Given an algebra of observables A and a state ω, a density matrix ρω acting on Hω can be obtained through the GNS construction (Hω,πω) that gives rise to the same expectation values as ω for elements a∈A, that is, ω(a)≡TrHω(ρωπω(a)). An entropy can be assigned to the state ω by computing the von Neumann entropy of the density matrix S(ρω)=−TrHω(ρωlogρω). This has proved to be useful, e.g., in the study of entanglement properties of identical particles (Balachandran et al., Phys. Rev. Lett. 110, 080503 (2013)). However, there are situations for which this density matrix is not uniqhttp://newweb.bose.res.in/Conferences/NCGQST2018/Speakers.jsp#ue, thus leading to an entropy ambiguity. This occurs whenever the irreducible components of the representation πω appear in Hω with multiplicities (Balachandran et al., Eur. Phys. J. Plus (2013)). In the present work, we develop an interpretation of this phenomenon as a gauge symmetry arising from the action of unitaries in the commutant of the representation via Tomita-Takesaki modular theory.

In the finite-dimensional case, a complete characterization of the ambiguity can be given in terms of the modular data, and a physical interpretation, in terms of quantum operations, can be obtained in terms of an equivalent description of the system as a bipartite system. % We will also obtain the ambiguity in the analogue problem of a %bipartite system through a cyclic vector induced isomorphism %Hω→H⊗H. Here both the state on the full system and its restriction on the gauge system will show the %phenomena. We extend our analysis to the case of group transformation C*-algebras describing the algebras of observables of quantum systems obtained by quantization on configuration spaces of the form G/H, with G a compact Lie group and H a finite, non-abelian subgroup.

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