Multi-parton interactions and nucleus-nucleus collisions

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Nuclear reactions at high-energy involve the scatterings of many constituent quarks and gluons of the colliding nuclei and provide and excellent ground to test the physics and phenomenology of multi-parton interactions (MPIs) models. Throughout most of the stages of a high-energy heavy-ion (A-A) collision – from the initial nuclear wavefunctions, through the pre-equilibrium state just after the collision, and into the subsequent thermalized quark-gluon plasma (QGP) phase – MPIs are behind (hard and soft) multiparticle production mechanisms and the collective behaviour of the produced quark-gluon medium.

The heavy-ions session of MPI'08 included five written contributions (three experimental, two theoretical) that showed in detail the crucial role of MPIs in our understanding of the physics of strongly interacting QCD matter:

- Cyrille Marquet ("Multiple partonic interactions in heavy-ion collisions") focused on recent theoretical developments on heavy-ion collisions during the three first stages of the interaction: (i) the initial-state characterized by saturated small-x gluon distributions described by the "Color-Glass-Condensate" effective field theory picture; (ii) the pre-equilibrium "glasma" phase formed right after the collision of the two nuclei accounting for multiparticle production from the released interacting gluons; and (iii) extra gluon radiation due to parton energy loss traversing the dense medium.
- Mark Strikman ("Antishadowing and multiparton scattering in hard nuclear collisions") discussed longitudinal and transverse parton correlations in hadron-nucleus collisions. The contributions to MPI due to hard collisions of the projectile with different target nucleons are considered, showing how terms involving different target nucleons give rise to strong anti-shadowing corrections (of about a factor 12 for triple parton collisions) which, remarkably, do not depend on the transverse correlations. By comparing the MPI cross sections in p-p and p-A collisions, the effects of longitudinal and transverse parton correlations may hence be disentangled. The possibility to measure σ_{eff} by looking at MPI in ultraperipheral collisions of heavy nuclei was also discussed which, by comparison with γp at HERA, would allow to measure the correlations between partons in the photon structure.
- The scaling laws relating (hard and soft) particle production in nucleus-nucleus and proton-proton collisions were reviewed by Klaus Reygers ("Multiple hard parton interactions in heavy-ion collisions"). On the one hand, the observed reduction of high-p_T hadron (but not direct γ) yields in A-A compared to p-p collisions (scaled by a factor accounting for the incoming parton fluxes), is a direct indication of *final-state* energy loss of the produced partons. On the other, the limited increase of multiple (soft) hadron production in A-A collisions from 20-GeV to 200-GeV as compared to simple MPI approaches, is indicative of an *initial-state* reduction of the incoming parton densities with increasing collision energies.

- The difficulties, challenges and perspectives of jet reconstruction in high-energy A-A collisions characterized by a huge underlying event background (about 2000 particles per unit rapidity at midrapidity are expected in Pb-Pb collisions at the LHC) were discussed by Magali Estienne ("Jet reconstruction in heavy-ion collisions").
- Andre Mischke ("Heavy-quark and Quarkonia production in high-energy heavy-ion collisions") reviewed the most important results in the heavy-quark and quarkonia sectors of heavy-ions collisions. Multiple interactions of charm and bottom quarks in the dense medium produced in A-A collisions account for many of the intriguing results obtained at RHIC such as: (i) the large quenching of high-p_T electrons issuing from the decays D and B mesons traversing the dense produced system, and (ii) the approximately equal suppression of J/Ψ yields observed at SPS and RHIC, accountable by an increased importance of heavy-quark recombination mechanisms at the top RHIC energies (up to 10 charm pairs are produced in a central Au-Au collision).