Newsletter

College of Physical and Mathematical Sciences

June 2008

In this issue:

BYU Study Adds a 'Twist' to Stars' Death Throes

Thirty-seven miles apart, twin stars orbit each other on a high-speed collision course. In a matter of milliseconds, the stars collide in spectacular fashion, spewing out radiation and forming an object so massive it collapses under its own weight and becomes a black hole.

Simulations of this stellar collision play out in Brigham Young University's Fulton Supercomputing Laboratory on a machine named MaryLou4, listed by Top500 as the 106th fastest computer in the world. The simulations are funded by the National Science Foundation and orchestrated by astrophysicists in search of the cause of a type of gamma-ray burst, the brightest flashes seen in space.

In the scientific journal *Physical Review Letters,* researchers from BYU demonstrate one important part of solving the riddle: Don't overlook stars' magnetic fields.

"Even though most or all stars have a magnetic field, a lot of prior research does not account for its effects during the final stages of the stars' lives," said BYU astrophysicist Eric Hirschmann. "Our results show that in certain circumstances the magnetic fields do play a role in the evolution of systems with two stars."

More than half of all stars are twins that share a solar system, such as the pair depicted on Luke Skywalker's planet, Tatooine, in *Star Wars.* If at least one of the stars is very large, then both will explode in a supernova when they run out of fuel. The burned-out cores left behind, called neutron stars, are so dense that they cause gravitational ripples in space as predicted by Einstein's theory of general relativity.

Hirschmann and BYU colleagues David Neilsen and Matthew Andersen, along with collaborators from Louisiana State University and Long Island University, focused on what happens when two neutron stars pull each other near. They found the stars' magnetic fields slow down the merger, allowing one extra orbit during the final 12 milliseconds.

While one more orbit may not sound like much, the delay increases the energy radiated by gravitational waves, increasing the likelihood that planned technology may pick up the signals under the right conditions.

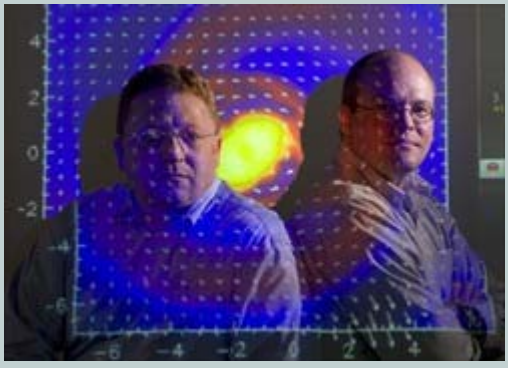
Astronomers base their interpretation of space signals on wave signatures generated by simulations. The more accurate the simulation, the closer science comes to explaining deep-space mysteries like gamma-ray bursts.

"The origin of gamma-ray bursts has been a mystery for 40 years, and the fireballs created in the mergers of neutron star pairs or neutron star-black hole pairs have emerged as the most likely sources of short gamma-ray bursts," said John Friedman, a physics professor at the University of Wisconsin-Milwaukee who was not involved in the study. "The code developed by this collaboration brings us one step closer to resolving this mystery."

The extra orbit seen in the BYU simulation also gave the stars' gravity more time to rip material away from each other before they merged. While the end result of this simulation was a black hole, the researchers suggest merging stars with very strong magnetic fields may meet a different fate.

"In a way, the magnetic field adds a new mechanism to tear the stars apart," Neilsen said. "If the stars begin to tear apart when they are still widely separated, and they shed matter, it may prevent the black hole from forming."

-Joe Hadfield, BYU News



Important Dates & Events in the College

June 2008

Parents urged to discuss Internet safety with children

PROVO — Spammers and pornography peddlers don't have any qualms about having the "porn talk" with children — neither should parents, said speakers at a "Communities for Decency" conference Saturday.

"Many of you have never, ever seen as an adult what your children have already seen," said Charles Knutson, host of the nonprofit program Internet Safety Podcast. "You either are going to have the pornography conversation with your child, or your child is going to suffer."

The conference, titled the Technology Summit, focused on how parents can combat the risks of technology. Speakers said parents should be aware that children have almost constant access to pornographic material through the Internet, Internet-enabled cell phones and video-gaming systems.

Ninety percent of children between the ages of 8 and 16 have viewed pornography online, said Knutson, a computer science professor at Brigham Young University. Most of these stumbled upon pornography while doing homework.

"The benefits of the Internet to the world are unprecedented," said Knutson, who has 10 children. "As a computer scientist, I'm excited. As a father, I'm absolutely as terrified as you are."

Knutson gave conference attendees a quick tour of the different ways parents can monitor Internet use. On the basic level, he said, parents can make a habit of checking the browser history on their home computers. Some children are tech-savvy enough to selectively delete entries in the history, however, so parents should learn how to check the cache and cookies on their computers as well.

Other options include automatic filters that monitor the type of content Internet users can access. In extreme cases, Knutson said, parents can install software that will record their child's keystrokes.

"You've got to understand you have the right to manage your child's access to material on the computer," Knutson said. "The bottom line is you have to somehow seize control."

This advice also holds true for cell phones, which, in most cases, can take and receive photos as well as download Internet content, said Davis County Attorney Troy Rawlings.

"If your children are armed with this type of technological capability, they're vulnerable," he said. "Don't be afraid to do something. Learn what you can and can't control through your cell-phone provider. Set rules. Have an open dialogue with children."

Rawlings argued that the sexualization of society, propelled by pornographic material, is affecting children's judgment and behavior. Most of the teenagers who were taking and passing along naked photos of themselves were "good kids," he said. "They are so bombarded with sexual material that this is somewhat normal to them," Rawlings said. "It may even be considered socially acceptable. This is the type of stuff they see."

Rawlings expressed concern that society's casual attitude about pornography may contribute to sex crimes.

"I can't remember being involved in a case dealing with a sexual offense against a child where porn wasn't a tie-in," he said. Fraser Bullock, founder of Citizens Against Pornography, agreed that pornography is one of the biggest dangers facing today's youth.

"We need to focus on the rising generation because we know how at risk they are," he said. "Let's protect those kids and those innocent minds."

by Elizabeth M. Stuart

Department of Statistics Hosts Summer Institute of Applied Statistics

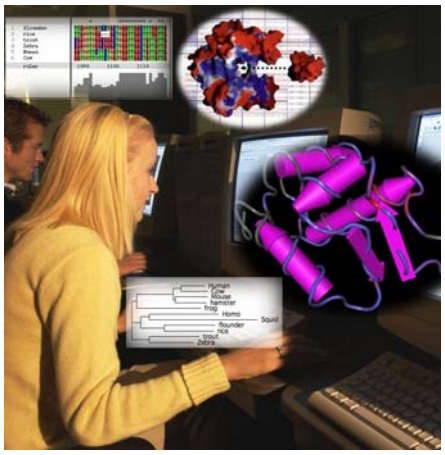
The 33rd Annual Summer Institute of Applied Statistics will be held June 18-20, 2008 and will be presented by Dr. Scott M. Berry of Berry Consultants. The title of his seminar is "Bayesian Clinical Trials." The course will describe recent Bayesian innovations in the design and analysis of clinical trials.

Additional details and registration information can be found at

http://statistics.byu.edu/summer_institute/

Of Mice and Men:

Bioinformatics Approaches to Down Syndrome



Eight students at BYU are applying an unusual combination of skills to understanding disease and making progress toward therapeutic intervention. Although researchers have long hypothesized that a point mutation in an individual's DNA causes certain diseases, recent findings suggest that these aliments might actually be generated by a duplication of certain genes. These BYU students have trained their attention on Down syndrome, one disease caused by gene duplication. In individuals with Down syndrome, three copies of chromosome 21, rather than the two copies that normally occur, create a specific genetic condition with attendant physiological manifestations. Drawing upon their rich background in biology, chemistry, statistics, and computer science, these students are developing computational software to analyze the influence that this extra copy of chromosome 21 has on the production of proteins that trigger Down syndrome symptoms. Their research could yield viable treatments not only for this condition, but also for a host of aliments (including many kinds of cancer) related to having multiple copies of the same gene.

For Nathaniel Gustafson, a double major in computer science and bioinformatics, the project gives him a chance to apply his knowledge and interest to a complex, real-world problem. Like the other students in the group – a combination of bioinformatics and computer science majors – he's as interested in the final goal of the project as in the vast educational opportunities it provides. "What interested me most about this group was that it seemed to delve into specific aspects of bioinformatics," he says. Not only that, but he relishes the chance to make substantive change in the medical world. "I also was drawn by the overall goal of this research group, to help better understand, treat, or prevent Down syndrome." While achieving that goal is still a long way off, the students in the group have narrowed down their research to some aspects of Down syndrome that, until now, other researchers have neglected.

One of these research aspects involves identifying intricate connections between signaling pathways, or structures that model the synthesis and regulation of proteins in living organisms. Research has linked one gene pathway, the "Hedgehog Pathway," with development of the jaw bone in mammals, but Gustafson and his fellow students are trying to understand how this pathway can influence jaw development in mice with Down Syndrome when it does not contain any genes from chromosome 21. To understand this puzzle, the students are applying computational analyses to a study of possible linkages between pathways. If this project is successful, it could lead to treatments for individuals with Down syndrome during early developmental stages that would minimize or even prevent certain symptoms.

The two BYU professors who oversee this group, Mark Clement and Quinn Snell, regard this project as a tremendous opportunity for their students to apply backgrounds in biology and algorithmic analysis to research that might lead to breakthroughs in medical treatments. The professors collaborate with Dr Randall Roper from Indiana University/Purdue University at Indianapolis. Dr. Roper breeds Down syndrome mice and will be able to run wet lab experiments to verify conclusions resulting from the computational analysis of the pathways. BYU students benefit tremendously from this collaboration, according to Dr. Snell. "He's terrific to work with," he says of Dr. Roper, "because he brings the context of the medical and biological side to the research were doing here." In weekly meetings, the students meet with Dr. Clement and Dr. Snell to measure progress and address questions about specific tasks. Currently, the students are testing and refining computations until they get to a stage of maturity where Dr. Roper can conduct experiments to test the results. Already, though, Dr. Snell is impressed by what the students have achieved. "We've found things that researchers have long believed are true but haven't found conclusive research for," he says. "We've established computational hypothesis for these ideas, and look forward to establishing some results in wet lab experiments in the future."

Their achievements thus far would not have been possible, however, without a set of conditions specific to BYU. "The collaboration between biology and computer science at BYU is unique," says Dr. Clement. "The computational biology and bioinformatics classes are taught in an interdisciplinary way with about half the lectures being taught by a computer science professor and half by a biology professor. The students from different disciplines have the opportunity to work with each other and to learn to exploit each others strengths." With complicated problems to solve, Gustafson acknowledges the ways this collaboration can generate productive feedback and suggestions for alternative approaches. "Sometimes things can come to a standstill, so it can also be very rewarding when the group gets together and pushes through those," he says.

And even if opinions in the group diverge, Gustafson appreciates the perspectives his fellow students bring to the table. "This research is kind of driven by new ideas, though different ideas come from each person and it can be difficult to transfer those ideas fully from one person to another." But even debating the merits of different directions the research could take produces productive results. "It's rewarding to see the intermediate steps of the project coming together" in these meetings, he says. One of his colleagues in the group, Chris Merris, agrees that discussing and evaluating different approaches to problems takes judgment and careful consideration. A bioinformatics major, Merris says that the most challenging part of working with the group is sometimes "just figuring out what to do and what direction to take, since research in general is very open-ended." Both students, however, see the possibility that their research might take them to a uniquely rewarding goal: better understanding gene pathways and applying this knowledge to advancing research and developing therapeutic interventions to address Down syndrome and other ailments.

Students this motivated and talented are bound for success, Dr. Clement feels, particularly since their strong backgrounds and novel approaches lead them to question pre-existing research and seek new solutions to this complicated problem. Although their work is challenging and their research often takes them into uncharted territory, these students stand to make significant contributions to the world at large. "I feel like these students are really going to make a difference in improving the well-being of mankind," he says. "I feel it a privilege to work with them and see their successes."

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