

Θ -vacua, PQ symmetry, Axions and all that

Roberto Peccei, University of California, Los Angeles

Abstract: In this colloquium, I describe how the structure of the QCD vacuum, which explains why the η and π mesons act so different dynamically, predicts the presence of a CP violating term in the theory proportional to the vacuum angle θ . To agree with the present experimental bound on the neutron electric dipole moment, however, this parameter must be very small ($\theta < 10^{-9}$). I discuss some possible solutions to this, so-called, strong CP problem and argue that the only viable solution remains that of having an additional chiral symmetry in nature, as was suggested by Helen Quinn and me thirty-five years ago. This PQ symmetry has associated with it a light pseudoscalar particle, the axion, with important astrophysical and cosmological implications. I describe the properties and dynamics of axions, focusing particularly on invisible axion models, where axions are very light, very weakly coupled and very long-lived, and discuss experiments which are presently searching for them. I conclude by presenting some possible hints for axions coming from the caustic structure of dark matter halos.