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Relative entropy in de Sitter spacetime

The role of entropy, in particular entanglement entropy, in quantum field theory has become increasingly prominent, and entropy has appeared in relation with several primary research topics in QFT: area theorems, c theorems, the AdS/CFT correspondence, quantum null energy inequalities etc. While von Neumann entropy, the basic concept in information theory, is divergent in QFT and can thus only be defined in cutoff theories (e.g. on a lattice), relative entropies are finite and can be directly defined in the continuum QFT. In the framework of Tomita-Takesaki modular theory, the relative entropy between the vacuum and a coherent excitation can be computed using the modular operator associated to the vacuum and the spacetime region that one is interested in. Unfortunately, its explicit form is only known in a few special cases. Using the known modular operator for de Sitter wedges and a recent result for the modular operator for conformal fields in de Sitter diamonds, we compute the relative entropy between the de Sitter vacuum state and a coherent excitation thereof in these regions. We show explicitly that the result is positive, convex and monotone, and thus satisfies the expected properties for a relative entropy.