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Soft-Collinear Supersymmetry

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Soft-Collinear effective theory (SCET) is a framework for organizing the infrared structure of theories that manifest soft and collinear divergences in the Feynman diagram expansion. We provide the first demonstration that SCET can be made compatible with supersymmetry (SUSY). SCET is formulated by expanding fields along a light-like direction, and then subsequently integrating out degrees-of-freedom that are away from the light-cone. This can be done consistently with a well-defined power counting parameter. Naively, the presence of a specific frame obscures Lorentz invariance and provides a possible obstruction for compatibility with extended space-time invariance, i.e., SUSY. In order to demonstrate that the SCET limit of SUSY Yang-Mills is itself consistent, we develop a formalism for 2-component fermions in the collinear limit, and then provide the first derivation of the SCET Lagrangian expressed in light-cone gauge. A proof that N = 1 SUSY Yang-Mills can be formulated in a self-consistent manor, and is given in terms of component Lagrangians (obstructions for chiral theories such as the Wess-Zumino model are also ellucidated). A novel "collinear superspace"is introduced, and can be used to derive the light-cone gauge SUSY SCET theory directly by integrating out half of superspace. Furthermore, this can be bootstrapped back to the full theory to yield the first direct derivation of the full theory SUSY Yang-Mills on-shell superspace action. Our formalism paves the way to explore the soft-collinear limit of N = 4 SYM or N = 8 supergravity.

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