Oscillation phenomena in multiparticle production processes

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There is good evidence for the presence of quasi-power law distributions decorated with log-periodic oscillation in many different, apparently very disparate branches of science. We can therefore expect that oscillations of certain variables in fact constitute a universal phenomenon which is to be expected in a large class of stochastic processes, independently of the microscopic details. In this presentation we concentrate on oscillation phenomena seen at LHC energies in transverse momentum distributions and multiplicity distributions. Large transverse momentum distributions apparently exhibit power-like behavior. However, under closer inspection, this behavior is in fact decorated with some log-periodic oscillations. It suggests that either the exponent of the power-like behavior is in reality complex, or that there is a scale parameter which exhibits specific log-periodic oscillations. This problem is discussed using Tsallis distribution with scale parameter T and with complex nonextensivity parameter q [1-3]. Fourier transforms of oscillations of the temperature $T(pT)$ deduced from the experimental data on multiparticle production, we have used to investigate oscillations in $T(r)$. We have found that the log-periodically oscillating $T(r)$ represents some log-periodic sound wave forming in the source [4]. The observed oscillations have been attributed to a discrete scale invariance. However, it turns out that such scale invariant functions also satisfy wave equations showing a self-similarity property. In both cases these functions exhibit log-periodic behavior. In what concerns multiplicity distributions $P(N)$, they are most frequently described by the Negative Binomial Distribution. However, with increasing collision energy some systematic discrepancies become more and more apparent. Presence of oscillation in counting statistics is well establish. We propose a novel phenomenological description of the observed multiplicity distributions which allows for a more detailed quantitative description of the complex structure of the experimental data on $P(N)$ [5]. It is provided by coefficients C_j (connected with combinants, but not identical to them) defined by the recurrence relation $(N+1)P(N+1) = \sum_j C_j P(N-j)$. We observe strong oscillations of coefficients C_j at LHC energies [5]. These oscillations will await their physical justification, i.e., indication of some physical process which would result in such a phenomenon.

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