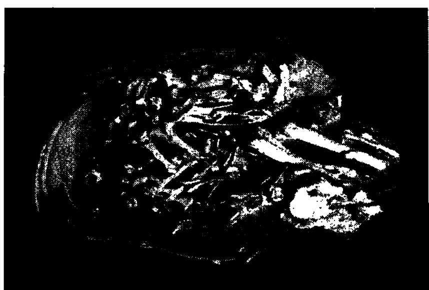
PALEONTOLOGY

Dino Embryo Recasts Parents' Image

A new find from the Gobi Desert in Mongolia has transformed a dinosaur from a ruthless baby-eating predator into a concerned parent. The vindicating evidence: the first embryo ever found from a group of dinosaurs called—perhaps erroneously—oviraptorids, which means "egg seizers" in Latin.

In 1923, that name seemed all too fitting. That year scientists found the first *Oviraptor* specimen lying atop a nest of eggs thought to belong to another species. The new oviraptorid embryo, however, comes from identical eggs, indicating that the original eggs had been misclassified—along with oviraptorids' behavior. "Rather than eating the eggs, they were incubating them or protecting them, because they were their own eggs," says Mark Norell, dinosaur curator at the American Museum of Natural History in New York City.



Egg hunt. The recent discovery of this oviraptorid dinosaur embryo *(left)* reveals that the species hatched from eggs like these *(below)*, found in 1923.

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On page 729, Norell and colleagues from the United States and Mongolia describe the nearly complete embryonic skeleton, dating from about 75 million years ago. The tiny bones, egg shells, and some associated dinosaur finds are not only changing the way paleontologists view this rare dinosaur, but also prompting a re-evaluation of dinosaur eggs and offering clues about the evolution of dinosaurs' living relatives, birds. "The discovery of an embryo is incredibly significant," says Philip Currie of the Tyrrell Museum of Palaeontology in Drumheller, Alberta.

The numerous oblong eggs discovered at Flaming Cliffs in Mongolia on the 1923 Central Asiatic Expedition sponsored by the natural history museum were originally assumed to belong to a species of plant-eating dinosaur, known as *Protoceratops*, because that is the most common dinosaur fossil found in the Gobi. And ever since, paleontologists have classified similar elongated eggs in the United States and Asia as those of vegetarian dinosaurs. The early expedition also found the rare and strange-looking *Oviraptor* atop the eggs. With a beak like a parrot's and an upright body with no wings, it was identified as a carnivore that probably died in a sandstorm while sucking the *Protoceratops* eggs.

But when Norell found the tiny oviraptorid skeleton poking through an identical oblong egg at a site 300 kilometers away from the Flaming Cliffs last year, he knew the old view must be wrong: "The first bone I picked up was an ankle, and I knew it was a theropod [bipedal dinosaur]. Theropods have very, very distinctive ankles," says Norell. As he and the expedition leader, Michael Novacek, looked through the nest of eggs, they realized that this theropod, like birds, must have been a brooder.

Other researchers, looking at the nests in light of this new information, have concluded that the adult oviraptorids were also exhibiting other birdlike behaviors. "They played with their eggs, like birds," arranging them in a circle, says Jacques Gauthier, curator of reptiles at the California Academy of Sciences. And like birds they apparently protected their eggs, sitting on them until the bitter end.

Connections to birds were also seen in two other embryonic skulls found in the same nest from another type of dinosaur, the carnivorous *Velociraptors*. The jaws of these two skulls also held a surprise: tiny, peglike teeth that are seen in some early birds, dating from about 150 million years ago. As adults, *Velociraptors* had very different teeth: serrated dentition "like steak knives," according to Gauthier.

This parallelism between adults and juveniles of the different groups offers clues about both dinosaur development and bird evolution. The newborn dinosaurs probably had a diet like that of a bird: perhaps eating insects. But the carnivorous adults needed sharp teeth to tear meat. Early birds, which split off from their meat-eating relatives millions of years earlier, had birdlike diets better suited to the infantile teeth. And so they retained them, never developing the daggerlike teeth of their adult cousins. "The early birds ended up looking like the babies of their ancestors," Gauthier explains. And now one of those babies—the oviraptorid—has managed to redeem its parents.

–**Ann Gibbons**

ASTRONOMY

Playing Hide-and-Seek With a Pulsar

John Middleditch doesn't completely trust the data that tell him he's found a new pulsar. It's safe to say that few other researchers do either, because that pulsar has vanished into the night once before.

Middleditch, who works at Los Alamos National Laboratory, shocked the astronomical community in early 1989 when he and his colleagues announced in *Nature* the discovery of a pulsar, or spinning neutron star, at the center of supernova 1987a. The discovery was a vindication of theory—supernovae are supposed to create pulsars—but the stunner was that the pulsar was spinning faster than most researchers imagined possible, around 2000 times a second. A year later, however, Middleditch's team announced a second stunner: The pulsar signal was spurious, an artifact caused by electrical interference from a videocamera hooked to the telescope his group had used.

Now Middleditch and his colleagues are being tormented by another ephemeral pulsar signal from the heart of the same supernova. In analyzing observations of 1987a by optical telescopes in Chile and Australia between February 1992 and February 1993, Middleditch believes he has again found brief pulses of light that reflect the presence of a pulsar. This pulsar has a period of 2.14 milliseconds, which means it's spinning at the more reasonable rate of 450 times a second. But other groups have not spotted it, and even Middleditch's own group has not seen the slippery signal for some time. "We've suffered a year without any obvious hits. Is it imaginary or real? Needless to say, it's been driving me crazy," he agonizes.

In late September, Middleditch and his collaborators met to analyze the data and, reluctantly, decided not to announce a find. "There really isn't enough to publish at the moment. The whole thing is frustratingly vague. The most we have is tantalizing hints," explains team member Jerome Kristian of Carnegie Observatories in Pasadena, California. For more than a year, Kristian, Middleditch, and the rest of their team have been discussing the data at meetings and informally putting the word out about the candidate, hoping some other group will produce confirmation—confirmation that is essential because of the 1989 false alarm. "The standard of proof is now two or three times the usual," says Robert Kirshner, a supernova expert at the Harvard-Smithsonian Center for Astrophysics (CFA).

It isn't that astronomers want to disprove the pulsar's existence; on the contrary, they've been longing to detect it since 1987a first appeared. "Where is the pulsar? It's one of the most exciting questions around," says the University of Wisconsin's Hakki Ogleman, a member of a European Southern Observatory team monitoring 1987a that has yet to confirm the new candidate. Catching a pulsar right after its birth has never been done, he explains, and observations would allow astronomers to fine-tune their largely theoretical models of how these objects form out of the collapsed core of an exploding star.

Middleditch's team plans further observations of 1987a in Chile in November and February. A few members of the group at CFA are also rushing to complete a new infrared detector that might offer a better view through the supernova's obscuring debris than do instruments that detect photons at visible wavelengths. That debris, in fact, may explain why the putative pulsar has temporarily disappeared. Other astronomers say they're hoping this is the case, for it would be cruel and unusual punishment for Middleditch and his co-workers if this turns out to be another false alarm. "It would be kind of like lightning striking twice," says University of Illinois astronomer Frederick Lamb.

–John Travis

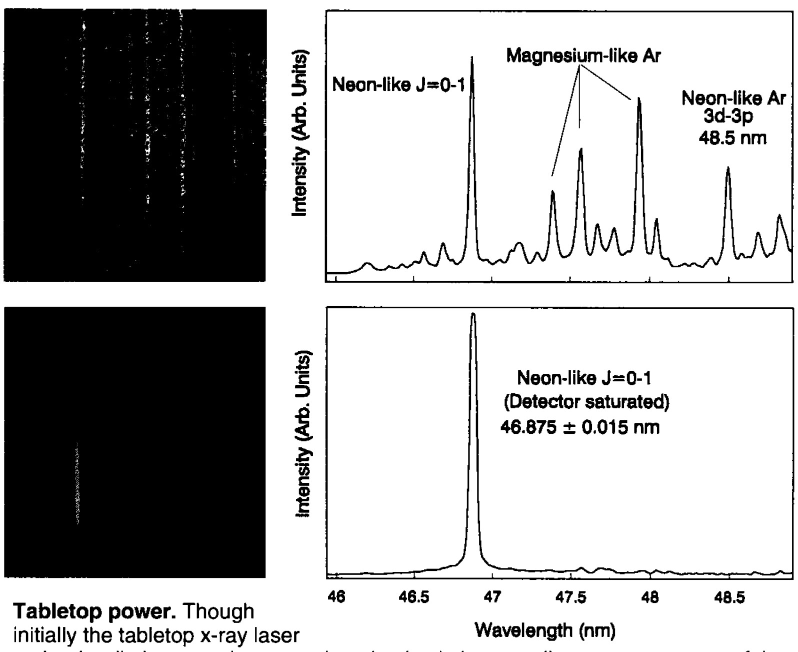
PHYSICS

Putting X-ray Lasers on the Table

Cutting out the middleman is a time-honored technique for reducing the cost and complexity of commercial transactions. Sometimes it works in physics, too. That, at least, is one conclusion that could be drawn from the successful demonstration of the first tabletop-sized, so-called "soft" x-ray laser (XRL), driven by a simple electrical discharge.

Scientists have been hankering for such equipment because soft x-rays—which are about 100 times less energetic than "hard" x-rays—have much shorter wavelengths than visible light does, and therefore can act on a much smaller scale. In biology, for instance, microscopes based on x-ray laser sources could provide higher resolutions than optical instruments do, while avoiding much of the specimen preparation necessary with electron microscopes—preparation that can alter microstructural details.

But previously, most XRLs incorporated expensive, room-sized, high-power optical lasers as energy sources. By eliminating the optical laser and replacing it with a simple electrical capacitor, Jorge Rocca and his colleagues in the electrical engineering department at Colorado State University in Fort Collins reported in the 17 October issue of *Physical Review Letters* that they have dramatically reduced the size and cost of the XRL equipment. The new machine is about the size of a large refrigerator. This downsizing is a "giant step," says Steve Harris, an x-ray researcher in the department of applied physics at Stanford University.



Tabletop power. Though initially the tabletop x-ray laser emitted radiation at various wavelengths *(top)*, the x-ray line grew most powerful when lasing conditions were improved *(bottom)*.

Lasers can create a beam of powerful, single-wavelength light when photons with various energies zip through a plasma of ions that have been pushed to a high energy level—say, through bombardment by hot electrons. Under the right conditions, these ions can be primed to release a photon with a specific energy and direction when "tickled" by the passage of an identical photon: As this process continues, the photons multiply and become an amplified pulse of coherent light. The first XRLs were demonstrated at Lawrence Livermore National Laboratory and Princeton University in 1984. Both prototypes used ungainly optical pump lasers to create the plasma (the Princeton version was the size of two offices). Since then, several groups have tried to shrink the necessary hardware by using the smaller optical lasers that have recently become available, but the XRL results so far have been mixed at best.

Rocca and colleagues reasoned that an electrical discharge could be coaxed into producing a hot plasma directly, eliminating the optical laser. The team first rapidly discharged a capacitor between electrodes at either end of a 4-millimeter-wide polyacetal plastic tube filled with argon gas. The 100-joule discharge stripped electrons from atoms in the gas and heated them, just as the optical lasers had, and the magnetic field generated by the current squeezed the plasma to a fraction of a millimeter.

As the hot electrons struck argon ions in the plasma, the ions were driven into excited states while randomly emitting photons of many energies. Among the randomly emitted photons were some at x-ray lasing energies, and their numbers avalanched along the tube. And the longer the tube—the team looked at lengths from 3 to 12 centimeters—the more x-ray photons were made, eventually producing a beam with laser characteristics.

Other laser scientists are impressed with the smaller, faster, cheaper effort. "In comparison to the laser-pump guys, [Rocca] uses garage technology," says Howard Milchberg, a laser researcher at the University of Maryland, College Park. Milchberg and others point out, though, that Rocca's laser can now produce x-rays of only 470 angstroms. Hard x-rays, of only a few angstroms in length, are of much higher energies and still require the power of an optical laser-pumped XRL to generate them. Rocca concedes the point—for now. But he's already working on ways to produce shorter wavelengths—eventually, perhaps, as short as 50 angstroms—using his "garage" setup. He argues, however, that the wavelengths he can already produce should be useful for imaging and other purposes. "There's a lot of stuff you can do with [these] photons," he says.

–James Glanz

James Glanz is a science writer based in Chicago.