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What We Have Learned from the Measurement of Azimuthal Anisotropy of Identified Particles in Relativistic Heavy ion Collisions

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Measuring the azimuthal anisotropy of particles produced in relativistic heavy ion collisions is a powerful probe for investigating the characteristics of the quark-gluon plasma (QGP), which is the phase in QCD matter of de-confined quarks and gluons. The strength of the elliptic anisotropy (v_2) in the momentum phase space is transferred from the geometrical anisotropy of the initial collisional region because of the pressure gradient. Thus, the measured v_2 reflects the equation of state of the dense matter, possibly the QGP, produced in the collisions. One of the most remarkable findings at RHIC is that the v_2 can be well described by hydro dynamical models assuming very short thermalization times (< 0.5 fm/c) in the low transverse momentum region ($p_T \leq \sim 1$ GeV/c). In the intermediate transverse momentum region ($p_T =1\sim4$ GeV/c), v_2 is scaled with the number of quarks, and consistent with the quark-recombination model. For a more comprehensive understanding of v_2, we have carried out systematic measurements of v_2 and studied the dependence on collision energy, species and centrality. We find that v_2 divided by the participant eccentricity of initial geometry exponentially increases with the number of participants to the 1/3 power. Taking the eccentricity and quark number scaling into account, there is a universal scaling for v_2 with different energies and collision sizes. The results indicate that v_2 is not decided by only the geometrical eccentricity, but it also depends on the size of collision, which can be related to the finite evolving time up to freeze out.