Mining for traces of galactic star deaths

Neutrinos are messengers from the stars. They carry clues about the supernova processes that make stars collapse and explode, as well as about the fusion reactions that fire our own sun. That is why astronomers glowed with excitement last year when two Cherenkov radiation detectors recorded the first, normally elusive neutrino particles from a supernova (SN: 3/21/87, p.180). At this stage in neutrino astronomy, however, such direct observations of supernovas are relatively rare and do little to help scientists calculate how often stars die by collapsing, an important part of understanding our galaxy's long-term evolution.

Now two scientists suggest another way of hunting for traces of galactic neutrinos. Wick C. Haxton and Calvin W. Johnson of the University of Washington in Seattle propose unearthing information about the frequency of galactic supernovas from deeply buried ores. Scientists have known that ores can serve as natural neutrino detectors because they contain certain atoms that have been transmuted from other elements during reactions with neutrinos. Researchers have suggested measuring the amounts of these atoms in order to gauge the number of *solar* neutrinos that have showered the earth.

In the May 26 NATURE, however, Haxton and Johnson identify a few specific neutrino reactions they believe will enable scientists to also measure the total *galactic* neutrino flux over the last several million years. And from this, they say, it is possible to refine estimates of the average rate of stellar collapse in our galaxy, which at present range from 1 in 7 years to 1 every 100 years.

One candidate reaction involves the transmutation of molybdenum to technetium, an element formed in nuclear reactors and nuclear explosions but rarely found naturally on earth. When a molybdenum neutron absorbs a neutrino, it casts off an electron and is transformed into a proton, changing molybdenum into a technetium atom. The researchers have singled out this reaction partly because it is the subject of the first geochemical hunt for solar neutrino traces. Scientists at Los Alamos (N.M.) National Laboratory are in the midst of measuring the amounts of technetium-98 and technetium-97 contained in molybdenum ore extracted from a mile-deep mine in Colorado.

Haxton expects solar neutrinos, which are less energetic than their galactic cousins, to produce most of the technetium-98 from molybdenum-98. In contrast, the technetium-98 atoms first produced by galactic neutrinos have so much extra energy that they usually decay into technetium-97. Scientists could use this difference to separate the galactic neutrinos from solar ones. In all, Haxton and Johnson estimate the amount of technetium-97 made by galactic neutrinos will equal about 40 percent of the technetium-97 created in the ore by solar neutrinos over the last 6 million years.

Actually finding and counting technetium atoms, however, is no easy task. To do it, the Los Alamos group has performed a bit of technical wizardry. According to project leader Kurt Wolfsberg, researchers expect to harvest (with the help of the mining company) a mere 1 million to 100 million technetium atoms from 10,000 tons of molybdenum ore. The purified technetium sample will be so small it will tax the sensitivity of current mass spectrometry techniques. So Wolfsberg's group has developed a new approach to technetium mass spectrometry that is 10,000 times more sensitive. The researchers expect to have preliminary measurements at the end of the summer and final values by the end of this year.

Haxton says the results should refine the upper limit of collapse-rate estimates. Because the results are based on the cumulative traces of the neutrino flux over millions of years, "this would be very useful and otherwise inaccessible information," notes John N. Bahcall at the Institute for Advanced Study in Princeton, N.J. However, calculating the number of galactic neutrinos depends on knowing the probabilities of the neutrino-molybdenum reactions, and these, he says, are presently uncertain by an unacceptable factor of 2 at least. While Bahcall doesn't foresee any near-term improvement from either theory or experiment, Haxton is more optimistic, saying that with careful experiments, "an uncertainty of 30 percent is not out of the question."

Whatever the outcome of this particular disagreement, the Los Alamos experiment and the other underground observatories now searching for solar and stellar neutrinos are creating an explosion in neutrino astronomy. "It's a terribly exciting period in our lives to do such science," Wolfsberg says. "We are going underground to look at stars."

— S. Weisburd

Bone density drops with thyroid therapy

Premenopausal women undergoing long-term therapy with thyroid hormones suffer a loss of hip-bone mass and may have an increased risk of hip fractures later in life, a new study indicates. The report's authors suggest thyroid hormones — among the most commonly prescribed medications for women — are less innocuous than many doctors believe and dosages should be carefully monitored and tailored to individual needs.

Thyroid hormones are prescribed, often in doses higher than those considered physiologically normal, for a variety of conditions characterized by a decline in thyroid-gland activity. The therapy can restore normal hormone levels or can mimic hyperthyroidism, in which thyroid gland function is increased above normal levels, to suppress other hormones that can exacerbate cancer or goiter.

Naturally occurring hyperthyroidism has been associated with osteoporosis, a progressive weakening of the bones due to decreased bone density. But other factors — including decreased estrogen levels in older women — also lead to osteoporosis, and this has confounded previous studies looking at the influence of thyroid hormone therapy on bone density.

Researchers at the University of Massachusetts Medical School in Worcester studied 31 premenopausal women who received L-thyroxin (L-T_4) for at least five years and compared their bone densities with those of age- and weight-matched women not on the hormone. Both groups had similar lumbar-spine densities, but hip-bone densities in women treated with L-T_4 were decreased 10 to 13 percent.

"Our finding ... raises questions the appropriate dosage of L-T_4 in these younger women, since the morbidity, mortality and expense arising from hip fractures later in life are now well documented," the researchers report in the June 3 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION. Despite the general belief that there is "relatively little risk" associated with thyroid hormone therapy, they say, high doses should be given only when absolutely necessary — such as to suppress thyroid-stimulating hormone in women previously treated for thyroid cancer.

"The key issue is that the dose of thyroid hormone has to be appropriate for the condition being treated," Daniel T. Baran, a coauthor of the report, told SCIENCE NEWS. Improved blood tests now allow more careful monitoring of hormone levels, he adds.

Meanwhile, debate continues over the value of dietary calcium supplements for restoring bone density in women with osteoporosis. New research reported last week by Christopher E. Cann of the University of California at San Francisco suggests that women age 20 to 45 may be able to increase bone density by 3 percent over a two-year period by more than doubling dietary intake of calcium to 1,500 milligrams per day.

— R. Weiss