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Gegenbauer Goldstones

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We investigate radiatively stable classes of pseudo-Nambu-Goldstone boson (pNGB) potentials for approximate spontaneously broken SO$(N+1) \to$ SO(N). Using both the one-loop effective action and symmetry, it is shown that a Gegenbauer polynomial potential is radiatively stable, being effectively an eigenfunction' from a radiative perspective. In Gegenbauer pNGB models, one naturally and automatically obtains $v \propto f/n$, where $n \in 2\mathbb{Z}$ is the order of the Gegenbauer polynomial. For a Gegenbauer Higgs boson, this breaks the usual correlation between Higgs coupling corrections andv/f' tuning. Based on this, we argue that to conclusively determine whether or not the Higgs is a composite pNGB in scenarios with up to $\mathcal{O}(10\%)$ fine-tuning will require going beyond both the Higgs coupling precision and heavy resonance mass reach of the High-Luminosity LHC.

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