电子科技大学
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Physical Experiments I

Pre-lab Assignment

The Frank-Hertz Experiment

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Score

Answers to Questions (20 points)

(1) What do you understand by the first excitation potential of an atom?

In this potential (minimum potential), it could accelerate the electrons and causing the atom to excite the electric potential for the first time if those electrons collide with the atom.

I also know that the first excitation potential of the mercury atom is 4.9V.

(2) What are the basic assignments of Bohr's theory of the hydrogen atom?

Who did an experiment to provide proof for his history?

1. The following three theorems are the basic assignments of Bohr's theory of the hydrogen atom.

- The electron moves in circular orbits about the proton under the influence of the Coulomb force produces the electron's centripetal acceleration.
- Only certain electron orbits are stable and allowed. In these orbits no energy in the form of electromagnetic radiation is emitted, so the total energy of the atom remains constant.
- Radiation is emitted by the hydrogen atom when the electron "jumps" from a more energetic state. The "jump" can't be visualized or treated classically. The frequency v of the radiation emitted in the jump is related to the change in the atom's energy, given by the formula.

$$E_i - E_f = hv$$

E_i is the energy of the initial state, E_f is the energy of the final state and $E_i > E_f$. h is Plank's constant.

The frequency of radiation is independent of the frequency of the electron's orbital motion.

2. The following people did experiment to proof its theorem.

- In 1897, the American astronomer Pickering found in the sagittal added 22 the spectrum of the star line is a set of unique, the line is called Pickering. Then the British physicist Mr Vance observation of the He + spectrum in the laboratory. It confirms that Bohr was right on the judgment.
- In 1914, Frank and Hertz bombard the mercury vapor with electron, namely, frank - Hertz experiment. This experimental shows that the mercury atoms exist within the quantum state of energy of 4.9 eV. In the 1920 s, Frank and Hertz continue to improve the experiment device, found that the mercury atom with the quantum which strongly prove the correctness of the Bohr's

assumption.

- British physicist Henry Moseley measured elements of a wide variety of X-ray spectral lines. Found that they have certain regularity, and the empirical formula, Moseley formula. Moseley find his empirical formula can be derived by the Bohr model, which provides strong evidence for the Bohr model.
- In 1932, (H.C. Urey) observed the spectra of deuterium（isotopes of hydrogen）and measured the deuterium's rydberg constant, which can proof the Bohr model.

(3) Why was the Frank-Hertz effect considered important enough to award a Nobel prize for its discovery?

In 1914, frank and Hertz discovered that the energy transfer of electrons in non-elastic collisions with atoms was quantized. After their precise measurements, they find when electrons collide with mercury atoms, the energy of electron loss remains strictly at 4.9 eV.

Because this experiment played an important role in the development of atomic physics.

In this experiment, the quantization of energy transfer during the collision of electrons and mercury-vapor atoms can be observed, and the first excitation potential of mercury atoms is measured. With the help of these, people can have a better understanding on the concept of atomic energy level.

This experiment provides direct evidences for the existence of energy levels, which is a powerful support for Bohr's atomic theory.

The statements above show what we can achieve and how physics is improved because of experiment. All of these tell us that this experiment is important enough to win a Nobel prize. And the official from Nobel prize says that they win this award “for their discovery of laws governing impact of an electron upon an atom”

References:

- Some parts I write on this prelab which is reference from Wikipedia and Baidu.
- Some parts of my prelab was got from the book (Introductory physics experiments for undergraduates, Haofu).