New LensClean results for B0218+357

Abstract

We present results from a preliminary analysis of a 15 GHz VLA + Pie Town data set of B0218+357 which shows a wealth of structure in the Einstein ring of this system. From these data we obtain constraints for the position of the lensing galaxy, which will potentially improve the accuracy in the determination of \( \mu_0 \), and maps of the lens plane and the unlensed source plane. This includes the first LensClean reconstruction of the polarization structure of the source plane.

Introduction

The lens system B0218+357 (Fig. 1) has the potential to be or become a ‘hidden Lens’ which can be used to determine the Hubble constant \( H_0 \) with a very high accuracy. Even in the age of ‘high precision cosmology’, independent constraints for \( H_0 \) are of high value since they can break degeneracies in the analysis of the cosmic microwave background. The combination of results from several lens systems also has the potential to provide invaluable information not only about cosmology but also about the galaxies themselves.

The main problem with B0218+357 in this game has always been the very poor constraints on the position of the lens galaxy. We used the LensClean algorithm to determine this position indirectly (Wucknitz, Biggs & Brown, 2004) which provided the first useful estimate of \( \mu_0 \) from this system. Only very recently a more direct approach was used by York et al. (2004) to measure the position in optical HST/ACS images. Both results are in very good agreement.

LensClean

The LensClean method (Kochanek & Narayan, 1992; Ellis, Kochanek & Hewitt, 1996) fits brightness models of the source directly to the measured visibility data, given a lens model. In an outer loop the lens model parameters themselves are varied in order to minimize the residuals and thus find the best lens model. The result is a self-consistent model both for the structure of the source and the mass distribution of the lens. See Fig. 2 and Wucknitz (2004) for details.

The most important unknown parameter of the lens model is the position of the lensing galaxy. We therefore used LensClean to exploit the structure of the Einstein ring as constraint for the lens position. Results for singular isothermal ellipsoid lens models are shown in Fig. 3 (red \( \sigma \) curves). With the time-delay of Biggs et al. (1999) we obtained a value for the Hubble constant of \( H_0 = 77 \pm 4 \) km s\(^{-1}\) Mpc\(^{-1}\) (1σ) using a 15 GHz VLA data set. This lens galaxy position was later confirmed by York et al. (2004); see also their poster at this conference.

New VLA + Pie Town data

In order to improve the accuracy of our results it was necessary to increase the resolution with a uv coverage as good as possible. We decided to use the VLA together with the VLBA telescope Pie Town, which is connected via an optical fibre link. The uv coverage and dirty beam of the 13h long track observed in June 2003 are shown in Fig. 4, both for the complete data set and the VLA part alone. Compared to the previous VLA-only 15 GHz data, resolution and sensitivity are improved significantly.

Polarization

Previous observations as well as our new data show an intriguing radial pattern in the linear polarization around the ring, with some interesting small-scale structure especially south of the B image (Fig. 6). Because lensing does not change polarization, this pattern must be part of the source itself.

Outlook

This is work in progress. The presented results are still very preliminary. A final calibration of the complete data set still has to be performed. Especially the LensClean self-calibration loop (Fig. 2) has not yet converged. Very important tasks for the future are fits of non-isothermal models, the radial mass slope of which can be constrained by existing VLBI observations. The goal is a simultaneous LensClean fit to the medium-resolution VLA+Pt data (sensitive for galaxy position) and the VLBI data (sensitive for radial mass distribution).

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References


