My project will be on the phase transition between the fluid and crystal states of a Wigner lattice which forms on the surface of liquid helium. This is interesting for me since it is a core part of the physics which I currently do research on in the Laboratory for Hybrid Quantum Systems. A project of mine currently involves simulating this using Python and Monte Carlo methods so this class project will fit in nicely here. It would be extra cool if I could complete my simulation and use it to provide additional insight into the coursework.

I haven't fully digested the physics of the system yet but roughly it goes as follows. We start with an idealized electron fluid with particles which can move according to the ratio of thermal fluctuations to coulomb interactions, and as we lower the temperature we can see the electrons start to form our Wigner crystal and the system becomes highly correlated, so we can describe the charge distribution throughout the surface of the film with delta functions (we consider each charge to be discrete). Note: Since this system is degenerate by nature, we need not concern ourselves with quantum mechanical effects, so we don't need to use QED or anything crazy to understand it. This project can be described in a purely semiclassical sense so I think it fits rather nicely into the theme of the course and my own research.


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