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Entitled

LOCALIZED EXACT SOLUTIONS OF NONLINEAR DIRAC EQUATION

by

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Date & Venue

01:00 PM
Thursday, 16 November 2017
Room 032, F3 Building

Abstract

The nonlinear Dirac equation is a relativistic classical field theory that describes the behavior of a system of self-interacting spinor fields. According to this theory, the interactions among spinor fields are represented by additional Kerr-nonlinearity added to the Dirac equation, which justifies and models the noticed solitonic behavior of the systems. In this present thesis, a special form of the nonlinear Dirac equation (NLDE) is considered, namely, the massive Thirring model (MTM) in (1+1)-dimensions, which models interactions among spinor fields in condensed matter, where exact localized stationary solutions are obtained using analytical methods. The physical properties of MTM and the corresponding conserved physical quantities are discussed through developing the continuity equation of the current density together with evaluating explicitly the elements of the energy-momentum tensor, which are then used to calculate some properties like charge and energy of the fields. Also, the same analytical methods are used to find stationary exact solutions of another model of NLDE, the Gross-Neveu model, which is of interest in high-energy physics.

Keywords: Nonlinear Dirac equation, Massive Thirring model, Gross-Neveu model, Self-interacting spinor fields, Energy-momentum tensor, Solitonic behaviour.