Revisiting the Quasi-Kinnersley Tetrad in Numerical Relativity

NICOLE ROSATO, JAMES HEALY, CARLOS LOUSTO, Rochester Institute of Technology — We present a method of constructing rotation parameters $a$ and $b$ for performing Type I and Type II transformations of Weyl scalars $\Psi_a$ into the quasi-Kinnersley frame. This frame is transverse ($\Psi_1 = \Psi_3 = 0$) and should have $\Psi_2 \to -\sqrt{I/3}$ asymptotically, where $I$ is a spacetime invariant. This frame better represents physical properties of the spacetime, such as outgoing gravitational radiation. Using the quasi-Kinnersley frame, we study an index $D$ that, in conjunction with the $S$ invariant, measures the deviations from Petrov Type D of a BBH system in the strong-field region. $D$ is invariant under Type II and III rotations, but not under Type I. Studying this index will tell us more accurately how far a BBH spacetime deviates from Type D. This index is used in numerical simulations of BBH systems to investigate the Petrov Type in the Strong Field region during the final inspiral and merger phases. This talk will also discuss how the gravitational wave scalar $\Psi_4$ in the quasi-Kinnersley frame can be used to extract gravitational radiation. Since the QK $\Psi_4$ is an accurate representation of outgoing radiation, waveforms can be extracted close to the BBH system, reducing computational expense.

1This research is part of the Blue Waters sustained-petascale computing project, which is supported by the National Science Foundation (awards OCI-0725070 and ACI-1238993) and the state of Illinois. Blue Waters is a joint effort of the University of Illinois at Urbana-Champaign and its National Center for Supercomputing Applications.

Nicole Rosato
Rochester Institute of Technology

Date submitted: 08 Jan 2020

Electronic form version 1.4