Deconvolving Spectra: Near-IR Spectroscopy of the Lens and Source in HE 1104-1805

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Abstract. A new method for spatial deconvolution of spectra is applied to near-IR spectroscopy of the doubly imaged QSO HE 1104-1805. The spectra of the QSO images and of the lensing galaxy are extracted, free of any mutual light contamination. Evidence for continuum microlensing is seen in the QSO images while the featureless lens spectrum, combined with previous photometry, indicates $1.0 < z_l < 1.3$.

1. Spatial deconvolution of spectra

Magain, Courbin & Sohy (1998; MCS) recently proposed a new image deconvolution algorithm which overcomes the drawbacks (the so-called "deconvolution artifacts") of the most popular techniques. Its success comes from a deliberate choice to achieve an *improved resolution* rather than an *infinite one*, i.e., it does not attempt to recover spatial frequencies forbidden by the sampling theorem.

High angular resolution is certainly a must in imaging, but it is also of great interest in spectroscopy. We have developed a spectroscopic extension to the MCS algorithm (Courbin et al. 1999) which, as does the image deconvolution technique, requires a good knowledge of the instrumental PSF (here, as a function of wavelength). One or more PSFs should be observed at the same time as the target. This is ensured either by aligning one long slit along a line joining the target and a point source or, better, by observing in MOS mode.

The algorithm improves the spatial resolution of the spectra as well as their sampling. It also decomposes the data into a sum of point and extended sources, hence allowing to unveil the (flux calibrated) spectrum of faint extended objects hidden by bright point sources, e.g., lens galaxies.

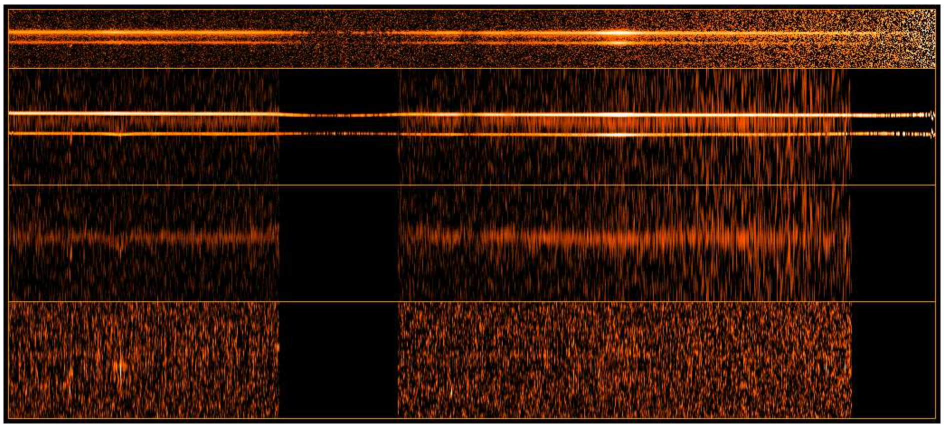

Figure 1. Near-IR spectroscopy of HE 1104-1805. From top to bottom: 1- NTT/SOFI spectrum ($1.5 - 2.6$ microns), 2- deconvolved version of the spectrum, 3- the spectrum of the lensing galaxy alone, 4- residuals in units of the photon noise.

2. Application to HE 1104-1805

We have obtained near-IR spectra of the doubly imaged QSO HE 1104-1805 (Wisotzki et al. 1993) with the ESO 3.5m New Technology Telescope, under good seeing conditions ($0.7''$). As no PSF star could be observed, the PSF spectrum was constructed from the brighter QSO image. This non-optimal procedure however allows us to unveil the spectrum of the lens between 1.5 and 2.5 microns (Fig. 1). This spectrum is consistent with previous IR photometry of the lens and, when combined with optical photometry, yields $1.0 < z_l < 1.3$. This redshift estimate assumes that the lens is an elliptical.

Subtracting a scaled version of the spectrum of the faint QSO image from the brightest one removes completely the broad and narrow emission lines of the source (including Fe II) and leaves a blue featureless continuum. This is suggestive of microlensing of the continuum. Finally, the Balmer decrement of the source indicates no reddening, supporting an early type lens.

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References

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