Supernovae: Traces on earth?

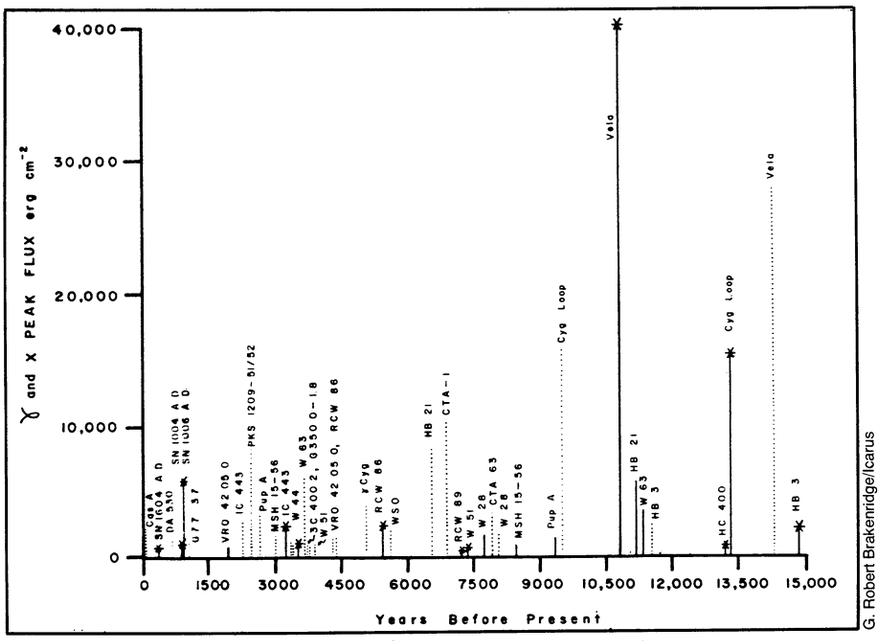
The brilliantly exploding stars called supernovae appear from various lines of evidence to have had sometimes significant consequences for life on earth, ranging from the inspiration of religious fervor in relatively recent times to the far more fundamental role of possibly generating a shockwave that triggered the formation of the solar system. In the intervening years, many other supernovae have punctuated the sky, some of them reaching the earth not only with their light, but with other emissions as well. Such occasional radiation baths, a researcher maintains, could have had substantial effects on the terrestrial environment—effects from which the evidence may yet remain.

This does not necessarily mean that supernova effects can be traced back to the birth of the planet, says G. Robert Brakenridge of the University of Arizona. Beginning with the initial burst, whose peak may last only a matter of months, a supernova casts forth its energy in a torrent of visible light, X-rays, gamma rays and more. Because the remnant supernova becomes more diffuse as it grows, he says, it is virtually indistinguishable from the interstellar medium after about 45,000 years (by which time it has reached a diameter of some 65 parsecs), which means that no terrestrial evidence older than the late Quaternary period can be matched with a still-detectable supernova source. A more reliable cutoff point, in fact, he adds, is about 15,000 years, since there is uncertainty about how fast remnant supernovae expand past diameters of 45 parsecs or so.

Even within that relatively short span, however, the earth has had quite a career as a supernova target. Writing in the April issue of ICARUS, Brakenridge charts the inferred peak flux of X-rays and gamma rays reaching the planet from several dozen supernovae (none with fluxes smaller than 500 ergs per square centimeter), and compares them with calculated ages for each starburst. Neither fluxes nor ages are firmly established (some of the ages, for example, include another scientist's correction factor for a supernova's angle out of the plane of earth's galaxy), but one supernova on the list stands clearly above the rest.

Called Vela, it appears from the work of Brakenridge and others to have subjected the earth to two or more times the radiation dosage of any other supernova on the list. Its age has been variously estimated to be from 8,400 to 14,300 years, but Brakenridge cites evidence to suggest a true age of between 10,000 and 11,000 years — in which range a number of possibly significant phenomena have been dated on earth.

Several other researchers have already noted that one consequence of supernova



Peak integrated X-ray and gamma-ray fluxes reaching the earth from supernovae over the past 15,000 years, including the prominent Vela supernova of 10,000 to 11,000 years ago. Did such radiation flashes cause significant effects on earth?

radiation striking earth's atmosphere might well be an increase in the amount of nitrogen "raining out" in compounds such as NO to the surface. Such nitrogen enrichments have been known to cause algal blooms in lakes, as well as other indications of increased nutrient supply. When the heightened photosynthesis prompted by such growth reduces the available oxygen supply in the water, Brakenridge says, the result has sometimes been the deposition of "sapropels and black, kerogen-rich sediments." Citing data from various lakes, bogs, alluvial deposits and riverbanks from California, Arizona, Colorado, Texas, Ohio, Minnesota, Missouri, Venezuela, Germany and northeastern Asia, he reports that just such blackish layers have been found in all of them — and all dating from about 10,500 years ago.

There are certainly alternative hypotheses, he notes, such as climate changes leading to better preservation of organic debris. "I simply wish to note the strong coincidence in time of the organic-rich zones from 11 cited localities to the time of greatly enhanced fixed-nitrogen flux predicted for the Vela supernova." And to point out that one effect of increased NO production could be an ozone-layer reduction leading to a slight global cooling, such as might help preserve organic sediments. There is no hard evidence for *global* cooling at this time, Brakenridge admits, but there are oxygen-isotope data suggesting at least northern-hemisphere cooling based on changes in ice volume.

Another supernova-induced change might be an increase in carbon-14 in the atmosphere, which would show up as errors in the ^{14}C dates of material from that period. There is a hint of such an anomaly in one study, Brakenridge says, but it will take a detailed comparison of wide-ranging samples from about that time to be sure. Another sign worth seeking, he says, is evidence of increased ultraviolet radiation reaching the earth's surface as a result of the depleted ozone layer. "The UV increase would have been short-lived but intense," perhaps 2 to 10 times the present level according to some researchers, and might show up as the widespread occurrence of "highly atypical lacustral [lake-growing] diatom assemblage zones" dated 10,000 to 11,000 years ago, such as have already been reported from Scotland.

There is, in short, a significant body of data that at least seems consistent with the possibility of Vela-caused changes in earth's environment, but even Brakenridge claims no more than that the idea ought to receive further study. Meanwhile, however, a Canadian researcher has proposed a far more dramatic scenario involving stellar effects on living organisms: that outbursts from the nucleus of the Milky Way may have left human beings alone as the only developed life-forms in their own galaxy.

Writing in the same issue of ICARUS, J. N. Clarke of the University of Toronto cites other researchers' suggestions that "many or even all large galaxies may undergo recurrent nuclear outbursts," such that the Milky Way may spend a million of every 100 million years as an intensely radiating Seyfert galaxy. The resulting enhanced cosmic-ray activity, repeated at "reasonable" intervals, he says, "should be able to keep the galaxy clean of intelligent life," except, of course, for earthlings, whose star system may have followed a path that fortuitously placed it in the protective envelope of a galactic spiral arm during each outburst. □