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PROGRESS REPORT ON THE DEVELOPMENT OF A METHOD TO DETECT FRACTIONAL CHARGES IN WATER AND ITS APPLICATION TO A SEARCH FOR QUARKS AT THE I S R

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A proposal to search for quarks in water after a prolonged irradiation at the I S R, using a development of the Millikan method, was proposed by us in document ISRC/70-33, and on the request of the ISRC a more detailed presentation of the proposal and the method to be used was made at the open session of the ISRC on February 17. As suggested by the committee in the minutes of the closed session on February 18, we have investigated, with Dr F. Bonaudi, the means for installation of a quantity of water for irradiation at the I S R and we wish to discuss the present status of these considerations and the progress obtained in the development of the detection method, to serve as a basis for the decision of the ISRC on the future of the experiment.

The present status of the detection method

At the open session on February 17th various difficulties which we had encountered, or expected to encounter, in the development of the detection method were discussed. The results which were then reported were obtained in a test equipment, which had only half the height of the electrostatic separating column we intend to use for the final experiment. Since then the full size, 5 metre high, column has been installed and water jets of satisfactory quality extending through the entire height of the column have been obtained. The defocussing effects which were discussed at the open session and tentatively attributed to local evaporation in conjunction with the sudden freezing of the supercooled droplets, have been resolved by the addition of alcohol which lowers the freezing point, consistent with the attributed explanation.

Modifications have been made to the system to allow the nozzle velocity of the jet to be reduced to about 10 m/s, necessary to keep the height of the jet within the 5 metre length of the tube. A diffusion pump has been incorporated in the vacuum system to achieve the pressure range 10^{-3} to 10^{-4} mm which is most suitable for the application of high electrostatic fields. As yet however this new vacuum system is not operating and we can therefore not yet report on the behaviour of the jet in the presence of the deflection voltage, which clearly would be the crucial test for the feasibility of the method.

In conjunction with the new vacuum system an observation chamber has been constructed around the apogee of the jet. Here the jet components due to integer charges and the paths of single background droplets and - hopefully - genuine fractionally charged droplets will be recorded by a 8 mm movie camera, modified to give exposures of several seconds. Stroboscopic illumination will allow both the time and space evolution of the droplets to be followed, which should allow droplets at the position expected for fractional charges but due to other effects, such as recharging during the trajectory, to be recognised as such by a different speed and direction.

The observation chamber also contains a slowly moving mylar film on which fractionally charged droplets will be collected in such a way that their position can subsequently be determined with high accuracy from the camera pictures. It may therefore be possible to recover the residue of droplets, which appear as carriers of fractional charges, and to investigate the residue by other methods, such as the diamagnetic levitation method developed by the Genova team, or the superconducting leviation method developed in Stanford.

In summary the development of the method is being pursued vigourously, no fundamental difficulties have as yet been encountered, but the crucial tests have still not been done.

The plans for the irradiation at the I S R

The proposal for an irradiation at the I S R assumed that one of the intersections could be surrounded as completely as possible by a layer of water of sufficient thickness to stop most of the quarks produced. The amount needed would depend on the mechanisms responsible for stopping and on the assumed energy spectrum of the quarks. In practice we have had to limit ourselves to the maximum amount which can be conveniently installed, and which can later be analysed by our detection method, and by these considerations we have arrived at a quantity of about 30 tons. This we propose to arrange in such a way that high energy designed by Dr Bonaudis group so as to be compatible with the safety of the machine and the need for access to the intersection and the equipment around it.

The most suitable intersection for the irradiation seems to be intersection I 7, which is not at present open to other experiments, and is not in fact very suitable for conventional experiments. To allow the beams in this intersection to be adjusted for maximum overlap monitoring counters similar to those installed at the I 2 intersection would have to be installed.

Time scale for the experiment

If the ISRC approves the experiment for installation in I 7, the subassemblies would be installed over a period of 3 months, at a rate determined by the delivery of the ice and the completion of the containers. The installation could be done during normal access periods of the I S R. After 12 months of irradiation of the complete setup, the assembly would be gradually demounted over a period of about 2 months during which the reduction in volume of the irradiated water will occur. We foresee to have by that time a simple evaporation plant, capable of evaporating of the order of $\frac{1}{2}$ ton per day. The plant would have to be coated with Teflon, which, by virtue of its non-polar character, is expected not to absorb possible fractional charges in the water. The residue after evaporation will be taken to Lund for investigation by the water jet method. We expect that this investigation will take about 1 month, which may partially overlap the period of evaporation. About 19 months will be required for the complete experiment.

It is intended to withdraw samples of irradiated ice in the course of the irradiation for preliminary investigations and test of the proposed method.

Conclusion

In making these plans and asking for approval we have assumed that the detection method will be perfected and made to work over the $1\frac{1}{2}$ year before it is actually needed. If in the course of this time unsurmountable difficulties would occur, we will of course withdraw our proposal and leave the intersection open for other experiments.

We believe that the subassemblies will be relatively easy to move if other experiments need to be installed in the intersection during part of the irradiation time. It is clearly of relatively litte detriment for our experiment if only say three of the four sub-assemblies are installed during one half of the irradiation. We would therefore not require a definite commitment for the whole period in order to proceed with the preparations, particularly since the effort and cost involved is very modest in comparison with most other experiments.