send copies to you as soon as I get them from the office. In short, my idea is that because of the surfeit of variables in air shower theory, a precise test of theoretical ideas is still not possible from a single experiment, and that it is necessary to observe, in one experiment and with the same equipment and for each individual event recorded, a number of "variables", like energy spectrum of the electrons plus the lateral distribution and, if possible, evidence on the composition. We have tried to do that by combining a hodoscope and a large cloud chamber in one experiment, and got what I consider as encouraging results. In particular, I am now interested in a study of the development of air showers in the atmosphere, for which preliminary work was done last summer at Mt. Evans (altitude 4,300m). In a continuation of this work, we are now setting up an experiment here at Echo Lake, altitude 3,260m, in the following way: A cloud chamber of approximately 18"xl8"xl8" is set up as "core selector" by demanding a particle density incident on it larger than that over two other trays in 2m distance. The chamber is fitted with five 1"-carbon plates as producers of nuclear events, and four 1/4"-lead plates to initiate the transition effect in lead (which is taken as a measure of the electron spectrum) under well-observable conditions. After traversing the chamber, the electrons pass first through a liquid scintillator under a 1/2"-lead shield, and then through four further counter trays, each again shielded by 1/2" Pb, so that the transition effect can be followed through about 13 radiation lengths. These counter trays, as well as the one on top of the chamber, are "hodoscoped".

Five further trays of large counters, two at 2m, the others at 4, 8 and 16m respectively, are also "hodoscoped" and show the "outside" electron density distribution. In this way, we can establish the lateral

structure function as a function of the (average) shower age, and learn from the chamber data additional details on composition &c.

The same experimental arrangement with a different triggering ~~xy~~ system, operating simultaneously, serves also another purpose. It has long been my pet prejudice that the composition of air showers, with their 1% mu-mesons and 1% N-particles, cannot readily be explained by the customary pi-meson picture with a 2:1 ratio of charged and neutral mesons. One simply does not get enough electrons this way (these considerations have not been published; they will be incorporated in an invited paper I am to give at the Albuquerque meeting of the APS this fall, and if I get around to writing up my text I shall certainly send you a copy). One may, therefore, suspect the existence of another particle or of other particles contributing to the electron component, and it is plausible, then, to look for them in the energy region where the K-particles become abundant, i.e. around 50 Bev. Our additional triggering system, therefore, demands high-energy penetrating showers locally produced, and we hope to learn about the possible existence of other electron-producing particles from an analysis of the electron cascades initiated in the lead plates of the chamber. This analysis is facilitated by separating the individual cascades, achieved by producing the shower in the carbon plates, and letting it spread before it reaches the lead plates and multiplication starts "seriously".

It is my opinion that this experiment, both the air shower and the local-shower part, should if possible be carried out at various altitudes (the reasons, I take it, are obvious). Hence I propose to bring the equipment used this summer at Echo Lake with me to Sao Paulo, to set it up there in order to familiarize you with our techniques, and then to take it to Chacaltaya where, I hope, we will run it for about two or three months. Probably the results of this study should be combined with those of the summer run at Echo Lake, in one common report, for which the members of the Syracuse group and these of the Sao Paulo group should sign as co-authors. But let's not anticipate too much.- Have I made myself clear enough ?

If I wish to concentrate upon this experiment, it is not only because it is part of our overall research program, but mainly also because it is the one experiment we can be sure to carry out, since practically the entire ~~xxx~~ equipment will be brought from Syracuse. But there are a number of other projects that I should like to see started, if it proves materially possible. For instance, I feel that the transparency effect and the charge exchange effect in high-energy collisions are worth a new study. Many objections can be raised against all the previous data (mostly along the lines of the arguments presented in my paper in Acta Phys. Austr. 6, 167 (1952) : unfortunately I don't have a reprint here, but if you should have trouble in locating it, I can arrange to have one sent). Moreover, a comparatively straightforward shower experiment could settle the question. But I am afraid I am in a hurry to get this letter out, and it is now 1.30 in the morning : thus, if you are interested, I shall give you the details next time (the time, I hope, also stands for an excuse for that typing) - Another project belongs more to a study of cosmic-ray primaries; it involves the construction of a diffusion cloud chamber for high-altitude work. But this should be made contingent upon the possibilities of flights and similar arrangements about which I know nothing as yet.

And that brings me to the most important question that I wanted to ask you. As you see, I should like to bring the equipment to Sao Paulo first, and to ship it from there to Bolivia. How that can, or should, be

be done I have not the faintest idea, and I have to rely entirely on your advice and help. If it were here I should try for Government transportation, by air (about $2\frac{1}{2}$ - 3 tons altogether, in a number of units). Is there anything like that practically possible ?

The second important question : what is at present the status of test equipment and similar necessities available at Sao Paulo ? In an earlier letter to Professor Bohm I had outlined what I should like to have; not that all of it is absolutely necessary for the beginning, but at least some of it should be around. Could you give me this information, and advise me what best should be done ?

I shall probably think of many more questions, but for the moment, and at this hour, I am "dry", and I must close to get this letter out in the morning. Please let me ~~know~~ have your opinion and advice soon, and I do hope that this will initiate a mutually profitable cooperation

Yours very sincerely,



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