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Mathematical Physics

Gravity, strings, modular and quasimodular forms

P. Marios Petropoulos, Pierre Vanhove

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Modular and quasimodular forms have played an important role in gravity and string theory. Eisenstein series have appeared systematically in the determination of spectrums and partition functions, in the description of non-perturbative effects, in higher-order corrections of scalar-field spaces, ... The latter often appear as gravitational instantons i.e. as special solutions of Einstein's equations. In the present lecture notes we present a class of such solutions in four dimensions, obtained by requiring (conformal) self-duality and Bianchi IX homogeneity. In this case, a vast range of configurations exist, which exhibit interesting modular properties. Examples of other Einstein spaces, without Bianchi IX symmetry, but with similar features are also given. Finally we discuss the emergence and the role of Eisenstein series in the framework of field and string theory perturbative expansions, and motivate the need for unravelling novel modular structures.

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