

# Summary of thesis

## Correlations between harmonic flow and transverse momentum in pp and p+Pb collisions at the LHC with the ATLAS detector

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The subject of presented thesis is study of the correlation between harmonic flow  $v_n$  and mean transverse momentum  $[p_T]$  of particles in the event in proton-proton collisions at  $\sqrt{s} = 5.02$  and 13 TeV and proton-lead at  $\sqrt{s} = 5.02$  TeV with the ATLAS detector has been conducted. It is performed for charged particles with pseudorapidity range  $|\eta| < 2.5$  and various transverse momentum ranges. The measured observable is a modified form of Pearson's correlation coefficient ( $\rho(v_n\{2\}^2, [p_T])$ ) between flow  $v_n\{2\}^2$  and  $[p_T]$ . The results are presented for harmonics  $n = 2$  and 3, and three arrangements of sub-events.

Within the uncertainties, the results obtained for  $\sqrt{s} = 13$  TeV are mostly compatible with those from  $pp$  at  $\sqrt{s} = 5.02$  TeV. The  $\rho(v_n\{2\}^2, [p_T])$  measured in  $pp$  collisions at  $\sqrt{s} = 5.02$  TeV are also compared to those from  $p$ -Pb at the same energy per nucleon pair. For the second harmonic, the correlation coefficients show a difference between  $pp$  and  $p$ -Pb at high multiplicity, which can be attributed to differences in the initial geometry of the collisions. For the third harmonic, the correlation coefficients are found to be compatible with each other.

The results for  $pp$  are compared to Pythia 8 and EPOS simulations. The Pythia 8 does not contain any collective effect, while the EPOS does contain them and in addition implements, gluon saturation, and hadronic cascade, which contribute to the value of  $v_n$  and thus  $\rho(v_n\{2\}^2, [p_T])$ . The results obtained using 1-subevent approach show differences between data and MC simulations, suggesting a different scheme of short-range correlation in  $pp$  data than in these MC simulations. Both Pythia 8 and EPOS results are able to reproduce the overall decrease of  $\rho(v_n\{2\}^2, [p_T])$  correlation coefficient calculated with 2- and 3-subevents. The comparisons suggest that color reconnection from multi-parton interactions dominates the  $\rho(v_n\{2\}^2, [p_T])$  in  $pp$ . The color reconnection range parameter is constant throughout the simulation, while the experimental data favor different parameters for different kinematic ranges and multiplicities.

Comparison of  $p$ -Pb results to models was also performed with HIJING for 1-subevent approach and IP-Glasma+MUSIC+UrQMD for 3-subevent methods, and qualitative agreements were observed. HIJING manages to produce the same trend without hydrodynamics and CGC. The consideration of initial spatial geometry and momentum anisotropy in IP-Glasma+MUSIC+UrQMD improves the agreement with the data. The data comparison with the results of hydrodynamic simulation suggests in the  $p$ -Pb that the source of entropy is located in the center-of-mass between colliding objects.