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Spectator-induced electromagnetic effects at CERN SPS energies

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We review our studies of spectator-induced electromagnetic (EM) effects on charged pion and kaon emission in nucleus-nucleus collisions at CERN SPS and RHIC BES energies. These are found to consist in (1) breaking of isospin symmetry for spectra of fast pions in the final state of non-central collisions (2) centrality dependent distortions in ratios of emitted pi+/pi- and K+/K- (3) charge splitting of pion directed flow, and (4) the enhancement of final state negative pion emission at spectator rapidity.

We compare our model calculations to results from STAR, NA49 and NA61/SHINE in the energy range 7.7 \leq \sqrt(s_NN) \leq 17.3 GeV. As it emerges from our analysis, the observed effects offer sensitivity to the actual space-time evolution of the hot and dense matter created in the course of the collision. The distance d_E between the pion formation zone at freeze-out and the spectator system can be estimated with a precision that depends on particle rapidity, and is better than 1 fm for fast pions in the collision c.m.s. At central rapidity our estimates agree with pion decoupling times obtained from standard femtoscopy [1].

As a result, a specific picture of the longitudinal evolution of the system emerges. We construct a simple model of the heavy ion collision, local in the impact parameter plane, and appropriate for the SPS energy range. This model can be regarded as a new realization of the "fire-streak" approach, originally applied to studies of lower energy nucleus-nucleus reactions. Starting from local energy and momentum conservation in the impact parameter plane, we nicely describe the centrality dependence of the pion rapidity distribution and total pion yields in Pb+Pb collisions at \sqrt(s_NN)=17.3 GeV [2]. In particular we also explain the broadening of this distribution when going from central to peripheral collisions. We discuss the resulting implications on the role of energy and momentum conservation in the early stage of the A+A reaction [3].

Finally, we comment on the possibility of using EM effects in relativistic heavy ion collisions to test the nuclear models of spectator break-up [4]. This includes possible new measurements in the framework of the NA61/SHINE Phase II programme.

References:
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