Mathematics > Differential Geometry

The complex Goldberg-Sachs theorem in higher dimensions

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We study the geometric properties of holomorphic distributions of totally null m-planes on a $(2m+\epsilon)$-dimensional complex Riemannian manifold $(\mathcal{M}, \bm{g})$, where $\epsilon \in {0,1}$ and $m \geq 2$. In particular, given such a distribution $\mathcal{N}$, say, we obtain algebraic conditions on the Weyl tensor and the Cotton-York tensor which guarrantee the integrability of $\mathcal{N}$, and in odd dimensions, of its orthogonal complement. These results generalise the Petrov classification of the (anti-) self-dual part of the complex Weyl tensor, and the complex Goldberg-Sachs theorem from four to higher dimensions.
Higher-dimensional analogues of the Petrov type D condition are defined, and we show that these lead to the integrability of up to 2^m holomorphic distributions of totally null m-planes. Finally, we adapt these findings to the category of real smooth pseudo-Riemannian manifolds, commenting notably on the applications to Hermitian geometry and Robinson (or optical) geometry.

Comments:	Section 2 partly rewritten: issue regarding self-duality clarified. Section 5.2 clarified. Some remarks added. Lemma 3.7 (previously 3.7) corrected. A few mathematical and notational inaccuracies corrected, and typos and sign mistakes fixed throughout. Some references added
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