RESEARCH MATTERS

JULY 2011 NEWSLETTER

Division of Research
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CGWA EXPLORING AND DISCOVERING SPACE WHILE ATTRACTING STUDENTS INTO PHYSICS.

There's talk of space-time and a fourth dimension, of black holes and dead stars. But this isn't a sci-fi movie set or a NASA research lab. Instead, it's the UTB/TSC Fort Brown Campus, where an innovative research center has put the university on the cutting edge of science.

At the Center for Gravitational Wave Astronomy (CGWA), students and professors are part of a high-tech hunt to track down gravitational waves, or so-called "ripples," produced after masses move through or collide in space. These waves, predicted by Albert Einstein in his Theory of General Relativity, have not been directly detected, but they hold the promise of revealing new information about the birth and evolution of the universe.

The center is working closely with researchers at the Massachusetts Institute of Technology (MIT), California Institute of Technology (Caltech), NASA and as far away as France and Germany to detect the elusive waves. It has helped to draw top-notch professors from around the world to join the university's staff and faculty. University researchers – including students –have moved the search forward with highly complex computer calculations, development of state of the art photonic components and the discovery of additional pulsars in space.

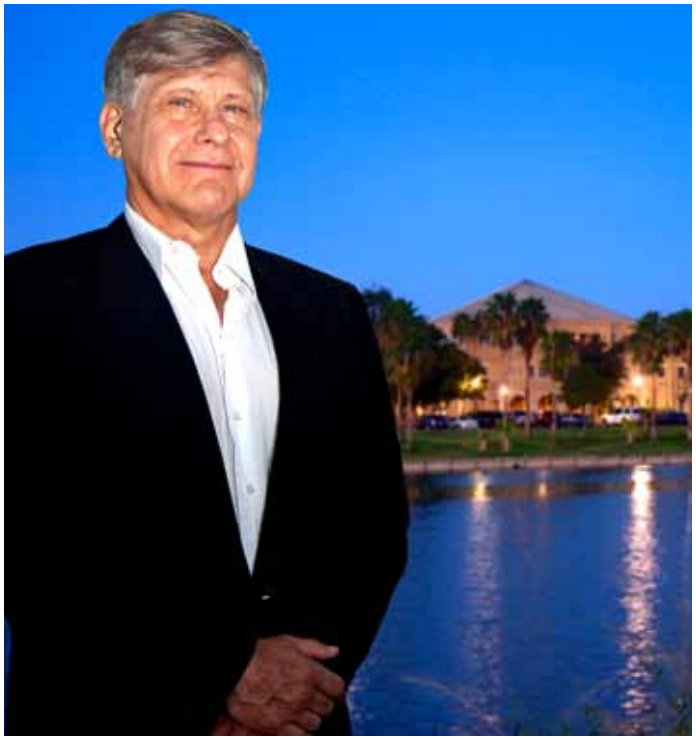
"The detection of gravitational waves is a major technological challenge," said physics Professor Mario C. Diaz, the center's director since it started in 2003.

The difficulty has to do with the nature of what is being measured, said Diaz, who has a Ph.D. in physics from the University of Cordoba, Argentina, and has been researching gravitational waves for more than a decade.

For example, scientists don't know when or how often something happens in space that produces gravitational waves big enough to be detected, he said. And when something does happen that produces waves, very sensitive instruments would be needed to detect the ripples because they may have started millions of light years away, he added.

But there's growing excitement in the scientific community that a breakthrough is near. Researchers are hopeful the Laser Interferometer Gravitational-Wave Observatory (LIGO) project, which has observatories in Washington and Louisiana, will soon have instruments sensitive enough to detect the waves. The CGWA, which is involved in LIGO research, expects these upgrades to be complete by 2014.

Being part of new discoveries, however, is not the center's only goal. As a byproduct of its research, the center would like to lure high-tech companies and even venture capital to the Rio Grande Valley. CGWA research could be used in many industries, including aerospace and health care. Already, the center is exploring the possibility of developing silicon carbide semiconductors for Semtech, a Department of Defense provider, Diaz said.



But Diaz believes the center's biggest accomplishment so far is its help in attracting students to physics and astronomy. UTB/TSC now has 47 declared physics majors, a 94 percent increase since fall 2008. About 54 percent are minorities, and 24 percent are females. Half of the declared majors are involved in research. In addition, the number of physics master's degree students has risen 45 percent since the fall 2008, and the total number of graduate students rose 118 percent during that same period.

The CGWA holds a yearly summer school on South Padre Island for advanced undergraduate and beginning graduate students in physics. It also holds many expos, seminars and contests aimed at getting elementary and high school students interested in physics and astronomy.

The center was established at UTB/TSC after the university received a grant from NASA's University Research Center program, which is designed to increase advanced degrees in NASA-related fields in colleges with a large number of minority students. In 2007, the National Science Foundation's Center for Research Excellence in Science and Technology (CREST) also awarded funding to the CGWA. The center receives more than $4 million yearly in external funding from various sources, including NASA and the NSF.

Diaz said his goal for the center over the next few years is to continue developing educational programs and to increase undergraduate enrollment in physics and the number of doctoral students.

And it wouldn't hurt if the elusive space ripples are finally detected.

"It most likely will happen after 2014," Diaz said. "2016? That would be a fitting homage to Albert Einstein, who predicted gravitational waves in 1916."

ARCC OBSERVATORY OFFERING A VIEW OF SPACE FROM FORT BROWN CAMPUS

Getting to the Arecibo Observatory in Puerto Rico is a time-consuming task: First you fly to San Juan, then you drive 1 1/2 hours west of the city.

Budding scholars in Brownsville, however, don't have to leave their backyard to access to the world's largest radio telescope.

The Arecibo Remote Command Center, or ARCC, is a remote control-and-command center for the radio telescope on the UTB/TSC Fort Brown Campus. Here, students at the high school level and higher can take real-time control of the telescope for deep-space exploration.

Located in the Science, Engineering & Technology Building, the center was launched in 2006 by Associate Professor Federick A. Jenet after he received a National Science Foundation Faculty Early Career Development grant. In 2008 the NSF awarded additional funding to sponsor physics scholarships in what is now known as the ARCC Scholars Program.

Jenet has a S.B. in physics from the Massachusetts Institute of Technology (MIT) and a Ph.D. in astrophysics from the California Institute of Technology (Caltech). He has also served as a postdoctoral scholar at the Jet Propulsion Laboratory at Caltech.

Jenet has worked with data from the Arecibo Observatory since he was a graduate student, first visiting the facility in the mid-90s. His experience with the observatory led to the idea of the center.

"I knew Arecibo could be controlled remotely, so I thought, why not take advantage of that?" Jenet said. "Students could control the telescope, and we could teach them how to observe and analyze the data."

ARCC focuses on the study of radio signals emitted by pulsars, or remnants of stars that emit radio pulses, to get more information about the formation and evolution of the galaxy. Pulsars are also being studied to help detect gravitational waves, or "ripples" in space-time, predicted in 1916 by Albert Einstein.

The Brownsville program has drawn the attention of other schools in the country. The University of Wisconsin-Milwaukee, which opened the second remote-command center, credits UTB/TSC with developing the concept ,and now Wisconsin scholars often collaborate with UTB/TSC students.

From the start, UTB/TSC's command center has had close ties with high school students in the Brownsville area. A summer school has been designed for them as well as regular meetings and observations during the school year. High school students are urged to not only observe but also to analyze their observations, and some have even presented their research at meetings of the American Astronomical Society.

"This gives high school students a chance to be part of the discovery process," Jenet said. "They are actually doing things that any scientist would be doing."

Now a junior ARCC scholar, Anthony Ford was a loyal fan of the command center's outreach programs when he went to Porter High School.

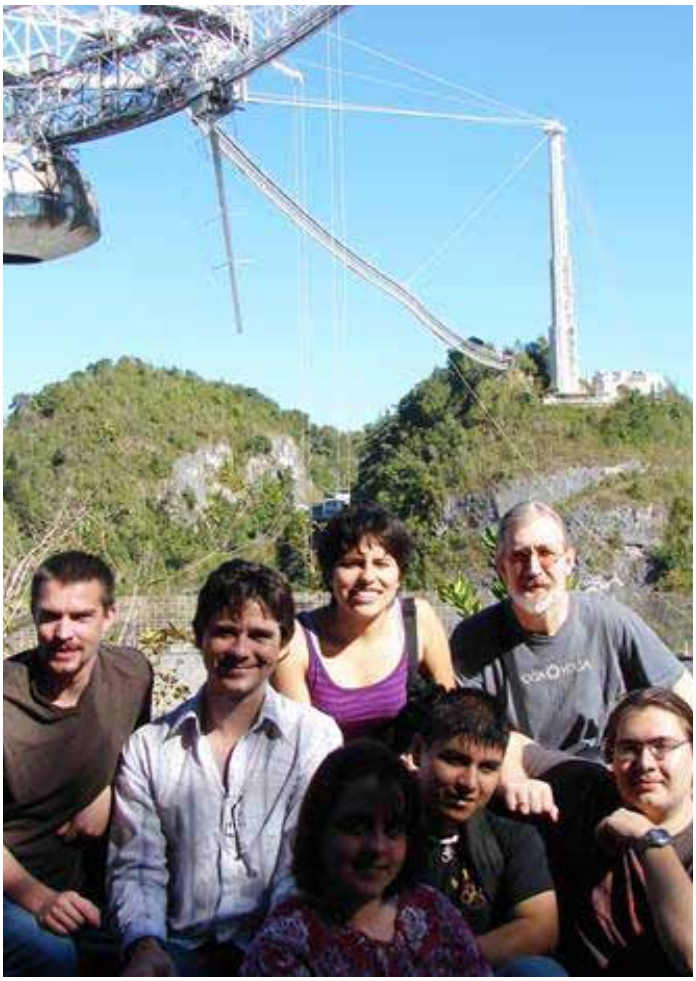
"I never missed a meeting. … I even got up at 3 a.m. for observations," Ford said.

He hopes to earn a master's and Ph.D., but for the immediate future he is looking forward to working with Jenet and other ARCC scholars on a new project: setting up a new radio telescope array to probe space at low frequencies. The project would consist of 256 6-foot-tall antennas over a relatively large area of land.

The project would be part of the Long Wavelength Array (LWA), sponsored by the University of New Mexico, the Jet Propulsion Laboratory and several other universities and institutions. LWA's goal is to have a number of these stations eventually in operation across the nation, Jenet said.

Jenet has a LWA prototype under development but is still seeking funding for the larger facility, which would probably be located off campus. Right now, the Port Mansfield area is under consideration, Jenet said.

"What we would like to do is get on the world scene of radio astronomy facilities," he said.



COOPERATIVE PH.D. IN PHYSICS ALLOWS STUDENTS TO STUDY IN BROWNSVILLE

A cooperative physics doctoral program between UTB/TSC and The University of Texas at San Antonio is allowing UTB/TSC student Marc Normandin to stay involved in the research he loves at the Center for Gravitational-Wave Astronomy while completing his doctorate.

"The center is affiliated with LIGO (the Laser Interferometer Gravitational Wave Observatory)," Normandin said. "In gravitational-wave astronomy, you need to be able to use actual data, not just theories."

Normandin, who was always interested in science when growing up in Canada, didn't discover gravitational-wave astronomy until he was an undergraduate at the University of Western Ontario and did a research paper on pulsars, or dense remains of stars.

A UWO professor helping him with the paper, Sree Ram Valluri, knew Soumya Mohanty, an Associate Professor at UTB/TSC, who was involved in gravitational-wave astronomy. Valluri and an anonymous referee of a grant where Normandin's research was mentioned both suggested Normandin contact Mohanty.

UTB/TSC invited Normandin to fly down to the university in 2005, and Normandin remembers receiving a warm welcome. At the end of 2008, after completing a bachelor's and master's in physics from UWO, he came to Brownsville to study.

"He chose to come all the way to UTB/TSC precisely so that he could do a Ph.D. in the area of gravitational-wave astronomy," Mohanty pointed out. "In that way, the cooperative with UTSA has been quite important for both him and us."

In 2009 and 2010, Normandin took core courses at UTB/TSC that would be applied to his doctorate and also earned a second master's degree. He officially started his doctoral program in January 2011. Aside from a few courses which can be taken via interactive video, most of the doctoral work consists in research performed at UTB/TSC and guided by UTB/TSC faculty.

Normandin, who now studies under Mohanty, is currently involved in population studies of gamma ray bursts.

One of the things he likes about UTB/TSC is the kind of guidance professors give. "They want you to become an independent researcher. It's mentoring, not hand-holding."

Normandin hopes to get his doctorate in 2013, then do postdoctoral research, although he's not sure where. Eventually he would like to have an academic career, but he would also consider industry. "I would be happy if I can use my mind to solve problems," he said.

He also hopes to be involved in gravitational-wave astronomy when these "ripples" in space are detected for the first time. So far there is only indirect evidence that these waves exist.

"All the research is indicating that they are there," Normandin said. "It would be really great to be part of something that helps solve the unknown, even if it's a tiny part."

For further information about this degree plan, visit Dr. Soumya Mohanty at SETB 2.254, call 956-882-6680 or email mohanty@phys.utb.edu.

NANO RESEARCH CHANGING MANY AREAS OF LIFE

University researchers probing the skies for gravitational waves are looking for the tiniest signals to confirm these "space ripples" exist. Some of the same scientists are also experimenting with the smallest of small in other scientific areas as well.

Assistant Professor Malik Rakhmanov has been working with the Laser Interferometer Gravitational-Wave Observatory (LIGO) project since 1994. A graduate of Moscow State University, he earned his Ph.D. in physics from the California Institute of Technology (Caltech), which jointly operates LIGO with the Massachusetts Institute of Technology (MIT). He has spent many years as a scientist-in-residence at the LIGO Observatory in Richland, Wash.

Rakhmanov has continued his research on gravitational-wave instrumentation since coming to UTB/TSC in 2008. He is also doing experiments in nanophotonics that could lead to all-optical computing.

"The goal is to better understand the interaction of light with matter and use this knowledge for building new photonic devices that will replace traditional semiconductor electronic devices in the near future," Rakhmanov said.

The research is taking place in a new optics lab in the Science, Engineering & Technology Building, Rakhmanov's pride and joy. Completed last summer, Rakhmanov and some of his students played a pivotal role in revamping the former classroom into a 1400-square-foot modern optics and nanophotonics lab and getting it operational.

The state-of-the-art laboratory has areas that are protected by soft-wall clean-room enclosures to perform precision optics experiments. It has research-grade optical tables, optics and electronics and an assortment of lasers, including the 10-W Nd:YAG highly-stabilized laser given to UTB/TSC by LIGO.

Rakhmanov thinks the UTB/TSC optics lab can compete with similar labs at larger and more well-known campuses. "Visitors from other universities who have seen the lab were impressed with its clean-room enclosures, lasers, optics, and electronics." said Rakhmanov.

In the same building, Associate Professor Karen Martirosyan is also dealing with things on a nano level. He is focusing on new nanomaterials that could do everything from making weapons lighter and more efficient to inventing tiny implantable biomarkers that could be used to help track cancer in patients.

He said the major challenge now is to make nanomaterials with tunable properties, which are now very expensive to develop and manufacture, more cost-efficient to produce.

Martirosyan, who has a Ph.D. in chemical engineering from ISMAN-Russian Academy of Sciences and the State Engineering University of Armenia (SEUA), came to UTB/TSC from the University of Houston in September 2010. He has been the principal investigator and co-investigator for several federal and state-funded research projects totaling about $2 million in the last five years. He was a participant in the 2010 Air Force Summer Faculty Fellowship Program and has been selected to the program again for summer 2011.

Martirosyan , who hopes to start a minor in nanoscience at the university, said he was drawn to UTB/TSC because of the opportunities for growth in the nanotechnology area.

Rakhmanov is also optimistic about the opportunities for students at the university right now. "Students here can get as good of an education in physics as anywhere else, provided they are motivated and willing to work hard," he said, giving the examples of two of his students, Sergio and Liliana.

Liliana Ruiz-Diaz, a junior in physics, landed a MIT internship this summer. Undergraduate Sergio Cantu, also a junior physics major, won a poster-presentation award in 2009 from SPIE, an international society for optics and photonics, and the Optical Society of America and is heading to MIT for a second internship this summer.

"There's a feeling of opportunity here, a feeling that something is happening," Rakhmanov said.

PUBLICATIONS LIST FOR CENTER FOR GRAVITATIONAL WAVE ASTRONOMY

1. LIGO-VIRGO-GEO JOINT PAPERS

The LIGO Scientific Collaboration: **M. Benacquista, T. Creighton, M. Diaz, R. Grosso, S. D. Mohanty, S. Mukherjee, V. Quetschke, M. Rakhmanov, J. D. Romano, R. Stone**, et al. [2011] Search for gravitational waves from binary black hole inspiral, merger and ringdown. General Relativity and Quantum Cosmology, Submitted 18 Feb 2011, arXiv:1102.3781v1 [gr-qc]

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