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Covariant L-S decomposition by spinor variable

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In high-energy physics, traditional spin-orbit (L-S) decomposition effectively describes 3-point interaction structures and fully characterizes 3-point kinematics. However, its formulation is entirely dependent on the Center-of-Mass Frame (CMF) angular variables (θ, φ), necessitating Lorentz boosts back to the CMF for decomposition in practical calculations, which adds complexity. To resolve this, we use covariant spinor variables to construct a formally covariant spin-orbit coupling. This formulation enables L-S decomposition of amplitudes in any arbitrary reference frame, eliminating the requirement to return to the CMF and streamlining spin-dependent analyses. Furthermore, leveraging this tool, we can establish the general structure of Form Factors, construct covariant spin-operators, and develop covariant tomography for high-energy interaction analyses.

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