Gergely Barnaföldi: Probing the exotic nuclear structure of ^{16}O through anisotropic flow fluctuations in OO and pO collisions at the LHC

Nuclei having 4n number of nucleons are theorized to possess clusters of α particles (4He nucleus). The Oxygen nucleus (^{16}O) is a doubly magic nucleus, where the presence of an α-clustered nuclear structure grants additional nuclear stability.

We exploited the anisotropic flow coefficients to discern the effects of an α-clustered nuclear geometry with respect to a Woods-Saxon nuclear distribution using a hybrid of IP-Glasma + MUSIC + iSS + UrQMD models in O–O and p-O collisions at sNN=7 TeV and sNN=9.61 TeV, respectively. In addition, we use the multi-particle cumulants method to measure anisotropic flow coefficients, such as elliptic flow (v2) and triangular flow (v3), as a function of multiplicity class. Anisotropic flow fluctuations, which are expected to be larger in small collision systems, are also studied for the first time in O–O and in p-O collisions.

We found that an α-clustered nuclear distribution gives rise to an enhanced value of v_2 and v_3 for the low-multiplicity events. Consequently, a rise in v_3/v_2 is also observed for the 0–10% multiplicity class. Further, for α-clustered O–O and p-O collisions, fluctuations of v_2 are larger for the highest multiplicity events, which decrease as the final-state multiplicity decreases. In contrast, for a Woods-Saxon ^{16}O nucleus, v_2 fluctuations show an opposite behaviour with decreasing multiplicity. When confronted with experimental data, this study may reveal the importance of the nuclear density profile on the discussed observables and provide physics validation for the hybrid model discussed in this work. These predictions can be testen in the first p-O and O-O collisions at the LHC in the forthcoming light ion programme mid-June 2025.