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Search for an interaction mediated by axion-like particles with ultracold neutrons at PSI

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The “Peccei-Quinn symmetry” first proposed to solve the strong CP problem, spontaneously breaks at some high energies where axion emerges. Subsequently, a new, short-range, spin-dependent interaction, which could be mediated by very light, weakly coupled bosons, such as the axion and other hypothetical axion-like particles (ALPs), was proposed. The monopole-dipole interaction involving the scalar and the pseudoscalar couplings has been extensively searched for worldwide as it violates the combined CP symmetry, which would give an evidence to one of the three criteria to explain the matter-antimatter asymmetry problem. Using the nEDM spectrometer at the Paul Scherrer Institute, we have searched for this ALPs-mediated interaction between unpolarized nucleons close to the material surfaces of the apparatus and polarized ultracold neutrons (UCN) stored in vacuum. The dominant systematic uncertainty resulting from magnetic-field gradients was controlled to an unprecedented level. No signature of a theoretically predicted new interaction was found, and we set a new limit on the product of the scalar and the pseudoscalar couplings for the monopole-dipole interaction. This new result confirms and improves our previous limit by a factor of 2.7 and provides the current tightest limit obtained with free neutrons. In this talk, I will describe the measurement technique of the search for this new interaction, explain the analysis method to achieve an unprecedented level of control of the systematic uncertainties, and show the results published in New Journal of Physics last year.

Orateur: CHIU, Pin-Jung (University of Zurich)