



Amsterdam Owen from Black Star

Notes from Abroad

Conference in Amsterdam

Physicists from six countries (Belgium, France, Great Britain, Holland, Sweden, and Yugoslavia) met in Amsterdam last November to attend a two-day conference on the general subjects of ion sources. We are indebted to Dr. C. J. Gorter for sending a report of the meeting by C. J. Zilverschoon from which the following was taken.

Dr. Zilverschoon writes that two long papers on matters of major interest in the field were given during each of the morning sessions, while the afternoons were devoted to short papers dealing with somewhat more specialized topics. C. J. Bakker, director of the Laboratory for Nuclear Research in Amsterdam, opened the conference with an introductory survey of general problems arising in connection with ion sources.

Of the longer papers, the first was given by P. C. Thonemann of Oxford, who discussed high frequency ion sources, and in particular the operating characteristics of an electromagnetic (ring discharge) source where, in spite of the 2000 volts over the discharge, an ion beam of small energy spread was obtained. To obtain the correct shape of the electric field (calculated by Pierce) Thonemann used a very small probe, surrounded by a little glass

cylinder which charges itself practically to the potential of the plasma. In this way he achieved a proton yield from the beam that was very high. Furthermore he used an inhomogeneous magnetic field of about 1000 gauss to concentrate the ions near the exit opening. He observed a strong dependence of the proton-molecule ratio in the beam on the strength of the magnetic field.

P. V. Veenstra of Utrecht, who gave the second lecture, described his work with a magnetic (Finkelstein) source, for which he determined the discharge current as a function of the strength of the magnetic field. He found the location of the maximum of this curve to depend upon the anode potential and its height to depend upon the pressure. As the pressure is raised, the ion current first rises gradually, until at a certain point it jumps suddenly to a value about five times larger than before. The same happens when the magnetic field strength is raised, the pressure being constant and not too low. When, in this state which he calls "superstate," the magnetic field or the pressure is decreased, the phenomenon shows hysteresis. There are, moreover, radio frequency oscillations in the discharge in the superstate. It was pointed out that

the superstate condition of enlarged ion current and radio frequency oscillations can also occur in the case of the Penning type source.

The first of the short afternoon papers was read by R. Björnerstedt of Stockholm, who discussed his experiments with a Zinn type ion source. In the addition to the usual suppressor to insure that secondary electrons do not spoil the measurements, a third electrode with smaller aperture was used. Remarkably, the ion current proved to be dependent on the probe material.

Major E. Thomas of Brussels, the next speaker, described a high frequency source to be used with a cascade generator. M. E. Reinders of Amsterdam pointed out that protons are formed with a beginning kinetic energy of several volts, whereas molecular ions have only thermal energy. In the case of the Nier type source, which Reinders uses in his mass spectrometer, the ionizing electron beam forms a potential trough which makes it more difficult for molecular ions to reach the exit slit than for protons. This means that the electron current must not be too high. In order to obtain as high an ion current as possible, the electron energy should be such that a maximum ionization cross section is reached, e.g., 100 electron volts for protons and 70 for molecular ions.

M. Hoyaux (Charleroi) started the second day with a lecture on cyclotron ion sources, where there must be taken into account the presence of a strong magnetic field, a radio frequency electrical field, and the circular symmetry of the cyclotron. The oldest type of ion source for cyclotrons is the filament source, in which electrons from a filament are accelerated to about 2000 volts to ionize the residual gas. The main disadvantages are an inhomogeneity in energy of the formed ions, the formation of too many molecular ions (which are out of resonance in the cyclotron), and the lack of sharp definition of the source's starting point, which gives rise to difficulties in deflecting the beam out of the cyclotron. The power consumption, furthermore, is very high.

The capillary arc source is an improvement, giving a more homogeneous beam and a point source, and the power consumption being reasonably low. As pumping speeds became greater, the opening in the capillary became larger, until finally a circular slit all around the capillary was used. Another type of capillary arc source is that using a radial arc running between the cathode and an outer jacket. By giving it a special shape, one of the dees is favoured, providing it with what might be called "feelers." A further improvement may be made by mechanically limiting the electron beam with a hood. The hooded arc makes possible an ion current of about one milliamperere on an outer target, although a very large pumping speed is necessary.

Dr. Hoyaux is now working with a source of the Von Ardenne type, in which, through the action of the magnetic field, the electrons oscillate between the pole pieces. Experiments have not yet been performed, but he has done a great deal of theoretical work on the problem and has been able to compute the potential distribution in the anode cylinder. This theoretical work will be continued and extended to the extraction mechanism.

J. Kistemaker of Amsterdam then discussed certain physical problems in high intensity sources, of which the most prominent are those of producing ions in the discharge, transporting ions to the exit opening, and extracting ions without disturbing the discharge.

First, in order to produce for a given electron current and gas pressure as many ions as possible, a favorable electron energy must be chosen (about 100 electron volts). Furthermore, the average total path length should be made as long as possible. In magnetic sources the total path length of the electrons may be enlarged by hampering their reaching the anode by means of strong magnetic fields and by correcting the shape of the electrodes.

Second, care must be taken that the potential distribution in the discharge is such that the ions converge towards the exit opening, or in other words such as to insure a self-focusing effect. The depths from which the ions are drawn, moreover, should not be too small if there is to be a sufficient supply of ions. It is also important that ions reach the exit opening with a moderate velocity.

Third, for given electrode configuration and potentials according to Langmuir, only a certain maximum ion current, limited by space charge, may be extracted. This provides a potential mountain or a kind of velocity selector in front of the exit opening, which allows only the fastest ions to get out. Sufficient ions must be present near the exit, however, to yield the space charge-limited current through the probe.

C. Cassagnol (Paris) spoke on the extraction and focusing of ion beams. He mentioned a special kind of magnetron type ion source consisting of two coaxial cylinders, of which the outer one is the anode, and the inner one is a perforated hot cathode. The potential between the cylinders is 200 volts. In the space between the two cylinders the electrons describe cycloidal orbits due to an axial magnetic field. Some of the ions created pass through the cathode into the inner cylinder and are extracted in axial direction. Experimental results are not yet available.

R. Bernas (Paris), speaking about an isotope separator, mentioned that the Nier source he uses has the following peculiarity: it gradually increases in strength, and then, when the current is about 2 milliamperes, it suddenly drops to practically zero. Probably another form of discharge has here originated, much like the transition to the "superstate" that Veenstra discussed.

P. M. Endt (Utrecht) said that he had pulsed a Finkelstein source hoping to obtain higher ion peak currents than in the stationary case as did Keller in Geneva with a Penning source. However, the result was negative: the peak values were just the same as in the normal case.

H. Brinkman (Arnhem) gave a useful suggestion for obtaining a very pure proton current (without molecular ions) by making hydrogen gas run through a tungsten cylinder at a temperature of more than 2500° C. If the pressure is sufficiently low, the dissociation is very great. If an anode is placed in the center of the cylinder, the emitted electrons are accelerated and can ionize the hydrogen atoms.

The conference was closed by a visit to the 30 Mev synchro-cyclotron in the Institute for Nuclear Physics.