EXECUTIVE SUMMARY

This research project focuses on reducing error in simulations of merging pairs of black holes in order to better study the gravitational wave emission at merger. It currently takes months of supercomputer time to perform difficult simulations (for example, where the black holes are spinning quickly or are very differently sized), and increasing the accuracy of these simulations translates to an increase in required computational resources. We would like to change the initial values given to the gauge equations to be closer to their settled shape, allowing the gauge to settle more quickly and reducing error in the simulations.

RESEARCH CHALLENGE

The challenge of this research is to gain accuracy in the most challenging binary black hole simulations without increasing computational cost. The low mass-ratio and high-spin areas of parameter space are very sparsely covered; we hope this project will fill out that parameter space so that researchers have waveforms to compare to potential detections from the Laser Interferometer Gravitational-Wave Observatory.

METHODS & CODES

To perform numerical relativity simulations, we use the Einstein Toolkit and specifically modify the Rochester Institute of Technology TwoPunctures initial data thorn. We are constructing new initial data values for the gauge based on their expected settled shape.

RESULTS & IMPACT

We are seeing a reduction in error using these new initial data, and therefore are gaining accuracy without actually having to use more computational resources.

WHY BLUE WATERS

These simulations require the use of large-scale computing resources due to computational intensity. The staff itself is knowledgeable about both the system and about the software we use.

Nicole Rosato is in the second year of a doctoral program in mathematical modeling at the Rochester Institute of Technology. She is working under the direction of Carlos Lousto and hopes to graduate in 2021.