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New method for checking a neutron electroneutrality by spin interferometry technique

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New approach for checking neutron electroneutrality is proposed. The main idea is to use the spin interferometry technique SESANS (Spin Echo Small Angle Neutron Scattering).
This technique provide a spatial splitting of neutron on two eigenstates with different projection of spin to the magnetic field. After passing through the working area these two eigenstates are coupled back by the opposite magnetic field. So, the phase of the interference pattern, i.e. azimuthal spin direction, is defined by phase difference of two neutron eigenstates, accumulated in working area. If such system is placed into uniform electric field E, then two neutron eigenstates, due to their spatial splitting, will be under different electric potentials. With presence of electric charge of neutron qn results in the energy splitting ΔEe=q_n E Δz and, respectively, will give additional phase shift Δφe=ΔEe τ/ħ, where Δz –value of spatial splitting, τ –time of neutron staying in electric field.
A simple test of possibility to measure a small phase shift by the SESANS technique was done at the WWR-M reactor (PNPI, Gatchina). The good agreement of the theoretical and experimental dependencies was obtained.
Furthermore, we propose an improvement of this technique using neutron Laue diffraction in perfect crystal. It based on a well known effect of diffraction enhancement when a small variation of the incident neutron beam direction leads to a considerable deflection of a neutron trajectory inside a crystal. A gain factor for the value of splitting Δz can reach more than 10ˆ5 in comparison with the standard SESANS. The prototype variant of setup is now under construction.
Preliminary estimations have show the using of technique mentioned above can improve the recent constraint on a neutron electric charge on two order of magnitude and reach the value about σ(q_n)˜10ˆ{-23}e.
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