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Restricted Weyl Invariance in Four-Dimensional Curved Spacetime

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We discuss the physics of *restricted Weyl invariance*, a symmetry of dimensionless actions in four dimensional curved space time. When we study a scalar field nonminimally coupled to gravity with Weyl(conformal) weight of -1 (i.e. scalar field with the usual two-derivative kinetic term), we find that dimensionless terms are either fully Weyl invariant or are Weyl invariant if the conformal factor $\Omega(x)$ obeys the condition $g^{\mu\nu}\nabla_\mu\nabla_\nu\Omega = 0$. We refer to the latter as *restricted Weyl invariance*. We show that all the dimensionless geometric terms such as R^2, $R_{\mu\nu}R^{\mu\nu}$ and $R_{\mu\nu\sigma\tau}R^{\mu\nu\sigma\tau}$ are restricted Weyl invariant. Restricted Weyl transformations possesses nice mathematical properties such as the existence of a composition and an inverse in four dimensional space-time. We exemplify the distinction among rigid Weyl invariance, restricted Weyl invariance and the full Weyl invariance in dimensionless actions constructed out of scalar fields and vector fields with Weyl weight zero.

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