



EXPERIMENT PROCEDURE:

- Measure target current I as a function of the voltage U between cathode and grid.
- Compare the distribution of current maxima with the excitation energies of neon atoms.
- Observe the light emitted by the excited neon atoms.
- Determine the number of light-emitting levels for various accelerating voltages.

OBJECTIVE

Record and evaluate the Franck-Hertz curve for neon and observe emission of light.

SUMMARY

The Franck-Hertz experiment for neon involves observing how energy is transferred from electrons as a result of inelastic collision while passing through neon gas. The transfer of energy occurs in discrete steps corresponding to the excitation by such collision of distinct energy level transitions in the neon atoms. The excited atoms then emit visible light.

REQUIRED APPARATUS

Quantity	Description	Number
1	Franck-Hertz tube with Ne filling	U8482220
1	Power supply unit for Franck-Hertz experiment, for 230 V AC Power supply unit for Franck-Hertz experiment, for 115 V AC	U8482130-230 or U8482130-115
1	Analog oscilloscope, 2 x 35 MHz	U11175
1	Digital Multimeter	U11809
1	High-frequency patch cord, 1 m	U11255
2	High-frequency patch cords, BNC / 4-mm-plug	U11257
1	Set of 15 safety patch cords, 75 cm	U13802

Franck-Hertz Experiment for Neon

BASIC PRINCIPLES

In the Franck-Hertz experiment neon atoms are excited by inelastic collision with electrons. The excited atoms emit visible light that can be viewed directly. Thus it is possible to detect zones where the light and therefore the excitation is more intense. The distribution of such zones between the cathode and the grid depends on the difference in potential between the two:

An evacuated glass tube that has been filled with neon gas to a pressure of 10 hPa contains a heated cathode C, a control grid S, a grid G and a target electrode A arranged in that sequence (see Fig. 1). Electrons are emitted from the cathode and are accelerated by a voltage U towards the grid. Having passed through the grid they reach the target and thus contribute to a target current I if their kinetic energy is sufficient to overcome a decelerating voltage U_{GA} between the grid and the target.

The $I(U)$ -characteristic (see Fig. 2) has a similar pattern to the original Franck-Hertz experiment using mercury gas but this time the intervals between minima where the current falls to almost zero for a specific voltage $U = U_1$ corresponding to the electrons reaching sufficient kinetic energy to excite a neon atom by inelastic collision just before reaching the grid are about 19 V. Simultaneously it is possible to observe a faint orange light close to the grid since the energy transition to the base state of a neon atom results in the emission of such light. The zone of illumination moves towards the cathode as the voltage U increases and the target current I rises once more.

For a higher voltage $U = U_2$ the target current also drops drastically and it is possible to see two zones of illumination. The electrons can in this case retain enough energy after an initial collision to excite a second neon atom.

As the voltages are further increased, other minima in the target current along with further zones of illumination can be observed.

EVALUATION

The $I(U)$ -characteristic exhibits various maxima and minima and the interval between the minima is about $\Delta U = 19$ V. This corresponds to excitation energy of the 3p energy level of a neon atom (see Fig. 3) so that it is highly likely that this level is being excited. Excitement of the 3s-level cannot be neglected entirely and gives rise to some fine detail in the structure of the $I(U)$ -characteristic.

The zones of illumination are zones of greater excitation and correspond to drops in voltage in the $I(U)$ -characteristic. One more zone of illumination is created every time U is increased by about 19 V.

NOTE

The first minimum is not at 19 V itself but is shifted by an amount corresponding to the so-called contact voltage between the cathode and grid. The emission lines in the neon spectrum can easily be observed and measured using a spectroscope (U21877) when the maximum voltage U is used.

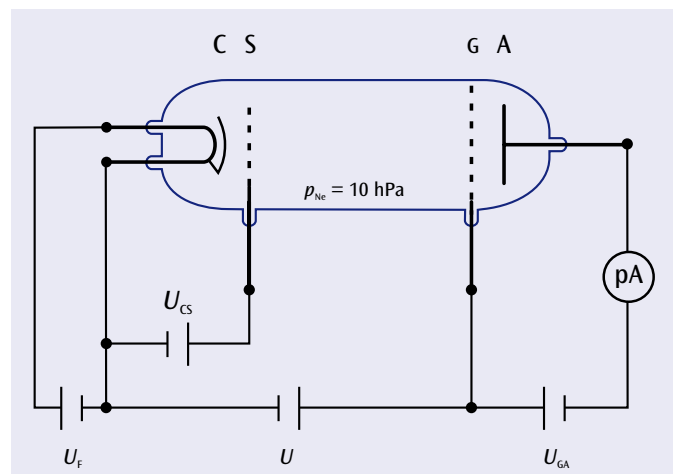


Fig. 1: Schematic of set up for measuring the Franck-Hertz curve for neon

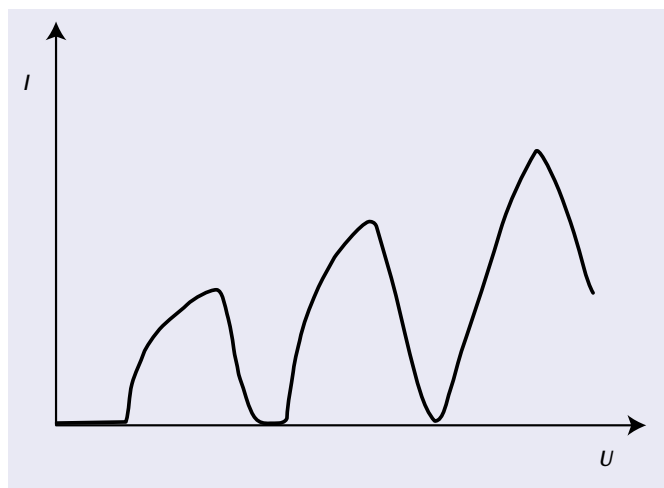


Fig. 2: Target current I as a function of the accelerating voltage U

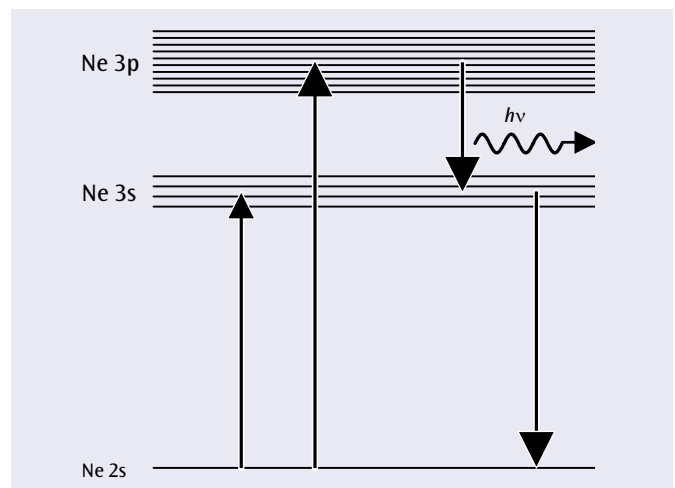


Fig. 3: Energy levels in neon atoms