Tidal Horizons

Stamatis Vretinaris,[1,*] Badri Krishnan,[1] and Erik Schnetter[2,3,4]

[1] *Institute for Mathematics, Astrophysics and Particle Physics, Radboud University, Heyendaalseweg 135, 6525 AJ Nijmegen, The Netherlands*

[2] *Perimeter Institute for Theoretical Physics, Waterloo, Ontario, N2L 2Y5, Canada*

[3] *Department of Physics Astronomy, University of Waterloo, Waterloo, ON N2L 3G1, Canada*

[4] *Center for Computation Technology, Louisiana State University, Baton Rouge, LA 70803, USA*

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abstract

I. INTRODUCTION

Horizon data is generated using the Kerr Shild data for a single black hole of mass 1 and spin 0.

We use the QuasiLocalMeasures thorn to extract information on the horizon such as the Ψ_2 scalar. For a Schwarzschild black hole this is

$$\Psi_2 = -\frac{M}{r^3} \tag{1}$$

We expand the Ψ_2 scalar into spherical harmonics

$$\Psi_2 = \sum_{l=0}^{\infty} \sum_{m=-l}^{l} C_l^m Y_l^m(\vartheta, \phi) \tag{2}$$

where

$$Y_l^m = (-1)^m \sqrt{\frac{(2l+1)}{4\pi} \frac{(l-m)!}{(l+m)!}} P_l^m(\cos\vartheta) e^{im\phi} \tag{3}$$

where P_l^m are the associated Legendre polynomials.

as a test we decompose Eq. (1)

$$C_l^m = \int_\Omega \Psi_2 Y_l^m(\vartheta, \phi) d\Omega = \Psi_2 \int_0^{2\pi} d\phi \int_0^{\pi} Y_l^m \sin\vartheta d\vartheta \tag{4}$$

all coefficients C_l^m except the C_0^0

$$C_0^0 = \Psi_2 \int_0^{2\pi} d\phi \int_0^{\pi} Y_0^0 \sin\vartheta d\vartheta = 2\sqrt{\pi}\Psi_2 \tag{5}$$

which evaluates to $C_0^0 = -0.443114$ for a Schwarzschild black hole of mass 1.

II. CODE DESCRIPTION

We use the `Carpet` infrastructure to produce initial data for a single Schwarzschild black hole by using the Kerr Schild data provided by the `Exact` thorn. The Weyl scalars are extracted by the `QuasiLocalMeasures` thorn and are imported through `kuibit`.

* svretina@physics.auth.gr

For the spherical decompositions we use the `pyshtools` library. We interpolate the horizon data onto a Gauss-Legendre grid and decompose it. The numerical value of C_0^0 we get is -0.44310608.

The accuracy of the interpolation is low and erros are introduced at this step.

Next steps:
- two schwarzschild black holes
- one schwarzschild one kerr
- two kerr

run for various values of
- distance, spin, mass ratio