Shielding for ambitious neutron experiment

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In science fiction stories it is either the inexhaustible energy source of the future or a superweapon of galactic magnitude: antimaterial. In fact, antimaterial can neither be found on Earth nor in space, is extremely complex to produce and thus difficult to study.

In order to nevertheless track down the origin of material and antimaterial in the universe, a European research group is measuring the power of the electrical dipole moment of neutrons, which represents a measure for the different physical properties of material and antimaterial.

The prerequisite for further, still more accurate measurements is a perfect insulation against electrical and magnetic radiation from the environment. Magnetically soft mumetal serves as a material of the new shielding - the design, testing and set-up of which the Physikalisch-Technische Bundesanstalt is responsible.

Neutrons are electrically neutral particles, when observed externally. As the neutron contains both positively and negatively charged quarks, it would be conceivable that there exist equally large positive and negative charges at a minimal spatial distance from one another in its interior. The neutron would then be an electrical dipole with two oppositely charged poles.

At the Institut Laue-Langevin (ILL) in Grenoble, a European research group is attempting to measure the magnitude of the electrical dipole moment of neutrons (nEDM) with high accuracy. In these experiments, the behaviour of extremely slow neutrons, so-called ultra cold neutrons (or abbreviated as UCN), is investigated in magnetic and electrical fields.

Due to the fact that neutrons possess a spin and thus have a magnetic moment, they are also subject to electromagnetic interaction. If an additional electrical field is applied, the neutron, if it possesses an electrical dipole moment, would have to slightly change its properties in a magnetic field.

So far, experiments have shown no sign that would indicate an appreciable electrical dipole moment. Due to the fundamental physical significance it is interesting, however, to further restrict the magnitude of the possible electrical dipole moment. The electrical dipole moment of the neutron is namely a measure of how strongly matter and anti matter differ from one another in their physical properties. In order to significantly improve the measurement uncertainty, a new setting up of the experiment at the Paul Scherrer Institut (PSI) with a stronger UCN source and a better magnetic shielding is planned.

As valuable know-how has been collected at the PTB during the assembly of the best-shielded magnetic cabin worldwide, this expertise is now to be used for the construction, testing and assembly of the new shielding of the neutron experiment. The measuring systems available at PTB will be used for the preliminary investigation of facility components. Of particular importance is the expertise at PTB for detecting even the slightest magnetic impurities.

Provided by PTB