Radiation in the de Sitter C-metric

Pavel Krtouš and Jiří Podolský

Institute of Theoretical Physics, Charles University, Prague

July 2004, GR17, Dublin

`http://utf.mff.cuni.cz/~krtous/`

We analyze the asymptotic behaviour of gravitational and electromagnetic fields which are generated by uniformly accelerated pair of charged black holes in asymptotical de Sitter spacetime. Such situation is described by the de Sitter C-metric, the solution of Einstein-Maxwell equations with a positive cosmological constant. The interpretation is achieved by employing suitable tetrads parallelly propagated along null geodesics. We explicitly describe the specific pattern of radiation which exhibits the dependence of the fields on a null direction along which the (spacelike) conformal infinity is approached. This directional structure of radiation supplements the peeling behaviour of the fields near infinity.

Based on the work

Krtouš P., Podolský J.: Phys. Rev. D **68**, 024005 (2003), *Radiation from accelerated black holes in a de Sitter universe*

Related work

C-metric with non-vanishing Λ

Podolský J., Ortaggio M., Krtouš P.: Phys. Rev. D **68**, 124004 (2003)
Radiation from accelerated black holes in an anti de Sitter universe

Krtouš P.: in preparation
Accelerated black holes in anti-de Sitter universe

Accelerated observers in (anti-)de Sitter universes

Bičák J., Krtous P.: Phys. Rev. D **63** (2001) 124020
Accelerated sources in de Sitter spacetime and the insufficiency of retarded fields

Bičák J., Krtouš P.: Phys. Rev. Lett. **88**, 211101 (2002)
The fields of uniformly accelerated charges in de Sitter spacetime

Bičák J., Krtouš P.: to be submitted to Phys. Rev. D
Fields of accelerated sources: Born in de Sitter

Directional structure of radiation

Krtouš P., Podolský J.: review submitted to Class. Quantum Grav.
Asymptotic directional structure of radiative fields in spacetimes with a cosmological constant

Krtouš P., Podolský J.: Phys. Rev. D **69**, 084023 (2004)
Gravitational and electromagnetic fields near an anti-de Sitter–like infinity

Krtouš P., Podolský J., Bičák J.: Phys. Rev. Lett. **91**, 061101 (2003)
Gravitational and electromagnetic fields near a de Sitter–like infinity

Radiation near a general infinity $\mathcal{I}$

Spacelike infinity

$$\left|\Psi_4^{\mathrm{i}}\right| \approx \left|\Psi_{4*}^{\mathrm{o}}\right| \eta^{-1} \left|1+|R|^2\right|^{-2} \times \left|1-\frac{R_1}{R_{\mathrm{a}}}\right| \left|1-\frac{R_2}{R_{\mathrm{a}}}\right| \left|1-\frac{R_3}{R_{\mathrm{a}}}\right| \left|1-\frac{R_4}{R_{\mathrm{a}}}\right|$$

R is stereographic parametrization of the direction of the null geodesic with respect of the reference tetrad
$R_{\mathrm{a}} = -\bar{R}^{-1}$ is a direction spatially antipodal to that given by R
R_1, R_2, R_3, R_4 are parameters of principal null directions
$\left|\Psi_{4*}^{\mathrm{o}}\right|$ is normalization factor

the character of the pattern is given by:

- **degeneracy** of principal null directions (Petrov type)

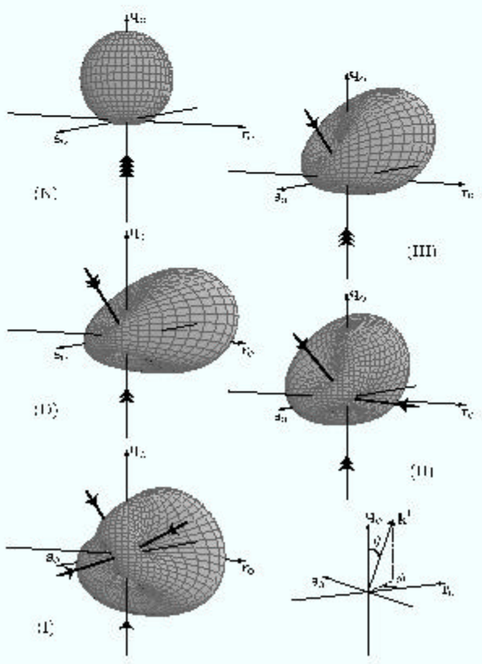
Timelike infinity

$$\left|\Psi_4^{\mathrm{i}}\right| \approx \left|\Psi_{4*}^{\mathrm{o}}\right| \eta^{-1} \left|1-|R|^2\right|^{-2} \times \left|1-\frac{R_1}{R_{\mathrm{m}}}\right| \left|1-\frac{R_2}{R_{\mathrm{m}}}\right| \left|1-\frac{R_3}{R_{\mathrm{m}}}\right| \left|1-\frac{R_4}{R_{\mathrm{m}}}\right|$$

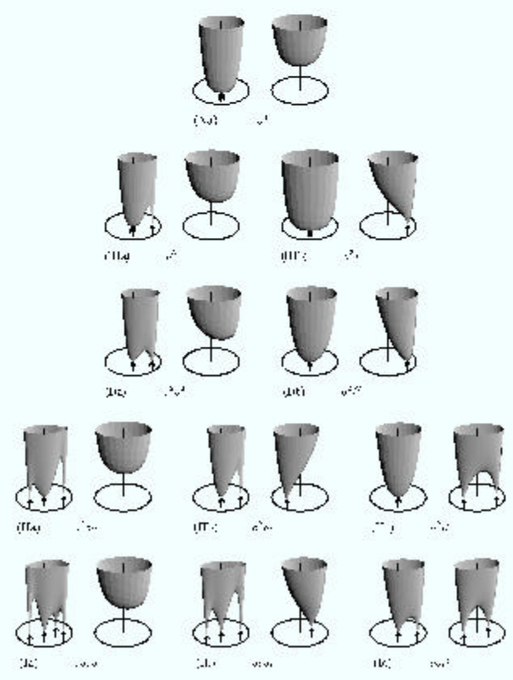
R is stereographic parametrization of the direction of the null geodesic with respect of the reference tetrad
$R_{\mathrm{m}} = \bar{R}^{-1}$ is reflection of R with respect to infinity
R_1, R_2, R_3, R_4 are parameters of principal null directions
$\left|\Psi_{4*}^{\mathrm{o}}\right|$ is normalization factor

the character of the pattern is given by:

- **degeneracy** of principal null directions (Petrov type)
- **orientation** of principal null directions with respect to $\mathcal{I}$



Specific directional structure of radiation for spacetimes of Petrov types N, III, D, II and I with spacelike infinity. Directions in the diagrams are spatial directions tangent to a spacelike $\mathcal{I}$. For each type, the radiative component $\left|\Psi_4^{\mathrm{i}}\right|$ along a null geodesic is depicted in the corresponding spatial direction $\mathbf{q}$ parametrized by spherical angles θ, ϕ. [Degenerate] principal null directions (PNDs) are indicated by [multiple] bold arrows. Thick lines represent spatial directions (opposite to PNDs) along which the radiation vanishes.



Directional structure of radiation near a timelike $\mathcal{I}$. All 11 qualitatively different shapes of the pattern when PNDs are not tangent to $\mathcal{I}$ are shown (remaining 9 are related by a simple reflection with respect to $\mathcal{I}$). Each diagram consists of patterns for ingoing (left) and outgoing geodesics (right). $\left|\Psi_4^{\mathrm{i}}\right|$ is drawn on the vertical axis, directions of geodesics are represented on the horizontal disc. *Reflected* [degenerated] PNDs are indicated by [multiple] arrows under the discs. For PNDs that are not tangent to $\mathcal{I}$ these are directions of vanishing radiation. The Petrov types (N, III, D, II, I) corresponding to the degeneracy of PNDs are indicated by labels of diagrams, number of ingoing and outgoing PNDs is also displayed.