the shield current and $f(V)$ is a geometrical factor which contains the ratio of the angle intercepted by the plate to the angle intercepted by the shield and a factor due to space charge effects near the cathode. To measure $f(V)$ we freeze out the xenon by dunking the top of the tube in liquid nitrogen. This reduces the xenon pressure to $\sim 10^{-3}$ Torr and P_s becomes very small so we get $f(V) \cong I_p^*/I_s^*$. Now we have $P_s = 1 - I_p I_s^*/I_s I_p^*$. Figure 3 shows that I_p has a maximum near 1 eV and that I_p/I_p^* approaches one there, indicating that there is very little scattering. At higher energies I_p/I_p^* is very small indicating a large probability of scattering. A plot of P_s calculated from the data using the above equation is shown in Fig. 4.

The probability of scattering is related to the mean free path by the relation $P_s = 1 - e^{-l/\lambda}$. For the 2D21 $l = 0.7$ cm so we can calculate λ. The cross section σ is related to λ by $n\sigma = 1/\lambda$, where n is the number of atoms per unit volume. A plot obtained from our values of P_s is shown in Fig. 5. A similar set of data for P_c ($P_c = P/\lambda$, where P is the pressure in Torr) given by Brode[7] is shown in Fig. 6. In the 2D21 fairly large angular deflections must be produced to scatter an electron out of the beam (greater than ~ 0.2 rad) so the cross section measured in the 2D21 will be smaller than Brode's data.

II. EXPERIMENTAL DETAILS

The filament of the 2D21 is operated on 4 V dc. This is lower than the recommended value of 6.3 V, but tends to reduce space charge effects. Since the cathode temperature is lower, the thermal kinetic energy of the electrons is smaller and this will result in a narrower distribution of electron energies. The shield and plate currents are obtained by measuring the voltages V_s and V_p with two Keithley model 600A electrometers (see Fig. 2). The voltage source V is a well regulated and filtered supply which may be varied between 0–15 V. The electron energy plotted in the figures is $V - V_s$. We have not included a correction for the contact potential difference between the cathode and the shield. This contact potential difference is approximately 0.4 V and was measured by noting that ionization occurs when $V - V_s$ is 0.4 V less than the tabulated ionization potential. A similar value was obtained by measuring the value of V required to cut off the electron current to the shield. The voltages V_s and V_p range from a few millivolts to a few tenths of a volt. The data may be displayed on an oscilloscope by using an audio oscillator for the source V and for the x axis of the 'scope.

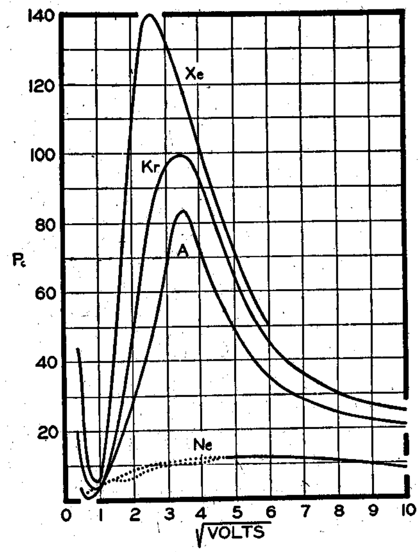

FIG. 6. The probability of collision P_c (= pressure times $n\sigma$) as a function of $(V)^{1/2}$ where V is the electron energy (from Brode see Ref. 2).

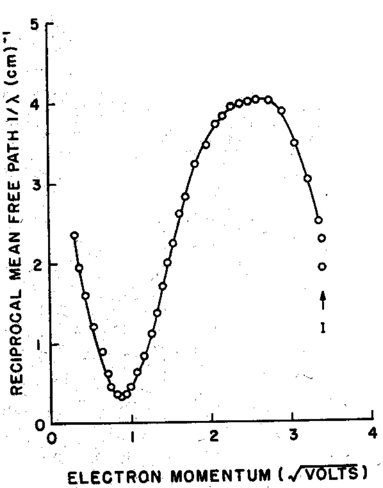

FIG. 5. The cross section times density $n\sigma = 1/\lambda$ as a function of $(V - V_s)^{1/2}$, where $V - V_s$ is the electron energy. Ionization occurs at "I".

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