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Constructing on-shell operator basis for all masses and spins

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We first propose a general method to construct the complete set of on-shell operator bases involving massive particles with any spins. To incorporate the non-abelian little groups of massive particles, the on-shell scattering amplitude basis should be factorized into two parts: one is charged, and the other one is neutral under little groups of massive particles. The complete set of these two parts can be systematically constructed by choosing some specific Young diagrams of Lorentz subgroup and global symmetry $U(N)$ respectively (N is the number of external particles), without the equation of motion and integration by part redundancy. Thus the complete massive amplitude bases without any redundancies can be obtained by combining these two complete sets. Some examples are presented to explicitly demonstrate this method. This method is applicable for constructing amplitude bases involving identical particles, and all the bases can be constructed automatically by computer programs based on it.

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