GGC physicist leads team in innovative black hole research

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Black holes are the subject of much fascination, not just in science but also in popular media. For example, the 2014 movie "Interstellar" portrays a fast-rotating, supermassive black hole, into which the protagonist falls in order to probe its center.

Such a scenario may be more than the stuff of Hollywood magic, according to a research team led by Lior Burko, associate professor of physics at Georgia Gwinnett College, and including Gaurav Khanna, associate professor of physics at UMass Dartmouth, and Anil Zengino?lu, science coordinator at the Center for Scientific Computation and Mathematical Modeling at the University of Maryland.

At the center of a black hole, density and gravity are infinite and the laws of physics and space-time, as we know them, cease to exist. The mysteries of this phenomenon have driven scientists to push the boundaries of what is known about black holes. Supercomputers are required to run the complex computer simulations used in this kind of research.

"Non-rotating black holes have been studied in computer simulations for decades," Burko said. "We developed a first-of-its-kind computer simulation of how physical fields evolve on the approach to the center of a rotating black hole."

The complexity of the simulation led the scientists to develop a new model that will help other researchers further understand black holes.

The simulation also revealed a result that might come as a surprise for those familiar with the usual portrayal of black holes.

"It has often been assumed that objects approaching a black hole are crushed by the increasing gravity," Burko said. "However, we found that while gravitational forces increase and become infinite, they do so fast enough that their interaction allows physical objects to stay intact as they move toward the center of the black hole. Therefore, the simulation is consistent with aspects of popular science fiction scenarios in which black holes are used as portals for hyperspace travel, which require space ships, and the astronauts within them, to stay intact."

The team's work will appear in a paper in the Feb. 9 edition of Rapid Communication in *Physical Review D*, a peer-reviewed publication of the American Physical Society. The research was supported by the National Science Foundation.

Critical to the project was the novel supercomputing support from UMass Dartmouth's Center for Scientific Computing & Visualization Research (CSCVR). Khanna serves as associate director of the CSCVR, which provides services for collaborative research in the computational sciences within the university and with researchers at other universities, national labs and industry.

"This has never been done before, although there has been lots of speculation for decades on what actually happens inside a black hole," Khanna said. "The problem is very challenging - requiring development of many new mathematical and computational techniques. I expect this to be a new additional area of focus for my research program over the next several years."

Burko joined the Georgia Gwinnett faculty in 2014. He received his bachelor's, master's and doctorate degrees in physics from The Technion

- Israel School of Technology in Haifa, Israel. Burko has held faculty positions at institutions such as the University of Utah and University of Alabama at Huntsville. His research interests include computer simulation/modeling, gravitational physics, black holes, space-time singularities and physics education.

Provided by Georgia Gwinnett College