Contribution ID: **153** Type: **Parallel Talk**

Small Instanton Effects on Composite Axion Mass

Friday 14 June 2024 10:00 (17 minutes)

Peccei-Quinn (PQ) mechanism is a prominent solution to the strong CP problem. In this mechanism, spontaneous breaking of an anomalous global symmetry (PQ symmetry) generates a pseudo-Nambu-Goldstone boson called axion, which is also a dark matter candidate. From observational reasons, the energy scale of the symmetry breaking is constrained to be greater than about 10^9 GeV, or even more to explain all the dark matter. With this constraint, a theoretical problem for PQ mechanism arises. The problem is that Planck-suppressed operators which explicitly violate PQ symmetry can easily generate non-zero effective theta angle exceeding the experimental limit. To avoid this problem, several models with higher-energy dynamics are proposed. Among them are composite axion models, in which PQ symmetry is spontaneously broken by strong dynamics in high-energy, resulting in the axion emerging as a composite state. In models with such high-energy dynamics, calculation of the axion mass only in QCD is not necessarily sufficient, and small instantons in higher-energy dynamics, absent in QCD, may enhance the axion mass. In my presentation, I will explain that small instantons do not enhance the axion mass in some specific composite axion models, although the enhancement seems possible at first sight.

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Session Classification: Dark matter, astroparticles and gravitational waves

Track Classification: Dark matter, astroparticles and gravitational waves