black, and the areas from which there was no reflection are self-luminous. We are looking from the top of the subject's head and seeing (from left to right) the cross section of the right eye, the nose, and the left eye. The orbit of the right eye (black triangle) is normal. We infer this because, at the given setting of the equipment, ultrasonic energy is reflected from the whole orbit. The left orbit, however, has a tumor which absorbs a great deal of the ultrasonic energy and, therefore, we get reflections only from its boundary. If an observer focuses on different layers of the 3-D image and moves his head, he can see and even measure the 3-D position of the tumor. Figure 2 shows the left temporal view of the same subject, except that in this case the areas reflecting the ultrasound are self-luminous. If one cross section of the reconstructed scene is of particular interest, the perturbing effect of the other parts can be eliminated simply by placing the mask used to record that cross section back in place.

The primary drawback associated with this method is the time needed. Development of a fast scanning technique and various automated hologram recording techniques should ease this problem considerably.

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11. Research was aided in part by U.S. Public Health Service grant HE-13660-05 and American Heart Association grant 69-869.
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28 February 1972

Acceleration of Argon Ions to 1.17×10^{10} Electron Volts

Abstract. *Argon ions were accelerated to 1.17×10^{10} electron volts in the Princeton Particle Accelerator. The synchrotron was tuned by use of a neon beam with a charge-to-mass ratio equal to that of the argon ions. The fully accelerated argon ions were detected by the observation of etched tracks in cellulose nitrate sheets and also by the use of scintillation counters. Predictions of the range and of the characteristics of argon tracks in plastics were confirmed.*

Argon ions have been accelerated to 11.7 Gev in the Princeton Particle Accelerator (*1*). The acceleration to relativistic energies of a particle as massive as argon is of interest in the study of biological effects of heavily ionizing radiation, including applications in cancer therapy (*2*), in the study of radiation effects in space (*3*), and in astrophysical problems (*4*).

The argon beam was created by simultaneously accelerating argon and neon ions with nearly identical charge-to-mass ratios in the Princeton Particle Accelerator. The argon beam was too weak to yield a pickup electrode signal strong enough to permit tuning of the radio-frequency acceleration. The relatively intense mixed beam was used for tuning and adjusting the synchrotron—the separated argon beam was detected only at full energy after extraction from the accelerator. The ions were created as Ar^{4+} and Ne^{2+} in a Penning ion gauge (PIG) ion source in the high-voltage terminal of a 3.5-Mv Van de Graaff injector and subsequently stripped to Ar^{12+} and Ne^{6+} by a carbon foil (8 μg/cm^2). After simultaneous acceleration of both ions in the synchrotron to the final energy of 287 Mev/nucleon, the two beams were extracted and stripped to Ar^{18+} and Ne^{10+} (see Fig. 1A) and separated by a dipole magnetic field. The argon ions were identified by both tracks in plastic and scintillation detectors.

Stacks of sheets (250 μm thick) of

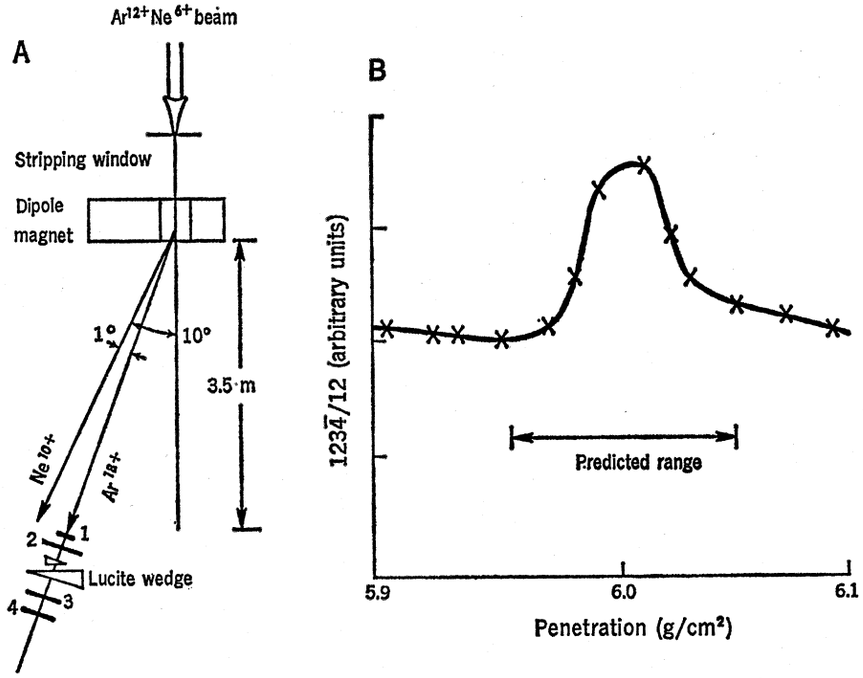

Fig. 1. (A) The experimental configuration. The mixed neon and argon beam was separated by the dipole magnet after stripping in the window. Scintillation counters 1, 2, 3, and 4 were used to detect the argon ions; the signal "$123\bar{4}$," which indicates the number of particles stopping in counter 3, was monitored as the Lucite wedge thickness was varied. This apparatus was also used for the cellulose nitrate exposure; the cellulose nitrate stack replaced counters 3 and 4. (B) The measured uncorrected signal "$123\bar{4}$"/"12" as a function of the total amount of absorber in the argon beam. A clean peak is seen at the predicted argon range. The uncertainty in the predicted range arises from uncertainties in the composition of materials in the beam. The precision of the variable Lucite absorber was better than 0.02 g/cm^2. The background under the peak is probably due to scattered neon ions.

Diacell cellulose nitrate were exposed to the argon beam behind Lucite moderators. The entrance angle was 34° to the normal. The sheets of cellulose nitrate which bracketed the predicted argon range were etched for 20 minutes in 6*N* NaOH. According to data and calculations of the track-recording properties of cellulose nitrate (*5*), the etching should make visible the last 5 to 7 mm of an argon track but only the last 1.8 mm of a neon track. To be identified as argon, a track was required to enter each layer at an angle of about 34°, to end at the predicted depth in the stack, and to have a path length of at least 6 mm. A total of 79 such tracks were found inside the beam spot (3.2 cm); none were found outside. During this exposure, 6.7×10^7 neon ions were counted in the primary beam. A partial scan of the sheets near the expected neon range revealed tracks of a length appropriate to stopping neon ions. It is likely that these neon ions were scattered into the argon beam by Coulomb interactions with the air in the beam line (the main neon beam was separated from the argon beam by only 1°). The argon tracks appeared as clear holes through each sheet of cellulose nitrate, whereas the neon tracks generally resulted in conical pits under the same etch conditions. A scan 9 mm upstream of the end of the argon tracks did not yield any pits that etched to full holes or that had well-defined conical structure with proper directions; this finding indicates an absence of background tracks.

A differential range telescope (*6*) with a remotely controlled Lucite absorber was also used to detect the argon ions. A clear signal was observed at the expected argon ion range of 6.06 g/cm², as shown in Fig. 1B. The magnitude of the signal was observed to fluctuate strongly as a function of the vacuum pressure in the synchrotron which averaged about 5×10^{-8} torr. This fluctuation was almost certainly due to the loss of beam by charge-changing collisions with the residual gas.

The electronically measured rates of the argon beam ranged as high as a few particles per second. These rates are sufficient to permit fundamental studies of particle properties, including dosimetry, track effect calibrations, and fragmentation cross sections. A very large increase in argon intensity would result from relatively small improvements in the vacuum. For example, if a vacuum pressure of 10^{-8} torr could be attained, a beam of several hundred particles per second should result. Unfortunately this experiment cannot be carried out since it has not been possible to secure operating funds for the laboratory and the synchrotron is now being put in a standby condition.

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5 May 1972

Open Channels in Sea Ice (Leads) as Ion Sources

Abstract. *Open channels in sea ice may be acting as sources of atmospheric ions.*

In 1970 an experiment was conducted at Point Barrow, Alaska, to measure the background aerosol (*1*). The measurements were made at a time when the ice was starting to break up offshore. One of the aerosols that was monitored consisted of sodium-containing particles (*2*); the number of these particles seemed to increase whenever a freshly opened lead appeared upwind of the station.

The conductivities of the positive and negative ions were also measured, and they seemed to increase in magnitude with the appearance of the leads. To check this observation, a Gerdien-type conductivity instrument (*3*) was flown to an area where freshly opened leads were observed. The instrument was positioned there in such a way that it sampled air which had just passed over a freshly opened lead (Fig. 1a, site A). Measurements were carried out at three different heights above the level of the ice (30, 70, and 120 cm) and are presented as a profile of both positive and negative conductivities (Fig. 1b). Baseline measurements were also made near the lee of the lead, 30 cm off the ice (Fig. 1a, site B; see arrows). Errors in the measurements may have been large because a calibration could not be done on the site. However, the measurements of conductivities of both

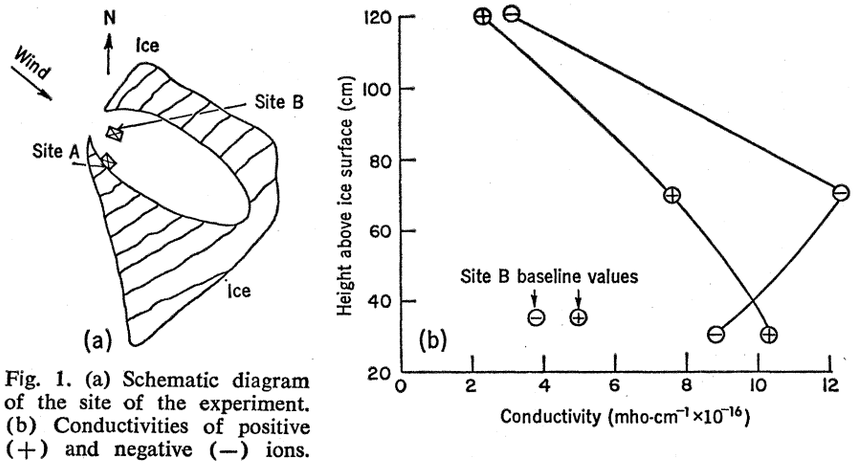

Fig. 1. (a) Schematic diagram of the site of the experiment. (b) Conductivities of positive (+) and negative (−) ions.