Deflection of electron beams in a magnetic field

Perrin tube and pair of Helmholtz coils

Object of the experiment

1. Investigating the deflection of electron beams in the magnetic field of two Helmholtz coils

Setup

Safety note:

The Perrin tube can be destroyed by incorrect connection and by voltages and currents that are too high.

Regarding the connection and technical data heed the instruction sheet 555 622.

Apparatus

1 Perrin tube	555 622
1 tube stand	555 600
1 pair of Helmholtz coils	555 604
1 high-voltage power supply 10 kV	521 70
1 DC power supply, 0...16 V, 0...5 A	521 545
1 magnetic needle	531 11
1 base for magnetic needle	513 51
2 safety connecting leads, 100 cm, red	500 641
2 safety connecting leads, 100 cm, blue	500 642
2 safety connecting leads, 100 cm, black	500 644
3 safety connecting leads, 25 cm, red	500 611
1 safety connecting lead, 25 cm, blue	500 612

Carrying out the experiment

Remark:

The direction of the magnetic field between the two Helmholtz coils can be determined by means of the magnetic needle. If the magnetic needle is positioned in the field of the Helmholtz coils, the pole of the needle which is marked with blue colour points in the direction of the field.

- Switch the high-voltage power supply on, and enhance the voltage until the luminous spot of the electron beam is visible on the screen of the Perrin tube.
- Switch the DC power supply on for supplying the pair of Helmholtz coils, and adjust a medium voltage.
- Slowly enhance the current, and observe the deflection of the luminous spot on the screen of the tube.
- Position the magnetic needle in the field of the Helmholtz coils below the Perrin tube, and determine the direction of the magnetic field.
- Change the polarity of the voltage at the DC power supply, and repeat the experiment.

Observation

Direction of the magnetic field	Direction of the deflection of the electron beam
←	↑
→	↓

If the current which flows through the Helmholtz coils is enhanced, the deflection of the electron beam increases.

If the direction of the current is reversed by changing the polarity, the direction of the magnetic field between the Helmholtz coils and the direction of the deflection of electron beam are reversed, too.

Evaluation

If electrons move perpendicularly to a magnetic field, a force acts on them, which is called Lorentz force.

The action of the Lorentz force is seen by the deflection of the electron beam from the centre of the screen.

The direction of the Lorentz force depends on the direction of the magnetic field.

The magnitude of the Lorentz force depends on the strength of the magnetic field.

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