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On α-para Kenmotsu 3-manifolds with Ricci solitons

A. Sarkar, A.K. Paul and R. Mondal

Abstract. The object of the present paper is to study α-para Kenmotsu Ricci solitons of dimension three. It is shown that an α-para Kenmotsu Ricci soliton of dimension three is expanding and a manifold endowed with such a soliton is manifold of constant negative curvature. It is also established that for an α-para Kenmotsu Ricci soliton, if the potential vector field V is pointwise collinear with ξ, then V is constant multiple of ξ. It is proved that if an α-para Kenmotsu Ricci soliton of dimension three is gradient Ricci soliton corresponding to the potential function f, then either $Df = 0$ or Df is collinear with the Reeb vector field ξ.

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Key words: α-para Kenmotsu manifolds; Ricci solitons; gradient Ricci solitons.

1 Introduction

The theory of almost contact and almost para contact manifolds is an important branch of research. Almost contact manifolds are of prime importance due to its significant applications in geometric optics, thermodynamics and string theory. Ricci and other geometric flows ([4], [5]) were introduced in Mathematics by Hamilton [9] and in Physics by Friedan [7] around almost in the same time, though with different motivations. More recently, such geometric flows have become popular, largely, because of Perelman's [13] work which lead to the proof of the well-known Poincare Conjecture. The notion of Ricci soliton was introduced by Hamilton [9]. This is considered as a natural generalization of Einstein metric and is defined on a Riemannian manifold (M, g) by

$$(1.1)\qquad (\pounds_V g)(X, Y) + 2S(X, Y) + 2\lambda g(X, Y) = 0,$$

where $\pounds_V$ denotes the Lie derivative operator along the vector field V. V is known as potential vector field. It is assumed that V is complete. Here λ is a constant, called soliton constant. S is the Ricci tensor and g is the metric. X, Y are the arbitrary vector fields on M. A Ricci soliton can be considered as a fixed point of Hamilton's Ricci flow:

$$\frac{\partial}{\partial t} g_{ij} = -2S_{ij}$$

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Authors' address:

Avijit Sarkar, Avijit Kumar Paul and Rajesh Mondal
Department of Mathematics, University of Kalyani,
Kalyani-741235, Nadia, West Bengal, India.
E-mail: avjaj@yahoo.co.in, avipmcu@gmail.com, rajeshmail.das@gmail.com