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# Avoiding singularities in Lorentzian-Euclidean black holes: the role of atemporality

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We investigate a Schwarzschild metric exhibiting a signature change across the event horizon, which gives rise to what we term a Lorentzian-Euclidean black hole. The resulting geometry is regularized by employing the Hadamard partie finie technique, which allows us to prove that the metric represents a solution of vacuum Einstein equations. In this framework, we introduce the concept of atemporality as the dynamical mechanism responsible for the transition from a regime with a real-valued time variable to a new one featuring an imaginary time. We show that this mechanism prevents the occurrence of the singularity and, by means of the regularized Kretschmann invariant, we discuss in which terms atemporality can be considered as the characteristic feature of this black hole. The physical foundation of the approach can be related to the conservation laws. In fact, the black hole is singularity free if Noether symmetries, related to the size and the mass of the gravitational system, are not violated. In other words, the emergence of imaginary time is the signature of a symmetry breaking. In this perspective, it is not possible to enter the black hole and the event horizon becomes the limit of our knowledge according to the standard laws of physics. Future challenges are related to the observational signatures of atemporality which actually means that the information comes only from the external black hole solution and, in addition, it is conserved. Other open issues are related to the quantum counterpart of the model. In fact, we could conceive the event horizon as a sort of potential barrier and the investigation of quantum particles impacting against it could open an interesting phenomenology to be explored.

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