Supernova X-rays: Too little too soon

It was a brilliant burst of light near the object 30 Doradus in the Large Magellanic Cloud last February that first called attention to the explosion of the nearest supernova in almost 400 years. Seeing the light first is natural for human beings. But as astronomers rush to observe this supernova 1987A, one of the main things they expect to record is radiation in the invisible portions of the electromagnetic spectrum.

All this radiation is physically the same as ordinary light, but visible light occupies only a short range of wavelengths in the middle of the total spectrum. As the expanding front of the supernova explosion becomes transparent to more and more wavelengths, new sections of the spectrum keep coming in. The latest are X-rays, recorded simultaneously and separately by a Japanese X-ray satellite and a German experiment attached to a Soviet space station.

The Japanese satellite Ginga and a West German X-ray telescope called Hexe, attached to the Soviet Mir space station, have found X-rays that appear to come from the supernova. Juergen Truemper of the Max Planck Institute for Extraterrestrial Physics (MPIFEP) in Garching, West Germany, and Yasuo Tanaka of the Institute of Space and Astronautical Science in Tokyo reported their groups' findings last week at the Fourth George Mason University Workshop on Astrophysics, held in Fairfax, Va.

Both groups agree that the supernova emits X-rays in the so-called hard X-ray range from 15 to 350 kilo-electron-volts (keV) energy. However, Ginga found an X-ray spectrum that extends beyond 15 keV down at least to 4 keV, into what observers call the "soft X-ray" range. Hexe, which belongs to the MPIFEP and the University of Tübingen, is not sensitive to these low-energy X-rays. However, another experiment on the Mir station, TTM, belonging to the University of Birmingham (England) and the Space Research Laboratory in Utrecht, the Netherlands, should have been sensitive to these soft X-rays but didn't find them. Gerry Skinner of the University of Birmingham reported that TTM recorded no soft X-ray flux and was able to say only that the intensity of supernova soft X-rays, if any, had to be lower than the instrument's threshold.

Tanaka tried to minimize what he called a "difference" rather than a "discrepancy" between the two reports and expressed confidence that it would be resolved. Others at the meeting were taking it more seriously. Robert P. Kirshner of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., who has been following the supernova in ultraviolet since it exploded, remarked, "Come on, fellows, we can't both be right."

Astrophysicists eagerly await each addition to the range of the supernova's emissions because different ranges of the spectrum are evidence of different physical processes they believe occur in the supernova. The hard X-rays found in these discoveries are supposed to come ultimately from processes of nuclear fusion and nuclear decay that between them make the heavier chemical elements. These processes in supernovas are particularly important to astrophysicists and nuclear physicists, because supernovas appear to be the only place in nature where the heaviest elements can be made.

The nuclear processes actually produce gamma rays, a form of electromagnetic radiation that is harder (more energetic and of higher frequency) than X-rays. However, according to the theoretical models, at the time of the reported observations (July through September) the matter in the expanding supernova shock front should still have been opaque to gamma rays. As they move around inside the supernova, the gamma rays collide with electrons in a process called Compton scattering, by which their energies and frequencies are diminished until they fall into the X-ray range. Then they can get out.

However, the spectrum of hard X-rays found by the observers is, as Tanaka said, "unusual for any kind of X-ray source." The intensity of the hard X-rays rose during July and August, but not as fast as theoretical models of supernovas predict. It dropped off in September, and so it may also be peaking earlier than the models expect. Theoretical suggestions thrown off the cuff to meet this situation include the idea that there may be less matter in the supernova than theorists have thought, or that it may not be uniform but patchy, so that there are gaps or rare spots in it. Either way, X-rays could get out sooner than expected.

The soft X-rays are even more of a question. Theorists tend to agree that the supernova front is still dense enough to be opaque to them. So some propose that the soft X-rays are coming from interstellar material just outside the supernova front, which is being struck and disturbed by the expanding front.

— D.E. Thomsen

A-bomb radiation doses reassessed

A long-awaited reassessment of radiation dose measurements from the Hiroshima and Nagasaki atomic bombs is nearly complete, researchers report, and is likely to result in more stringent radiation protection standards. The new calculations are based on revised estimates of the yields of those bombs and make use of new computing techniques for measuring radiation exposures. Like previous reports (SN: 5/30/81, p.343), the latest findings are controversial.

Roger J.M. Fry of the Oak Ridge (Tenn.) National Laboratory and Warren K. Sinclair of the National Council on Radiation Protection and Measurements in Bethesda, Md., report that a new, computer-assisted dose measuring system adopted in 1986 has provided more detailed information about the World War II blasts. Fully revised risk estimates are not expected to be released until 1988. However, the scientists write in the Oct. 10 LANCET, it is probable that "future risk estimates for radiogenic cancer will be somewhat higher" than before.

Atomic-bomb survivors are the primary source of data on long-term radiation risks for humans. Those data are being reviewed by the Radiation Effects Research Foundation (RERF), an organization jointly administered by the Japanese Ministry of Health and the U.S.-based National Academy of Sciences. New findings by RERF will be taken into account by the International Commission for Radiological Protection, which sets worldwide radiation protection standards for patients, radiation workers and the general population.

RERF's latest revisions, according to Fry and Sinclair, include an increase of about 20 percent in the estimated total yield of the Hiroshima bomb. The potential for gamma radiation to penetrate into bone marrow and deep organs is also calculated to be higher than was previously assumed. Despite these two factors, each person probably received a lower radiation dose than was thought, according to the research. This conclusion was based primarily on the findings that ordinary house walls provide more protection than had been believed and the two bombs gave off only 10 percent as many neutrons as had been previously estimated. This appears to suggest that the increased frequency of cancer seen in A-bomb survivors was caused by smaller doses of radiation than was heretofore believed.

In its standard-setting deliberations, the International Commission will be faced not only with new data from the RERF but also with the vocal opinions of scientists who are publicly urging the commission to tighten its standards by as much as a factor of five. Toward that end, the commission was petitioned last month by 800 scientists — including two Nobel laureates and a participant in the Manhattan Project — to lower its dose limits for nuclear and other radiation workers from the current 50 millisieverts per year to 10 millisieverts per year.

— R. Weiss