ELECTRIC DRIFT OF POSITRONS IN HELIUM

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A number of recent theoretical (e.g., [1]) and experimental [2, 3] papers deal with the interaction between slow positrons and helium atoms. The results of the cited papers do not confirm the earlier hypothesis [4] that the elastic-scattering cross section of slow positrons in helium is independent of the positron energy.

Interest may attach in this connection to certain data obtained by us in an investigation of the behavior of positrons in gas targets (mainly in helium), aimed at studying the feasibility of producing the strong-current positron source proposed by G. I. Budker [5].

Our experimental procedure differed from those used by others [2 - 4]. Positrons from a radioactive Na^{22} source entered a cylindrical chamber of 50 mm diameter filled with the investigated gas. The target was located 60 cm away from the source. We investigated the change in the number of positrons reaching the target (and becoming annihilated there) as a function of the gas pressure and of the longitudinal electric field. The annihilation quanta were registered with a coincidence circuit. The transmission was increased by placing the chamber in a longitudinal magnetic field of intensity up to 500 Oe.

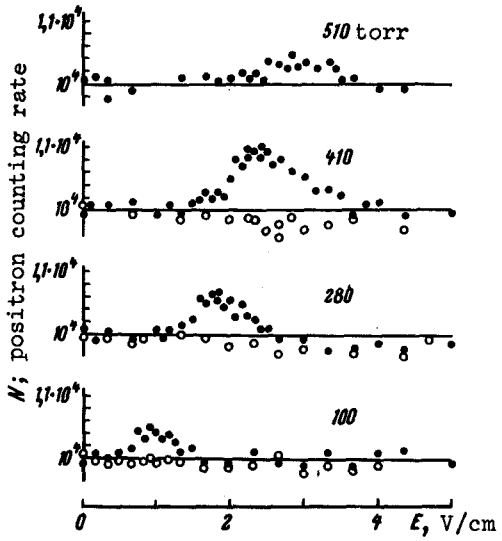
The positron current to the target can be arbitrarily divided into two components. The first includes the positrons that failed to slow down to an energy on the order of the lower threshold W_0 of positronium production. The size of this component is not affected by a sufficiently weak electric field. The second component includes the slow positrons with $W < W_0$, which experience only elastic collisions. In the absence of an electric field, the slow positrons reach the target from a region whose boundary is located a distance on the order of $L_D = (1/3\lambda v\tau)^{1/2}$ from the target (λ - positron mean free path, v - their average velocity, and $\tau = (ncz_{eff}\pi r_0^2)^{-1}$ - annihilation lifetime).

Application of an electric field can change the intensity of this component, provided that $u\tau \gtrsim L_D$, where u is the drift velocity. From this we can get, in particular, an estimate of the minimal electric field at which the counting rate beginst to increase

$$(E/P)^2 \text{ [V/cm-atm]} \gtrsim 10W^{3/2}z_{eff}\sigma,$$

where W is the average energy of the slow positrons in eV, and σ is the elastic-scattering cross section (in units of πa_0^2).

The figure shows the results for helium. An increase of the counting rate was observed in a narrow interval of the values of E/P ($\sim$ 3 - 6 V/cm-atm). This result can be attributed to the fact that the positron scattering cross section in helium has a minimum, in analogy with the Ramsauer-Townsend effect for electrons. The absolute increase of the counting rate depends strongly on the impurities (a similar effect is noted in [2]). For numerical estimates of the



Dependence of the positron counting rate on the values of the accelerating (dark points) and decelerating (light points) electric fields at various helium pressures.

cross sections, further investigations are necessary. The influence of a weak electric field on the counting rate confirms also the hypothesis that the positrons are decelerated in helium to low energies.

The effect was not observed in other gases, such as H_2, O_2, N_2, Ne, and Ar at E/P < 50 V/cm-atm and Xe at E/P < 10^3 V/cm-atm.

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OBSERVATION OF HIGH-FREQUENCY OSCILLATIONS IN STRONG EXCITATION OF FERROMAGNETIC α-Fe_2O_3

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We report in this paper an experimental observation of high-frequency (HF, about 1 MHz) oscillations of magnetization and elastic oscillations in antiferromagnetic (AF) single-crystal hematite (α-Fe_2O_3), which occurred under the influence of a definite level of microwave pumping.

The experiments were performed at room temperature, at a frequency 9300 MHz, with longitudinal and transverse polarization of the microwave pumping field. The constant magnetizing field was applied in the basal plane of the crystal. The samples used were spheres and plates with a resonance curve (measured at an approximate freuqency 37 GHz) of width from 500 to 1000 Oe. The HF oscillations were displayed on the screen of an S4-8 spectrum analyzer following detection of the microwave signal reflected from a resonator containing the sample.

Figure 1 shows a plot of the excitation threshold of the HF magnetization oscillation for longitudinal polarization of the pumping field. We see that: 1) the HF oscillations are excited only in a definite region of the magnetizing fields, and 2) the threshold curve shows