Supernovas help solve an elemental mystery

When massive stars die, they often go out with a bang. Erupting in giant explosions called supernovas, these behemoths litter the cosmos with carbon, oxygen, and heavier elements.

A new study now suggests that supernova activity may help solve a long-standing puzzle: the abundance in the solar system and throughout the galaxy of three low-mass elements — lithium, beryllium, and boron.

Astronomers have tried for years to account for the mix of these elements in the solar neighborhood, but their attempts have proved fruitless. For instance, they long ago abandoned the notion that nucleosynthesis, the fusion of light nuclei to make heavier atoms at a star's core, could generate the elements. That's because the burning of the lightest nuclei — hydrogen and helium — synthesizes the more massive elements, skipping the formation of lithium, beryllium, and boron.

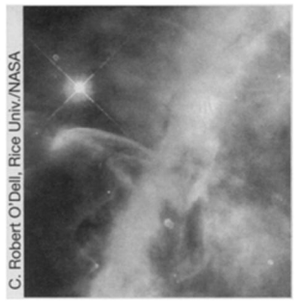
An alternative proposal — that lithium, beryllium, and boron are simply debris from the crash of cosmic rays into heavy nuclei in the interstellar medium — has fared somewhat better.

The shattered nuclei presumably would form the trio of elements; however, calculations show that this process alone wouldn't generate atoms in the observed pattern. The collisions would produce twice the measured ratio of boron to beryllium and only half the observed abundance of boron-11 to boron-10.

Now, a recent discovery suggests a second source for the elements. Last year, Hans Bloemen of Space Research Leiden in the Netherlands and his colleagues used data from NASA's Compton Gamma Ray Observatory to identify a series of intriguing, broad emission lines coming from Orion, the closest stellar nursery to Earth. Their report sparked a French research group to propose a new and promising explanation for the abundance of lithium, beryllium, and boron in the sun's vicinity.

Michel Cassé and Roland Lehoucq of the Centre d'Études de Saclay in Gif-sur-Yvette and Elisabeth Vangioni-Flam of the Institute of Astrophysics in Paris detail their work in the Jan. 26 NATURE.

The gamma-ray emissions indicate that the stream of low-energy carbon and oxygen nuclei coming from the direction of Orion is 30 times more intense than the stream detected near the sun. Cassé and his colleagues calculate that when these low-energy particles collide with lighter cosmic rays, they form the trio of elements in the observed abundances.


C. Robert O'Dell, Rice Univ./NASA

Hubble Space Telescope image of part of the Orion nebula, the nearest stellar nursery to Earth.

The team notes that Orion, like many other star-forming regions, has experienced supernova activity recently. These exploded stars provide the enhanced emissions of low-energy carbon and oxygen nuclei in Orion, the researchers assert.

Alastair G.W. Cameron of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., notes that to contribute to the mix of these elements near the sun and elsewhere in the galaxy, the same process should occur in star-birthing regions throughout the Milky Way. The trio of elements would then have enriched the cloud of dust and gas from which the solar system emerged.

"This is one piece of the puzzle in understanding how the solar system formed," Cameron says. — *R. Cowen*

Family's grammar loss provokes debate

A speech and language disorder that affects 16 of 30 members in four generations of an English family has sparked scientific controversy over exactly what's wrong with the afflicted individuals and what their plight implies about the nature of language.

A new report, published by a British research team in the Jan. 31 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, concludes that family members with the disorder inherited a broad range of problems. These include difficulty in pronouncing sounds of all kinds, low verbal and spatial intelligence, and lapses in grammatical knowledge. A genetic flaw in areas of the brain devoted to muscle control and spatial orientation apparently fosters the bevy of symptoms observed in the "K" family, argues project director Faraneh Vargha-Khadem, a psychologist at the Wolfson Centre in London.

"We see across-the-board impairments of cognitive and noncognitive functions in affected family members," she says. "It's hard to argue for a selective deficit in one of those domains."

Vargha-Khadem's conclusion comes as encouraging news to Philip Lieberman, a linguist at Brown University in Providence, R.I. He suspects that the human brain's movement and coordination centers — which maintain links to higher-order "thinking" regions (SN: 10/29/94, p.284) — contain a system that orchestrates vocal communication.

However, linguist Myrna L. Gopnik of McGill University in Montreal, who directs a separate investigation of the K family, disagrees. The new evidence indicates that affected family members inherited a disturbance of the brain circuits that inject grammatical structure into speech and cause nonlinguistic problems in some individuals, Gopnik says. Her position supports the theory that the human brain evolved a specific capacity for language (SN: 5/28/94, p.346).

Vargha-Khadem's team evaluated 13 affected and 8 unaffected members of the K family, ranging in age from 6 to 75. Affected members made substantially more mistakes on tests in which they were to provide the past tense of regular verbs (such as "walked" for "walk") and irregular verbs (say, "swam" for "swim"). Comparable error rates emerged for both types of verbs, the scientists note, and many slips involved inappropriate use of a regular form (for instance, "swimmed"). The team says this suggests that affected individuals have some knowledge of rules for signifying verb tense.

These people also exhibited severe problems in making mouth and facial movements, only some of which are involved in talking, the London team adds. These included clicking the tongue, closing an eyelid, and protruding the lower lip and jaw. Stringing movements together — such as closing the lips and then opening the mouth and sticking out the tongue — proved particularly trying.

Average scores of affected individuals on IQ tests of both verbal and nonverbal problem solving fell about 20 points below those of their unaffected relatives, signaling pervasive intellectual shortcomings in the former group, Vargha-Khadem says.

"This shows that general mechanisms of motor control, cognition, and language are involved in these cases, not specific genes coding for language disorders," contends Lieberman.

Nonverbal IQ and pronunciation abilities vary widely from one affected K family member to another, but grammatical knowledge that most people retrieve effortlessly confounds all affected individuals, McGill's Gopnik responds.

Greek and Japanese speakers with the same disorder also show core linguistic deficits that are sometimes accompanied by other problems, she says. — *B. Bower*