

Microquasar Observations with MERLIN

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Abstract. A series of observations of microquasar GRS1915+105 were made by the MERLIN telescope array in the spring of 2003 at 18 cm. The images show polarization in the jet components, with two epochs displaying Faraday rotation of ~ 2500 rad/m^2 . This effect is a demonstration of the similarities between microquasars and extragalactic jets.

1. Introduction

Of the X-ray binaries in the galaxy, about 50 are also detectable at radio wavelengths. This is thought to be synchrotron radiation from relativistic jets. Their similarity to quasars except for much smaller scales and distances from us has named these sources microquasars. Effects such as apparent superluminal motion are now seen in both and here we look for another feature seen in extragalactic jets, Faraday rotation, the rotation of the plane of polarization with respect to wavelength.

One object considered a microquasar is GRS1915+105. It was first found in X-rays with the watch instrument on the GRANAT satellite (Castro-Tirado et al. 1994) before a radio counterpart was found (Mirabel et al 1993). It is best known as the first source in our galaxy to show apparent superluminal motion (Mirabel & Rodríguez 1994). These ejections have allowed an estimate to the upper limit to its distance of 11.2 ± 0.8 kpc (Fender et al 1999).

2. Observations

The times of the 5 observations of GRS1915+105 by MERLIN are in table 1. All the observations were made at 1658.0 MHz with 16 MHz bandwidth. Also observed was a phase calibrator 1919+086, a flux calibrator 3C286 and point source 0552+368. The data sets from the observations were transformed into FITS files by telescope specific programs at Jodrell Bank Observatory that also set the flux scale from 3C286. The FITS files were then loaded into NRAO AIPS. bad data was removed using the AIPS task IBLED. CALIB and CLCAL were then used to calibrate 1919+086. The gain corrections were then applied to the target source. To correct for the leakage of flux from one cross polarized mode to the other, the task PCAL was run on 1919+086. The polarization angle was then calibrated with respect to 3C286. Finally the target source went through several loops of self calibration.

To measure the Faraday rotation each epoch was split into four subbands and images were made in total intensity, polarized intensity and polarization angle. The position of the peak polarized intensity of a component was used when measuring the angle.

Table 1. Times of MERLIN observations of GRS1915+105 in 2003

Start Time	End Time
March 06 02:00	March 06 14:40
March 24 09:33	March 25 13:14
April 17 23:45	April 18 10:45
May 09 22:00	May 10 10:00
June 15 19:30	June 16 07:45

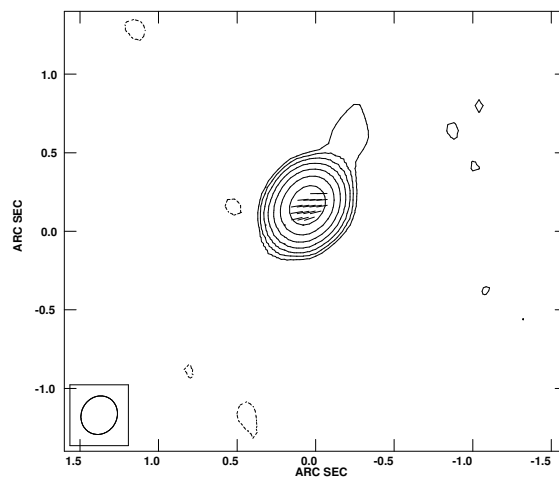


Fig. 1. GRS1915+105 March 6. The contours go up in powers of two from 0.24 mJy/beam, the bars give polarized intensity and angle, 1 arcsec equals 12.5 mJy /beam. observed PA at 1658 MHz is -81.3° , 3% polarization.

3. Results

In three images shown the contours go up in powers of two from 0.24 mJy/beam. Due to instrumental problems no polarization could be detected for the March 24-25 and May 9-10 observations. The Fig. 1 image is slightly extended to the north west and has polarization $\sim 45^\circ$ to the jet angle. The rotation measure in this epoch is 2640 ± 140 rad/m^2 . In Fig. 3 there is polarization in the northern component roughly perpendicular to the jet axis then polarization parallel to the jet axis in the the southern component. Neither component shows significant Faraday rotation. Fig. 4 shows polarization only in one component and then along the axis of the jet. There is a rotation measure of 2490 ± 252 rad/m^2 in this component.

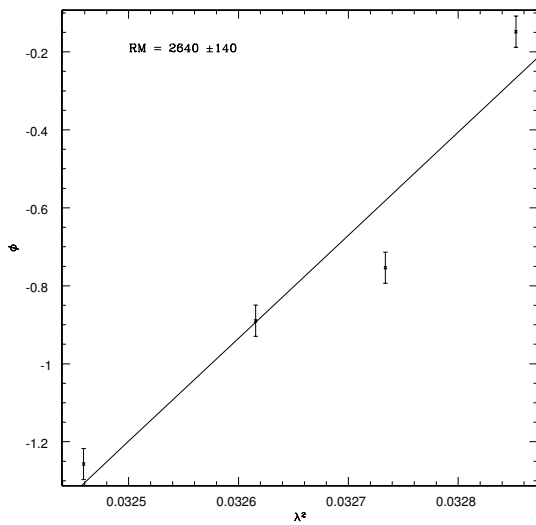


Fig. 2. GRS1915+105 Faraday rotation in March 6 observation, wavelength squared is in metre squared, polarization angle in radians. intrinsic PA = -87 rad

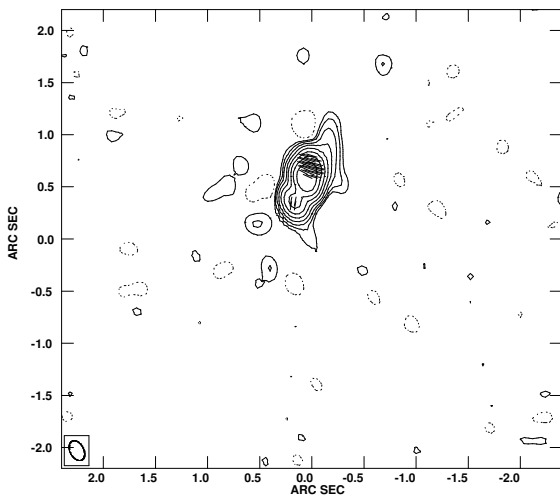


Fig. 3. GRS1915+105 April 18 epoch, observed PA at 1658; MHz northern component 73.7° , southern component -10.8° .

A comparison can be made with two pulsars close to the line of sight, PSR B1913+10 and PSR B1914+09. Their Faraday rotations were measured by Hamilton & Lyne (1987) to be 244.5 ± 1.0 and 61.1 ± 0.2 rad/m^2 respectively. This suggests that the majority of the rotation is occurring inside the jet.

4. Conclusions

GRS 1915+105 shows in two epochs rotation measures of ~ 2500 rad/m^2 . Looking at the rotation in pulsars close to the line of sight suggests that this is mainly occurring inside the jet. These results can be compared with the Faraday rotation seen in extragalactic jets (e.g. Cotton et al. 2003).

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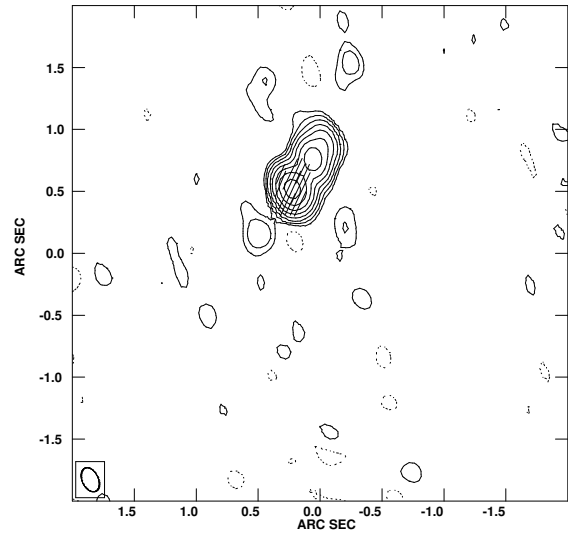


Fig. 4. GRS1915+105 June 15. 13 % polarized. Observed polarization angle at 1658 Mhz is -24.9° .

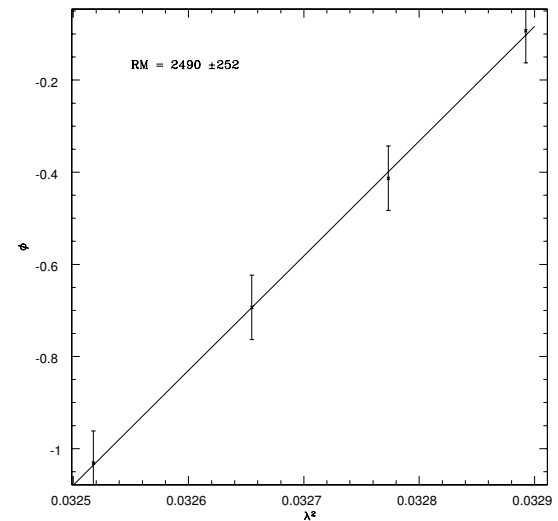


Fig. 5. GRS1915+105 Faraday rotation in June 15-16 observation. intrinsic PA = -82 rad.

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