Galaxy γ rays may be cosmic happening

If one's eyes were sensitive to light with a wavelength tens of thousands of times smaller than that of blue, then one would see that the entire night sky glows. From all directions, the earth is bathed in a diffuse rain of cosmic gamma rays, and discovering their origin is a problem that still bedevils astrophysicists. Two explanations have emerged during the past years as the most likely. Either the omnipresent radiation is an archeological artifact from the early moments of the Big Bang, or it is the cumulative effect on earth of the emissions from galaxies distributed universe-wide. Appropriate arguments and experimental data are frequently and alternately invoked to make one idea seem more plausible than the other but with no decisive effect so far.

Now, Volker Schönfelder of the Max Planck Institute believes he has found persuasive evidence that Seyfert galaxies like NGC 4151 may be responsible for the high energy cosmic radiation. In reaching this conclusion, he measured NGC 4151's spectrum of gamma radiation up to energies of 10 million electron volts. He accomplished this remarkable achievement by using a Compton telescope, so-called for its reliance on the Compton Effect. This well-known effect refers to the peculiar, quantum mechanical process in which high energy light, scattering off electrons, behaves like a particle and not like a wave, as it more commonly does. A Compton telescope is not only able to detect high energy radiation, it locates the source of it with notable accuracy.

The spectrum that Schönfelder obtained of NGC 4151 has, interestingly, a shape similar to that of the well-known spectrum of diffuse cosmic gamma rays. In particular, there is in both spectra a telltale bend that occurs at radiation energies of about 3 million electron volts. In his July 27 NATURE article, Schönfelder suggests that this remarkable coincidence "strongly supports the hypothesis that the diffuse cosmic gamma radiation results from the superposition of many unresolved galaxies of the same type as NGC 4151."

There are currently some 25 identified Seyfert galaxies in the universe (NGC 4151 being one of the brightest and nearest to us of them), and it is generally estimated that they represent about one percent of all the spiral galaxies. Enigmatic and therefore fascinating for many reasons, Seyferts tend to emit comparable quantities of X-rays and visible light, whereas normal galaxies typically radiate only one ten-thousandth as much energy in the form of X-rays as in visible radiation.

Although most previous studies had measured the emissions of NGC 4151 up to energies of only about 100,000 electron volts, one collaborative effort last year by a group from the Laboratorio di Fisica Cosmica e Technologie Relative in Milan and the University of Southampton looked but saw no bend in the same region observed by Schönfelder. This discrepancy may be resolved within a year, however, because physicists at the University of California in San Diego are analyzing the relevant data obtained from NGC 4151 via the HEAO-1 satellite (SN: 12/17/77, p. 406). Using its various detectors, the satellite has accumulated measurements over a wide range of energies, up to those obtained by Schönfelder.

In the long run, the UCSD group will also evaluate the spectra of other Seyfert galaxies and thereby determine just how archetypical is the one of NGC 4151. This determination is, of course, crucial to Schönfelder's result, since his suggestion requires the superposition of many similarly shaped spectra in order to preserve the presence of that bend. □

New leads on treating senility

Senile dementia is a devastating disease that progressively destroys a person's ability to learn and remember, and for which there is currently no cure. Several treatments have surfaced, but they did not guarantee improvement and carried some risk of serious complications (SN: 5/7/77, p. 292). Now several other potentially effective, safer treatments for senility are reported in the July 21 SCIENCE. The treatments involve drugs that manipulate the nerve-transmitting chemical acetylcholine, which has been linked with learning and memory functions in the brain.

Acetylcholinesterase is an enzyme that normally destroys acetylcholine in the central nervous system. A drug called physostigmine inhibits the action of this enzyme and thus allows acetylcholine to build up in the central nervous system. Last year researchers reported that physostigmine markedly improved the memory of a woman suffering from herpes simplex encephalitis, which can cause mental confusion and other symptoms. Kenneth L. Davis and his colleagues at the Veterans Administration Hospital in Palo Alto, Calif., have now explored physostigmine's ability to enhance human memory under more stringent conditions.

First they presented 19 healthy subjects with a series of digits, gave them an injection of either physostigmine or saline (a placebo) and nine minutes later asked the subjects to recall as many digits as they could. The experiment was then repeated with subjects who had received the drug getting a placebo, and vice-versa. Physostigmine did not affect the subjects' recall, so the scientists concluded that it does not enhance short-term memory. Next they gave the subjects a list of nouns to learn, injected them with either physostigmine or saline (and in a second trial gave them the opposite) and asked them to recall the nouns 80 minutes later. The subjects recalled significantly more words after getting physostigmine than saline, and researchers concluded that physostigmine enhances long-term memory. Still a third experiment revealed that physostigmine can also enhance retrieval of information from long-term memory.

Thus, physostigmine appears capable of improving long-term memory and retrieval of information from long-term memory, Davis and his co-workers conclude. And, since a deficiency in acetylcholine has been implicated in senile dementia, they advocate that physostigmine now be tested on patients with this disease to see whether it can help them remember.

The other report in SCIENCE deals with arecholine, a drug known to intensify the effects of acetylcholine, and choline, a chemical precursor of acetylcholine, and their ability to enhance learning rather than memory. N. Sitaram and Herbert Weingartner of the National Institute of Mental Health and J. Christian Gillin of St. Elizabeth's Hospital in Washington gave healthy subjects sequential injections of saline, arecholine, choline and finally scopolamine, a known antagonist of acetylcholine. Each time they tested the subjects for the speed at which they were able to learn a fixed sequence of 10 words belonging to a familiar category (fruits, vegetables, cities, etc.). Both arecholine and choline speeded the rate at which the subjects learned the sequence, compared with the speed at which they learned under the influence of a placebo (presumably their normal rate), whereas scopolamine slowed the rate.

"In view of our data," the researchers conclude, "the possible use of arecholine or choline as a therapeutic agent in dementia needs further exploration."

There is also a possibility, of course, that the three drugs — physostigmine, arecholine and choline — might benefit mentally healthy persons as well as dementia patients. The study by Sitaram and his colleagues, for instance, showed that the degree of learning enhancement produced by arecholine and choline, and the impairment in learning after scopolamine, were inversely proportional to the subjects' performance on placebo; that is, poor performers were more vulnerable to both enhancement and impairment of learning than were good performers. And the study by Davis and his co-workers showed that subjects varied considerably in memory augmentation after receiving physostigmine. Davis and co-workers caution, however, that persons who already have good memories may already have adequate acetylcholine, and taking physostigmine might not only *not* improve, but actually impair their memories. □

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