Gravitational Form-factors of the Pion from the Instanton Vacuum

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The matrix element of the second-order generalized form factors (GFFs) operator between pseudoscalar meson states is expressed in terms of two real form factors, i.e. $A_{2,0}(Q^2)$ and $A_{2,2}(Q^2)$ which correspond to the gravitational form factors:

$$
\langle \phi(p_f) | \bar{\psi}(0) \gamma_\mu i \overleftrightarrow{D}_\nu \psi(0) | \phi(p_i) \rangle = 2 P_{\{\mu} P_{\nu\}} A_{2,0}(q^2) + 2 q_{\{\mu} q_{\nu\}} A_{2,2}(q^2) \quad (1)
$$

where $\overleftrightarrow{D}_\mu = \frac{1}{2}(\overleftarrow{D}_\mu - \overrightarrow{D}_\mu)$, $q = p_f - p_i$, $P = (p_f + p_i)/2$ and $Q^2 = -q^2 > 0$. $D_\mu$ is the QCD covariant derivative and $\{\ldots\}$ denotes the symmetrization over indices and subtraction of the trace [1]. The low-energy theorem predicts that the form factors should satisfy the following constraints [2,3]

$$
A_{2,0}(0) = \frac{1}{2} \quad (2)
$$

$$
A_{2,0}(0) = -4 A_{2,2}(0) + O(m^2). \quad (3)
$$

In the present talk, we investigate the gravitational form factors of the pion and the kaon within the framework of the local and nonlocal chiral quark models, taking into account the current quark mass and the large $N_c$ limit. We discuss the pressure and angular momentum distributions of the pion and the kaon. We also derive the transverse densities corresponding to the EMT form factors which are identified as the form factors corresponding to the second moments of the vector generalized parton distributions [4].

![Figure 1: The mass form factor of the pion in the chiral limit](image)