Last stages of spectral evolution via turducken method

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Definition

- *Turducken:* is a dish consisting of a partially de-boned turkey stuffed with a de-boned duck, which itself is stuffed with a small de-boned chicken. (Wikipedia)

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- *Relativistic turducken:* to stuff a black hole.

The idea

- "If no physical information can leave the interior of the black hole, why not just change the interior to one's advantage?"

Brown et al. Phys. Rev. D 76, 081503(R) (2007)

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- ”If no physical information can leave the interior of the black hole, why not just change the interior to one's advantage?”

- Constraint violations do not propagate outside the black hole, provided the system is hyperbolic and all characteristics speeds are less than or equal to one.
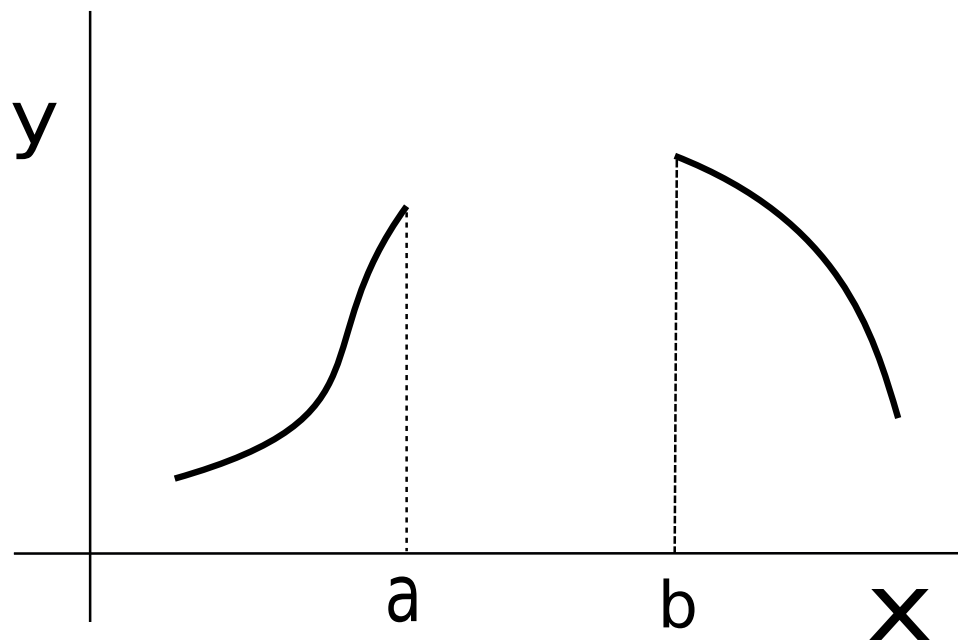
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The recipe

How to stuff a black hole? The smoother the better.

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1D analogy for continuous 2nd derivatives

- 6 conditions: $f(x)$, $f'(x)$, $f''(x)$ at $x = a, b$

- $f(x) = c_0 + c_1 x + c_2 x^2 + c_3 x^3 + c_4 x^4 + c_5 x^5$

- $f(x)$ is solution of

$$\frac{d^6 f}{dx^6} = 0$$

The recipe

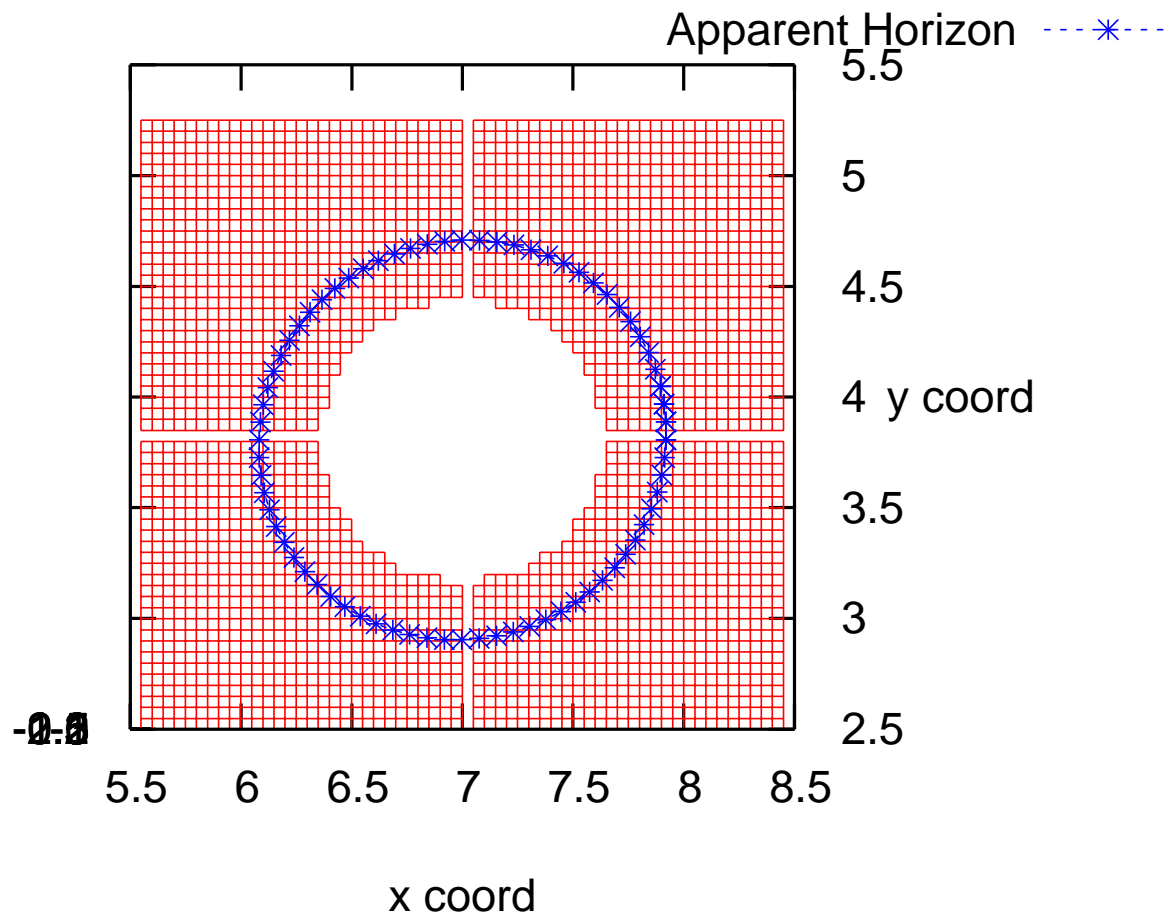How to stuff a black hole? The smoother the better.

3D version

$$\left(\partial_x^6 + \partial_y^6 + \partial_z^6\right) \Phi = 0$$

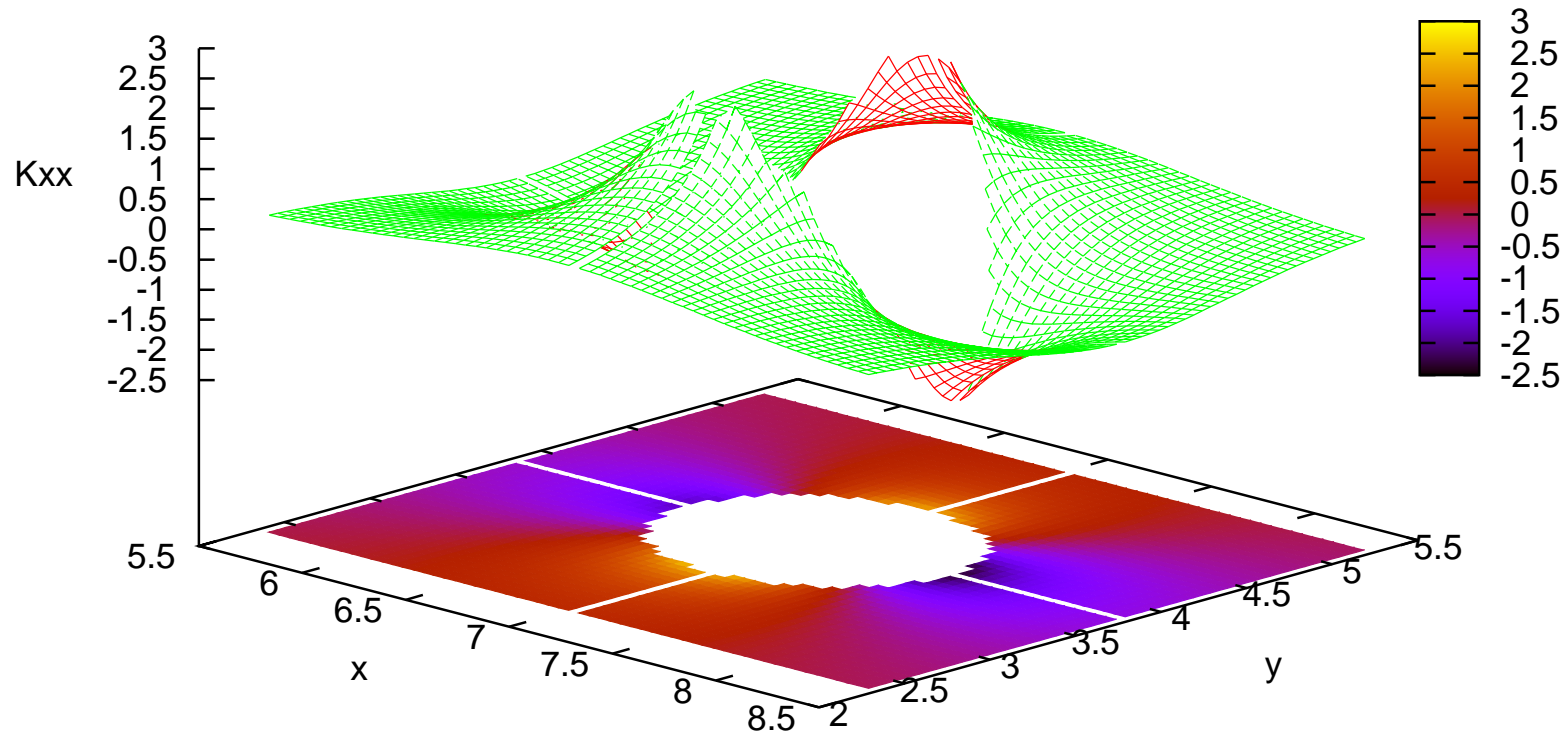$\Phi =$ lapse, shift, metric, extrinsic curvature
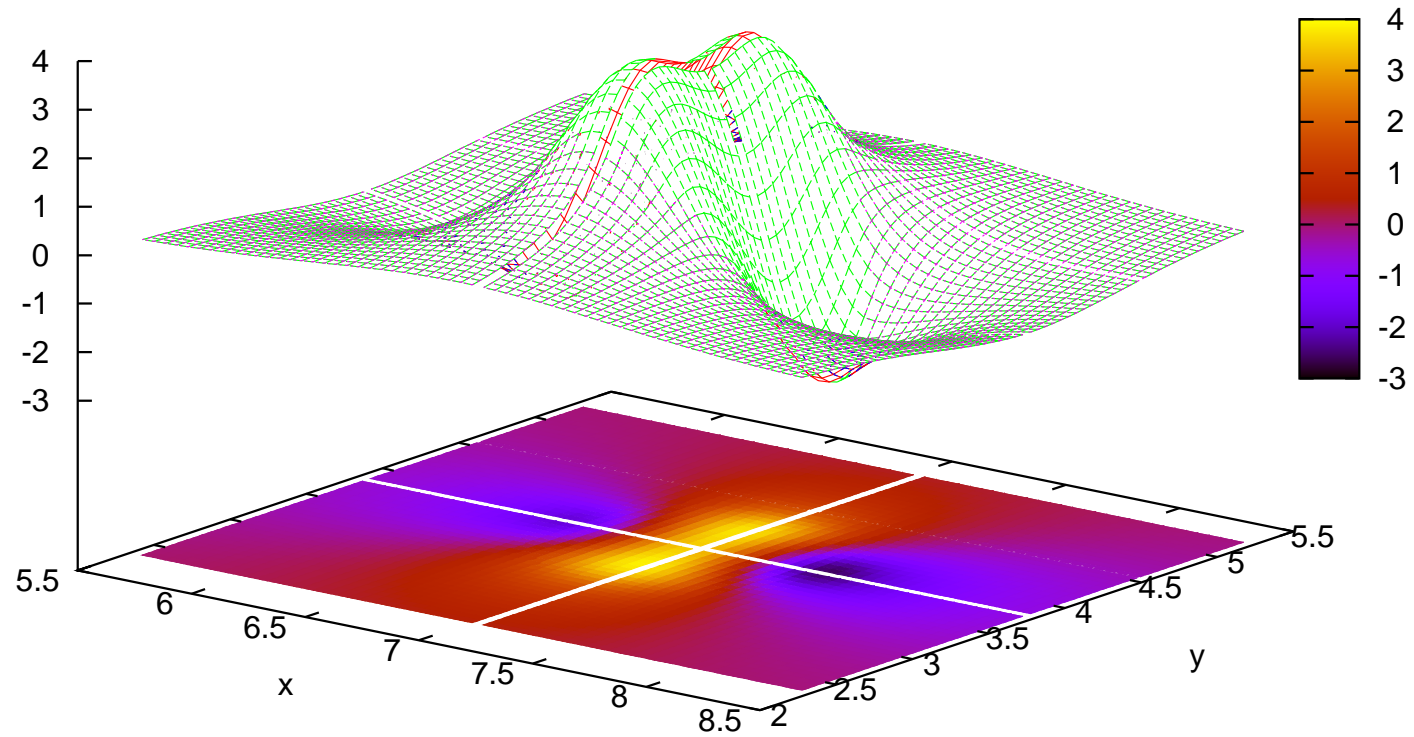
The stuffing

Kxx lev8 dx=0.033 t=0

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Evolving stuffed Black Holes

Initial Data: Caltech-Cornell 15 orbit run at $t = 7600$.

Gauge: $1 + \log$, gamma-driver

Formulation: 1st order formulation of BSSN

Grid: Cartesian, 9 refinement levels. $\Delta = 4.2M \rightarrow 0.0084M$. CFL=0.4, 4th order FD.

Boundary: Outer boundary at $192M$, outgoing BC

Orbits and merger

Start AH movie
Start lapse movie

Conclusion and further work

- The relativistic turducken provides a stable approach to Binary Black Hole evolutions.

- Functionality of excision with a topologically trivial domain.

- Exploration of different mass, spin and spin orientation.