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Generic algorithm for multi-particle cumulants of azimuthal correlations at the LHC

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Multi-particle cumulants of azimuthal angle correlations have been compelling tools to probe the properties of the Quark-Gluon Plasma (QGP) created in the ultra-relativistic heavy-ion collisions and the search for the QGP in small collision systems at the LHC. However, only very few of them are available and have been studied in theoretical calculations and experimental measurements, while the rest are generally very interesting, but their direct implementation was not feasible.

In this talk, I will present a generic recursive algorithm for multi-particle cumulants, which enables the calculation of arbitrary order single and mixed harmonic multi-particle cumulants. Among them, the new 10-, 12-, 14-, and 16-particle cumulants of a single harmonic, named $c_n\{10\}$, $c_n\{12\}$, $c_n\{14\}$, and $c_n\{16\}$, and the corresponding v_n coefficients, will be discussed for the first time. The Monte Carlos studies show that these new multi-particle cumulants can be readily used along with updates to the generic framework of multi-particle correlations to a very high order. Finally, I will propose a particular series of mixed harmonic multi-particle cumulants, which measures the general correlations between any moments of different flow coefficients. The study of these new multi-particle cumulants in heavy-ion collisions will significantly improve the understanding of the joint probability density function which involves both different harmonics of flow and also the symmetry planes. This will pave the way for more stringent constraints on the initial state and help to extract more precisely information on how the created hot and dense matter evolves. Meanwhile the efforts applied to small systems could be very helpful in the understanding of the origin of the observed collectivity at the LHC.

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