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Searching for New Physics in Soft Unclustered Energy Patterns

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Most collider-based searches for new physics focus on final states with a small number of high-momentum particles. In contrast, a Soft Unclustered Energy Pattern (SUEP) represents a distinct signature characterized by a high multiplicity of spherically distributed, low-momentum particles. Such a signature can arise from strongly coupled, quasi-conformal Hidden Valley models.

Although it may seem very exotic, such an extension of the Standard Model is well-motivated, as quantum chromodynamics exhibits similar behavior in its non-perturbative regime. However, identifying SUEPs at the LHC poses unique challenges, as their diffuse, low-momentum nature closely resembles the ubiquitous background from pile-up interactions. Furthermore, detecting them often requires pushing detector performance beyond its original design specifications.

Despite these challenges, the signature offers promising opportunities to explore new physics in uncharted regions of the kinematic phase space. This presentation reviews existing experimental searches for SUEPs and explores potential new strategies.

Presenter: LORY, Alexander (LMU Munich)

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