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QCD energy-momentum tensor using gradient flow

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We study the energy-momentum tensor in QCD for $N_f = 2+1$ dynamical quarks. In order to tame violation of the translational invariance on lattice we use the gradient flow method as a non-perturbative renormalization scheme. We adopt two values for the up and down quark mass. One is the physical mass with which we measure the one point function of the energy-momentum tensor and derive the equation of state in QCD. The other is a rather heavy mass of about $m_{ud} \simeq 59$ MeV with $m_\pi/m_\rho \simeq 0.63$. Using the latter gauge configuration we measure correlation functions of the energy-momentum tensor, from which we extract some transport coefficients. We also measure the chiral condensate and topological charge and study their temperature dependence.

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