

## Alpha-shapes model: a tool to catalogue nuclear pasta

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The so-called “pasta structures” are expected to form from neutron-proton interactions in the crust of neutron stars. Since different nuclear models predict the existence of these structures, it is convenient to have a classification scheme to compare results from the various models. In this project, such classification was sought through the use of the alpha shapes method applied on pastas created with molecular dynamics. In summary, pastas of nuclear matter (systems composed of protons and neutrons, without electrons) were created with the molecular dynamics code LAMMPS, for systems with 4,000 nucleons, at varying proton content, and at temperatures ranging from 0.01 MeV to 1.0 MeV, and at densities from  $0.02 \text{ fm}^{-3}$  to  $0.20 \text{ fm}^{-3}$ . The resulting structures were studied using the Minkowski functionals (namely, volume, area, curvature and Euler characteristic) over the arrangements of lines used to connect the nucleons by the method known as “alpha shapes”. The main outcome was an evolution of the different shapes (namely, gnocchi, spaghettis, lasagna and their inverses) in the Euler number-curvature plane. This result appears as a solid promise to achieve the characterization sought.