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Fermi Gas in *D*-Dimensional Space

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We consider a Fermi gas in D-dimensional space and show how the physical properties of the system behave as a function of the dimension D, in particular, the density of states, the Fermi energy, and the radius of the Fermi hypersphere.

1. INTRODUCTION

Recently, there has been much interest in the investigation of the dependence of physical systems upon the dimension D of space. It is believed that the dimension of space plays an important role in quantum field theory [1], in the Ising limit of quantum field theory [2], in random walks [3], and in the Casimir effect [4]. Other workers have discussed path integration of a relativistic particle in D-dimensional space [5, 6], and some authors have considered the relationship between the eigenstates of a hydrogen atom and a harmonic oscillator of arbitrary dimension [7, 8] and the construction of coherent states defined in a finite-dimensional Hilbert space [9–13].

The purpose of this paper is to consider the Fermi gas in D-dimensional space. The organization of this paper is as follows. In Section 2, I calculate the density of states $g(E)$, which is the number of particle quantum states per unit energy range; in Section 3, I derive the Fermi energy; Section 4 is a conclusion.

2. DENSITY OF STATES

Consider a large number of identical noninteracting spin-1/2 particles contained in a box with impenetrable walls each of length L. The time-independent Schrödinger equation inside the box is

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