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Left-right splitting of elliptic flow due to directed flow in heavy ion collisions

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Recently the splitting of elliptic flow v_2 at finite rapidities has been proposed to be the result of global vorticity in non-central relativistic heavy ion collisions [1]. Here we confirm the existence of the v_2 splitting. However, we show that this left-right v_2 splitting (on opposite sides of the impact parameter axis) is mostly due to the non-zero directed flow v_1 at finite rapidities, with the splitting given by $v_2(p_x > 0) - v_2(p_x < 0) \sim 8v_1/3\pi$ [2]. It is thus expected to depend sensitively on the transverse momentum, rapidity range, particle species, and colliding energy. We then use a multi-phase transport model, which automatically includes the vorticity field and flow fluctuations, to demonstrate these features.

We also find that the v_2 splitting contains a contribution from a new type of triangular flow, which at finite rapidities correlates to the reaction plane. In addition, the v_2 splitting measurement does not necessarily need to measure the 1st-order event plane Ψ_1; it only needs to know whether the 2nd-order event plane angle Ψ_2 or $\pi + \Psi_2$ corresponds to the $p_x > 0$ side. So the left-right v_2 splitting contains similar but somewhat different information compared to the conventional separate v_1 and v_2 measurements; and it could be easier to do. Therefore, this observable should benefit the studies of the three-dimensional geometry and evolution of the dense matter created in heavy ion collisions.

[1] Z. Chen, Z. Wang, C. Greiner, and Z. Xu, arXiv:2108.12735 [hep-ph].
[2] C. Zhang and Z.-W. Lin, 2109.04987 [nucl-th].

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