Misner “assists” in BH theory

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Three “assists”

- Finkelstein: unidirectional membrane
- Carter: fourth constant for Kerr geodesics
- Israel: spherical BH-- peculiar vs.generic

David Finkelstein

- Finkelstein (submitted to PR Jan. 9, 1958) finds a “perfect unidirectional membrane” at r=2M in the Schwarzschild metric.
- He describes this work as “a by-product of a topological program [with Misner]” which was completed later -- Annals of Physics 6, pp 230--243 (1959).
- In the “Misner festschrift” (Camb. U Press 1993) he describes his excitement when, I helped him find “kinks” in a metric field.

David Finkelstein

- On that day (probably March 1, 2057 when Finkelstein gave a GR seminar at Princeton) I taught him how to visualize tumbling light cones.
- Why was that difficult? Because then one usually thought that contravariant vs. covariant vectors were just a notational convenience.
- For null vectors that's not the case.

Finkelstein discovers the BH horizon

- Now one knows that contravariant vectors are linear approximations to curved lines, while covariant vectors are linear approximations to the equipotentials of a scalar function.
- Only the contravariant vectors are readily sketched as a local light cone.
- The next slide is taken from the Finkelstein paper. Are there earlier sketches of non-constant light cones in any (i.e. not this metric) context?

David Finkelstein

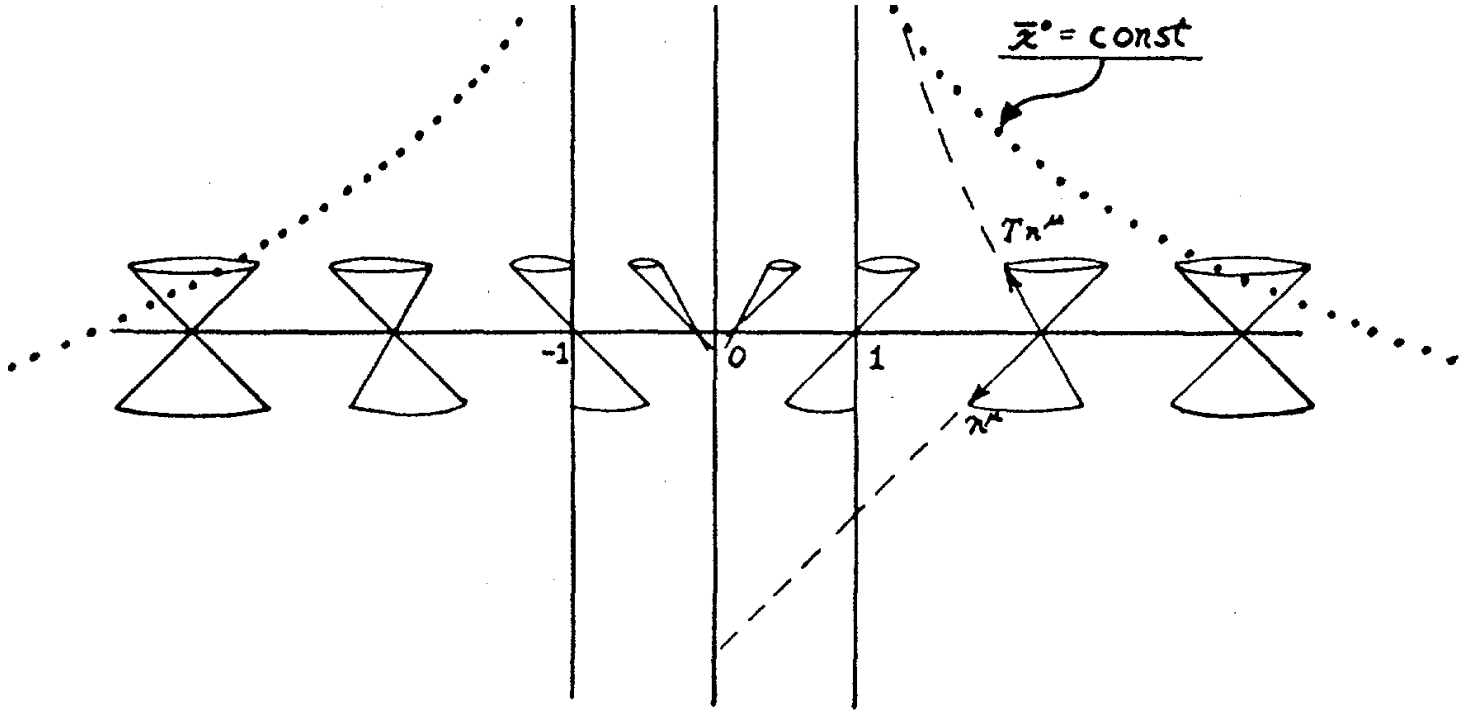
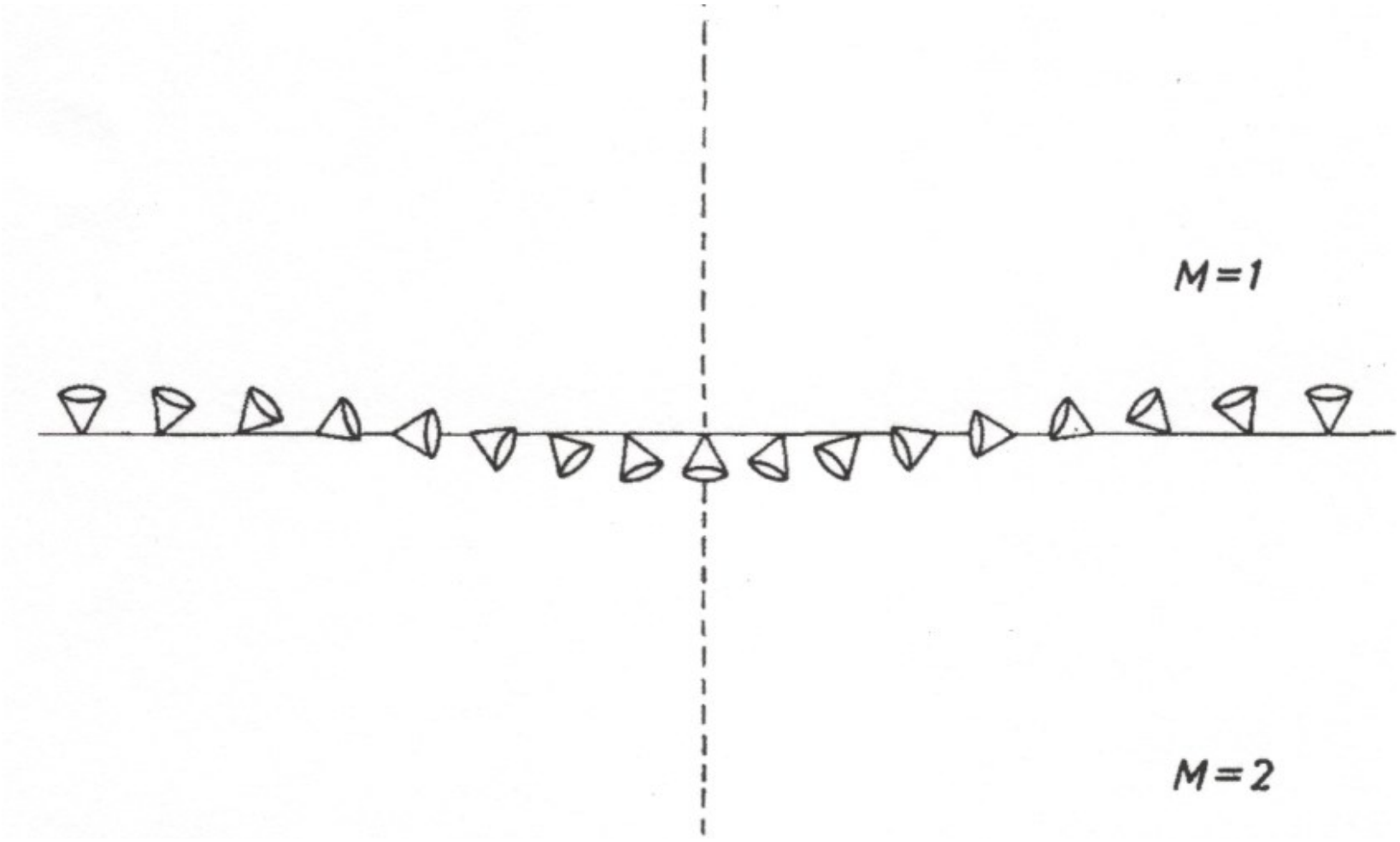


FIG. 1. The line-element in the (x^0,x^1)-plane. The light-cones in the (x^0,x^1,x^2)-space are indicated in perspective. The semipermeable membrane is $x^1=\pm 1$. A null geodesic (with tangent n^μ) is shown which reaches the center $x^1=0$. A null geodesic (with

“Kink” from Ann.Phys.1959



David Finkelstein

- Finkelstein remarks in his 1993 recollection

"So the relativistic black hole first arose as a particle model, with the astrophysical applications hardly mentioned."

- But the Beckedorff-Misner upgrade of Oppenheimer and Snyder did notice a little astrophysics.

See its 1963 presentation: http://drum.lib.umd.edu/handle/1903/4280 or search "Digital Repository U MD" for Misner

Misner “assist” re the Carter constant for Kerr geodesics

Brandon Carter

- Carter, B.: Global structure of the Kerr family of gravitational fields. Phys. Rev. 174, 1559 (1968)
- On an NSF senior postdoce in Sciama's group Misner remembers:

Sciama wanted Carter to look at geodesics in Kerr, not necessarily in the equatorial plane, (where lots of people had a picture of what was going on).

Brandon Carter

[Misner remembers:]

He told Carter that there was a relevant problem he had always been amused by in classical mechanics—it was the axially symmetric problem of a charge moving in the field of a massive electric dipole. There there is an extra constant of motion beyond energy and z-angular momentum. See MTW exercise 33.7 for details, and Corben and Stehle 1960, p.209.

Brandon Carter

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Mon, Apr 6, 2015 at 11:20 PM

My memory of those distant days is no longer reliable - if it ever was - but I think it was the example of the electric dipole, which had been drawn to my attention, I think, by Charlie that encouraged me to look for something similar in the Kerr solution.

Best wishes, Brandon

Misner “assist?” re the generic significance of the uniquenss theorem for static horizon hypersurfaces

Israel

- Event Horizons in Static Vacuum Space-Times
- Werner Israel
- Phys. Rev. **164**, 1776 – Published 25 December 1967

Misner attended an Israel London seminar on this topic in 1967.

A quote from this paper reads:

Israel

The result of this paper would have important astrophysical consequences if it were permissible to consider the limiting external field of a gravitationally collapsing asymmetric (nonrotating) body as static. In that case, only two alternatives would be open— either the body has to divest itself of all quadrupole and higher moments by some mechanism (perhaps gravitational radiation), or else an event horizon ceases to exist.

Israel

- I can't recall my interactions with Israel at that seminar, but do believe that I conjectured that similar results might be sought for Kerr black holes (not widely recognized then as BHs)
- I suppose I saw Israel's result by its current interpretation, namely that all (spherical) BHs must have the Swarzschild metric at and outside the horizon. This because I was aware of Vishveshwara's work indicating that gravitational waves damp symmetry.