$\bar{D}$ mesons as probes for exploring the chiral symmetry in cold nuclear matter

Nagoya University

Daiki Suenaga

$\bar{D}$ mesons as probes for exploring the chiral symmetry in cold nuclear matter

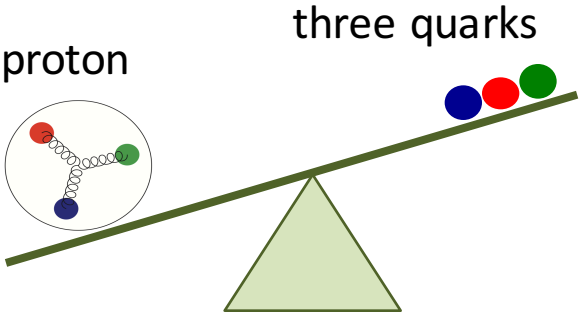
Nagoya University

Daiki Suenaga

1. Introduction

- **What is chiral symmetry ?**
  - Proton is made of three quarks, HOWEVER …

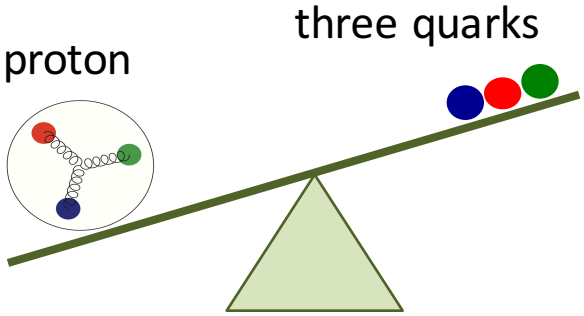
Proton mass is much larger than the sum of mass of three quark



1. Introduction

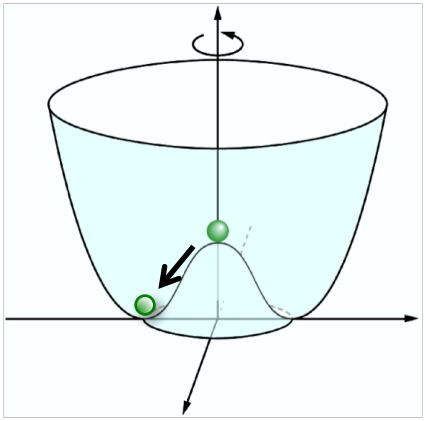
- **What is chiral symmetry ?**
  - Proton is made of three quarks, HOWEVER …

Proton mass is much larger than the sum of mass of three quarks



  - This mass gap is explained by the spontaneous breakdown of **chiral symmetry**

Chiral symmetry is spontaneously broken in the vacuum



1. Introduction

- How about chiral symmetry in nucleus ?

in vacuum

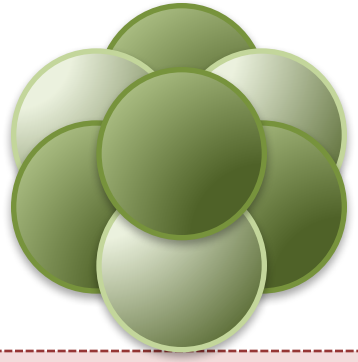
chiral symmetry is broken

1. Introduction

- How about chiral symmetry in nucleus ?

in vacuum

in nucleus



chiral symmetry is broken

chiral symmetry is △△ ??

- How can we explore the chiral symmetry in a nucleus ?
- What can be good probes ?

$\bar{D}$ mesons as probes for exploring the chiral symmetry in cold nuclear matter

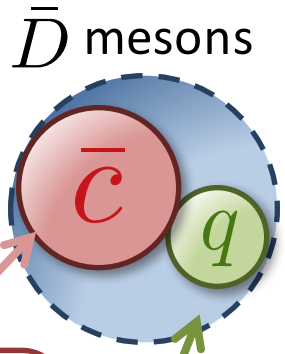
Nagoya University

Daiki Suenaga

In collaboration with
Masayasu Harada, Yong-Liang Ma, Yusuke Takeda

2. Analysis

- What is $\bar{D}$ meson ?



$\bar{c}$ quark

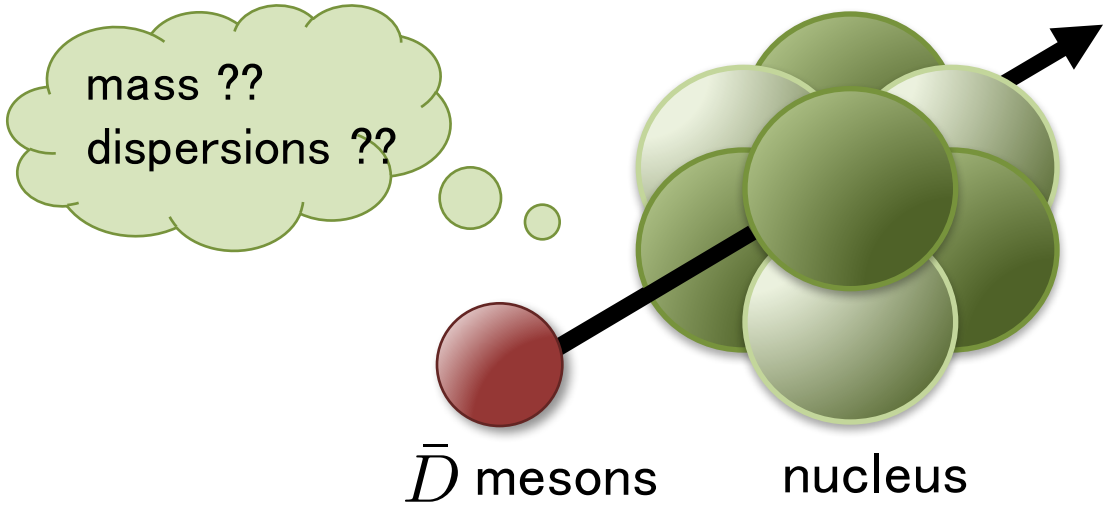
– $\bar{c}$ mass is heavy and $1/m_Q$ expansion is applicable
(Heavy quark symmetry)

u, d quarks

– u, d quarks can interact with nucleus and
we can extract the information of **chiral symmetry**

2. Analysis

- **What have we done ?**

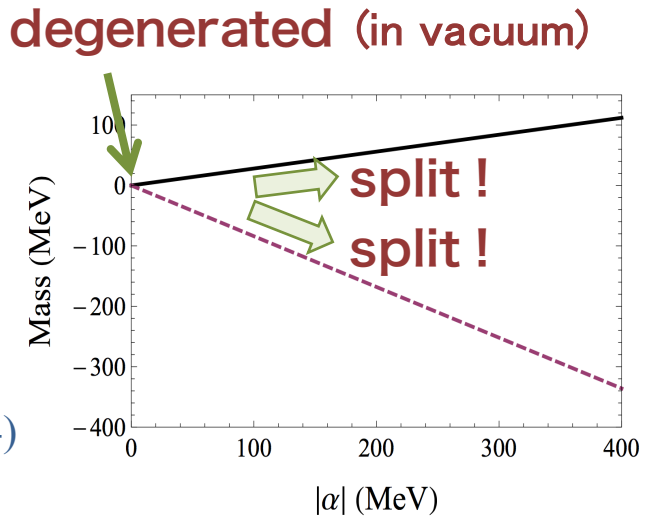


- We calculated the modifications of $\bar{D}$ mesons in a nucleus such as **mass** and **dispersion relations**
- We considered how can we obtain the information of **chiral symmetry** from such modifications

3. Results

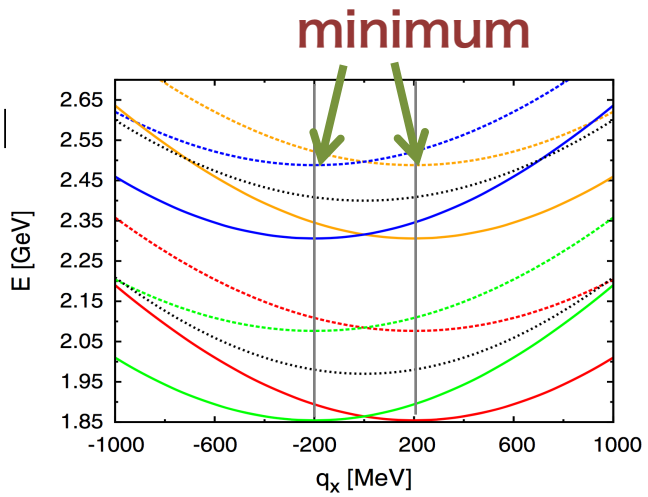
- **Results**
  - In the spin–isospin correlated matter, $\bar{D}(0^-)$ and $\bar{D}^*(1^-)$ mix and the mass will be split

D. S, B.-R. He, Y.-L. Ma, M. Harada; PRC **89**, 068201 (2014)



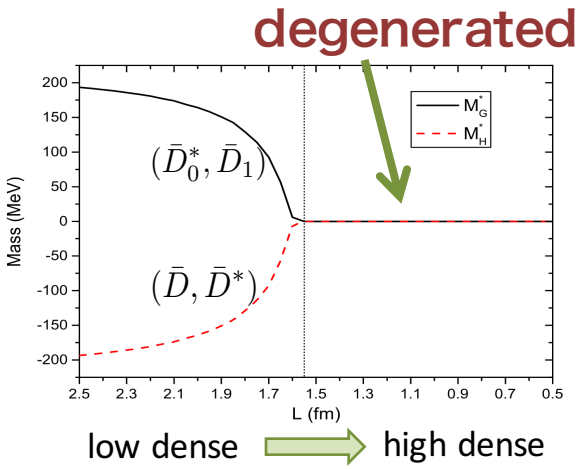
  - In the DCDW (Dual Chiral Density Wave) phase, $\bar{D}(0^-)\,\bar{D}^*(1^-)\,\bar{D}_0^*(0^+)\,\bar{D}_1(1^+)$ mix and their dispersions have negative group velocity

D. S, M. Harada; PRD **93**, 076005 (2016)



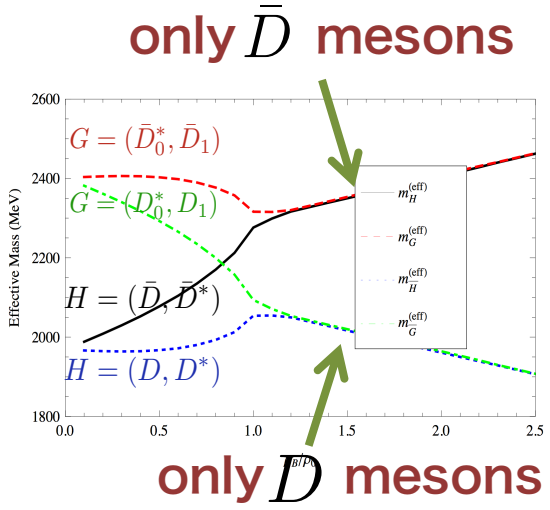
3. Results

- **Results**
  - We put $\bar{D}(0^-)\,\bar{D}^*(1^-)\,\bar{D}_0^*(0^+)\,\bar{D}_1(1^+)$ on the Skyrmion crystal, and we see that mass of chiral partner is degenerated at high density region



D. S, B.-R. He, Y.-L. Ma, M. Harada; PRD **91**, 036001 (2015)

  - When we take into account the mean field of $\langle\omega_0\rangle$, mass of D and $\bar{D}$ has different behavior



M. Harada, Y.-L. Ma, D. S and Y. Takeda; in preparation (2016)

Thank you for your attention !