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Power-law spacetime in terms of (2+1)-dimensional light-cone cuts and metricity conditions

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The null-surface formulation (NSF) of general relativity is equivalent to standard general relativity but uses null surfaces instead of a metric or a connection. The NSF, itself, exists in two distinct but mathematically equivalent versions: (a) Future-directed light rays leave a spacetime point and intersect null-infinity. The resulting light-cone cut encodes the properties of the spacetime; (b) The angular coordinates (Bondi coordinates) of null-infinity are used to label null surfaces, thereby producing a family of null surfaces which satisfies so-called metricity conditions. These are the NSF field equations. Any solution of these equations provides a description of spacetime and can be used, for example, to reproduce the spacetime metric (which would satisfy the Einstein equations).
The NSF is a nonlocal theory, describing nonlocal objects such as surfaces. It contrasts markedly with the usual general relativistic formalism which uses local fields, such as the metric. Minkowski spacetime is easily described within the NSF framework. However, nontrivial spacetimes have proved much more difficult to describe and, owing to the complexity of the NSF field equations, only a handful of solutions have been found. This talk presents a new exact solution that corresponds to a power-law spacetime with a dust source and everywhere positive mass-energy density. This solution is the first solution that directly links Version (a) and Version (b), thereby illustrating both versions of the NSF and demonstrating their equivalence. The new solution will be outlined at first in 2+1 dimensions. Its generalization to 3+1 will then be described.

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