



UNIVERSITY OF MIAMI  
COLLEGE of  
ARTS & SCIENCES

## Miami Physics Conference 2026

---

**Date:** Dec 11-17, 2025  
**Location:** Lago Mar Resort  
**Affiliation:** Tokyo University of Science

Nobuyuki Sawado

### Physics of Einstein-Dirac system: the Dynamical Fermion and the Dirac-sea in General Relativity

#### Abstract

The Einstein-Dirac system is a model enjoying interplay between quantum fermions and curved spacetime. There are several variations in the model and also the solutions, including coupling to electromagnetism, Yang-Mills fields, skyrmions, many particle fermions, the multiple shell structures, and so forth. We study the system of a Dirac fermion coupled with a nonlinear chiral field on static, spherically symmetric spacetime based on the chiral quark soliton model (CQSM). The CQSM originally was a model of hadron inspired by the low-energy regime of large- $N_c$  QCD, realizing localized fermions with the full inclusion of the Dirac-sea, which is derived from a regularized one-fermion loop. We extend the CQSM in spherically symmetric curved spacetime and coupled with Einstein gravity. The Dirac-sea dilutes the effect of the energy-momentum tensor, which induces an inactive point for the impact of gravity even when the localizing matter exists. The Dirac-sea effect becomes dominant for larger dynamical mass  $M \sim |\bar{\psi}\psi|$ , leading to the emergence of the negative ADM mass.