# GRAVITATIONAL LENSING OF QUASAR 0957+561 AND THE DETERMINATION OF $H_0$

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## 1. Introduction

The double quasar 0957+561 was the first discovered instance of multiple imaging via gravitational lensing. The galaxy cluster is an important deflector as well as the first ranked galaxy. This has so far precluded construction of a unique model of the lens, reducing the accuracy of the derived $H_0$ value. We have obtained deep images of the system at CFHT. The cluster is sufficiently massive to cause distortions on distant background galaxy images. We have used a mass map derived from lensing distortions to improve the accuracy of the cluster center location and place new limits on $H_0$.

## 2. The Time Delay

Vanderriest et al. (1989) obtain a value of $415 \pm 20$ days based on optical data. Schild (1991) obtains a value of $404 \pm 10$ days also based on optical monitoring. From radio monitoring studies Lehar et al. (1991) conclude that the time delay is $513 \pm 40$ days.

## 3. The Mass Distribution

The galaxy principally responsible for the lensing (G1) has a redshift of 0.36. Bernstein et al. (1993) find that the surface brightness profile is well



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fit by a power law with index $n = -1.94 \pm 0.06$. The position angle of the galaxy may twist slightly about a mean value of 55° . From spectroscopic observations Rhee (1991) derives a velocity dispersion $300 \pm 50$ km $s^{-1}$ for G1.

The parameters for the galaxy model are: the velocity dispersion, the ellipticity, the galaxy position angle and the power law index. The cluster is modeled as a pseudo-isothermal sphere. The cluster maps show that the cluster potential is not perfectly smooth. This can be taken into account by adding a shear component to the two components listed above. The shear component has two parameters the magnitude of the shear and its position angle. The effect of the shear may be taken as some indication of the changes in the models that would result from the addition of lumps to the mass distribution.

The observations were made with FOCAM and the SAIC CCD at CFHT in January 1994. We obtained a 3 hour integration in B band and a 4 hour integration in I-band. By inverting the estimated shear field inferred from the observed shapes and orientations of background galaxies we have obtained a map of the surface mass density of the matter lensing Q0957+561.

## 4. Conclusion

From the map of the mass distribution we can locate the center of the cluster relative to the lensing galaxy. We measure the cluster center position to be at a distance ($r_c$) of 9 arcseconds from the lensing galaxy in the direction $\theta_c = 193°$. By limiting the range in values that these two parameters can have we eliminate all models except those having $H_0$ less than 70 km $s^{-1}$ $Mpc^{-1}$.

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