On the final definition of the causal boundary and its relation with the conformal boundary

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The notion of causal boundary ∂M for a strongly causal spacetime M has been a controversial topic along last decades: on one hand, some attempted definitions were not fully consistent, on the other, there were simple examples where an open conformal embedding $i:M\hookarrow M_{0}$ could be defined, but the corresponding conformal boundary $\partial_{i}M disagreed drastically with the causal one. Nevertheless, the recent progress in this topic suggests a final definition for ∂M, which is developed here in detail. Our study has two parts: To give general arguments on a boundary in order to ensure that it is admissible as a causal boundary at the three natural levels, i.e., as a point set, as a chronological space and as a topological space. Then, the essential uniqueness of our choice is stressed, and the relatively few admissible alternatives are discussed. (II) To analyze the role of the conformal boundary $\partial_{i}M$. We show that, in general, $\partial_{i}M$ may present a very undesirable structure. Nevertheless, it is well-behaved under certain general assumptions, and its accessible par $\partial_{i}^{*}M$ agrees with the causal boundary. This study justifies both boundaries. On one hand, the conformal boundary $\partial_{i}^{*}M$, which cannot be defined for a general spacetime but is easily computed in particular examples, appears now as a special case of the causal boundary. On the other, the new redefinition of the causal boundary not only is free of inconsistencies and applicable to any strongly causal spacetime, but also recovers the expected structure in the cases where a natural conformal boundary is available. The cases of globally hyperbolic spacetimes and asymptotically conformally flat ends are especially studied.

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