In conclusion, we have tried to show that there exist very large resistance anomalies which are not due to superconductivity and for which there are no theoretical explanations available. These effects are found in lightly degenerate semiconductors and their magnitudes are sensitive to impurity concentration. Contrary to previous assumptions that there is only one type of anomaly, we find that there are several, and careful experiments are necessary to separate them.

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CHARGE SPECTRUM OF RECOILING ^{216}Po IN THE α DECAY OF ^{220}Rn*

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The influence of α decay on the electronic structure of the recoil atom is ideally studied in ^{220}Rn because of its gaseous state. The monoenergetic 116.5-keV nuclear recoil enables one to use electrostatic charge separation without momentum analysis in a magnetic field.

Figure 1 gives the schema of the charge spectrometer. Prior to operation, the apparatus

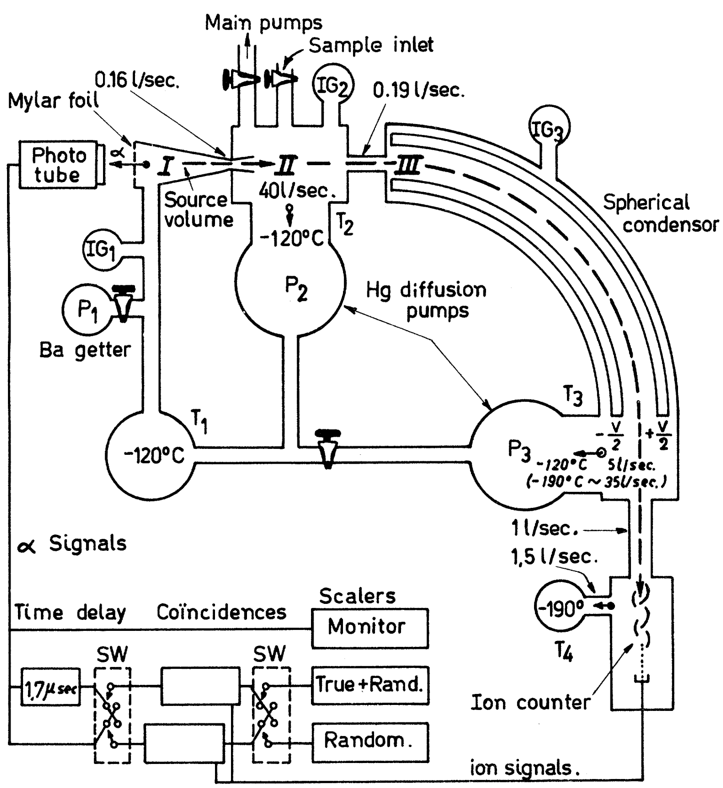

FIG. 1. Schema of the recoil spectrometer (not to scale). If cold trap T_3 is filled with liquid air, the pumping speed of "stage 3" rises to 35 litres/sec for Rn by condensation of this gas.

is thoroughly evacuated and isolated from the main vacuum. The ^{220}Rn gas from a 20-mc/sec ^{228}Th emanating source is then allowed to enter chamber II where it is pumped into the source volume (chamber I) and continuously recycled. The residual pressure is kept at 1.5×10^{-5} mm Hg and 5×10^{-6} mm Hg, respectively, in chambers II and III, by the mercury pumps P_2 and P_3 and their cold traps. Building up of pressure in chamber I due to the action of P_2 and P_3 is prevented by the getter pump P_1 and kept at 10^{-5} mm Hg or better as measured during runs. Partial pressure of Rn in chamber I is about 2×10^{-9} mm Hg as deduced from α counting rates. The source volume is 1 cm^3 and 3 cm long.

The major part of the background counting rate, from activity surrounding the ion detector, is eliminated by the fast-coincidence counting between α particles and the recoil ions.

The α particles pass through the 1-mg/cm^2 Mylar window of the source volume and are counted with a 0.1-mm-thick Cs I(Tl) crystal. The ions recoiling in the opposite direction enter the Purcell-type[1] spherical deflector of 12-cm mean radius and of 4.8×10^{-4} solid angle aperture and are focused on a 17-stage Cu-Be electron multiplier from E. T. H., Zürich. The symmetrical deflector voltage is reproducible within less than 0.1% by means of a zero-reading bridge using standard resistors and a normal Weston cell. Linearity is better than 0.5%. The energy or charge resolution of the complete experimental setup is 4% at half-maximum [Fig. 2(a)].

In order to take into account the time-of-flight shift across the length of the source volume, the resolution time of the coincidence circuits is made about 0.1 μsec. Figure 2(b) shows a typical delay curve. The counting rate diminishes less abruptly on the right side of the curve. This corresponds to the gradually decreasing Radon density in the cone-shaped exit region of the source volume and to shorter time delay of the recoil ions.

For the determination of the random coincidences special care was taken. A 1.7-μsec delay line makes allowance for the time of flight of the ions in the spectrometer. Two identically constructed coincidence circuits are connected before and after the time delay, the former giving statistically random coincidences (Fig. 1). The resolution time of the two circuits is made equal within 10% by bias setting. As a further improvement, the two circuits are automatically commuted every 15th second (Fig. 1, SW). Random coincidences recorded by the two scalers in this manner are equal within about 0.5%.

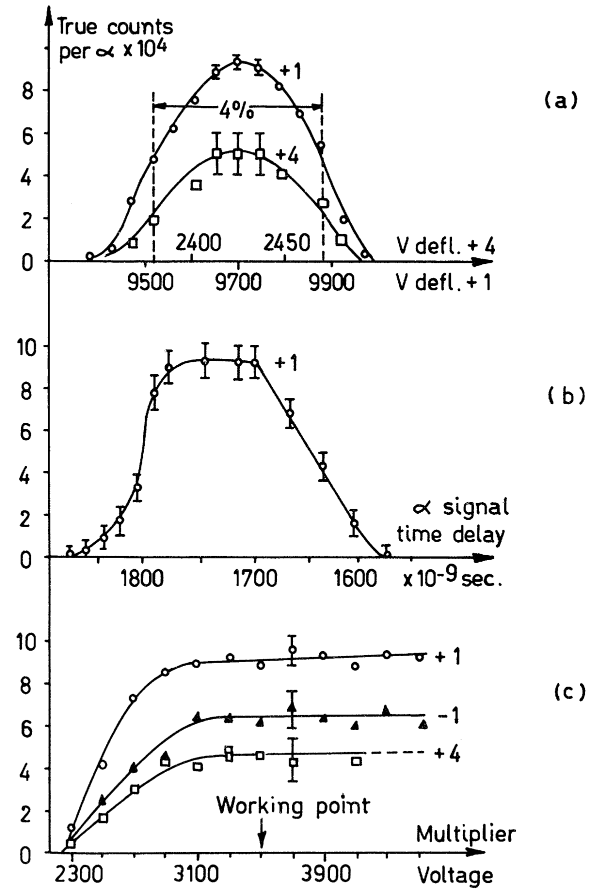

FIG. 2. (a) Counting rate of charge +1 and +4 versus deflector voltage. Upper deflector voltage scale is for charge +4, bottom scale for +1. (b) Delay curve of the ^{216}Po$^+$ recoil ions, showing the effect of source volume length and source aperture. The horizontal part corresponds to the difference in time of flight of the ions coming from the 3-cm-long source (about 93 nsec). The decreasing radon density at the source aperture accounts for the linear slope at the right. (c) Counting efficiency of the multiplier for charges +1, −1, and +4. Curves for charges +2 and +3 are similar in form.

Preliminary measurements[2] of the α spectrum of the ^{222}Rn gated by the fast-coincidence signals show no measurable contribution of the ^{218}Po and ^{214}Po deposit to the observed recoil events.

As reported by Barnett, Evans, and Stier,[3] heavy ions of 10-keV energy or more have a sufficient secondary electron yield for 100%

Table I. Mean intensity values of ^{216}Po recoil ions, normalized to charge +1, for two different pressures.

^{216}Po charge	Pressure in source volume (mm Hg) 10^{-5}	1.5×10^{-4}
−2	Not measurable (<0.03)	...
−1	0.70 ± 0.014	0.69 ± 0.020
0	28[a]	...
+1	1	1.03 ± 0.030
+2	0.69 ± 0.012	0.69 ± 0.040
+3	0.56 ± 0.015	0.62 ± 0.040
+4	0.50 ± 0.017	0.49 ± 0.030
+5	0.29 ± 0.012	0.29 ± 0.030
+6	0.21 ± 0.011	0.19 ± 0.030
+7	0.12 ± 0.010	0.10 ± 0.020
+8	0.053 ± 0.010	0.048 ± 0.015
+9	0.040 ± 0.010	0.039 ± 0.015
+10	not measured	...

[a]Estimated value reliable within a factor of 2 based on the transmission power of the charge analyzer.

counting, hence the detection efficiency depends only on the over-all gain of the circuitry. This dependence on gain was checked by measuring the coincidence counting rates versus multiplier voltage for charges from −1 to +4 [Fig. 2(c)]. Each curve reaches the plateau region at about 3 kV. Normal operating point was 3.5 kV.

In two months, the reproducibility of the relative-intensity measurements was about 5%. We set this value as maximum error in the reliability of the results. The mean intensity values of the ^{216}Po recoil ions normalized to charge +1 are given in the first column of Table I; the second column lists the spectrum obtained at a much higher pressure in the source volume. The good agreement between these spectra shows the results to be free of distortion due to charge-exchange collisions in the gas traversed by the ions.

Uncertainties quoted are standard errors on counting (typical true/random counting rate for charge +1 was about 2000/400 counts per hour).

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NONEXISTENCE OF THE TETRANEUTRON*

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We present in this note the results of an investigation concerned with the question of whether there exists a particle-stable state for the tetraneutron. At the present moment, there seems to be evidence both for and against the existence of such a state.[1-4]

The recent experiment of Ajdačić et al.[2] with the reaction $H^3(n,p)3n$ indicates that there is a bound state for the trineutron n^3, with a binding energy of about 1 MeV. Using the argument of Goldanskii[5] about the neutron pairing energy, this would imply that the tetraneutron n^4 would certainly exist. The fact that He^8 is particle-stable[6] with a mass excess between[7] 31.6 and 32.4 MeV implies that the maximum possible binding energy of n^4 is 3.1 MeV. If it were greater, then He^8 would decay into $\alpha + n^4$. Thus the maximum neutron pairing energy of a particle-stable n^4 is around 1 MeV, which seems rather low compared with the values of pairing energies for other light nuclei.[5]

On the other hand, there is seemingly strong-