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# Spin-1 formalisms applied to hadronic processes

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## Abstract

The description of massive spin-1 particles—such as the $\rho$, $\omega$, and $\phi$ vector mesons—is fundamental for modeling interactions in hadronic scattering processes within quantum field theory. To address this challenge, the theory offers three formalisms: the Proca formalism $\left(\frac{1}{2},\frac{1}{2}\right)$, employing a vector field; the Chizov formalism, utilizing an antisymmetric tensor field $(1,0)\oplus(0,1)$; and the hybrid field based on the linear Duffin-Kemmer-Petiau (DKP) theory $(1,0)\oplus\left(\frac{1}{2},\frac{1}{2}\right)\oplus(0,1)$. This work presents a comparative study of these three frameworks applied to processes involving vector mesons, aiming to contrast their theoretical characteristics (degrees of freedom, gauge invariance, and causality) with their phenomenological implications.

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