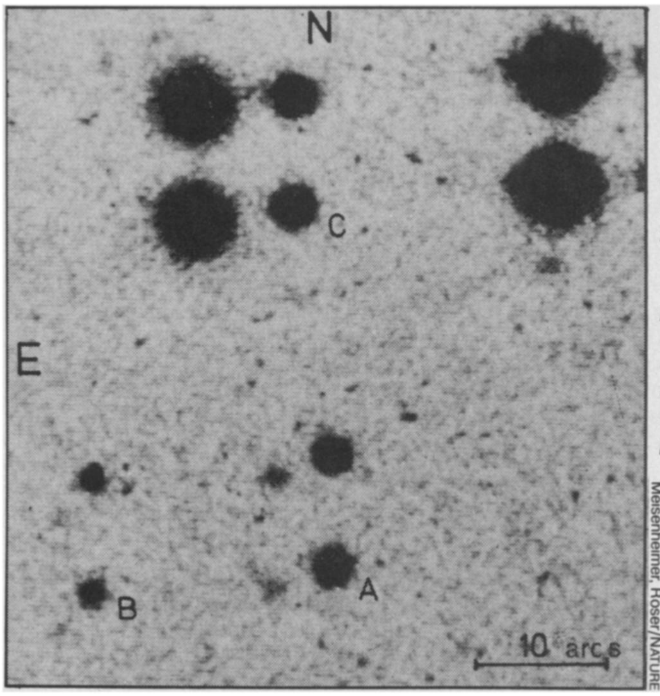
Acceleration in radio galaxy lobes

Viewed by their radio emissions, galaxies appear a good deal larger than they do in visible light. The visible part of the galaxy usually lies in the center between two huge lobes of radio-emitting material, which are many times the size of the visible portion. Astrophysicists believe that extremely energetic processes produce these radio lobes. Now, in the Feb. 6 NATURE, two astronomers from the Max Planck Institute for Astronomy at Heidelberg, West Germany, report an important piece of direct evidence for such processes.

The scientists, K. Meisenheimer and H.-J. Röser, have measured the polarization of the light from a visible hotspot on the outer edge of one such radio lobe, the southern lobe of the galaxy 3C33. This is the first time the optical polarization of such a hotspot has been measured, they say, and the optical polarization exactly matches the polarization of the radio waves from that lobe. Such a match is evidence that the hotspot belongs to the lobe and is not a chance association of some completely different object shining through the lobe. Moreover, detection of synchrotron radiation over such a wide range of frequencies from radio to optical is evidence that highly energetic processes are accelerating electrons in the lobe.

Synchrotron radiation comes from accelerated electrons that are forced by an ambient magnetic field to follow helical paths. The corkscrewing motion of the electrons gives their emissions a strong polarization in a particular direction, and to an astronomer the finding of such polarized radiation indicates the presence of this synchrotron mechanism. According to Meisenheimer and Röser, the importance of finding the optical polarization is that the electrons that produce the optical frequencies must move in very short paths. Their radiation, therefore, maps the regions where the acceleration is happening more closely than does that of the radio waves, whose source electrons move much farther from the place of acceleration while they are radiating.

Meisenheimer and Röser did this work at the European Southern Observatory at Cerro La Silla, Chile, using the Max Planck Society's 2.2-meter telescope located on La Silla mountain. The very high sensitivity of charged coupled devices (CCDs), the photoelectronic sensors now used for the most delicate astronomical imaging, enabled them to determine the optical polarization of the hotspot. To determine polarization, these astronomers inserted into the telescope a rotatable plane-parallel double-calcite plate. Calcite separates a beam of light into two parts polarized at right angles to each other and sends them over slightly different paths. On the CCD this procedure makes two images of every object.



Double images produced by a polarizing plate in the 2.2-meter telescope. The heavy, dark images are reference stars, and they show little or no evidence for preferential polarization. The hotspot of 3C33 is the fainter pair of images to the left (southeast) of the star labeled A. A significant difference in brightness is apparent in them.

If the light from a given object is predominantly polarized in a particular direction, and if the calcite is rotated properly to align with it, the two images will show a marked difference in brightness; most of the light will take one path, the one corresponding to the dominant polarization. "After the first 30-minute exposure, a highly polarized optical object near the hotspot of 3C33 south was immediately conspicuous," Meisenheimer and Röser write.

It is therefore possible for the first time to discuss the nature of the radiation-producing processes in such a hotspot on the basis of a range of frequencies emitted that runs from 1 billion to 100 trillion hertz, Meisenheimer and Röser say. On that basis, considering the probable physical characteristics of the neighborhood, they think it reasonable that the electrons are accelerated in shock waves.

This concurs with a belief based on the shapes of the lobes that they are material forcefully ejected by some high-powered "engine" in the center of the galaxy. (There is much other evidence for such an engine.) As such material moves outward through the tenuous gas in intergalactic space, it should produce shocks at its leading edges. *— D.E. Thomsen*

Stomach butterflies scramble EGGs

Butterflies in your stomach aren't all in your head, according to Larry VandeCreek. Using an electrogastrograph, an external electrical monitoring device that is to the stomach what the electrocardiograph is to the heart, he and his colleagues at Ohio State University in Columbus have been able to measure the "butterflies." The technique is also being used to study other conditions, among them motion sickness, which Pennsylvania State University researchers have linked to erratic electrogastrograms (EGGs).

Like all muscles, the stomach muscle is stimulated by electricity. While the electrical signal in the stomach is minuscule compared with that in the heart, it can still be picked up by electrodes placed on the skin.

Electrical signals from the stomach were first measured in 1922, but the much stronger heart signal made external recording difficult. In the past several years, however, sophisticated electronics has enabled the stomach signal to be isolated from the heart's.

VandeCreek and his colleagues tested 20 people who claimed they were prone to stress-related stomach upsets, and 20 people who said they were not. In the study, which has not yet been published, electrodes were placed on the skin over the stomachs of fasting volunteers. The readings were initially identical, with amplitudes averaging 50 to 70 microvolts. But when the butterfly sufferers were asked to imagine themselves in a stressful situation, their wave forms intensified to as much as 500 microvolts. "It's a little storm in there," VandeCreek says. Readings from people without the problem remained steady.

He and his colleagues are currently looking at anorexics; preliminary data indicate they get butterflies just thinking about food. He also hopes to use the technique in biofeedback experiments to see