OBSERVATIONS OF LINEAR POLARIZATION AT 32 GHz OF THE GALACTIC CENTER ARC

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ABSTRACT. The Galactic Center Arc has been observed with the Effelsberg 100-m telescope at 32 GHz. The percentage polarization is of the order of 50%. The magnetic field structure is uniform in a direction parallel to the Arc.

1. INTRODUCTION

The Galactic Center Arc is a bar like structure close to Sgr A running nearly perpendicular to the Galactic plane at $l \simeq 0\overset{\circ}{.}2$. The length of the Arc is about 15' or 40 pc. High resolution observations have resolved it into a number of linear filaments (Yusef-Zadeh et al., 1984). Linear polarization from the Galactic Center Arc has been reported from a series of observations in the frequency range between 4.5 GHz and 15 GHz (Sofue et al., 1987 and references therein; Yusef-Zadeh and Morris, 1987). These observations have been made using the Effelsberg 100-m and the NRO 45-m telescopes with angular resolutions between 2.'7 and 1.'2 and with the VLA, where an angular resolution of a few arcseconds can be achieved. Based on these observations rotation measures (RM) have been derived showing unusual high RM-values of several thousand rad/m^2. Consequently significant depolarization is expected and also the determination of the magnetic field direction is influenced even for observations at a frequency as high as 15 GHz. Higher frequency observations are needed to outline the magnetic field structure and the intrinsic percentage polarization.

2. OBSERVATIONS

The Effelsberg 100-m telescope has been used at a frequency of 32 GHz to map the Galactic Center Arc. The observations were made in April and July 1988 during test observations of a new receiver system, which consists of three horns with six receivers and three polarimeters. The horns are aligned in azimuth-direction with a maximum spacing on the sky of 6.'4. The HPBW is about 27". Software beam switching is applied to remove weather effects as described by Morsi and Reich (1986). The effective

M. Morris (ed.), The Center of the Galaxy, 265–267.

bandwidth is 1.8 GHz (31 GHz to 31.9 GHz and 32.1 GHz to 33 GHz). The calibration of the polarization data has been made using lower resolution maps at 32 GHz of the highly polarized sources Cyg A and Tau A beside 3C286. The accuracy of the percentage polarization is about 10% and that of the polarization angle is about 5°.

3. RESULTS AND DISCUSSION

Figure 1 shows the 32 GHz map of the Galactic Center Arc obtained from two coverages. The map has been slightly convolved to 36" angular resolution in order to improve the signal/noise ratio. Since the Galactic Center is observed from Effelsberg at elevations as low as 10° extinction is considerable and the calibration accuracy is limited so far to about 15%.

Strong linear polarization is visible in Fig. 1. The bars show the magnetic field direction for the case of negligible Faraday rotation. At 32 GHz even RM-values of about 5000 rad/m² cause a rotation of the polarization angle of only 23°. Deviations of this order of the polarization angle from the Arc direction are seen in the southern part. High RM-values are in fact indicated for this region, since 10 GHz single dish maps show no or little polarization from this area due to high depolarization. Therefore the magnetic field structure seems to run exactly parallel to the Arc structure.

The percentage polarization is close to 50% near the intensity maximum of the Arc. North of it the percentage polarization further increases

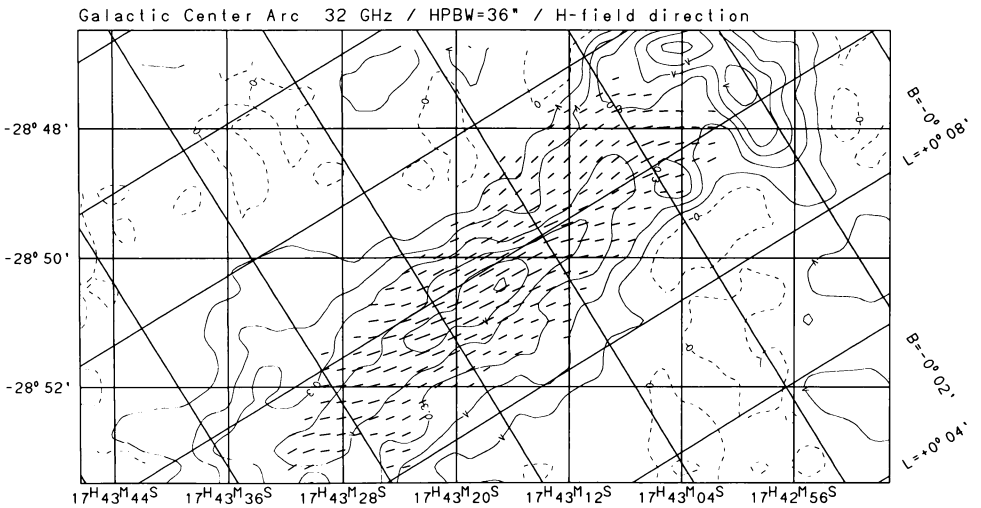

Figure 1. Total intensity contours are shown in steps of 100 mJy/beam area (HPBW = 36"). Polarization bars are shown in the projected H-field direction (see text). A bar length equivalent to 15 " corresponds to 300 mJy/beam area of linearly polarized intensity.

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to values of the order of 70%, but for the northern region in Fig. 1 the total intensity emission is somewhat underestimated due to an influence of the Bridge emission on the western zerolevel of the map. A value of 50% of linear polarization seems to be representative for the Arc emission at 32 GHz. Reich et al. (1988) have determined spectral indices between $\alpha \simeq +0.1$ and $\alpha \simeq -0.3$ ($S \sim \nu^{\alpha}$) for the Arc emission between 10.7 GHz and 43.25 GHz. If this emission is entirely non-thermal an intrinsic degree of linear polarization close to 60% is expected, which is very near to the observed value at 32 GHz. This implies a small fraction for the irregular magnetic field component on the scale of a few parsecs. Therefore, RM and depolarization fluctuations as observed on much smaller scales (Yusef-Zadeh and Morris, 1987) have to be explained by large density fluctuations of the depolarizing thermal medium in the line of sight.

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