

“Parking Garage” Structures in Biophysics and Astrophysics

Objective: Use large scale GPU computing to perform detailed molecular dynamics (MD) simulations of neutron star crust, including complex nuclear pasta phases, to determine possible structures.

Accomplishments: MD simulations with 50,000 to 400,000 nucleons find new layered structure connected by helical ramps.

Impact: Newly discovered helical defects in nuclear pasta impact radio and X-ray obs. of neutron stars and provide model of an important biological structure. MD simulations can provide insight into self-assembly of structures, arrangement of multiple ramps, and dependence of structures on interactions.

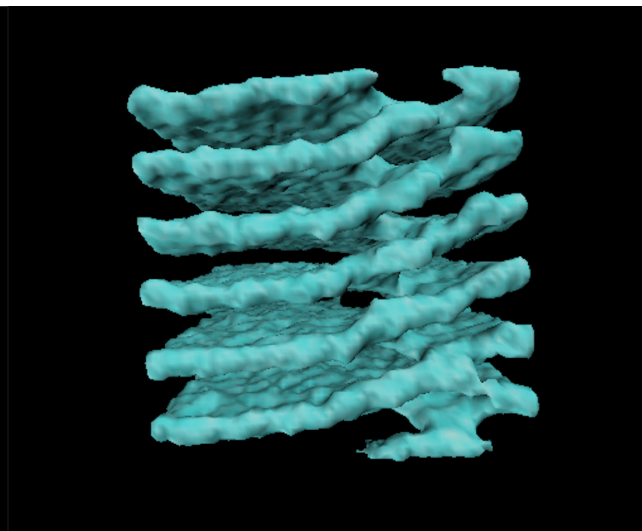
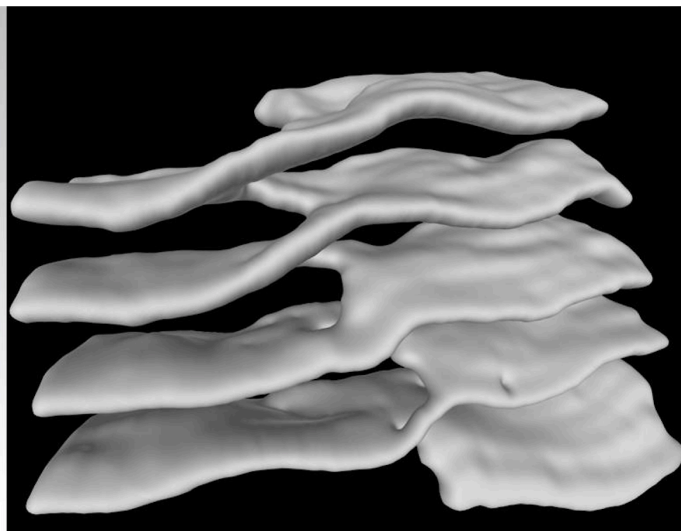
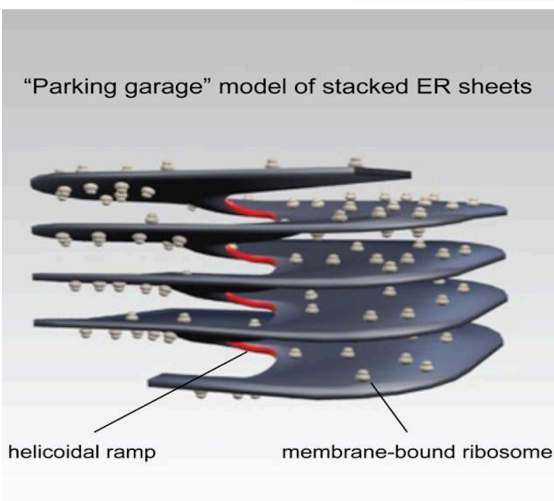


Fig. 1: (Left) Endoplasmic reticulum (ER) is a structure present in cells where proteins are synthesized with the help of the large surface areas. (Middle) 3D electron micrograph of stacked ER sheets in secretory salivary gland cells of mice [2]. (Right) MD simulation of nuclear pasta involving 75,000 nucleons at a density of 0.05 fm^{-3} that shows very similar flat layers connected by a helical ramp [1].



U.S. DEPARTMENT OF
ENERGY

Office of
Science

NUCLEI
Nuclear Computational Low-Energy Initiative

References: [1] Phys. Rev. Lett. **114**, 031102 (2015)
[2] Cell **154**, 285 (2013)

Contact: C. J. Horowitz, horowit@indiana.edu