Nucleon spectral function in nuclear matter from QCD sum rules

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• The mass difference between nucleon ground state and N(1535) is about 600 MeV.

• It is predicted that Chiral symmetry breaking cause these difference.
Mass spectrum of the nucleons

Positive parity
N(1440)
N(1650)

Negative parity
N(1535)

When chiral symmetry is restored, the mass spectrum will change.

To investigate these properties from QCD, non-perturbative method is needed.

Analysis of QCD sum rule in nuclear matter
Nucleon QCD sum rules

\[ \Pi(q) \equiv i \int e^{iqx} \langle 0 | T[\eta(x)\bar{\eta}(0)] | 0 \rangle d^4x \]

\[ = \int_0^\infty \frac{1}{\pi} \frac{\text{Im}\Pi(t)}{t - q^2} dt = \int_0^\infty \frac{\rho(t)}{t - q^2} dt \]

is calculated by the operator product expansion (OPE)

Non perturbative contributions are expressed by some Condensates.

\[ \langle \bar{q}q \rangle, \ \langle \frac{\alpha_s}{\pi} G^2 \rangle \ \ldots \]

An order parameter of chiral symmetry

We apply this method to the analyses in the nuclear matter.