Pion weak decay constants in nuclear matter

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In nuclear matter, the pion weak decay constant is separated into the two components f_t, f_s corresponding to the time and space components of the axial-vector current. Using QCD sum rules, we compute the two decay constants from the pseudoscalar-axial vector correlation function in the matter $i \int d^4x \ e^{ip\cdot x} \langle \rho | T[\bar{d}(x) i\gamma_5 u(x) \ \bar{u}(0)\gamma_\mu \gamma_5 d(0)] | \rho \rangle$. It is found that the sum rule for f_t satisfies the in-medium Gell-Mann−Oakes−Renner (GOR) relation precisely while the f_s sum rule does not. The f_s sum rule contains the non-negligible contribution from the dimension 5 condensate $\langle \bar{q} i D_0 i D_0 q \rangle_N + \frac{1}{8} \langle \bar{q} g_s \sigma \cdot \mathcal{G} q \rangle_N$ in addition to the in-medium quark condensate. Using standard set of QCD parameters and ignoring the in-medium change of the pion mass, we obtain $f_t = 105$ MeV at the nuclear saturation density. The prediction for f_s depends on the dimension 5 condensate and on the Borel mass. However, because of the positivity condition for the dimension 5 condensate, the OPE constrains that $f_s/f_t \geq 1$, which does not agree with the "tree level" prediction from the in-medium chiral perturbation theory. Depending on the value of the dimension 5 condensate, f_s at the saturation density is found to be in the range $112 \sim 134$ MeV at the Borel mass $M^2 \sim 1$ GeV^2.