Smashing debut for novel atomic nuclei

Researchers have identified six new isotopes in the debris resulting from high-speed collisions between krypton ions and a nickel target. The discovery of these rare atomic nuclei – particularly arsenic-65 – provides the first experimental evidence to support a key step in a theoretical model that describes how a neutron star generates intense bursts of X-rays.

"This is the first time that arsenic-65 has been identified," says graduate student Michael F. Mohar of Michigan State University in East Lansing. "It's an astrophysically important result." Mohar and his co-workers report their discovery in the March 25 PHYSICAL REVIEW LETTERS.

Working at Michigan State's National Superconducting Cyclotron Laboratory, the researchers directed a high-energy beam of krypton-78 ions into a nickel target. The interaction produced a spray of atomic nuclei, which then passed through a detector for identification.

The six newly identified isotopes – arsenic-65, gallium-61, germanium-62, germanium-63, bromine-69 and strontium-75 – lie very near a somewhat ill-defined, theoretically derived boundary known as the proton-drip line. This boundary marks the point at which the repulsive forces between protons in a nucleus become so great that no more protons can be added to create a new nucleus. An added proton would simply "drip off."

The new isotopes survive for at least 150 nanoseconds – the time it takes them to travel the detector's length. "What we've done so far is simply identify the isotopes," Mohar says. "We are now planning experiments to actually measure their decay half-lives. This is what the astrophysicists need."

Arsenic-65 in particular occupies a strategic position in a hypothetical chain of nuclear reactions taking place on the surface of a neutron star that has collected material from a nearby, hydrogen-rich star. In this model, the energy required to drive the thermonuclear explosion necessary to produce an X-ray burst would come from a special sequence of nuclear fusion reactions in which nuclei capture protons to create new isotopes.

Evidence that arsenic-65 exists and has a sufficiently long half-life would remove a potential bottleneck in this proton-capture process. "Whether or not arsenic-65 exists affects how much energy you get out in an X-ray burst . . . and the time between bursts," says astrophysicist Stanford E. Woosley of the University of California, Santa Cruz, who with a colleague first proposed the proton-capture pathway for generating X-ray bursts.

– I. Peterson

Eggs not silent partners in conception

A human egg cell does not idle languidly in the female reproductive tract, like some Sleeping Beauty waiting for a sperm Prince Charming to come along and awaken it for fertilization. Instead, new research indicates that most eggs actively beckon to would-be partners, releasing an as-yet-unidentified chemical to lure sperm cells.

A binational team of researchers, led by Michael Eisenbach of Israel's Weizmann Institute of Science in Rehovot and David L. Garbers from the University of Texas Southwest Medical Center in Dallas, have found a fluid in some women's ovaries that acts as a powerful chemical magnet for attracting sperm cells. The substance – drawn from the ovarian follicles that nurture maturing eggs before they are released during ovulation – has the potential for eventual use in treating some forms of infertility, the researchers suggest.

"If we succeed in isolating the attractive factor from the fluid . . . this may be a way to enrich a sperm sample and select for sperm capable of fertilizing [a particular] egg," says Eisenbach. Antibodies to the purified factor might also serve as a contraceptive, he says.

"It's biologically plausible that there should be a chemical attraction between egg and sperm," says Robert Stillman, a reproductive endocrinologist at George Washington University in Washington, D.C. "Now a lot of work needs to go into isolating and characterizing [the attractant]."

Eisenbach and his colleagues set out to determine whether human eggs exude an attractive substance after previous studies done by others showed that female mammals can hoard dormant sperm, which later spring into action after the female ovulates. The researchers, who report their results in the April 1 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, collected fluid from the follicles of 40 women whose mature eggs were being removed for *in vitro* fertilization. Fluid from half of the women caused two to three times as many sperm to swim through a filter as did a plain salt solution. In another test, sperm also changed direction to swim toward a squirt of the fluid. Moreover, an egg from a follicle whose fluid attracted sperm proved nearly twice as likely to be fertilized as one from a follicle whose fluid drew no sperm.

The fluid attracted only the most active sperm. Eisenbach says this finding could explain why only 200 to 300 of the roughly 280 million sperm contained in one ejaculate actually reach an ovulated egg.

– C. Ezzell

Roman conquest clues emerge at Carthage

At the ancient archaeological site of Carthage, scientists digging into sediments beneath a harbor have uncovered clues to the military strategy that led to the city's defeat by the Romans more than 2,100 years ago. The findings help clarify the historian Appian's written account of the siege of Carthage, led by the Roman general Scipio in 146 B.C., says geoarchaeologist John Gifford of the University of Miami, a co-director of the project.

Scipio's attack destroyed Carthage, then a major metropolis and center of an extensive Mediterranean trading network. The battle served as the culmination of three great wars between Rome and Carthage in the 3rd and 2nd centuries B.C. But Appian's description leaves unclear the method by which the Romans overwhelmed the fortified city.

Research conducted at the north African site – now part of Tunisia – in the summers of 1985 and 1986 yielded underwater remains of a stone causeway that allowed Scipio's army to attack from a base on a barrier island about 600 meters from Carthage's port, Gifford's team contends. They have submitted their findings for publication.

"We think Scipio had his men dump thousands of tons of rock into the shallow harbor, which was only a few meters deep, and build an artificial landfill over which he mounted an attack on the harbor walls," Gifford asserts.

Scipio may have borrowed the strategy from a military predecessor, Gifford adds. In 312 B.C., the Greek ruler Alexander the Great conducted a successful siege of Tyre, another coastal Mediterranean city, by building a causeway from a barrier island to its port. Scipio had access to written accounts of that campaign, and Gifford suspects the Roman general appropriated Alexander's tactic.

Gifford's team also dug into the history of Carthage's coastline by extracting 16 sediment cores from different locations around the surviving port. The composition of sediment from the bottom of some of the cores, along with radiocarbon dates obtained from bits of carbon, suggests a natural lagoon existed at the site around 500 B.C. Historical records indicate the Carthaginians resculpted the coastline and built two large harbors around 200 B.C.

Work at Carthage and other Mediterranean sites increasingly shows that "ancient engineers were capable of organizing substantial civil engineering projects," Gifford says.

– B. Bower