Estimate of the magnitude of P-odd correlations

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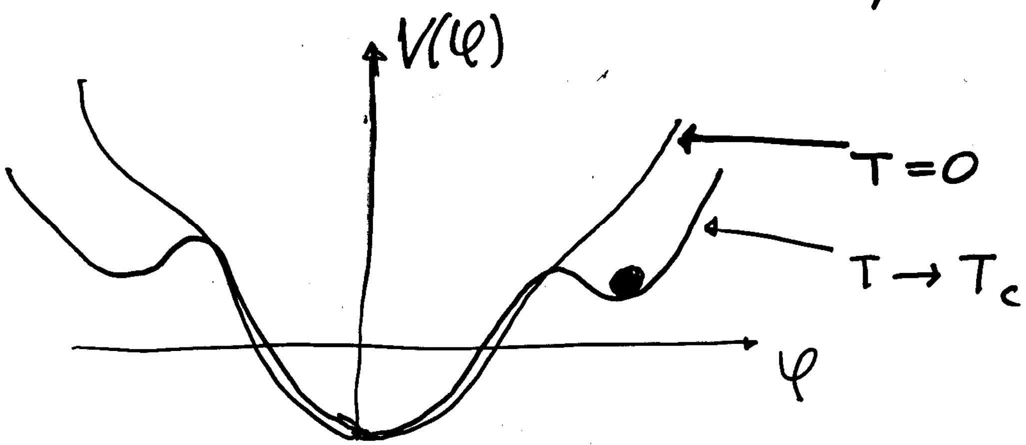
1) consider effective potential

$$V(\varphi_i) = f_\pi^2 \left[- \sum_i \mu_i^2 \cos\varphi_i + \frac{a}{2} \left(\sum_i \varphi_i - \theta \right)^2 \right]$$

$a \sim \int d^4x \langle Q(x) Q(0) \rangle$ is topological susceptibility



when $T \to T_c^-$, a vanishes: $a(T) \sim \left(\frac{T_c}{T} - 1\right) \equiv \Delta t$

effective potential then starts to develop metastable minima ("false vacua") $\Rightarrow$ P, CP odd domains

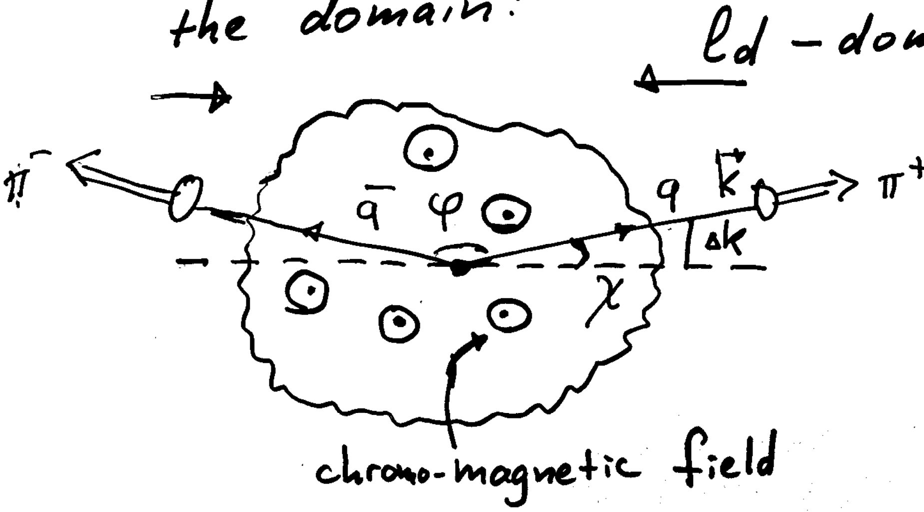
2) • Effectively, inside the domain $\theta_{eff} = \langle \sum \varphi \rangle \neq 0$

• this corresponds to

$$\langle 0 | Q(x) | 0 \rangle_\theta \neq 0$$

• since $Q(x) = \frac{g^2}{32\pi^2} tr(G\tilde{G}) \sim \vec{E} \cdot \underline{\vec{B}}$, the domain contains chromo-magnetic field

3) Consider creation of $q\bar{q}$ pair in the domain:



consider P-odd observable $\frac{|[\vec{p}_{\pi^+} \times \vec{p}_{\pi^-}]|}{|\vec{p}_{\pi^+}| \cdot |\vec{p}_{\pi^-}|} = \sin\varphi$

$$\sin\varphi = \sin 2\chi$$

- In the quasiclassical approximation

$$\chi \simeq \frac{\Delta k}{k} \simeq \frac{g \cdot B_\perp \cdot (\ell_d/2)}{k}$$

- Estimate $g \cdot B$:

$$\langle 0|Q(x)|0\rangle_\theta = \frac{1}{2}\,\tilde{m}_\pi^2 \tilde{f}_\pi^2 \sin\left(\frac{\theta}{N_f}\right)$$

$$\tilde{m}_\pi^2 \tilde{f}_\pi^2 = m_\pi^2 f_\pi^2 \left(\frac{\langle\bar{\Psi}\Psi\rangle_T}{\langle\bar{\Psi}\Psi\rangle}\right); \qquad \frac{\langle\bar{\Psi}\Psi\rangle_T}{\langle\bar{\Psi}\Psi\rangle} \sim \Delta t^{1/2} \sim 0.1$$

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$$\theta_{eff} \simeq 3.918$$

assume $|\vec{E}| \sim |\vec{B}|$, $\vec{E}$ and $\vec{B}$ have random relative orientation

$$\langle gB\rangle \simeq \sqrt{32\pi^2 \langle Q(x)\rangle_\theta} \simeq 0.04\ GeV^2$$

Putting all numbers together,

we estimate

$$P \doteq \langle \sin\varphi \rangle \simeq 2\chi \simeq \boxed{(0.04 \div 0.2)\ \frac{\ell_d\,[\mathrm{fm}]}{k\,[\mathrm{GeV}/c]}}$$