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Instantons and spharelons at HL and HE-LHC

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Instantons are nonperturbative tunneling processes between topologically distinct vacua which occurs in non-Abelian gauge theories. Even though instanton processes are a core prediction of the SM, providing insights in the vacuum structure of the theory, they have so far not been experimentally observed. Instanton processes in the electroweak sector (sphalerons) lead to violation of baryon+lepton number, and have important implications for baryogenesis. While their cross-section is predicted to be vanishingly small at LHC energies, sphalerons might be in reach of upcoming high energy colliders, such as the HE-LHC. We present promising search strategies for sphaleron production, based on the large predicted multiplicity of gauge bosons and the expected upper limits on their cross-section achievable at both the high luminosity and high energy LHC. In the QCD sector instantons lead to chirality violation and are thought to play a role in many aspects of the long distance behaviour of the theory.
QCD instantons have been searched for in ep scattering at HERA, but insofar they have not been looked for in pp collisions, where their cross-section is predicted to be enhanced. We discuss possible search strategies for both the LHeC and HL/HE-LHC

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