Starbursts and Gasjets: High-Energy Astronomy

"High-energy astronomy" may mean observations that record high-energy radiation such as X-rays or gamma rays. It may mean observations of astrophysical processes that involve greater energies than most. Or it may mean simply "strange astrophysics." All three points were evident in topics discussed in a special session at last week's meeting of the American Astronomical Society in Calgary, Alta., Canada.

Starbursts are one way to try to account for the large amounts of energy observed coming from very small regions in the centers of a number of galaxies. They might be a way to interpret Seyfert galaxies, a large class of galaxies with very active nuclei that fascinate a lot of astronomers. Starbursts, as D. W. Weedman of Pennsylvania State University described them at the session, are massive and extraordinary outbursts of star formation, for example 100,000 stars of spectral classes O and B in quite a small volume (and quite a short time).

For a first example Weedman cited the galaxy NGC 7714. This is a galaxy with a bright nucleus, but it's not a Seyfert. Its spectrum shows evidence of ionization, the presence of ionized gas. This is a typical product of stars, and leads to the suspicion that a lot of stars are present. That was confirmed by recent observations by the International Ultraviolet Explorer satellite, which found dark absorption lines in NGC 7714's ultraviolet spectrum that are characteristically made by mass flowing out of class O stars. "Thanks to this new generation of high technology stuff we could say we were seeing a starburst galaxy," Weedman says.

NGC 7714 is also a radio source putting out 13.5 megajanskys of radiation from a region only 1.5 seconds of arc across on the sky. (This corresponds to about 250 parsecs or 900 light-years in actual distance.) It is also a weak X-ray source, as the Einstein observatory determined. It is therefore not a Seyfert (which would have stronger X-ray emission), and it most likely does not have a nonthermal source of radiation in its center.

Without a nonthermal source, the radio and X-rays have to come from supernova remnants, which are clouds of matter blown outward from the point where a star has ended its life in a supernova explosion. It is reasonable to expect many supernovas because stars cannot last very long under starburst conditions. About 10,000 supernova remnants in the nucleus of NGC 7714 can account for the observed radio and X-ray flux. That figures out to about one supernova a year. Starbursts may be the location of the majority of supernovas in today's universe and may have seen an even larger proportion in the past. Weedman says. An interesting physical question is what happens as 10,000 supernova remnants bump and collide with each other in such a small volume. It hasn't been figured out yet.

Starburst activity may happen also in regions of galaxies that are interacting, that is, colliding with each other. Or if the colliding galaxies are small, intense star formation may pervade the whole galaxy instead of just limited regions. A question from the floor elicited the opinion that the Magellanic Clouds, which show intensive star formation throughout their volumes, may be starbursting because they are about to interact with our galaxy.

SS433 is a starlike object inside our own galaxy. Its spectrum in visible light shows evidence for three separate components, one relatively stationary and two that appear to be moving back and forth. Theorists have supposed that SS433 is a star or stellar system that is ejecting matter in rotating streams (SN: 3/1/80, p. 140).

Extremely detailed radio maps of SS433 have been made during the past year and a half with the Very Large Array of radiotelescopes near Socorro, N.M. R. M. Hjellming of the VLA staff reported the results.

The radio contours show corkscrews of matter stretching away from the center. This is best explained by ejection from a rotating source, ejection that occurs at 80° to the line of sight and 20° to the axis of rotation. The period of rotation is 164 days. This corresponds with the parameters of motion determined by the optical evidence.

The activity in the interior of SS433 seems to be relatively uncomplicated. The velocity of the matter coming out is about a quarter of the speed of light, and it does not change from time to time, nor according to the wavelength of observation. The intensity of emission falls off as matter moves out along the corkscrew in a way that rules out some absorption mechanism operating on the radiation. The spectrum does not change with the passage of time. "The dominant thing SS433 is doing," says Hjellming, "is putting out kinetic energy."

This simple kinetic explanation may prove embarrassing for astronomers who are trying to fit the model of SS433's corkscrew jets to similar jets and tails on radio galaxies. Models of these objects generally propose some complicated physical processes in their centers to explain various aspects of their appearance. If simple kinetics can explain the jets and tails, the two pieces may prove difficult to reconcile. □

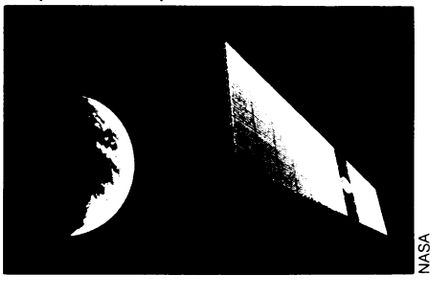
NRC opposes sunsat development funds

One proposed future answer to earth's energy problems has been solar-power satellites (SPS)—huge arrays of solar cells, miles on a side, deployed in earth-orbit and transmitting billions of watts of energy to receivers on the ground. Beside the SPS concept, involving trillions of dollars, decades of time and tens of thousands of tons of material (some of it possibly obtained from the moon and beyond), the scale of man's other major engineering endeavors would pale to near-invisibility. Yet the idea has its supporters, and calls for research into SPS possibilities prompted the National Aeronautics and Space Administration to join with the Department of Energy and several contractors last year in a detailed appraisal of what such a project might involve.

Now a committee of the National Research Council has evaluated the resultant "reference system" and concluded that no funds should be spent to "pursue development" of an SPS for at least the next decade. It could not be an economically competitive energy source in 20 years, says the committee's just-issued report, or even in twice that long a period without "radical advances in technology." The envisioned system would involve 60 satellites, each six miles long and three wide, beaming power to ground stations whose system-wide output would total 300 billion watts of electricity. The NASA/DOE study estimated that the overall cost would be about $1.3 *trillion,* and the NRC panel believes that figure to be "substantially low." A likelier number, reports the group, is about $3 trillion — roughly equivalent to an annual expenditure of 12 times the entire present NASA budget every year for the next half-century.

But even the NASA/DOE figures are mind-boggling, and there are other problems or major uncertainties virtually every step of the way. "Why, then," says the NRC analysis, "do we entertain the concept

Proposed solar-power satellite over earth.



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