Circular Polarization Measurements at Centimeter Wavelengths

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Abstract

The University of Michigan 26-Meter paraboloid has been used to monitor the integrated emissions of over a dozen active extragalactic objects at 4.8, 8.0, and 14.5 GHz in all four Stokes parameters for more than a decade. The low level of instrumental polarization in Stokes V (less than 0.1 percent) is verified by repeated observations of galactic HII regions such as M17 and M42. We present light curves and spectra in all 4 Stokes parameters for the bright QSOs 3C 279, OV-236, and, 3C 454.3 and for the radio galaxy 3C 84. 3C 279 and OV-236 have exhibited V as high as 1% with variability time scales of months to years. The polarity of V has been observed in our source sample to reverse with time, and we have observed simultaneous opposite polarities of V within our frequency range of 5 to 15 GHz. The variability observed includes temporal changes in polarity at a single frequency, frequency-dependent differences in polarity at a single epoch, and long-term ordered changes in amplitude. This research was supported in part by funds from NSF grant AST-0607523.

Calibration: Frequent observations of galactic HII regions & Selected Extragalactic Objects (see Aller, Aller, & Plotkin 2003).

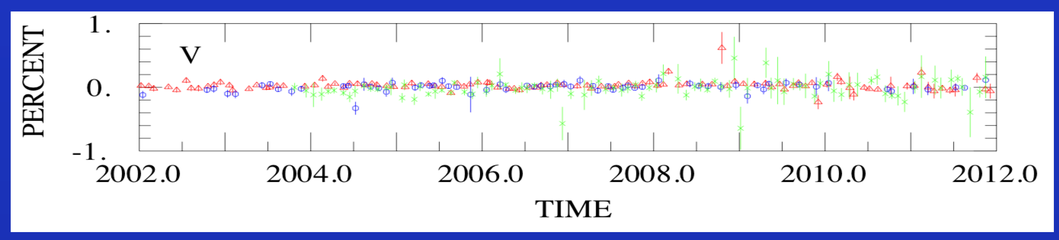

Figure 1: Monthly averages of V for the un-polarized galactic HII region DR 21

Observed Polarization Time Variability in Four Example Sources

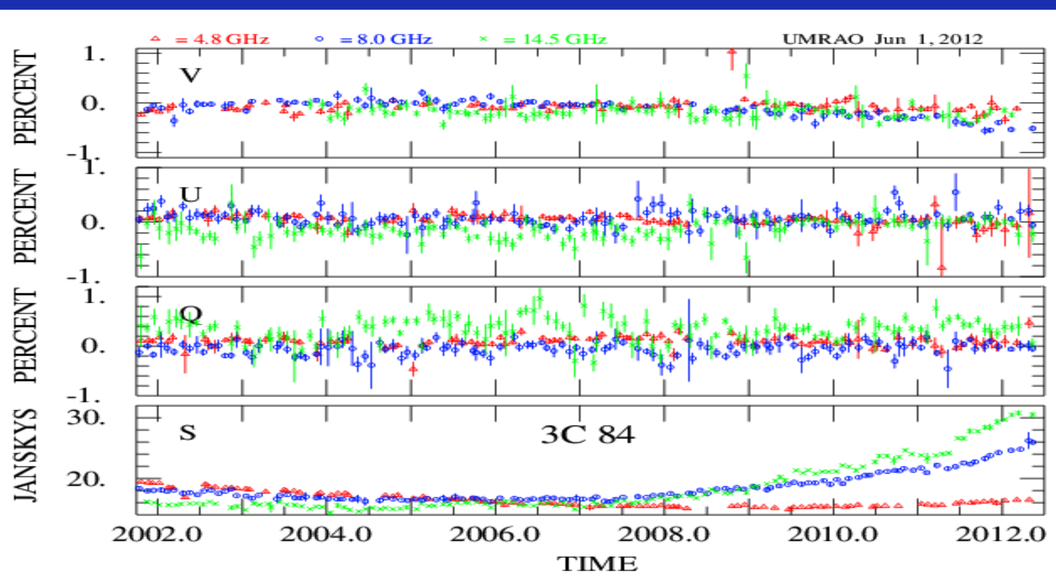

Figure 2: Monthly averages of the total flux density in Janskys S, and the Stokes parameters Q, U & V in percent for the variable radio galaxy 3C 84. Note the systematic drift in V to negative values as the new outburst developed starting in 2007.

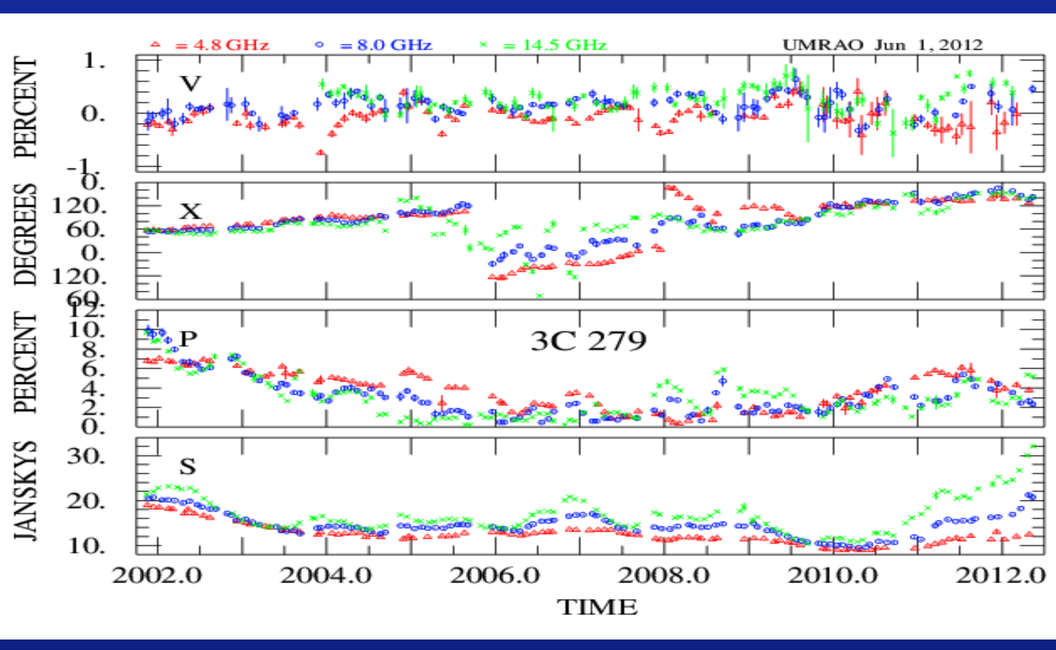

Figure3: From bottom to top, monthly averages of the total flux density, fractional linear polarization, electric vector position angle, and fractional circular polarization for the QSO 3C 279. Note the sign changes in V with time.

In the majority of the objects studied in the UMRAO program, circular polarization is a transient phenomenon, lasting only weeks to months, with V<<1%. Changes in the polarity of V with time have been observed in several sources, and we have seen simultaneous opposite polarities of V within the same source in our frequency range of 5 to 15 GHz. The QSOs 3C 279 and OV-236 have exhibited V as high as 1%, with variability time scales of months to years but have maintained the same polarity over several outbursts in total flux. In some sources the polarity of V at a given frequency has changed with time, and we have observed simultaneous opposite polarities of V within our frequency range of 5 to 15 GHz. The behavior of V appears to be consistent with the model predictions of Jones and O'Dell (1977) although the apparent stability in the polarity of V over a series of outbursts is unexpected.

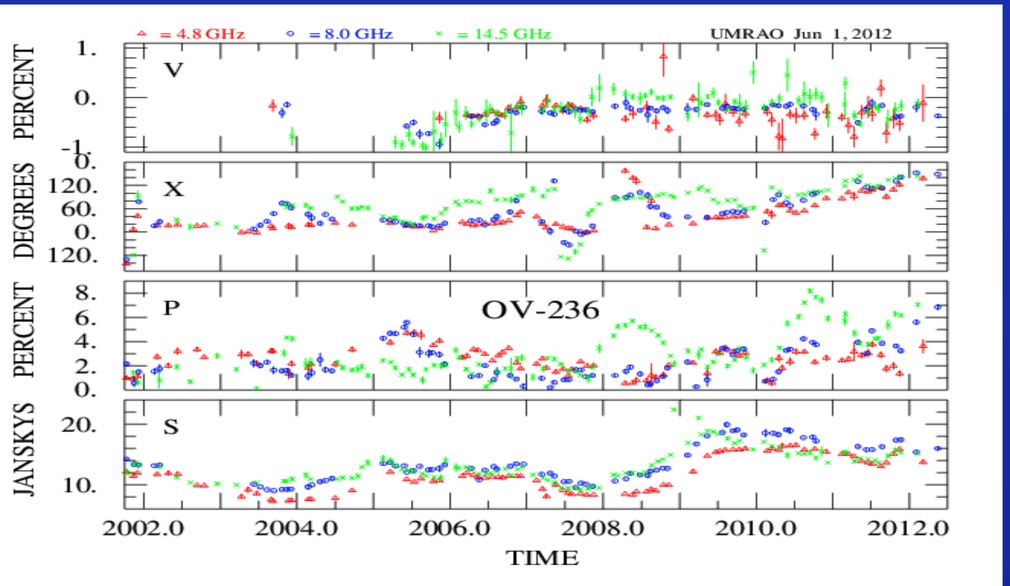

Figure 4: From bottom to top, monthly averages of the total flux density, fractional linear polarization, electric vector position angle, and fractional circular polarization for the QSO OV-236. Following several years of exhibiting a negative V of more than one percent, V approached zero but has been drifting back to negative values since 2008.

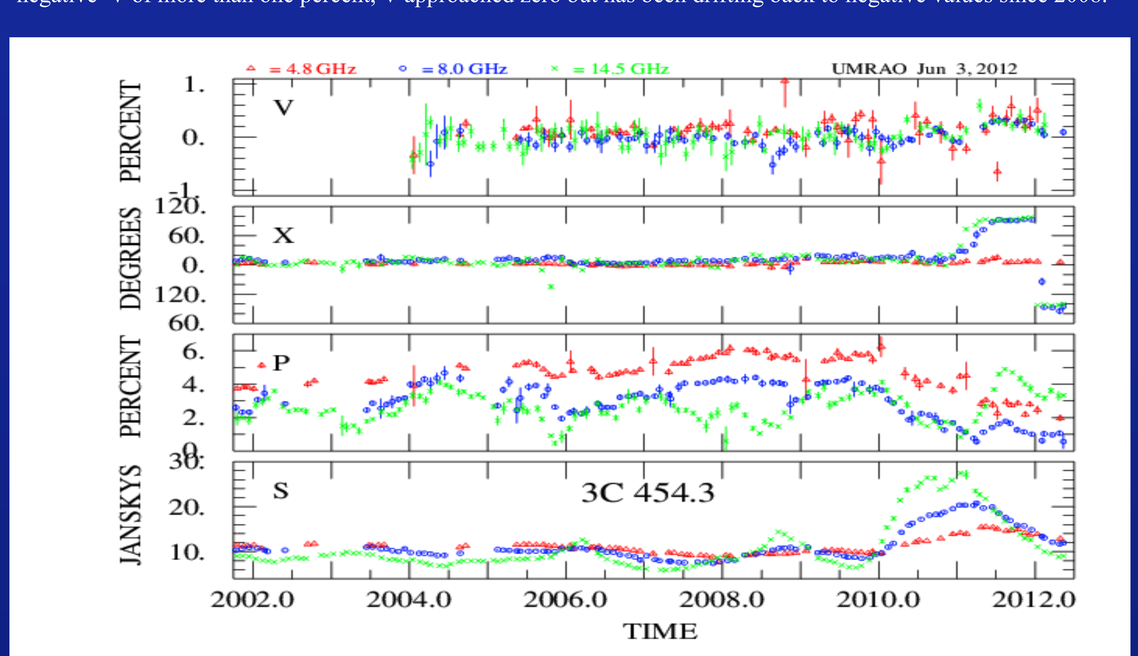

Figure 5: From bottom to top, monthly averages of the total flux density, fractional linear polarization, electric vector position angle, and fractional circular polarization for the QSO 3C 454.3

References

Aller, H.D., Aller, M.F., & Plotkin, R.M. 2003, *Ap. Space Sci.*, **288**, 17.
Jones, T.W. & O' Dell, S.L. 1977, *ApJ*, **214**, 522.

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