# The Leading Correction to the Thomas-Fermi Model at Finite Temperature in a Functional Form

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## Abstract

The research of heavy atoms at finite temperature focuses on finding a universal model that describes the electron screening potential, the distribution of the electrons in the atom and the ionization energy of the atom. Such a model is the semiclassical Thomas-Fermi (TF) model, and its later generalization for atom at finite temperature.

We found a correction to the TF model at finite temperature that is more dominant than the quantum and exchange corrections. We believe that this is the leading correction for this model. This correction suggests a quantum mechanical treatment for the strongly bound electrons in the atom, while maintaining the semiclassical treatment for the rest of the electrons.

First, we obtained a new energy functional for the zero order model, then we found the strongly bound electrons correction to this functional.

We established that our correction is the leading correction in the thermodynamical regime that is in the scope of this work, as it is in the zero temperature case. We used this corrected functional to derive a self-consistent potential and the electron density in the atom, and to calculate the corrected energy and pressure.

At this stage, our model has a built-in validity limit $\beta Z^2 \gg 8$, in atomic units. However, our model captures many interesting high temperature phenomena, such as the interior of the sun and the plasma produced in National Ignition Facility (NIF).