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Modular Index Theory and Twisted Cyclic Cocycles for KMS States on Certain C^ -algebras*

We continue our investigations on an index theory appropriate to C^* -algebras with a gauge invariant KMS state. Examples include the Cuntz algebras each of which has many inequivalent circle (gauge) actions with their own invariant and inequivalent KMS states. Despite the fact that these C^* -algebras generate type III_λ factors in the representations given by their KMS states, we are able to obtain an index theorem for certain “modular partial isometries” (formulated in terms of spectral flow) from a twisted cyclic cocycle where the twisting comes from the modular automorphism group for the given gauge invariant KMS state.

From these “modular partial isometries” we construct a twisted K_1 -group for these algebras that we can pair with this twisted cocycle. As a corollary we obtain a noncommutative geometry interpretation for Araki’s notion of relative entropy in these examples.