

Bessel Functions and Their Applications: Solution to Schrödinger equation in a cylindrical function of the second kind and Hankel Functions

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Abstract: Bessel functions are a series of solutions to a second order differential equation that arise in many diverse situations. Develops the different kinds of Bessel functions and explores the topic of zeroes. In a solution of a free particle (zero potential) time-independent Schrodinger equation as applied to cylindrical function of the second kind (Neumann functions) and cylindrical function of third kind (Hankel functions of first and second kind), we would see that the solution in each case which is present in the solution of Bessel differential equation are the same.

Keywords: Bessel Equation, Bessel Functions, Modified Bessel Equation, Modified Bessel Functions, Neumann Function, Hankel Functions, Schrodinger Equation.

1. INTRODUCTION

Bessel function were studied by Euler, Lagrange and the Bernoulli. The Bessel functions were first used by Friedrich Wilhelm Bessel to explain the three body motion, with the Bessel function which emerge in the series expansion of planetary perturbation. Bessel function are named for Friedrich Wilhelm Bessel (1784-1846), after all, Daniel Bernoulli is generally attributed with being the first to present the idea of Bessel functions in 1732. He used the function of zero order as a solution to the problem of an oscillating chain hanging at one end. By the year 1764, Leonhard Euler employed Bessel functions of both the integral orders and zero orders in an analysis of vibrations of a stretched membrane, a research that was further developed(refined) by Lord Rayleigh in 1878, where he proved that Bessel functions are particular case of Laplace functions (Niedziela,2008). The Bessel function was the result of Bessel study of a problem of Kepler for determining the motion of three bodies moving under mutual gravitation. In 1824, he incorporated Bessel functions in a study of planetary perturbations where the Bessel functions appear as coefficients in a series expansion of the indirect perturbation of a planet, that is the motion of the Sun caused by the perturbing body.

Bessel's differential equation arises as a result of determining separable solutions to Laplace's equation and the Helmholtz equation in spherical and cylindrical coordinates. Therefore, Bessel functions are of great important for many problems of wave propagation and static potentials.

In 1926, Erwin Schrödinger as a result of his interest by the de Broglie hypothesis created an equation as a way of expressing the wave behavior of matter particle, for example, the electron. The equation was later named as Schrödinger equation which can be written as:

$$\left(\frac{-\hbar^2}{2m} \nabla^2 + U(r, t) \right) \psi(r, t) = i\hbar \psi(r, t)$$

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