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Boundary conditions and infrared divergences

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We review the procedure to construct ground and KMS states, for real scalar fields whose dynamics is dictated by the Klein-Gordon equation, on standard static Lorentzian manifolds with a time-like boundary. We observe that this construction, depending on which boundary condition we fix on the boundary, does not always lead to a bi-distribution $w_2 \in \mathcal{D}'(M \times M)$ for the two-point correlation function of the given state. The reason why it fails to be a bi-distribution is the presence of infrared divergences. We discuss an explicit example, namely a real scalar field on Bertotti-Robinson spacetime, proving that infrared divergences occur when Neumann boundary conditions are imposed at the time-like boundary, while for those of Robin-type the underlying two-point correlation function is a well defined bi-distribution of Hadamard form.

Primary authors: Prof. DAPPIAGGI, Claudio (University of Pavia); SINIBALDI, Luca (University of Pavia); Dr CAMPOS, Lissa (University of Pavia)

Presenter: SINIBALDI, Luca (University of Pavia)

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