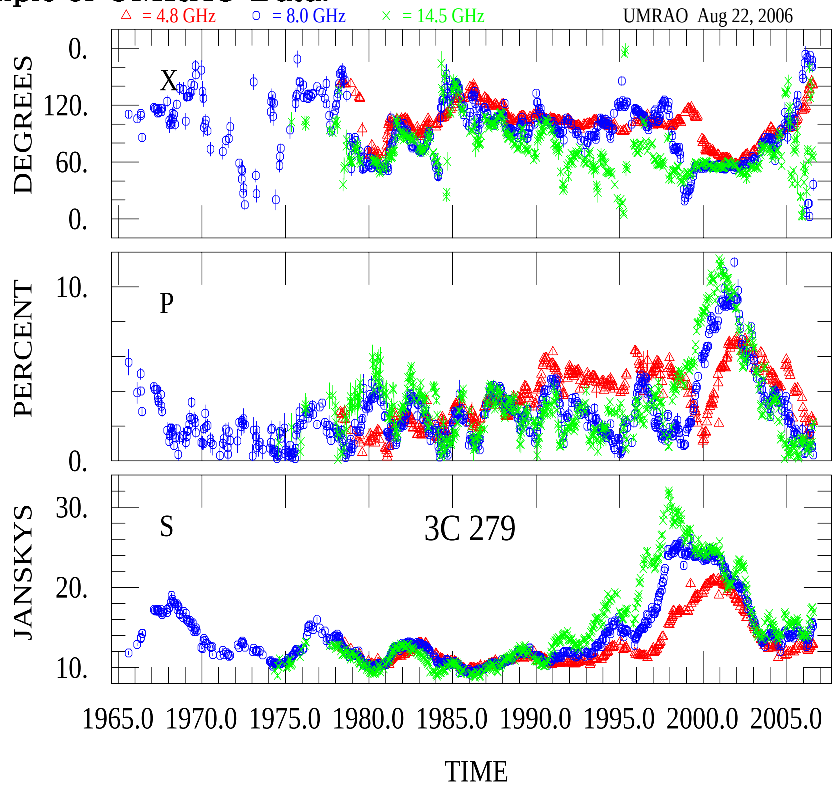
Example of UMRAO Data:



Recent data for the QSO 3C 279, showing the variation with time of both total and polarized fluxes. The three symbols denote data at the three observing frequencies: frequency-dependent behavior helps us to determine the conditions in the emitting region. The bottom panel shows variations in the total flux, which are believed to result from the passage of shocks along a light-year scale jet associated with the nucleus of this galaxy. The middle panel shows variation in the polarized part of the emitted radiation, and by providing information on the degree of tangling of the magnetic field, supports the shock 'picture', which predicts a compression of the magnetic field, effectively giving it more order. The top panel is the orientation of the plane of the polarized emission, which gives information on the direction of the magnetic field in the emitting region, and so provides information about the fluid flow pattern in the jet.

Open houses are normally held on the third Sunday of September, from 2pm to 4:30pm, with brief introductory lectures at 2:15pm and 3:15pm. For confirmation and details contact (734) 764-3440.

mfa&pah/8-06

The University of Michigan

Radio Astronomy Observatory

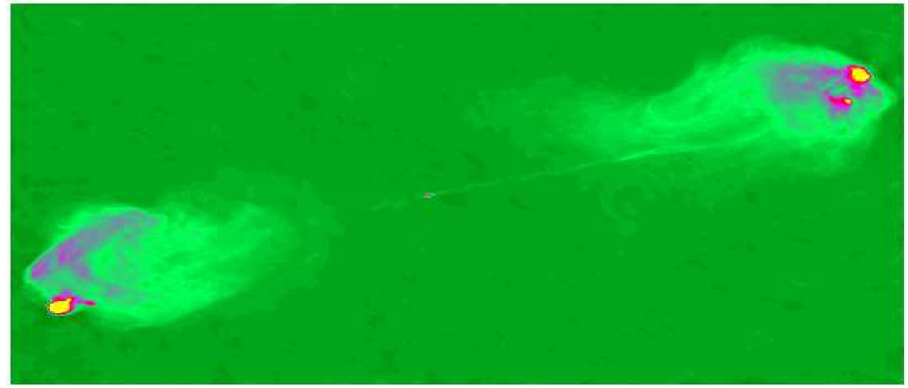
(http://www.astro.lsa.umich.edu/)

The primary instrument at the Observatory is a 26-meter (85-foot) diameter parabolic reflector with a 36-foot focal length. This instrument was constructed in 1958 at Stinchfield Woods as a research instrument, under contract from the Office of Naval Research. At the time of its construction, the Michigan dish was one of the largest radio telescopes in the world. Subsequent to 1968 the research and operation of the Observatory have been supported by grants from the National Science Foundation and by funds from the University of Michigan, with some supplementary funding from NASA for ground-based observations of a small group of sources being observed with satellite-borne instruments.

The surface of the dish is constructed from doubly curved panels of aluminum sheeting. Overall, it deviates by less than 0.125 inches from a true paraboloid. The telescope has a two-axis equatorial mounting (with a 40-foot diameter polar gear and a 38-foot diameter declination gear) constructed of galvanized structural steel; the counterweights are lead. The polar and declination axes are aligned to within an accuracy of 20 arcseconds. The total weight of the telescope including mounts and support structures is 400,000 lbs; the foundation is made of concrete blocks weighing 710 tons. Radiometers operating at the Observatory's primary observing frequencies of 4.8, 8.0, and 14.5 GHz are permanently installed near the focus. The cost of the telescope, including mount and concrete foundation but excluding radiometers, was about $270,000, a very low sum compared to present day construction costs.

For the past four decades the 26-meter telescope has been dedicated to the study of total flux density and linear polarization from active extragalactic objects (AGNs) in the radio-wavelength region of the electromagnetic spectrum, and this telescope continues to be one of the few instruments in the world dedicated to that type of research. The discovery that extragalactic objects vary in brightness with time scales of weeks to a few years was made using this instrument in 1964-65, the discovery of variability in linear polarization was made here in 1966, and recently the telescope has been used for the first spectral monitoring of circular polarization, an important but relatively unexplored property which is difficult to measure because of the low emission levels. Research at the Observatory is focused on understanding the physical conditions in the relativistic flows in the light-year scale jets of these objects and the relation of the jet to the spinning black hole and associated accretion disk which powers the AGN. The following radio map shows the radio source Cygnus A obtained with the Very Large Array in New Mexico, in which two oppositely directed jets spanning half-a-million light years are 'fed' by smaller scale flows such as are studied at this Observatory. Over 100 jet sources are being observed as part of a joint program being carried out using the Very Large Baseline Array of the National Radio Astronomy Observatory; those imaging data follow the structural evolution.

An important aspect of AGN studies involves investigating the relationship between the radio-wavelength variations and the behavior of the radiation in other regions of the electromagnetic spectrum. An exciting and unexpected discovery from data obtained with detectors



aboard the Compton Gamma Ray Observatory, a satellite launched in 1991, was that several dozen radio-variable objects also emit high energy γ-rays. A group of about a dozen sources have also been detected at TeV energies using ground-based instruments, and the site and origin of this high energy emission remains an enigma. Several of these sources are sufficiently bright at radio band to observe with UMRAO, and those observations have been used in several studies attempting to pin down source parameters using broadband data.

Because of the time scales (several years in some cases) of the phenomena studied, the Michigan observing program relies on continuous observations over periods of many years. An important element in the success of the program has been the consistency and continuity of the data acquisition. In 1977 the telescope was placed under full control of a specialized computer system which allows it to acquire and record data completely unattended; this procedure has resulted in greater uniformity in the data, as well as an enormous increase in the number of observations, typically over 10,000 per year. Because of this automated mode of operation, the telescope is able to observe on a round-the-clock basis, even without personnel at the observatory. The telescope has consistently operated at near the 90% time-level, with down-time only for radiometer changes, occasional weather-related problems, scheduled maintenance, or mechanical/instrumental upgrades.

The list of objects to be observed is changed frequently (sometimes daily) to reflect the current status of individual sources. These lists are generated using computer programs that simulate the functions performed by the telescope to obtain flux measurements (both on-source and background), and to move from source to source. Data are first transferred to the control computers at the telescope site and then transported via a high speed modum to the Ann Arbor campus where reductions are carried out using a system of computers in the Department of Astronomy.

In addition to the work described above, the telescope is used to provide hands-on training for both graduate and undergraduate students at the University of Michigan.