

New Hyperkähler Metrics and New Supermultiplets[★]

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Abstract. We present new constructions of hyperkähler metrics along with the three new classes of $N = 4$ supermultiplets that they derive from. Further, we provide a general setting for understanding the constructions and give a detailed description of the multiplets in $N = 2$ and $N = 4$ superspace.

I. Introduction

In this paper we present a general class of new Legendre transform constructions of hyperkähler metrics in a broad framework which illuminates our previous constructions [1–3]. As in these references, we construct (two or three dimensional) $N = 4$ supersymmetric nonlinear σ -models in terms of off-shell multiplets and then find a duality relation via a Legendre transform to a formulation in terms of $N = 2$ chiral superfields [4, 5]. This yields the Kähler potential, and hence the metric, explicitly. In contrast with the original Legendre transform construction, the methods presented here do not in general lead only to metrics with isometries or analogous constraints. Our basic new insight is an understanding of $N = 4$ superspace that allows us to find broad new classes of off-shell multiplets. We use the holomorphic superspace techniques of [4, 6, 7, 3]; the method is presumably equivalent to the harmonic superspace approach [8, 9] (which, however, lacks a general technique for extracting the metric), and is closely related to twistor theory [10, 2].

In Sect. II, we give three general classes of constructions without explicit reference to superspace or supersymmetry. In Sect. III, we discuss $N = 4$ superspace and the three classes of supermultiplets that lead to the constructions of Sect. II; in preparation for finding the metric, we describe these multiplets in $N = 2$ superspace. Finally, in Sect. IV we derive the construction of Sect. II. We use the notation of [2, 3] where applicable.

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