

Supported by European Women in Mathematics and by the Program POSDRU/89/1.5/S/49944, "Al. I. Cuza" University of Iași, Romania.

Cotangent bundles with para-Kähler structures of natural diagonal lift type

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Abstract

We first characterize the natural diagonal almost product structures on the (total space of the) cotangent bundle T^*M of a Riemannian manifold (M, g) . Studying the integrability conditions of an almost product structure P of natural diagonal lift type on T^*M , we obtain that P is a locally product structure on T^*M if and only if the base manifold is a space form, and two coefficients involved in the expression of P are some rational functions of the other two coefficients, their first order derivatives, the energy density, and the constant sectional curvature of the base manifold. Analyzing the compatibility and the anti-compatibility relations between the almost product (locally product) structure P and any natural diagonal metric G , we show that (T^*M, G, P) is a Riemannian almost product (locally product) or an (almost) para-Hermitian manifold if and only if some proportionality relations between the coefficients of P and G are satisfied. Finally, studying the closedness of the associated 2-form, we prove that (T^*M, G, P) is an (almost) para-Kähler manifold if and only if a certain proportionality factor involved in the characterization of the (almost) para-Hermitian manifold (T^*M, G, P) is the derivative of the other proportionality factor.

AMS Classification: 53C05, 53C15, 53C55.