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Dear Dr. Pickavance,

I am very glad to give you my opinions concerning the value of various types of bubble chambers for high energy research in answer to your request. Although I am sure you have already had expert advice on this question, my experience with propane and xenon chambers may be at some use to you.

It is obvious to me that hydrogen-deuterium chambers possess unique and enormous advantages in the simplicity of interpretation of particle scattering, production, and absorption processes and for this one reason, simplicity of data interpretation, kinematically and otherwise, the hydrogen chamber is the best track detector for experiments feasible with it. Experience in the past few years has shown that there is a class of experiments, some completed, and some in the future, that cannot be done with hydrogen chambers, (at least not economically in terms of exposure time at the machine and analysis time)$\frac{1}{2}$

We are in the process of analyzing the first heavy liquid bubble chamber experiment. We have analyzed 80,000 out of 160,000 pictures of the xenon chamber (30 cm diameter, 25 cm deep) exposed to a 1.1 BeV π^- beam. The pictures contain about 1400 Λ^0-θ^0 productions. At the half-way point we have already found excellent values for the ratio of neutral to charged decay rates of Λ^0 and K^0, as well as a value for the up-down asymmetry of the "unseen" mode $\Lambda \to \pi^0 + n$. For some years cosmic ray Λ's have shown an unexpected forward-backward asymmetry which, if taken seriously, is evidence for parity violation in the strong reactions leading to strange particle production. No such effect is found in hydrogen, but it was argued that perhaps the "asymmetric Λ's " resulted from collisions of Σ's in the heavy atoms (C,Fe, and Pb) in which they were produced in the cosmic ray experiments. To test this idea, a large unbiassed Λ-sample produced in heavy nuclei was needed. Our Λ's were able to show that the asymmetry does not exist for Λ's made in at least one heavy atom (Xe) at one energy (1.1 Bev), and strongly suggests that the cosmic ray data (85 cases for the whole world) were statistically or systematically weak.

Parity violation in hyperon decay leads to a longitudinal polarization of the decay nucleons, their longitudinal polarization being algebraically (sign and magnitude) equal to α , the parity-mixing parameter describing the decay. This longitudinal nucleon polarization is given a transverse component by the laboratory motion of the center of mass of the decaying hyperon so that a right-left asymmetry in the scattering of the nucleon against nuclei in the liquid is expected. Since the asymmetry as well as the total cross-section are small in hydrogen, this is a difficult (or may be altogether unfeasible) experiment in hydrogen. The Berkley propane chamber group has just reported in Moscow a value for the helicity at the Λ decay proton on the basis of a number of scatterings in propane (mostly against C since its "polarizing strength" is much greater than that of H). We hope to obtain a similar result in our xenon pictures. Now that we know that $\Sigma^+ \rightarrow p + \pi^0$ shows a large updown asymmetry, a similar measurement on Σ^+ decay protons is of the greatest interest. Even more interesting would be a measurement of the helicity of neutrons from $\Sigma^\pm \rightarrow \pi^\pm + n$ although that is much harder but may be feasible in propane.

I could go on adding examples of current and future experiments which use propane or heavier liquids to great advantage for

1) ~~efficient~~ γ ray detection
2) study of particle interaction against nuclei (polarization, isospin arguments as for the He^4, C^{12} etc.)
3) study of possible cooperative phenomena inside nuclei in partible production and interaction
4) cases in which range measurements aid particle identification or kinematical analysis or in which it is desired to stop particles to observe their absorption or decay
5) experiments requiring high density to increase the probability at rare events such as double or triple scatterings or of $K^0 - \bar{K}^0 - K^0$ conversion and diffraction

Since it is difficult to predict the precise direction of the experiments or of possible future chemical developments concerning practical bubble chamber fillings (price of xenon may drop, some new substituted heavy metal-organic liquid may be usable, etc) I advocate a "universal bubble chamber" in addition to a hydrogen-deuterium chamber. It should be able to operate from about $-25^\circ C$ to $125^\circ C$ (from xenon up to the really easy limit for most diaphragm and gasket materials), be very safe against escape of toxic or inflammable materials, be constructed of the most corrosion-resistant of reasonable materials, have 15,000 to 20,000 gauss field, have at least three cameras, and be as simple and reliable as possible.

To me it has always seemed important in high energy physics to have available a great diversity of techniques so that new theoretical ideas may be tested, and experimental uncertainties resolved with the greatest possible range of conditions of observation. Only with such flexibility can the creative imagination of the experimenter attain its best results in studying the important problems in Physics. To limit oneself to one or several techniques, except in case of dire economic necessity, is to fly in the face of experience in experimental physics and to deny the worth of inventive ingenuity.

I have been a bit long-winded and perhaps allowed myself an excess of philosophy. Please excuse me for this.

With best wishes

Sincerely yours,

D. A. Glaser