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A HIGH PRECISION PARTICLE DETECTOR USING NOBLE LIQUIDS

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DISCLAIMER

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We agree wholeheartedly with Peter Rice-Evans[1] and the Editors of Nature[2] that there exists a need for higher resolution particle detectors at the new synchrotrons. Following a suggestion by one of us,[3] we are working toward the development of a thin multi-conductor chamber filled with a noble liquid. Our initial efforts with liquid argon have been described in several NAL Summer Studies Reports[4] and the successful operation of a liquid xenon proportional counter is the subject of a recent paper.[5]

We briefly summarize what has been learned thus far:

(1) A liquid xenon proportional chamber with an 8mm diam cathode and a single 4 μm anode detects charged particles with nearly 100% efficiency. The pulse rises in less than 150 nsec and is typically 0.15 pC in size. (Using liquid argon all our chambers have been sensitive only at scattered points along the wire.)

(2) The electric field necessary for electron avalanche is approx 2 million V/cm. (Consequently the central wire must be the anode in order to avoid field emission.)

(3) For the detection of ionization pulses (liquid gain = 1) produced by a moveable collimated source of alpha particles, a 700 μm thick chamber having 5 wires spaced 25 μm apart has a spatial accuracy better than 15 μm rms.

(4) A series of parallel conducting strips mounted on a substrate is capable inducing electron multiplication.

(5) Severe electronegative contamination of liquid xenon (due to unknown impurities) can occur even when the oxygen and nitrogen is held below 0.1 parts per million.[6]

We are now working to improve our control over electronegative impurities, to show that a series of substrate mounted conductors has high precision in the avalanche mode, and to develop a practical read-out scheme.

While the liquid xenon multi-conductor chamber provides accurate spatial information in its "thin" form, it also provides efficient, rapid X-ray and γ-ray detection in its "thick" form. The former should prove invaluable in the fields of high energy and cosmic ray physics, while the latter holds equally great promise in the field of radiology.

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[1] Rice-Evans, P., Nature, 232, 625 (1971).

[2] Editorial, Nature, 232, 599 (1971).

[3] Alvarez, L. W., Group A Physics Note 672, University of California Lawrence Radiation Laboratory, Nov. 1968.

[4] Derenzo, S. E., et al., National Accelerator Laboratory, Batavia, Illinois, Summer Study reports SS-154 (1969) and SS-181 (1970).

[5] Muller, R. A. et al., Phys. Rev. Letters, 27, 532 (1971).

[6] Many of our purification techniques are described in Zaklad, H. (D. Eng. Thesis), Lawrence Radiation Laboratory Report UCRL-20690 (1971).

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