Cyg X-3: Photinos, quark nuggets?

Cygnus X-3 is a binary star location in the sky where powerful physical processes are going on. Long known as a strong emitter of X-rays, Cyg X-3 also seems to be emitting an exotic form of radiation that is difficult to explain and may involve some hitherto unexpected and unknown physics. Now, a few months after this strange radiation was first seen, tentative explanations are beginning to appear.

The exotic radiation was not found by equipment actively looking at Cyg X-3. It turned up in experiments set up to look for radioactive decay of the proton. (Some of the latest theories of physics require that the proton, contrary to previous belief, should decay radioactively.) Such decays would be extremely rare, so experiments to search for them consist of large masses of water, put deep underground to shield them from ordinary cosmic rays and other ambient radiation.

None of the proton decay experiments has yet seen proton decay, but the strange radiation from Cyg X-3 has appeared in two of them. One of these is a collaboration between the University of Minnesota in Minneapolis and Argonne (Ill.) National Laboratory and is located in the Soudan mine in northern Minnesota. The other, located in a tunnel under Mont Blanc, Europe's tallest mountain, is under the aegis of the CERN laboratory in Geneva and goes under the interesting acronym NUSEX.

What appear in these water tanks are actually muons, a well known variety of particle. Muons have too short a lifetime to have come themselves from Cyg X-3 but rather something that decays into muons near the earth has come from there. By their properties these muons cannot come from any decay of the ordinarily known progenitors. To come straight from Cyg X-3, the progenitor of the muons has to be electrically neutral — if it were charged, the magnetic field of the galaxy would curve its path — but for reasons of energy, neither neutrons nor gamma rays will fit.

"Such observations would require a new particle or a new physical process," write M.V. Barnhill III, T.K. Gaisser and Todor Stanev of the University of Delaware at Newark and Francis Halzen of the University of Wisconsin at Madison in the Oct. 3 NATURE. They go on to suggest a new particle, quark nuggets. Quarks are supposed to be the elementary building blocks out of which most known particles are made. Theory also predicts that quarks could stick together in lumps that do not make up particles of the ordinary sort. The nuggets could be made in processes associated with a quark star, a star made up of a lot of quarks stuck together — if such a thing happens to be at the heart of Cyg X-3. The quark nuggets would be produced in a charged form and accelerated by electromagnetic fields near the quark star and then neutralized on the way.

Another suggestion for the exotic radiation is photinos. One of the attempts to unify all of physics in a single theory are the supersymmetry theories, which propose that every known particle has a supersymmetric partner. The photino is the partner of the photon or particle of light. In the same issue of NATURE, V.J. Stenger of the University of Hawaii in Honolulu suggests photinos. These photinos would be produced in very high energy processes that start with energetic protons produced by the source in Cyg X-3.

—D.E. Thomsen

Clams and worms fueled by gas?

A tenet of deep sea oceanography used to be that, in terms of life, the seafloor is a veritable desert at depths far beyond the touch of sunlight. But lately scientists have been finding the most exotic and lush biological communities thriving in some rather unlikely places — from hydrothermal vents (SN: 1/12/80, p. 28) to a saline seep off of Florida (SN: 12/15/84, p. 374). Now a team of researchers from Texas A&M University in College Station, report the discovery of similar kinds of sea creatures living at oil and methane seeps about 150 miles south of the Louisiana coast.

"This report significantly expands the geographical area in which one would expect to find dense hydrothermal vent-type taxa in the deep ocean," write Mahlon C. Kennicutt II and co-workers in the Sept. 26 NATURE.

Among the animals that Kennicutt's group collected last December were clams and tube worms. During another series of trawls in May in the same area, they recovered an even greater diversity of organisms including mussels. A number of new species were found, most of which appear to be related to those living near vents.

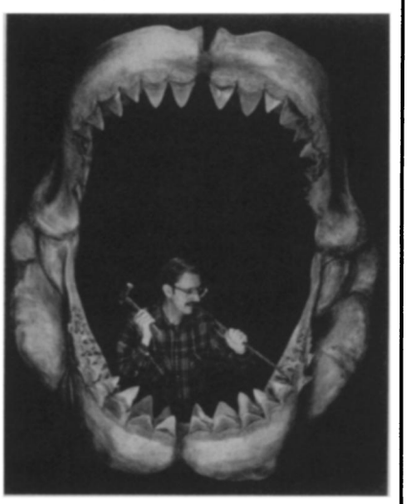
Like the hydrothermal vents and Florida seeps, the oil seeps contain hydrogen sulfide (H_2S) which is known to be used as an energy source by sulfur-oxidizing bacteria that live inside of animals or are eaten by them. This process, called chemosynthesis, enables the communities to live with little or none of the sunlight required for photosynthesis. But unlike these other environments, the Louisiana seeps also leak hydrocarbons which appear to contribute to the food chain as well. Kennicutt's group found that the concentration of carbon-13 isotopes (which can be traced through many food chains) in seep clams and tube worms reflected the range of values found in oil and methane. But because they also correspond to carbon-13 measurements of vent animals, it's not clear whether H_2S or hydrocarbons are the dominant food source. Future studies using sulfur and carbon-14 isotopes should help. "Knowing organisms, they probably do a little of everything," says Kennicutt.

Another focus for study is how the animals tolerate the highly toxic substances at the seeps such as aromatic hydrocarbons. The researchers also plan to return to the seeps in a year with the *Johnson Sealink* I submersible to study the community structure of the animals. It is possible that most of the animals live at the periphery of the seeps, shielded by a zone of microbes that detoxify the chemicals, notes Kennicutt.

Since hydrocarbon seeps occur in many shelf areas, the researchers believe that seafloor biological communities may be much more prevalent than has been assumed. "Until sites other than the vents in the Pacific were found, people pretty much thought that this was probably an isolated evolutionary development," says Kennicutt. "The question now is whether all of these sites are linked together with common ancestry or have they all evolved by themselves?"

—S. Weisburd

Shark jaws of old



Jaws large enough to consume a Volkswagon Beetle are on display as part of a new permanent exhibit on sharks at the Smithsonian's National Museum of Natural History in Washington, D.C. The fiberglass reconstruction houses the teeth of the 40-foot prehistoric shark Carcharodon megalodon, *which became extinct 4 million years ago. The triangular, serrated teeth were donated by fossil hunter Peter J. Harmatuk of Bridgeton, N.C. The teeth are graded in size from 6 inches in length in the front of the jaw to 1 inch in the back. The shark used its teeth to slash through flesh and bones of whales. The nearest living relative of the* Carcharodon *is the great white shark, which is only 20 feet long.*