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Milliarcsecond Structure of the Faraday Effects in 3C 147: "The CSS Prototype with Highest Rotation Measure" (Which Is Not)

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Abstract. We analyze polarization observations of 3C 147 at milliarcsecond scale which we have made with the VLBA at L, S, and C band and with the MERLIN array at K band. Several constraints placed by the observations on the physical conditions of the magnetoionic gas which produces the Faraday rotation are briefly discussed. Our data show that the Faraday rotation increases towards the VLBI core component with a maximum observed value of RM$\sim 4600 \pm 80$ rad m^{-2}. Such a value does not support the inclusion of 3C 147 as a source with exceedingly-high faraday rotation (SEFR), as suggested from published low-resolution observations.

1. Introduction

Compact steep spectrum (CSS) sources are paradoxical in the sense that sources with negligible Faraday rotation (e. g., 3C 138, 3C 286, etc.) coexist with CSSs with very high integrated rotation measures (Inoue et al. 1995; Kato et al. 1986).

It has long being thought that the quasar 3C 147 is among the top four CSS sources with the highest rotation measures (3C 295, Taylor et al. 1992; 3C 216, Taylor et al. 1995; 3C 119, Flatters, these Proceedings, p. 109) since it exhibits integrated RM> -1200 rad m^2. At sufficient resolutions which minimizes the beam depolarization, one can expect that the rotation measure images ot show even four-figure rotation measures. These objects, which we are referring as sources with exceedingly-high faraday rotation (SEFR's) are of great astrophysical interest since they will be preferably found in sources which evolve in magnetized media with high column densities. It is worth emphasizing that good SEFRs must show high <u>observed</u> Faraday rotation since the amount may be boosted up by the redshift-correction factor $(1+z)^2$ if the rotation measures are derived from centimeter wavelength observations.

In this project we present some preliminary evidence that even the CSS sources with high RMs do not need to have extremely high rotation measures at high resolution. This implies that any low-resolution rotation measure analysis of the CSSs may not be a safe criteria to set out their sample properties.

2. The Observations

Polarization observations of 3C 147 with the VLBA were done at 1.6, 2.7, and 5 GHz in December 1995. We have made polarization images of 3C 147 at 5 and 2.7 GHz at two frequencies which are 8 MHz apart. Previous MERLIN observations at 5 GHz (Lüdke et al. 1997) pointed out that the polarized flux arises from less than 100 pc from the core component.

In order to better assess the brightness distribution along the jet, we have produced a combined MERLIN and VLBA image at 5 GHz at 6 mas resolution to see the features on the jet. The combined map shows that the jet contains at least six knots of emission and that it propagates quite straight toward a bright hotspot at the jet head. No polarized emission is seen along the jet with the sensitivity limit defined by 16 telescopes at 5 GHz or with the MERLIN array at 22 GHz.

3. Discussion and Conclusions

At 5 GHz, the Faraday rotation in the central component is resolved and can be detected in our images. The beam depolarization or the increase of fractional polarization with resolution is seen here, suggesting that the scale lengths of the depolarizing medium are at least partially resolved by the present observation.

In 3C 147 there are two adjacent regions of high rotation measure, $\sim 4600 \pm 80$ rad m^2 and $\sim -1100 \pm 80$ rad m^2. The absolute value of the rotation measure is larger in the component closer to the core, as expected when the magnetic field and thermal particle densities increase towards the center. Since these regions have rotation measures of opposite sign, their effects largely cancel resulting in a much lower integrated rotation measure. Then, the vector difference between the rotation measures of these components give a value which is about the integrated rotation measure of 3C 147 available in the literature.

The results given here illustrate the effects of beam depolarization in low resolution polarization measurements of CSS sources. At sufficient resolution small regions of high rotation measure become visible. In 3C 147 regions of high RM, but of opposite sign, cancel in lower resolution measurements causing a serious underestimate of the rotation measures. Therefore, we see that beam depolarization is an important source of error in polarization measurements of CSS sources. Other examples of CSS sources in which this effect occur are given somewhere else in these proceedings.

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