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Exotic (dark) eigenspinors of the charge conjugation operator and cosmological applications

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We report about some achievements and developments provided by the (dark) eigenspinors of the charge conjugation operator. Exotic dark spinor fields has been investigated in the context of inequivalent spin structures on arbitrary curved spacetimes, which induces an additional term on the associated Dirac operator, related to a Cech cohomology class. Exotic terms operating on standard model Dirac spinor fields are usually absorbed by gauge transformations encoded as a shift of some vector potential representing an element of the cohomology group $H^1(M, \mathbb{Z}_2)$. That is not the case of the dark spinor fields, once they cannot carry gauge charge. As a consequence, this program requires a complete evaluation of topological analysis. Since exotic dark spinor fields also satisfy Klein-Gordon propagators, the dynamical constraints related to the exotic term in the Dirac equation can be explicitly computed. It is possible for cosmological applications to assume that the dark spinor fields depend only on the time variable via a matter field $\kappa(t)$ compatible with homogeneity and isotropy, and acts as the only dynamical cosmological variable, The matter field $\kappa(t)$ satisfies a first order ordinary differen- tial equation in time derivative, involving the time component of the total energy-momentum tensor, the Planck mass, and the Hubble constant. It forthwith implies that the non-trivial topology associated to the spacetime can drastically engender — from the dynamics of dark spinor fields — constraints on the spacetime metric structure. Besides being candidates to the dark matter problem, dark spinor fields are shown to be poten- tial candidates to probe non-trivial topologies in spacetime, as well as to explain the spacetime metric structure. (R. da Rocha, A. E. Bernardini and J. M. Hoff da Silva, JHEP 1104, 110 (2011).)