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Null shells: general matching across null boundaries and connection with cut-and-paste formalism

Abstract: Null shells are a useful geometric construction to study the propagation of infinitesimally thin concentrations of massless particles or impulsive waves. In this talk, I will present the necessary and sufficient conditions that allow for the matching of two spacetimes with respective null embedded hypersurfaces as boundaries. Whenever the matching is possible, it is shown to depend on a diffeomorphism between the set of null generators in each boundary and a scalar function, called step function, that determines a shift of points along the null generators. Generically there exists at most one possible matching but in some circumstances this is not so. When the null boundaries are totally geodesic, the point-to-point identification between them introduces a freedom whose nature and consequences are detailed. The expression for the energy-momentum tensor of a general null shell is also shown. Finally, the most general shell (allowing for non-zero energy, energy flux and pressure) that can be generated by matching two Minkowski regions across a null hyperplane is presented. This connects the original Penrose's cut-and-paste construction with the standard matching formalism.

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