

## Correlated Dirac eigenvalues and axial anomaly in chiral symmetric QCD

We introduce novel relations between the derivatives ( $\partial^n \rho / \partial m_l^n$ ) of the Dirac eigenvalue spectrum ( $\rho$ ) with respect to the light sea quark mass ( $m_l$ ) and the  $(n + 1)$ -point correlations among the eigenvalues ( $\lambda$ ) of the massless Dirac operator. Using these relations we present lattice QCD results for  $\partial^n \rho / \partial m_l^n$  ( $n = 1, 2, 3$ ) for  $m_l$  corresponding to pion masses  $m_\pi = 160 - 55$  MeV, and at a temperature of about 1.6 times the chiral phase transition temperature. Calculations were carried out using  $(2+1)$ -flavors of highly improved staggered quarks with the physical value of strange quark mass, three lattice spacings  $a = 0.12, 0.08, 0.06$  fm, and lattices having aspect ratios 4 - 9. We find that  $\rho(\lambda \rightarrow 0, m_l)$  develops a peaked structure. This peaked structure arises due to non-Poisson correlations within the infrared part of the Dirac eigenvalue spectrum, becomes sharper as  $a \rightarrow 0$ , and its amplitude is proportional to  $m_l^2$ . We demonstrate that this  $\rho(\lambda \rightarrow 0, m_l)$  is responsible for the manifestations of axial anomaly in 2-point correlation functions of light scalar and pseudo-scalar mesons. After continuum and chiral extrapolations we find that axial anomaly remains manifested in 2-point correlation functions of scalar and pseudo-scalar mesons in the chiral limit.

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