MAPPING THE EXTINCTION IN DUSTY LENSES: OPTICAL AND IR IMAGING OF MG J0414+0534

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The source of the gravitational mirage MG J0414+0534, found in a radio survey (Hewitt et al. 1992), is an extremely reddened quasar at z $\simeq$ 2.63 (Lawrence et al. 1995) but the redshift of its lensing galaxy is still unknown ($\simeq$ 0.8 ?). Whether the extinction occurs mainly in the *lens galaxy* or in the *source* itself is a matter in debate. Also, a discrepancy is observed between the radio and optical flux ratios for images A_1 and A_2, which could be due either to differential magnification near a caustic or to differential extinction (Schechter et al. 1992, hereafter SM92; Angonin-Willaime et al. 1994, hereafter AW94). The new IR and optical data discussed here could throw some light on these obscure issues.

Data were obtained almost simultaneously at visible and IR wavelengths with the Canada-France-Hawaii telescope: in R band with the imaging mode of SIS (Subarcsecond Imaging Spectrograph) on the night of 15 August 1994; in K band the following night, with the Redeye camera (Simons et al. 1994). Near simultaneity eliminates any trouble from intrinsic variations and time delays for measuring the extinction. The pixel size was 0.173" for SIS and 0.201" for Redeye. Good seeing (see Table 1) allowed an accurate image decomposition. In R, a synthetic PSF was built from the surrounding standard stars (see AW94). The photometric accuracy for the decomposition is limited by photon noise. In K, the measurable stars were too faint and the PSF was determined iteratively from the object itself. The photometric accuracy, although limited by this process, is better than in the visible. In particular, the properties of the lensing galaxy are easily measured (this will be reported elsewhere). Table 1 summarizes the photometric data available from earlier studies and from these observations. The most striking feature is the dimming of A_1 by a factor 2 (0.75 mag) in R between 1992 and 1994. The other components, checked against the local photometric sequence, did not vary significantly.

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TABLE 1. Summary of Measured Flux Ratios

color (date)	A/B	A_1/A_2	A_1/B	A_2/B	seeing (")	exposure (mn)
Radio (average)	5.0	1.15±0.05	2.7	2.3		
I (1991, cf. SM92)	3.2	2.5±0.2	2.2	0.9		
R (1992, cf. AW94)	3.2	3.0±0.4	2.4	0.8		
R (15/08/1994)	2.1	1.3±0.15	1.2	0.9	0.70	2×10
K (16/08/1994)	4.6	1.39±0.05	2.68	1.92	0.62	13×2

To understand this data set, we should note that: (1) the time delay $\Delta t(A_1\text{-}A_2)$ is too short to explain the A_1/A_2 variations; (2) in 1994, the flux ratios in the radio and in K are similar, while the R data agree with an extra extinction for A_1 and A_2, most likely due to the lens galaxy; (3) the reddening indices (R-K, or R-radio) are identical for A_1 and A_2 in 1994; (4) in 1991-92 the A_1/B ratio in R was close to the radio value.

Two different interpretations are then possible:

- In 1992, the extinction was comparable for A_1, B and C, but definitely larger for A_2. In 1994, A_1 was also more absorbed because its light beam was crossing a cloud in the lens galaxy. Gravitational magnification causes a "fast scanning" of highly amplified images across the galaxy (the proper motions can reach $\sim 10^4$km/s), which speeds up the observed variations.
- The fading of A_1 is simply the end of a microlensing event, the "normal" flux ratios being close to those measured in 1994. In 1992, the extinction of A_1 was compensated by microlensing amplification and it was just *by chance* that A_1/B in the visible was close to the radio value.

In any case, we can conclude that the large extinction of MG J0414+0534 is due **at least partly** to the lens galaxy. Since microlensing is achromatic, deciding between a microlensing event or variable extinction from "gravitational fast scanning" for image A_1 could have been done in 1992 with IR and visible photometry or, better yet, bidimensional spectroscopy. Such techniques are relevant for a future monitoring.

References

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