Workshop 2

The dwarf planet Pluto consists of a 250km thick shell of frozen nitrogen surrounding a 100km thick layer of water (some of which may be liquid) and an 800km radius solid core [1]. The surface pressure is 1Pa and the temperature is between 40K and 60K. It snows nitrogen, there are nitrogen dunes and glaciers, water icebergs drift across the surface, and there are water ice mountains several kilometres high.

At this pressure and temperature, nitrogen forms an HCP lattice with a nitrogen **molecule** at every point [2].

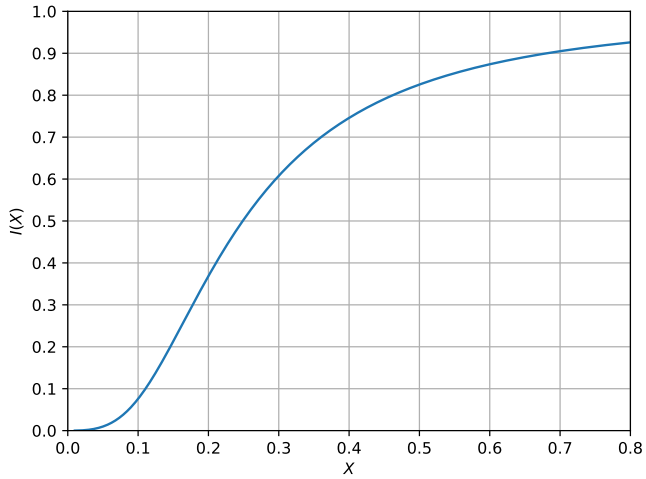
HCP has the same packing fraction as FCC, and the lattice constant for FCC N_2 is $5.667\,\text{Å}$.

The bulk modulus of solid nitrogen is found to be $1.47\,\text{GPa}$ at 50K.

Use the Debye model to estimate the heat capacity of solid nitrogen on the surface of pluto.

A graph of the following equation is given below:

$$I(X) = 3X^3 \int_0^{1/X} \frac{x^4 e^x}{(e^x - 1)^2} dx$$



Critique use of the Debye model for this substance.

[1] http://dx.doi.org/10.1016/j.icarus.2006.06.005

[2] Young, D. A. (1975). Phase diagrams of the elements (No. UCRL–51902). California Univ.