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Cluster recognition using Machine Learning applied to Neutron star crusts

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The core of a neutron star can be considered as uniform nuclear matter with densities above the nuclear saturation density $n_0 = 3 \times 10^{14} \text{ g/cm}^3$. On the other hand, the outer crust of a neutron star is a Coulomb crystal with densities of several orders of magnitude below the nuclear saturation density. In between these two, we can find complex, non-uniform phases of nuclear matter called nuclear pasta, the product of the attractive-repulsive nuclear and Coulomb forces. The nuclear pasta phases and transitions are usually described with the help of the Minkowski functionals, which are a set of metrics to quantify geometrical shapes.

In the present study, we use Molecular Dynamics to simulate nuclear matter under the conditions of nuclear pasta. We explore the use of Machine Learning algorithms to describe the phases and transitions of the nuclear pasta.

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