

# $D$ meson properties in nuclear medium from QCD sum rules

**Kei Suzuki<sup>1</sup>, Philipp Gubler<sup>2</sup>, Makoto Oka<sup>3,4</sup>**

<sup>1</sup>Theoretical Research Division, Nishina Center, RIKEN, Wako, Saitama, 351-0198, Japan

<sup>2</sup>ECT\*, Villa Tambosi, 38123 Villazzano (Trento), Italy

<sup>3</sup>Department of Physics, Tokyo Institute of Technology, Meguro, Tokyo, 152-8551, Japan

<sup>4</sup>Advanced Science Research Center, Japan Atomic Energy Agency, Tokai, Ibaraki, 319-1195, Japan

It is interesting to investigate behaviors of hadrons at finite density system (e.g. nuclear matter). As with  $\rho, \omega, \phi$  mesons investigated for a long time, open charmed ( $D$ ) meson also plays a role of a probe of the partial restoration of chiral symmetry breaking. In the future, low energy heavy-ion collision experiments by J-PARC and the Facility for Antiproton and Ion Research (FAIR) at GSI are expected to study properties of compressed baryonic matter where  $D$  meson can be modified. Our purpose of this work is to study this phenomenon from a theoretical viewpoint.

QCD sum rules is a powerful tool to extract hadron properties based on QCD. In this work [1], we investigate spectral functions of pseudoscalar  $D$  meson in nuclear matter by applying the maximum entropy method (MEM) to QCD sum rules [2]. MEM enables us to extract the spectral functions without any phenomenological ansatz, and thus to visualize modification of the spectral functions due to density effects from nuclear medium.

As a result, we found that masses of both  $D^+$  and  $D^-$  mesons grow gradually with increasing density due to the partial restoration of the chiral symmetry breaking as shown in Fig. 1. Furthermore, we obtained  $D^+-D^-$  mass splitting of about  $-20$  MeV at the nuclear saturation density, which is caused by matter effects (charge symmetry breaking) such as Pauli blocking between the quark in the  $D$  meson and quarks in the nuclear matter.

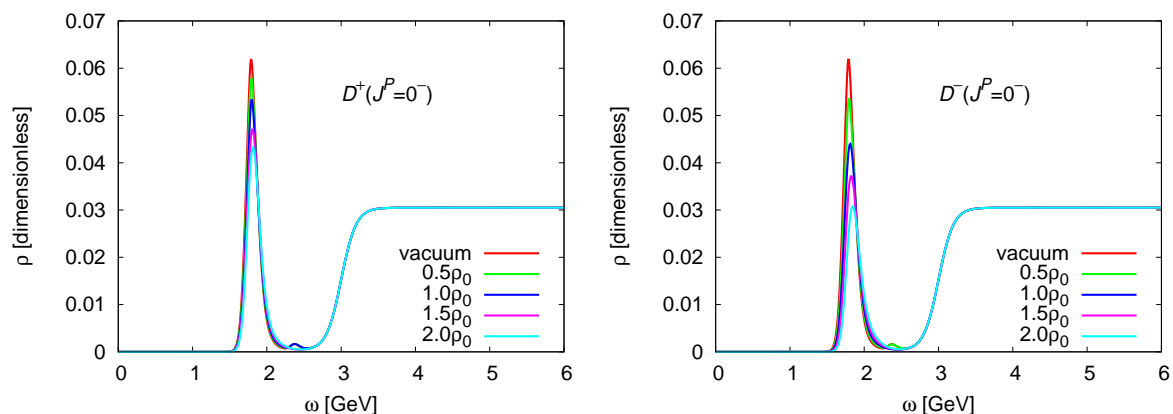


Figure 1: Spectral functions extracted from  $D^\pm$  meson sum rules in nuclear medium with MEM.  $\rho_0$  is the nuclear saturation density.

[1] K. Suzuki, P. Gubler and M. Oka (in preparation)

[2] P. Gubler and M. Oka, Prog. Theor. Phys. 124, 995 (2010)