Practical № 7

CONFIRMATION OF BOHR POSTULATES:

Experimental determination of the first potential for the excitation of krypton atoms

EXPERIMENTAL SETUP

A three-electrode lamp (ПМИ-2) filled with krypton vapor is used to observe the resonance excitation curve.

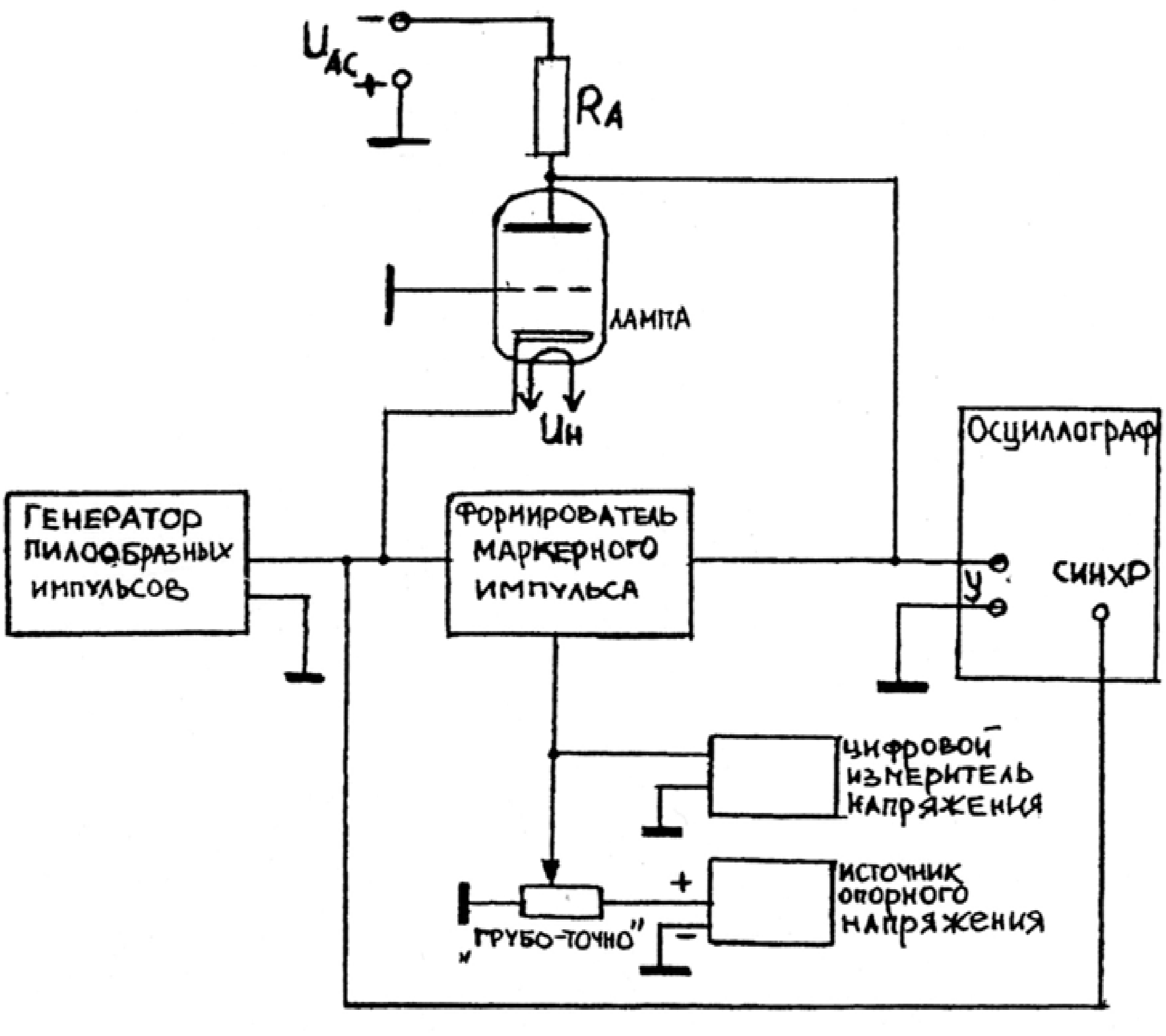

Fig. 7.1 Experimental setup block scheme

Fig. 7.2 Photograph of the experimental setup

From the saw-tooth generator (located in the measuring device) voltage pulses U_{KC} (amplitude is approximately 40 V) are applied to the cathode of the lamp. The same pulses start the oscilloscope sweep. From stabilized sources of constant voltage (located inside the measuring device) the lamp is also supplied with an adjustable voltage $U_{н}$ and a blocking voltage U_{AC} which ensure the normal operation of the lamp. The anode current of the lamp I_A is converted by the measuring device into a voltage proportional to the current: $U_A = I_A R$, and is fed to the input "Y" of the oscilloscope.

If the oscilloscope sweep voltage U_{KC} and grid voltage are synchronous, a still image of the current-voltage characteristic with one or several minima (pic.7.3) is observed on the oscilloscope screen.

The number of maxima or minima on this curve depends on the magnitude of the amplitude saw-tooth voltage applied to the grid of the lamp. If the amplitude voltage is equal to the critical one, the electrons experience one inelastic collision, which corresponds to the appearance of the first minimum in the current-voltage characteristic. If the voltage on the grid is equal to twice the critical potential, a second minimum appears on the curve, due to the fact that the electron can experience two inelastic collisions, etc.

At the same time, the measuring device forms a marker on the oscilloscope screen, which can be moved around the screen by the handles “ГРУБО” and “ТОЧНО”.

If you hover the marker on the points of interest in the displayed graph, the coincidence of the reference voltage and the instantaneous sawtooth voltage occurs, which allows you to measure the voltage with a digital voltmeter.

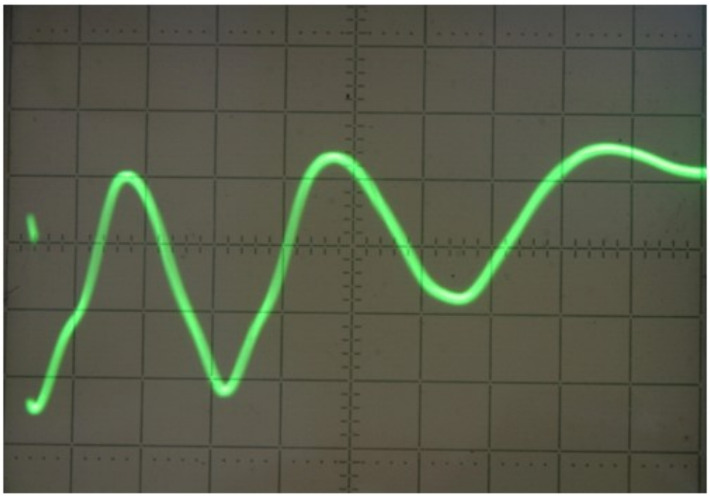

Fig. 7.3

Measuring the voltage corresponding to the appearance of the first and second maxima on the current-voltage characteristic, one can determine the distance (in electron-volts) between the energy levels $\Delta W = W_1 - W_0$.

MEASUREMENT AND DATA PROCESSING

1. Set the ms/div switcher to *2 ms/div* position and v/dvi switcher to *0,1 V/div* position.
2. Turn on the oscilloscope and use the "Баланс", "↕", "↔" knobs to set the beam on the screen of the oscilloscope.
3. Turn on the measuring device. Keep the lamp turned on for 10 minutes to set the lamp operating mode.
4. Set the “внутренний” oscilloscope synchronization mode. Adjust the oscilloscope sync for a stable picture on the screen.
5. Using the “ГРУБО” and “ТОЧНО” knobs, move the marker along the oscillogram, combining the left edge of the marker with the characteristic points (maxima) and measure the indicator of the measuring device. Record the voltmeter reading when the first and second current maxima appear.
6. Repeat measurements 3 times.
7. Determine the first resonant potential and the difference of the energy values of the krypton atom at the main and first excited levels.

8. Using the obtained ΔW value, calculate the wavelength of the resonance radiation of krypton.

9. After the measurement, turn off the measuring device with the “Off” switch on the rear panel of the measuring device. Turn off the oscilloscope.

10. According to the results of measurements and calculations, fill in Table 1.

Table 1

<table>
<tr><th>$U_{max\ 1}$, V</th><th>$U_{max\ 1}$ average, V</th><th>$U_{max\ 2}$, V</th><th>$U_{max\ 2}$ average , V</th><th>Ucr , V</th></tr>
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<tr><td colspan="2">ΔW_{exp} , eV</td><td colspan="2">λ. , Å</td><td></td></tr>
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QUESTIONS

1. Why the atomic model proposed by Rutherford was unsuccessful?
2. Formulate the Bohr postulates.
3. Write down the Balmer formula for the Lyman-, Balmer- and Paschen- series.
4. How to explain the line-spectra of atomic-gases with the Bohr's postulates?
5. What spectral series contains the absorption spectrum of a hydrogen?
6. What are the experiments of Frank and Hertz? What conclusion follows from them?
7. What ways the atom can be translated into an excited state?
8. Draw a system of energy levels of the hydrogen atom; show on it the quantum transitions corresponding to the main and boundary lines of the Lyman, Balmer, Paschen series. Determine the wavelengths corresponding to 1) the border of the Lyman series, 2) the border of the Balmer series, 3) the border of the Paschen series.
9. What is called excitation potential? How to determine the second potential excitation of a hydrogen atom?
10. Using the energy level diagram, explain the concepts of excitation energy, binding energy, and ionization energy for a given state. For any given n, show that $E_{ion}=E_{exct}+E_{bond}$.
11. What is the ionization potential and what is it equal to a hydrogen atom??
12. Determine the calculated ionization potential and the first excitation potential of the hydrogen atom. Indicate this transitions on the energy level scheme.