Phase structure of the Quark-Meson model

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I. INTRODUCTION

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II. 2 FLAVOR QUARK MESON MODEL

The effective action of the 2 flavor quark-meson model reads

$$\Gamma_k[\Phi] = \int_x \{ Z_{q,k}\bar{q}(\gamma_\mu\partial_\mu - \gamma_0\mu)q + \frac{1}{2}Z_{\phi,k}(\partial_\mu\phi)^2 + k_k\bar{q}(T^0\sigma + i\gamma_5 T\cdot\pi)q + V_k(\rho) - c\sigma \} \tag{1}$$

where $\rho = \frac{1}{2}\phi^2$ is chirally invariant variable

The dimensionless meson and quark masses are obtained by

$$\bar{m}_\pi = \frac{V_k'(\rho)}{k^2 Z_{\phi,k}} \tag{2}$$

$$\bar{m}_\sigma = \frac{V_k'(\rho) + 2\rho V_k''(\rho)}{k^2 Z_{\phi,k}} \tag{3}$$

$$\bar{m}_q = \frac{h_k^2\rho}{2k^2 Z_{q,k}^2} \tag{4}$$

with the Wetterich equation

$$\partial_t\Gamma_k[\Phi] = \frac{1}{2}\,\mathrm{Tr}\, G_{\phi\phi}[\Phi]\partial_t R_k^\phi - \mathrm{Tr}\, G_{q\bar{q}}[\Phi]\partial_t R_k^q \tag{5}$$

the regulator

$$\partial_t V_k(\rho) = \frac{k^4}{4\pi^2}\{(N_f^2-1)l_0^B(m_{\pi,k},\eta_{\phi,k};T) + l_0^B(m_{\sigma,k},\eta_{\phi,k};T) - 4N_cN_f l_0^F(m_{q,k},\eta_{q,k};T,\mu)\} \tag{6}$$

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here $l_0^{B/F}$ are threshold functions which are defined as

$$l_0^B(\bar{m}_{\phi,k}^2,\eta_{\phi,k}) = \frac{2}{3}\frac{1}{\sqrt{1+\bar{m}_{\phi,k}^2}}\Big(1-\frac{\eta_{\phi,k}}{5}\Big)\Big(\frac{1}{2}+n_B(\bar{m}_{\phi,k}^2,T)\Big) \tag{7}$$

$$l_0^F(\bar{m}_{q,k}^2,\eta_{q,k}) = \frac{1}{3}\frac{1}{\sqrt{1+\bar{m}_{q,k}^2}}\Big(1-\frac{\eta_{q,k}}{4}\Big)\Big(1-n_F(E-\mu)-n_F(E+\mu)\Big) \tag{8}$$

$$\eta_{\phi,k} = \frac{1}{6\pi^2}\Big\{\frac{4}{k^2}\rho(V_k'(\rho))^2 \tag{9}$$

III. RESULTS

A. phase diagram at chiral limit

IV. SUMMARY AND DISCUSSIONS

In this work, we have studied

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