Contribution ID: **34** Type: **Oral**

On the trapping of cold neutrons in nano-scaled Fabry-Perot resonating cavities & neutron lifetime considerations

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Relatively to the atomic constituents' counterparts, the neutron is singular as it is sensitive to the four fundamental interactions: strong, weak, electromagnetic, and gravitational. This multi-sensitivity makes neutron wave-matter optics a particularly versatile tool for testing quantum mechanics [1-4], specifically and fundamental physics concepts in general. The lifetime of a free neutron defined via its beta-decay ⟨τn⟩ is of a pivotal importance within the standard model & cosmology.
Indeed, the precision on the neutron lifetime is of a paramount importance as it regulates the precision of the 1st element of the Cabibbo–Kobayashi–Maskawa matrix, central to the standard model. The two major methods used to measure ⟨τn⟩ while trapping free neutrons, namely, the beam and the bottle methods give different neutron lifetime values; ⟨τn⟩Beam ~ 888.0 ± 2.0 s , that obtained by the bottle technique is smaller; of about ⟨τn⟩Bottle ~ 879.4 ± 0.6 s. In addition of the persistent difference of ~10 s persists for years, even if the two methods have been modified to enhance the experimental accuracy. This latter was shown to be enhanced if one could trap cold neutrons in nanostructured Fabry-Perot resonators.
This contribution reports on the de Broglie wave-matter quantum duality coupled to the Fermi total reflection phenomenon in addition to the tunneling & trapping of cold neutrons in such nano-resonating cavities. This quantum mechanics trapping driven phenomenon allows trapping times of cold neutrons with a precision governed by the Heisenberg uncertainty of about 10-12 s [5].
1-•Zeeman neutron tunneling in Ni-Co-Ni thin film resonators
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2-•On the possibility to observe the longitudinal Goos-Hänchen shift with cold neutrons
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3-•V-Ni multilayered monochromators and supermirrors for cold neutrons,
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4•A way to reach high accuracy in the determination of the magnetic London penetration depth in superconductors by polarized neutron reflectometry
Maaza et al, Physics Letters, 1996, 218(3-6), pp. 312–318
5•Nano-structured Fabry-Pérot resonators in neutron optics & tunneling of neutron wave-
Maaza et al, Journal of Neutron Research -1 (2023) 1–16 1 DOI 10.3233/JNR-220015

Notes

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