

## ABSTRACT

Spin is an important aspect in determining the character, rate of collision and consequently the properties of ultracold atoms. Helium-3 and Helium-4 isotopes have been under extensive study because they have unique properties. The concept of duo-fermion spin has remained elusive in determining the properties of Helium isotopes. This study was aimed at determining the thermodynamic properties of Helium-3 and Helium-4 isotopes with a duo spin fermion degeneracy. Our objective included determining internal energy, specific heat, entropy and the lambda transition temperature. The partition function of the system with duo-spin and varying number of bosons and fermions was developed as a means of studying the thermodynamic properties of the system. This study focused on a grand canonical ensemble of Helium-3 and Helium-4 whose thermodynamic properties were determined by comprehensively singling out the duo spin component. The computer softwares were used in generating results from the derived equations and drawing the graphs. The internal energy, specific heat and entropy were established, analyzed and found to increase with temperature. The jump or kink in the specific heat implied that there is a phase-like transition at temperature of about  $35\text{ K}$ .