OAK RIDGE National Laboratory

Reporter

UT-BATTELLE

U.S. Department of Energy

Number 85, January-February 2007

New ‘spin’ on pulsars

3-D simulations uncover mechanism behind supernova remnant’s rotation

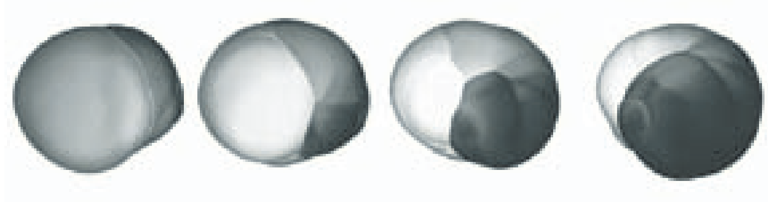
Tony Mezzacappa likens pulsars to big, cosmic lighthouses. To astronomers, the pulsar appears as a series of flashes of radio emissions. However, like a lighthouse, the pulsar—a spinning neutron star—is constantly emitting radiation but rotating so that the radiation is only seen when the pulsar spins around to the viewer’s perspective.

As an astrophysicist in ORNL’s Physics Division, Tony has been instrumental in developing a new theory of how pulsars are formed. He and John Blondin, a professor at North Carolina State University, recently published a paper in *Nature* theorizing how neutron stars are made to spin, with work stemming from supercomputer models of core-collapse supernovae.

Discovery leads to a new model for pulsar formation.

The complex three-dimensional models produce a rate of spin similar to that measured in actual pulsar observations. Previous theories projected a much faster spin than what has been actually observed.

Neutron stars are born in core collapse supernovae. Supernovae come in two forms: thermonuclear and core-collapse. Thermonuclear supernovae happen when a white dwarf star pulls material from another nearby star onto itself, collapses and eventually explodes outward. Core-collapse supernovae, which involve massive stars, occur more often than thermonuclear supernovae.



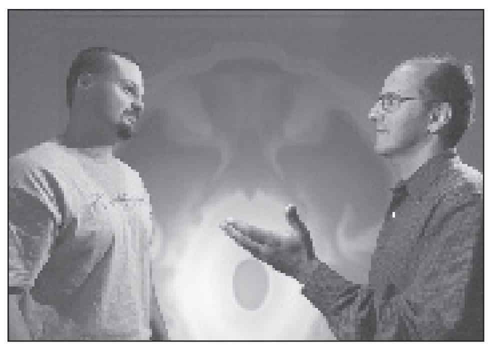
This visualization shows the progression of spiral formation in a supernova, a “sloshing” that eventually results in a pulsar’s spin. Three-dimensional computer models are the only models that show this effect.

For a star to die in a core-collapse supernova explosion, it must be huge—8 to 10 times the mass of our sun, with many layers, “like an onion,” Tony says.

Core-collapse results in either a black hole or a neutron star, which sometimes forms a pulsar.

The widely accepted theory has been that pulsars are formed from relic angular momentum, or the rotation left over from the original star after the collapse. Tony likens it to an ice skater who goes into a spin. The tighter the skater pulls in his or her arms, the faster the rotation. The only problem, says Tony, is that if it happens this way, the pulsars would spin much faster than what has been observed.

Young pulsars spin anywhere from once every 15 milliseconds to once every 300 milliseconds. Older pulsars can spin at a faster rate, spun up by other mechanisms as they age. The problem with pulsar formation as explained by relic angular momentum is that the pulsar would spin at a much faster rate.



Bronson Messer (left) and Tony Mezzacappa in 2001, early in their collaboration on core-collapse supernovae.

The Mezzacappa-Blondin simulations unveiled a new possibility.

“Our models were showing an unstable shockwave, ” says Tony, a discovery that would lead to a new model for pulsar formation.

When a core-collapse supernova occurs, the shockwave expands outward and then stops expanding for a very short time. At that time, if the shockwave is disturbed, Tony and John found that it would not return to its original spherical shape but continue to deform. This phenomenon is called the the Stationary Accretion Shock Instability, referred to as the SASI.

Below the distorted shockwave, Tony and John noticed that the interior fluids were rotating. Around the proto-neutron star in the center of the supernova, the fluid was moving in a counterclockwise rotation. In the outer shockwave, the fluid was moving in a clock-

(See PULSAR, page 6)

Feats of supercomputing strength require support system

The new theory of how a pulsar’s peculiar spin is created, published recently in an article co-authored by the Physics Division’s Tony Mezzacappa, wasn’t arrived at by peering through a telescope.

Instead, the findings, published in *Nature*, can be attributed to the emerging capability to perform three-dimensional simulations using powerful supercomputers such as ORNL’s Cray XT-3 Jaguar. Tony and John Blondin, his coauthor at North Carolina State University, credit the 3-D model with almost serendipitously uncovering the forces that enable their theory to match what is actually observed in pulsars.

Supercomputers are complex, high-maintenance machines. Although ORNL and collaborating scientists who have adopted modeling and simulation into their research have solid knowledge of programming, they also rely on the Center for Computational Science’s Scientific Computing group to optimize their codes on the Lab’s supercomputers.

“Cutting-edge computational science is always going to require custom software. Therefore, researchers need to know something about computational science—but they don’t need to know every nut and bolt,” says CCS’s Bronson Messer, who worked on the ORNL-NCSU pulsar project.

In fact, ORNL’s Center for Computational Sciences is building a reputation not only as the home of one of the world’s most powerful supercomputers for general research but also as home of one of the best support systems for simulation and modeling.

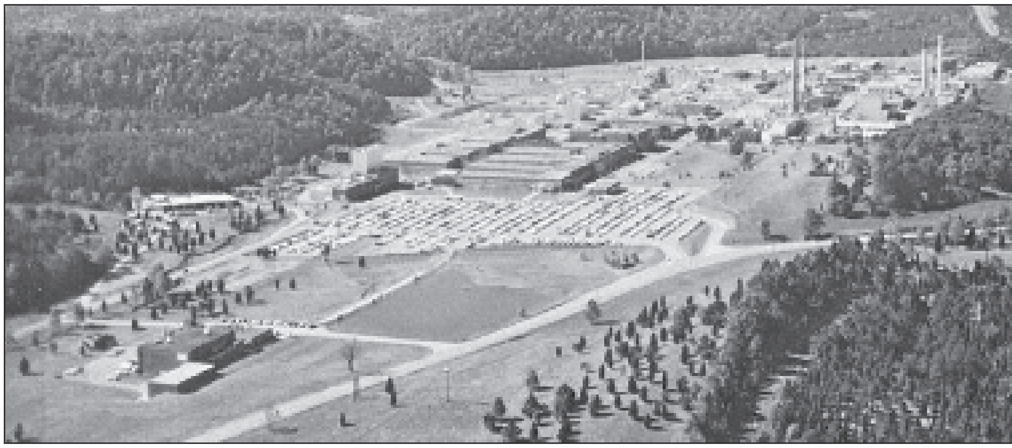
(See COMPUTING, page 6)

Space costs reflect investments in Lab's future

ORNL's modernization campaign, which began in earnest in 2002 and has already resulted in a complex of new facilities and associated program growth, has been accompanied by an upward evolution in space costs for Laboratory tenants.

These charges, which are basically rent, ultimately come from research dollars. Perspectives on what is received in return vary, sometimes based on where the tenant is sitting; for instance, in new, modern space or in some of the older and, for some, less desirable facilities.

"There are just two space rates: a rate for 'conditioned' and for 'unconditioned' space," explains Facilities Management Division Director Jimmy Stone. "Conditioned space is an office or lab where people work; unconditioned space can be generally considered warehouse or storage space."



Recognize this place? The Information Technology Services Division's Greg Bell came across this old postcard of ORNL recently. He believes it's from the late '50s or early '60s. It's a familiar angle, looking from the north, but there is no Holifield Tower, or much of anything, beyond the former east parking lot, where the new east campus is now.

Although all occupants pay the same rate whether they are in old or new space, organizations have Facility Use Agreements with FMD that specify what the Laboratory provides in general maintenance and services. These agreements vary from organization to organization, Jimmy says, because the wants and needs of the organizations vary.

The FUAs typically cover general maintenance, such as janitorial service, changing the light bulbs and unclogging drains. In Building 4500-South, one of the older but more heavily populated buildings that includes research labs for the Materials S&T, Biosciences and Chemical Sciences divisions, the FUA provides and maintains systems for hot and cold process, distilled and chilled water; hot drains; compressed air; air-conditioning maintenance and air balance (no easy task in that particular building); electricity; communications; and native, large equipment such as overhead cranes. The FUA also provides 24-7 coverage on critical equipment and an equipment predictive and preventive maintenance program.

Work for programmatic functions or special-order tasks, such as plumbing or wiring changes for lab equipment or a new coat of paint on an office, are requested and funded by the tenant, although FUAs cover the "common" areas such as halls and lobbies.

The everybody-pays-the-same model still grates against some, particularly those in older space. But Business and Information Services' Mike Emery, who watches over space finances, says there are tradeoffs.

"Upkeep costs are higher on the older facilities, which require more maintenance. They also use more energy than the newer facilities," he says.

Mike watches over a current $45 million space budget for the Lab, of which about 60 percent goes to maintenance and janitorial upkeep. Under the model, labs and offices are treated equally and rates are the same regardless of building or complex.

Roughly 30 percent of the space budget is used for leases or rent. Leased space includes the privately funded buildings on the new campus (the Research Office Building and adjoining facilities and the nearly completed Multipurpose Research Facility), the National Transportation Research Center and some office and warehouse space in Oak Ridge. About $2 million goes to property taxes on the private facilities and $1.1 million is for facility planning and engineering. Another $1 million is set aside for special projects or unplanned requirements that surface in the course of a year.

Space and utility costs are often confused, Mike says. Utilities—the light bill—are not covered in the space charge but are also charged at a standard rate per square foot (ORNL has a $40 million utility budget).

Utilities represent an area where tenants of older facilities may be coming out ahead. Jimmy notes that older facilities, such as the 4500 complex, are energy hogs while new building are more efficient, even though the tenants pay the same utility rate per square foot. Exceptions are major power users, such as the SNS, HFIR and the supercomputing organization, who pay actual costs.

ORNL went to a space charge in the late 1990s as a result of "reengineering" changes to the business systems model. ORNL under UT-Battelle adopted the landlord-tenant model that produces the use agreements.

Deputy Director for Operations Jeff Smith acknowledges that the new facilities brought with them increased space cost; he also points out that the investments in new facilities have been instrumental in R&D program growth in several areas.

"The Laboratory leadership made a strategic decision a few years back. We could have continued forward with the old, outdated facilities and infrastructure that UT-Battelle inherited in 2000, or invest in new facilities and infrastructure to bring ORNL into the 21st century. If we had chosen the former, our space costs would be much lower … but the facilities would literally be unable to support today's research programs," Jeff says.

"For example, ORNL wanted to be a leader in supercomputing in the 1990s, but there was no place to put a supercomputer. The new facilities have enabled that program to grow, as have others. Those new programs will ultimately foster continued growth," he says.

"ORNL's modernization, which is supported by these space charges, has helped secure the future of the Laboratory," Jeff says.—*B.C.*

Reporter

is published for employees and retirees of Oak Ridge National Laboratory, which is managed by UT-Battelle for the U.S. Department of Energy.

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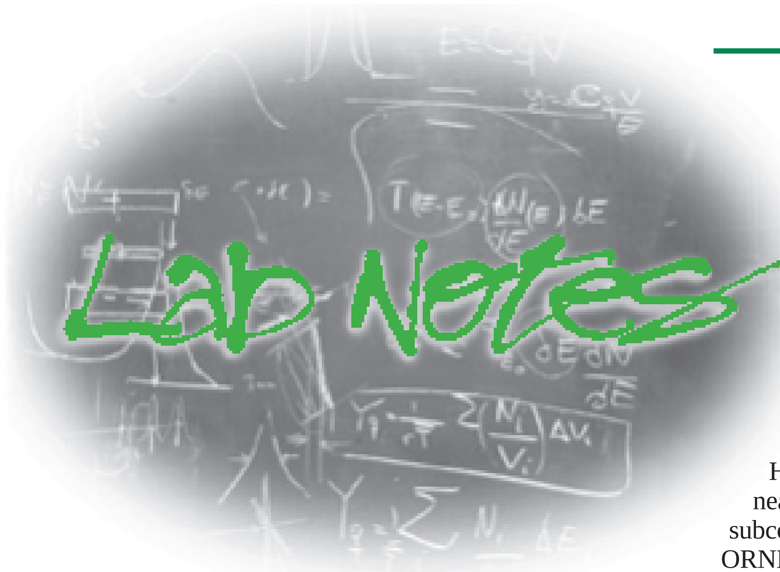


SNS: Beacon shines bright

Word from Chestnut Ridge is that the Spallation Neutron Source continues to please its builders, which means that, eventually, it will delight the neutron science community.

Following a December maintenance shutdown, the SNS was restarted the second week in January. Previously, SNS accelerator physicists performed the startups. This time, says the Research Accelerator Division's George Dodson, the SNS operators were at the controls, coached by the accelerator physicists.

"It's part of our transition to operation," he says. "New software makes it a highly automated process, much faster than it used to be. We tuned our way all the way through the linac in 16 hours instead of the usual 24."

In other words, it's becoming close to second nature. Currently at the start of an 18- to 24-month ramp-up to full operation, the SNS is already proving its mettle as a robust proton accelerator and neutron producer without peer.

"SNS is the highest energy proton linac in the world. Actually, we set that record a year ago," George says. "SNS has also set the record for highest number of protons in an accumulator ring and a record for the highest brightness, or protons per pulse onto the target."

As far as neutrons go, three instruments are currently receiving neutrons—the backscattering spectrometer and the liquids and magnetism reflectometers. In some configurations, the reflectometers measure the full neutron beam intensity, which the detector team notes is sufficient to saturate the detectors, even operating at a current two percent of the SNS's eventual 1.4 megawatt of power.

The Neutron Scattering Science Division's Ken Herwig says that the SNS is already producing enough neutrons to perform research.

"The backscattering spectrometer and reflectometers have enough neutrons, even at current power levels, to do science," Ken says. "The instruments have to be tweaked and must complete their commissioning process, but we are currently planning for our first real measurements."

"Doing good" for destitute kids

Funds that UT-Battelle contributed to match employee donations to the Asian tsunami relief effort are helping needy children in India. The $100,000 corporate donation will go toward building a permanent facility for the Divine Children's Home in Trivandrum, a city near the southern tip of the subcontinent.

ORNL Director Jeff Wadsworth, Computing and Computational Sciences Associate Laboratory Director Thomas Zacharia and Communications and External Relations Director Billy Stair were part of a Lab contingent that visited India in January to explore collaborative opportunities in science. A day of the trip was devoted to the orphanage, which currently provides a home to 30 children who would otherwise be destitute and on the streets.

Residents at the Divine Children's Home in Trivandrum, India. UT-Battelle's gift will help the home shelter three times as many kids.

The Team UT-Battelle board of directors approved the gift, which will help build a permanent orphanage to house as many as 90 children. The Divine Children's Home was founded by April Walker, who Jeff describes as someone with a "vision for doing good."

ORNL employees and UT-Battelle together donated nearly $200,000 to help victims of the Dec. 26, 2004, tsunami that killed hundreds of thousands and devastated areas along coastal regions of the Indian Ocean.

Doing good on the home front

Second Harvest Food Bank of East Tennessee has named UT-Battelle its corporate donor of the year for helping the charity food distributor accommodate an influx of evacuees that poured into East Tennessee in the wake of Hurricane Katrina.

A corporate donation of $50,000 from UT-Battelle to Second Harvest helped provide food and personal care items to the displaced survivors of the catastrophic storm.

"UT-Battelle and its employees made truly heroic contributions to people in need in East Tennessee," says Second Harvest Executive Director Elaine Machiela. "The funds they have contributed enabled us to provide food and necessities for the nearly 4,000 evacuees while still caring for the 100,000 permanent residents who receive food from our six programs and 350 agency-food partners."

In addition to helping out in crises, Second Harvest has ongoing programs to send food to needy families and support meal programs in both urban and rural school systems in the area. There is need: Machiela says more than half the kids in the food bank's 18-county region qualify for federal food aid, and in some counties most kids qualify.

Last year Second Harvest distributed food for 7 million meals, a 14-percent increase over 2005 while trimming its overhead by two percent. By running things right and directing otherwise wasted packaged and prepared foods to hungry mouths, 95 cents of every Second Harvest dollar is applied to putting food on a hungry person's plate.

Reported by Bill Cabage

Jay Nave

Lab Director Jeff Wadsworth and Second Harvest Executive Director Elaine Machiela.

Outstanding efforts result in Significant Event Awards

Significant Event Awards were distributed recently for outstanding accomplishments in research and operations. Congratulations to the following staff members.

Biological and Environmental Sciences

Denise Casey, for creating the first newsletter of the Artificial Retina Project for the Office of Science.

Annetta Paule Watson, Dennis Opresko and Robert Young, for developing Community Preparedness Guidelines for Chemical Warfare Agents.

Computing and Computational Sciences

Daniel Getman, Mark Gardner and Hamilton Hunter, for developing the Sensor Network Area Protection System, an evolutionary project in the use of emerging sensor data.

A.E. Baker, Mark Dobbs, Suzanne Willoughby, C.D. Fisher and Brian Swail, principal contributors from the Computing and Computational Sciences team, for planning and management of the successful power outage of the ORNL central computing facility.

Ed D'Azevedo, for significant algorithmic contributions to improve Quantum Monte Carlo simulations of materials science.

Energy and Engineering Sciences

P.D. Lloyd, R.F. Lind, J.F. Jansen, J.C. Rowe and L.J. Love, for the two-year research program for development of a new and unique mobility system (POP-T vehicle).

Fred Peretz, for successful management of the Space Nuclear Auxiliary Power Reactor dismantlement project through approval of the readiness and removal of NaK coolant.

Donald Spong, for developing a methodology for analyzing and displaying the self-consistent plasma flows in stellarators and the application of these techniques to five different stellarator configurations.

Bruce Bevard, for serving as chief architect of the NRC's "Laboratory Technical Consortia" with ORNL and Pacific Northwest, Brookhaven and Argonne national labs.

Lloyd Clonts, Bill Bryan and William Holmes Jr., for developing a very low-power transducer bus interface module for taking critical temperature and measurements and providing motion controls at a USEC R&D facility in extreme environments.

Michael Ehinger, for being a significant contributor to the Global Nuclear Energy Partnership.

Karen Kaldenbach and Norman Turk, for accomplishments in support of ORNL's expanded role in DOE-NNSA's Material Protection Control and Accounting Program.

Karen Fugate, for efforts to meet an aggressive milestone for publication of the proceedings for the 14th Symposium of Separation Science and Technology for Energy Applications.

Dorothy Tate, for initiative and actions enabling the Nuclear Technology Programs Office to continue to function during an interim period.

High Flux Isotope Reactor

Dean Myles, Lee Robertson and George Wignall, for successfully demonstrating operation of new SANS instruments at HFIR during the DOE Basic Energy Sciences review of the Center for Neutron Scattering.

J. Fair, J.K. Carter, D. Smith and J. Castleberry, for dedicated support of the administrative support team vital to the successful preparation and completion of the BES review of the Center for Neutron Scattering.

National Security

W.H. McDonald, M.B. Wise, K.J. Hart, A.V. Palumbo, L.J. Hauser, C.W. Schadt, W.H. Griest and J.C. Doesburg, for preparation for ORNL's proposal for Systems-of-Systems for future CB detection with a focus on genetically modified organisms and genetically engineered threats.

Physical Sciences

D.L. Erdman, R. Battiste, J.M. Starbuck, E. Lara-Curzio and D.W. Bradford, for activities to support the restart of the Palo Verde Nuclear Power Plant.

Paul Koehler and Roland Overton, for successful efforts to re-establish operation of the Oak Ridge Electron Linear Accelerator.

G.L. Bell, J.D. Hunn, R.A. Lowden, F.C. Montgomery, P.J. Pappano and M.P. Trammell, for completing a DOE Level 2 milestone by fabricating test articles for the Advanced Gas Reactor Fuel (AGR-1) irradiation experiment.

J.C. Blackmon, D.W. Stracener, M.S. Smith, D.W. Bardayan and S.B. Kennedy, for safely developing a unique, intense beam of radioactive beryllium-7 for nuclei astrophysics experiments.

Leslie Wilson, for preparation of stripping foils for the Spallation Neutron Source to meet a ring commissioning deadline.

Stanley Cooper, for developing a system to manage radioisotope inventories for a radiological facility.

David Harper, for contributing to the successful completion of the Materials S&T Division's Materials Processing Group High Bay Revitalization.

Brenda Campbell, for being a major contributor to the success of the Genome to Life proposal and project.

Spallation Neutron Source

J.A. Crabtree, M.P. Howell, T.S. Neustadt, M. Santana and D.M. Vandygriff, for team efforts to help SNS recover from a critical inner reflector plug component failure to meet the project completion date.

D.C. Lousteau, M.W. Wendel, J.A. Crabtree, K.K. Chipley, L.L. Jacobs, M.J. Rennich, R.E. Battle, G. Farquharso and G.A. Johnson, for team efforts to install and commission the SNS mercury target, which paves the way to next-generation neutron sources.

R. Savino, A.W. Webster, J.A. Crandall, T.L. Toomey, W.E. Barnett Jr., T.M. Carroll, J.R. Maines, K.R. Rust, W.D. Newby, J. Tang and J.E. Cleaves, for successful installation of the SNS accumulator ring, which was completed as scheduled and represents a major milestone in the SNS project.

D.W. Freeman, M.A. Plum, E.B. Iverson, T.J. Shea, F.X. Gallmeier and P.D. Ferguson, for being the team that orchestrated the final steps that culminated in the successful production of neutrons, demonstrating to the world that the SNS had successfully met its commissioning goals.

Business and Information Services

R.L. Etheridge, R. Stooksbury, A.S. Goin, B.N. Shaw and J.R. Duncan, for significant contribution to the SNS project by awarding over $5 million worth of critical path instrument procurements.

Carol Rice, for serving as the key subject matter expert for the Electronic Work for Others (eWFO) user implementation.

Environment, Safety, Health and Quality

Gerard Payne, for having a lead role in metrology accreditation and the first Positron Emission Tomography Intercomparison Laboratory.

Sandy Beeler, Tim Forrester and Randy Pukelek, for significant contributions to the continued development of the ORNL Nevada Test Site Waste Disposal Program.

Susan Michaud and David Skipper, for contributions to the Environmental Management System improvements to reduce the environmental impact of Laboratory operations.

C.A.J. McCollister, J.P. Adams, A.L. Herrell, M.A. Johnson, R.E. Peden Jr, V.K. Raby, L.C. Wilson Jr., D.E. Rice and J. Davis, for response to and reduction of hazardous materials incidents at ORNL.

Facilities and Operations

Keith Dempsey, for efforts in support of major new ORNL initiatives and facilities in security and supercomputing.

Richard Griffin and Owen Hale, for excellence in planning and executing the Computational Sciences Building supercomputing Facility planned outage.

Richard Griffey, for significant contribution and technical support to the CSB power and computer outage.

James Payne, for leading safety awareness training of STOP For Each Other (electrical safety training) for all F&O non-supervisory employees.

Charles Lamb Jr. for development and implementation of the Emergency and Standby Diesel Generator Management Program.

Donald Sampsell for efforts to coordinate and manage craft support to the Cold Source Project.

Ronnie Crawford and Gary Fraker, for significant roles in completing the installation of the DOE-sponsored HERMES project, which is a PEP milesetone.

Eric Stroud, for development and implementation of the Emergency and Standby Diesel Generator Management Program.

P.H. Vasquez, G.M. Cross, T.S. Orr and R.B. Kendall, for reducing costs and complexity of improving compliance with state and federal environmental regulations associated with the F&O Best-in-Class Chemical Management System.

Mark Lower and Kathy Parton, for development and initial implementation of ORNL's Pressure Vessel Program.

L.J. Mezga, S.L. Laman, J.K. Beeler, E. Ryan Jr. and J. Slaten, for contributions to the planning; characterization; asbestos, PCB and universal waste abatement; and demolition of the Freels and Solway Bend buildings.

Nuclear Operations Directorate

R. Haire, I.G. Gross, K.A. Breeden, M.J. Pierce, J.K. Gibson, T.L. Harvey and J.A. Miller, for successful completion of the Building 5505 Radiological Inventory Reduction (special form capsule re-packaging) project.

Office of Laboratory Director

Thomas King Jr., for unbiased, nonparochial review of detailed program and technology assessments and identification of crosscutting R&D themes to advance DOE's Energy, Science and Environment mission objectives.

Bonnie Nestor, for contributions to the Office of the Laboratory Director.

Lynn Kszos, for contributions to the Office of Strategic Planning during the interim period without a director.

Communications & External Relations

Peggy Tinnell, for significant contributions to the success of Club ORNL.

Human Resources

Deborah Stairs, for leading the accomplishment and implementation of three different goals this year, including the "Developing Leadership Potential" pilot program, the Gallup Q-12 survey and a new Succession Planning Model.

Office of Counterintelligence

Christopher Marsalis, Rolf Migun and Sam Howard, for team efforts to conclude an investigation that had been languishing, making it possible for senior management to make sound judgments on how best to brief senior DOE officials.

Lab power grid gets boost with TVA's new substation

ORNL's 25- to 30-megawatt electrical power demand has remained fairly steady over the past 40 years. But with power-hungry petaflop machines destined for ORNL's Center for Computational Sciences, as well as other potential projects, that demand is projected to double within the next three to five years.

A brand new power substation, brought fully online in January, replaces the Laboratory's 60-year-old existing substation and promises to satisfy the power needs for the half- century to come.

The Tennessee Valley Authority built the $19 million facility as part of its power grid, says Lynn Degenhardt, who managed the construction project for ORNL.

The partnership with TVA allowed ORNL to save significantly on construction costs by tapping into TVA's buying power as a large utility, saving on equipment, poles, line and other components of the substation.

The substation is located near the 7600 Experimental Gas-Cooled Reactor site. TVA and ORNL picked the site, Lynn said, because of its proximity to fusion research being done in the 7600 area and because the site was flat, with little rock to be removed to make way for the ample footings needed by the substation.

The location allowed the substation to tie in to a 40-megawatt line that had been installed as part of the EGCR project but, as the project did not reach completion, never used.

The substation's location, Lynn said, actually helps TVA manage its power grid, and offers the opportunity to feed new lines into Hardin Valley and Solway as development there continues to surge. From these high voltage lines, transformers bring the power down to 13.8 kilovolts and then lines carry power, via three switchgear buildings, to the ORNL campus, 7600 area and High Flux Isotope Reactor. The site has room to add a fourth transformer and switchgear building as the Lab's demand for power grows.

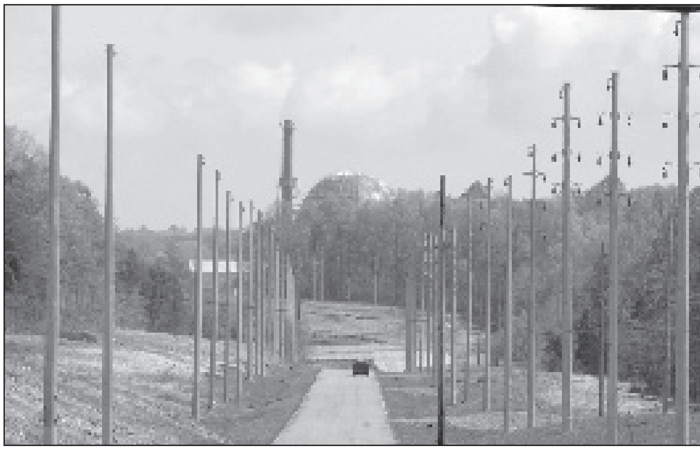
With state-of-the-art equipment and safety features, the new substation features controls that tie into the Laboratory's computer network, allowing Lynn and others to monitor the equipment remotely. There is also a fiber-optic arc-detection system that automatically shuts down power coming in and out of the building if a circuit shorts. Another safety system pipes away potentially explosive copper vapor that could result from a short circuit.

"When we started negotiations with TVA two-and-a-half years ago, we had no idea that we were going to get a petaflop computer in the CSB. Now we have the power available and the reliability," Lynn says.

Charlie Bruce, of Facilities & Operations' Electrical Utilities group, says ORNL is "tightly tied" to the TVA grid. The substation's 161-kilovolt lines now or eventually will receive power from all of TVA's power plants including Kingston and Bull run steam plants and Fort Loudoun dam.

Lynn, who will retire at the end of February, said building the substation has been the highlight of his nearly 33-year career at ORNL.

"This is my last hurrah," he says. "If you're an electrical power engineer it's always your dream to be able to build a new substation from scratch." —*Larisa Brass*



New transmission lines mark the way to TVA's new substation, near the site of the old Experimental Gas Cooled Reactor, seen on the horizon.

Computing

Continued from page 1

"The pulsar result was completely computational," Bronson says. "It came because we could run for a long time and we could run in 3-D, both of which require a lot of powerful processors."

Two-dimensional models of the collapse of giant stars did not reveal the flows that create a spin more in line with what astronomers actually observe.

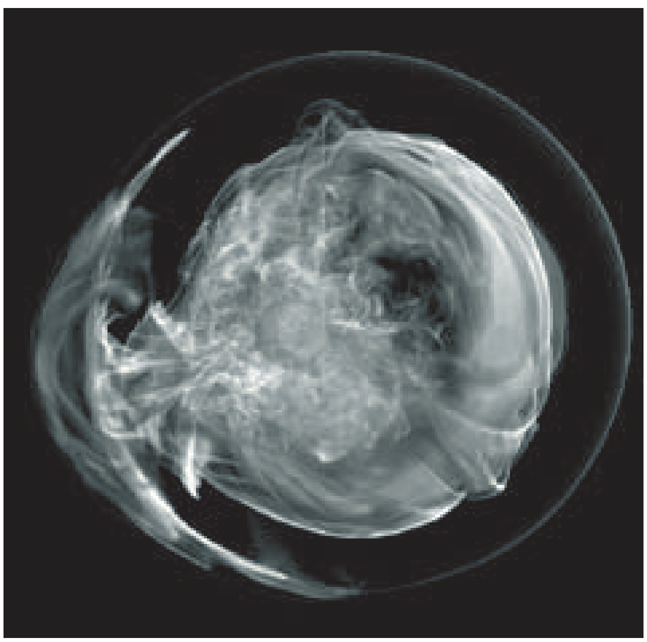
Bronson describes the process of executing a complex code on a supercomputer as an arduous process of running, stopping, tweaking and testing. CCS's computational scientists often provide both in-depth knowledge of the computer itself and a good grasp of the science involved in the simulation, enabling projects on the machines to maximize the efforts of all the scientists involved.

A "motley crew" who work together, live close to the machine and share insights with each other.

The ever increasing power and speed of supercomputers add to their complexity but also enable researchers to do more science in less time.

"The metric that people care about is the 'wall-clock time to solution'—in other words, how long it takes between starting dinner and putting it on the table. It's not just the run itself, but the whole process of discovery," Bronson says.

A key element in the process is the compiler, a software program that turns the researcher's code into instructions for the computer. Like a foreign-language translator, a good compiler optimizes performance by picking up on idiosyncrasies in the code, conveying what is meant rather than what is explicitly said.



John Blondin, NCSU

Three-dimensional simulations, made possible by the growing computational capacity, helped reveal the dynamics behind the pulsar's slower-than-expected spin.

"A good compiler can make life much easier for a developer," Bronson says. "Compiler writers are very specialized people."

(If you're the type of uncle who likes to give nephews career advice, take one aside at the next family reunion and whisper "compiler writer" in his ear.)

Bronson expects parallel computing to become more elegant and efficient as computing powers ramp up past the 100 and 250 teraflop/s range—by sheer necessity. But the human element will always be vital to the process.

"Computing on the 'bleeding edge' of technology will always mean you will have to do some things for yourself. Of course, the forefront computing of today becomes the everyday stuff tomorrow," he says.

Bronson believes the biggest barriers facing scientific computing are power consumption and reliability. Supercomputers gulp electricity; in fact, the building that houses ORNL's Center for Computational Sciences recently switched over to a new substation to feed the hungry computers. Moreover, adding processors also means having more processors that can fail, putting operators in an increasingly hectic race to change out bad units. Designers, Bronson says, are looking for ways to make the machines more robust.

Bronson describes the Scientific Computing group, which supports scientists in research ranging from advanced materials theory to climate change to astrophysics, as a "motley crew with different interests," but who otherwise work together, live "close to the machine" and share insights with each other. For instance, knowledge gained in supernova simulations could be applied to combustion modeling.

Through that sharing of experience, the researchers come out ahead.

"We're not just a cycle shop," Bronson says. "We're in a partnership with our users."—*B.C.*

Pulsar

Continued from page 1

wise rotation equal to that of the interior fluid (the total angular momentum remained zero). The SASI seemed to be driving these counter rotating flows.

The SASI also caused the movement of the stellar core fluid to exhibit "sloshing," pushing the supernova into different shapes. In a two-dimensional model where the effect moved along one axis, Tony says that the shape becomes much like a cigar.

In three dimensions, however, the SASI leads to "spin-up," or the formation of a pulsar. The SASI-induced flow spirals as it sloshes. When formed, the pulsar in the model spun once every 50 milliseconds, a situation more plausible—and more reconciled to what has actually been observed—than the relic angular momentum, "ice skater" explanation.

Relic angular momentum had to be taken into account, however. Tony and John ran models with and without relic angular momentum, to see what role it played. They found that in both instances, the SASI still occurred, but it occurred faster in the presence of relic angular momentum. The three-dimensional models were the only models that showed the formation of spin-up.

"We can't understand core-collapse supernovae and their remnants unless we simulate them in three dimensions," says Tony.

Making the models was a serious undertaking. John and Tony used ORNL's Cray Phoenix supercomputer to process the models. Aside from the time and work in writing the code and mapping it onto billions of grid points, the simulation took days to run, produced 40 terabytes of data and required contributions from a number of people. Complete supernova models will take months to run. (See the companion article on page 1.)

It is an arduous process, but Tony isn't satisfied.

"More work needs to be done," says Tony. "We need a complete supernova simulation to determine whether our findings are robust."

Studying supernovae is very important, Tony says. Half the heavy elements (elements heavier than iron), which include elements necessary for life, come from core collapse supernova explosions. He and others who study core collapse supernovae hope to discover more about our existence in the universe.—*Whitney Downing*

Whitney Downing is a science writing student at Maryville College.

New Staff Members

Charles Phillip Baxter, Audit & Oversight Dir.
Sean Patrick Coombs and Thomas Matthew Powell, Facilities Management
Jayme Lynn Green, Stacey Lynn Jones, Heidi Louise Lesser, Douglas James Engle, Debra Michelle Garrett, Bert Anthony Love, Timothy Thomas Miner, Ryan James Morgan, Brooks Vincent Coleman and Michael Thomas Spaar, NScD Research Accelerator
Carl Wilbur Irvine and Ronald Keith Keever, Nonreactor Nuclear Facilities
Thomas Andrew Kerr and Daron Jay Keesee, Laboratory Protection
Paul Christian Snijders, Materials Science & Technology
Richard L. Graham, Center for Computational Sciences
Sharon Kay Allen, HPC Operations Group
Jason Keith Aycock, Jason Robert McDaniel and Edward Merle Johnson, Craft Resources
Chen Jin and Jean Christophe Bilheux, NScD Neutron Scattering Science
Sandra Kay Trail, Fabrication
Ranga Raju Vatsavi, Computational Sciences & Engineering
Zili Wu, Chemical Sciences
Anthony Ray Horton and Enis Tuncer, Fusion Energy
Phillip Ryan Lawlor and Dennis Lebron Aslinger, Facilities Development
Andrei Yurievich Petrov, US ITER
Benjamin Paul Hay, Chemical Sciences
Yu (Cathy) Jiao, Marie Urban and Paul William Donnelly (co-op), Computational Sciences & Engineering
Ryan M. Adamson, Information Technology Services
Stephen W. Poole and Jonathon Alexander, Computer Science and Mathematics
Albina Y. Borisevich and Satoshi Okamoto, Materials Science & Technology
Barbara Cornett and Blair Arthur Ross Jr., National Security
Scott M. Hollenbeck, Center for Nanophase Matl's Sciences
Michael David Sugarman, Safety Services
Wendy Ann Wilson, NScD Neutron Facilities Development
Yun Pan, Environmental Sciences

Club ORNL: Roundball, Dollywood, music coming up

Feb. 17. Cooking Classes at Whitestone Inn. Session 1 is Everything Chocolate. Deadline for registration is 2/12/07. This hands-on class includes a special chocolate breakfast plus lunch with a great chocolate dessert. This class is limited to 50 people, at a cost of $63 per person, and runs from 9 a.m. to 4 p.m.

Session 2, the Complete Gourmet Meal, is full.

Contact Deneise Lane at Whitestone Inn, 888-247-2464, ext. 157 or deneise@whitestoneinn.com. Payment is required when you make the reservation.

Feb. 25. UT Women's Basketball vs. Vanderbilt (1 p.m., Thompson-Boling Arena) ticket purchase deadline is Feb. 19. Group rate of $5 per ticket, plus a $1 per ticket handling charge ($6 total). *No limit on number of tickets to purchase.* Tickets sold on a first-come, first-serve basis. Purchasers' names will go in a drawing for one of eight basketballs autographed by coach Pat Summit (4) and coach Bruce Pearl (4).

Tickets are available at this link: https://www.groupticketwindow.com/groupticket/college/TennesseeUniversity/group. Sign-in: ornl (lowercase). Password: govols (lowercase).

Once you sign in, the available basketball games will appear. Click on the game and follow the directions. For further information, contact Club ORNL athletic chair Joan Lawson (lawsonjw@ornl.gov or 576-9120).

Late February-early March. Dollywood tickets will go on sale late February or early March. Watch *ORNL Today* and the Club Website.

March 16: KMA "Alive after Five" featuring music by Oak Ridge's own Little Big Band.

March 31: Predators Hockey

April 21: Keeneland Racing Trip. Adults only event. Cost covers bus ride, admission and buffet.

April 28-29: Big South Fork Overnight. Cost will cover lodging and two meals —dinner on 4/28 and breakfast on 4/29.

May 17: Golf tournament **May 23:** Car show

Interested in the most up-to-date Club ORNL News? Check out the club's Web page online via the ORNL home page. To gain access to the ORNL home page, one must first register in XCAMS by going to http://www.ornl.gov/adm/clubornl_signup.shtml. After receiving your XCAMS account and Club ORNL membership, retirees can then go directly to https://www.ornl.gov/adm/clubornl. Nancy Gray (576-9479; graynl@ornl.gov) is Club ORNL's point of contact for retirees.

Service Anniversaries

January 2007

35 years: William R. Wing, Computer Science & Mathematics; Auzzie Bee Freeman, Logistical Services

30 years: Michael A. Kuliasha and Mary Jayne Long, National Security; Dennis M. Opresko and Gregory P. Zimmerman, Environmental Sciences; Raymond W. Tucker, Donald J. Adams and Bobby R. Whitus, Engineering S&T; Steven H. Overbury, Chemical Sciences; R. L. Cline and Clyde Phillip McGinnis, Nuclear S&T; Dennis E. Boyd and L. A. Grayso, Craft Resources; Earnestine Sloan,Creative Media; Linda J. Foote, Biosciences; Robert James Shamblin, Integrated Operations Support; Thomas J. McLaughlin, NScD Research Accelerator

25 years: Mike L. Evans, Nonreactor Nuclear Facilities; Cyrus Baktash, Physics; Lynn M. Smalley, Materials S&T

20 years: Teresa J. Cochran, Quality Systems & Services; Natalie L. Crippen and Julia Suzanne Kuliasha, National Security; C.G. Spence, Human Resources; Michael Wayne Hodge, Audit & Oversight; Gyula Eres, Materials S&T; Anthony Vito Palumbo, Biosciences; George W. Hill, Information Technology Services

February 2007

40 years: James D. White, National Security Dir.; Rolland B. Rayder, Craft Resources

35 years: Willard H. Johnsey Jr., Craft Resources

30 years: Michael Eugene Mellon and Gwen L. Justice, Logistical Services; Robert W. Smithwick III, Chemical Sciences; Sherri J. Cotter, Facilities Development; Pauline A. Thomas, Curtis E. Moore and Maria A. Goodman, Craft Resources; Joseph N. Herndon, Energy & Engineering Sciences; Donald William Lee, Environmental Sciences; Joe Wolfe, Environmental Protection & Waste Svs; Edward D. Blakeman, Nuclear S&T; Edwin R. Blackburn, Facilities Management; Luther David Lambert, Nuclear Nonproliferation; Randy Howell, Materials S&T; Stanley C. Forrester, Fusion Energy; Michael Edward Borum, Laboratory Protection; Randall J. Wood, NScD Research Accelerator

25 years: David Kennard, Integrated Operations Support; Ellen D. Smith, Environmental Sciences; Vasilios Alexiades, Computer Science & Mathematics; François G. Pin, Engineering S&T; Terry C. Awes, Physics

20 years: Lisa Violet Patt, Audit & Oversight; Gerard Francis Payne, Quality Systems & Services; Randy Ogle, Center for Nanophase Matl's Sciences; Anthony Wayne King, Environmental Sciences; Michael B. Gettings, Engineering S&T

SNS, supercomputing, nanoscience highlight 2006

Creation of the first neutrons at the Spallation Neutron Source was one of many ORNL high points in a year filled with milestone achievements.

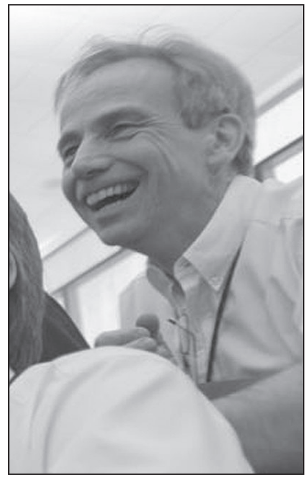
In 2006 ORNL moved to the forefront of neutron science, opened DOE's first nanoscience center, built the world's most powerful nonclassified supercomputer and assumed leadership of the U.S. role in the international effort to build a fusion reactor.

"We have experienced a truly remarkable year at ORNL and have laid the groundwork for even greater scientific achievements in the future," says ORNL Director Jeff Wadsworth. "We will continue to build on this foundation for years to come."

The first neutrons at the Spallation Neutron Source—"spalled" at 2:04 p.m. on April 28—climaxed a seven-year, $1.4 billion construction project and launched a new era of scientific research in Oak Ridge. The historic moment was witnessed by jubilant staff in the SNS control room and reported by media around the world.

Finished "on time, on budget and on scope" with an excellent safety record, the facility will eventually contain a suite of 24 instruments and greatly expand scientists' ability to study and manufacture lighter and stronger materials.

Complementing SNS is the High Flux Isotope Reactor's cold neutron source, which passed crucial systems tests in 2006 and will soon be one of the leading sources of "cold" neutrons for advanced materials research. Together, the two facilities will make ORNL the undisputed world leader in neutron science. Located adjacent to the SNS, ORNL's NanoScience Center hosted 139 visiting researchers in 2006. The $65 million facility, also completed ahead of schedule and under budget, allows users to study and create materials 100,000 times smaller than a human hair.



Curtis Boles

At the sight of the SNS's first neutrons on April 28, Accelerator Systems Division Director Ian Anderson's expression said it all.

This relatively new field of nanoresearch has endless potential, including technologies to improve the environment, better sensors for industry, nanoscale computer processors, renewable energy and lighter and more durable materials for vehicles of the future.

ORNL's National Center for Computational Sciences finished the year at No. 10 on the TOP500 Supercomputers list. A processor upgrade last summer pushed the Cray XT3 system at ORNL to 54 teraflops (54 trillion mathematical calculations per second) of computing power—the fastest peak processing of any nonclassified supercomputer.

The TOP500 list was released in November and does not include 68 new Cray XT4 cabinets that will enable ORNL to exceed 100 teraflops early this year and reach 250 teraflops in 2008.

DOE's Leadership Computing Facility at ORNL is on a path to reach a petaflop, or 1 quadrillion mathematical calculations per second, by 2009. Working in partnership with the Tennessee Valley Authority, the facility received an additional 3.3 megawatts of power in 2006 to support the enlarged machines.

The U.S. Project Office for ITER, an international effort to build an experimental fusion reactor in Cadarache, France, was moved to Oak Ridge in 2006. The U.S. effort, led by Ned Sauthoff, hopes to benefit both from ORNL's considerable fusion expertise and the Laboratory's successful experience with the SNS construction project.

ITER, Latin for "the way," seeks to explore the feasibility of power from fusion—the process that heats the sun and stars. Several ORNL staff members have joined or are scheduled to join both the U.S. and International ITER teams.

ORNL also announced plans in 2006 for the Oak Ridge Science and Technology Park, the first private business office development to be located onsite at a national laboratory. The 12-acre park, with plans to expand to approximately 40 acres, will be occupied by university branch offices, start-up companies and outside industry, offering tenants better access to ORNL researchers, instruments and facilities.—*Mike Bradley*

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