Contribution ID: **182** Type: **not specified**

Interplay of vertical and horizontal gauge symmetry for a high-quality axion

Thursday 29 May 2025 15:40 (20 minutes)

We present an axion model based on the Pati-Salam group, where $\mathrm{SU}(3)_{f_R}$ (part of flavor symmetry) has also been gauged. The choice of field content ensures a careful interplay of the two symmetries, such that an accidental global $\mathrm{U}(1)$ Peccei-Quinn (PQ) symmetry emerges. The resulting axion is of high quality for the breaking scale in a certain range, and the model's Yukawa sector is realistic. A characteristic feature of having both a vertical (Pati-Salam) and horizontal (flavor) symmetry are anomalons — parametrically light fermions required to cancel gauge anomalies. We analyze their interplay with neutrinos and their production in the early universe. Their effect on ΔN_{eff} could serve as a low energy probe for the underlying dynamics of PQ quality.

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Session Classification: Axions