A QUASI-STEellar OBJECT PLUS HOST SYSTEM LENSED INTO A 6′ EINSTEIN RING BY A LOW-REDSHIFT GALAXY

Kajal K. Ghosh1 and D. Narasimha2

1 USRA/NSSTC/MSFC/NASA, 320 Sparkman Drive, Huntsville, AL 35805, USA; kajal.k.ghosh@nasa.gov
2 Tata Institute of Fundamental Research, Mumbai 400 005, India; dna@tifr.res.in

Received 2008 January 23; accepted 2008 October 21; published 2009 February 19

ABSTRACT

We report the serendipitous discovery of an Einstein Ring in the optical band from the Sloan Digital Sky Survey (SDSS) data and four associated images of a background source. The lens galaxy appears to be a nearby dwarf spheroid at a redshift of 0.0375, lensed by a galaxy at a very low redshift of 0.684, forming a ring of nearly 6′ around the lens nearly along a ring of radius ∼6″. Single-component lens models require a mass of the galaxy of almost 10^{12} M_\odot within 6′ from the lens center. With the available data, we are unable to determine the exact positions, orientations, and fluxes of the quasar and the galaxy, though there appears to be evidence for a double- or multiple-merging image of the quasar. We have also detected strong radio and X-ray emissions from this system. It is indicative that this ring system may be embedded in a group or cluster of galaxies. This unique ring, by virtue of the closeness of the lens galaxy, offers a possible probe of some key issues such as the mass-to-light ratio of intrinsically faint galaxies and the existence of large-scale magnetic fields in elliptical galaxies.

Key words: galaxies: individual (SDSS J091949.16+342304.0) – galaxies: structure – galaxies: evolution – galaxies: elliptical and lenticular, cD – gravitational lensing

Online-only material: color figures

1. INTRODUCTION

Galaxy formation has remained an open issue in astronomy and cosmology. Several multiwavelength deep surveys have been carried out to measure the evolution of the mass-to-light ratio and to constrain the process(es) of galaxy formation and evolution, but they have their inherent limitations. Gravitational lensing offers an unbiased technique to directly measure the mass of galaxies as well as constraints on the mass distribution (Kochanek & Narayan 1992; Warren et al. 1996; Kochanek et al. 1999; Kochanek et al. 2001; Myers et al. 2003; Warren & Dye 2003; Bolton et al. 2004; Cabanac et al. 2007; Gavazzi et al. 2008 and references therein). Tight constraints on these measurements can be made by observing nearby lens systems having multiple images as well as perfect Einstein Rings, because these systems will not suffer from well known ellipticity–shear degeneracy (see Keeton et al. 1997). In addition, a detailed observation of the galaxies in the vicinity as well as the shape of the luminous mass in the main galaxy is feasible for very nearby galaxies. Consequently, a strong constraint on the mass-to-light ratio of the lens galaxy is, in principle, possible from such a system. For the formation of a perfect (360°) “Einstein Ring,” the lens and the source have to be aligned such that an extended structure in the source straddles at least three of the vertices of the tangential lens caustic. In this process, the lens and an inner image of the source will appear almost as a single object close to the center of the ring. To date, not many Einstein Rings are known that have large circumferences (Belokurov et al. 2007 and references therein), though recently they have discovered a ∼300′′ Einstein Ring system. Here we report the discovery of an almost perfect optical “Einstein Ring” (Sloan Digital Sky Survey (SDSS) J091949.16+342304.0), a quasar at a redshift of 0.684, lensed by a galaxy at a very low redshift of 0.0375, forming a ring of nearly 6″ radius, and four associated images. Observations and data analysis are described in Section 2. Computations of models and interpretations of results are presented in Section 3. Section 4 presents the significance of this powerful lens system, and discussion and conclusions are presented in Section 5.

2. OBSERVATIONS, DATA ANALYSIS, AND RESULTS

Figure 1 shows the SDSS composite image in the field of SDSS J091949.16+342304.0. A close-up view of the unique Einstein Ring system of SDSS J091949.16+342304.0 is shown in Figure 2. It can be seen from this figure that there appear to be two objects at the center. This is further supported from the results of the image-projection profile of the central region. The nature of these two objects has been determined from their spectra, which are shown in Figure 3. The SDSS spectrum of the quasar at the center (SDSS J091949.16+342304.0) shows that it is at a redshift of 0.6842 ± 0.0014. This spectrum was dereddened using the Galactic extinction curve (Schlegel et al. 1998), then the wavelength scale was transformed from the observed to the source frame. This is shown in black, and the SDSS composite quasar spectrum is shown in magenta (vanden Berk et al. 2001). We adjusted the relative extinction between these two spectra to match their red wings of Mg II (2800 Å) line and the fluxes at 5100 Å. It can be seen from these two spectra that the absorption features between 5100 Å and 5300 Å are present only in SDSS J091949.16+342304.0 and not in the composite spectrum. In order to check the validity of these lines, the Fe II emission lines were subtracted from the observed spectrum of SDSS J091949.16+342304.0. We obtained the Fe II model spectrum in the optical (3530–7570 Å) band from Anabela C. Goncalves. First, we determined the required broadening by comparing the full width at half intensity maximum (FWHM) of the iron lines in the observed and the template spectra. Then by varying the scaling factor we created a large number of template spectra, which were subtracted from the observed spectrum to determine the residual spectra. Standard deviations at the continuum around 4600 Å.
A small circle and the ellipse show the positions of the source and the lensing galaxy. "A" and "B" are the two images of the source. It appears that the visible region of the residual spectra were computed. Finally, the residual spectrum with the least value of the standard deviation was subtracted from the observed spectrum (Veron-Cetty et al. 2001; Vestergaard & Wilkes 2001). The spectrum of SDSS J091949.16+342304.0 without iron emission lines clearly displays the presence of Ca ii lines with high significances. These lines are clearly absent in the SDSS composite quasar spectrum, which can be seen from Figure 3.

Next, we subtracted the SDSS composite quasar spectrum from the observed spectrum of SDSS J091949.16+342304.0 and the residual spectrum, at the observer’s frame, is shown at the upper plot of Figure 4. Clearly, two absorption lines around 9000 Å (8863 and 8988 Å) and one around 5040 Å are present. Other prominent absorption and emission features present in this spectrum are artifacts. All three absorption lines are consistent with a redshift of 0.0375 ± 0.002. Thus, we identified these absorption features as redshifted (0.0375 ± 0.002) Hβ and Ca ii absorption lines (8498, 8542 and 8662 Å), which are marked on this figure. We could not identify the first Ca ii triplet line (8498 Å), which will be redshifted at 8817 Å, as this line is located at the red wing of the redshifted (0.6842 ± 0.0014) Mg triplet lines (Mg1, Mg2, and Mgb around 5175 Å) of the host galaxy of the quasar. In addition, we could not identify the Hα line from the foreground galaxy, because it is located on the blue side of the quasar’s Hβ emission line. To identify the nature of the foreground galaxy, we compared the residual spectrum with the SDSS spectra of different types of galaxies, which are at redshifts between 0.37 and 0.38 and are fainter than 18.2 mag in the SDSS r-band. The limit of 18.2 mag comes from the SDSS photometric results of the central region of Figure 2. In this figure, we have marked two objects with a circle and an ellipse, whose measured brightnesses are 19.6 ± 0.2 and 18.4 ± 0.1 mag in the SDSS r-band, respectively. Finally, from the results of the comparison of spectra, we find that the residual spectrum is similar to that of the dwarf elliptical (dE) galaxy, which is shown in the lower plot of Figure 4. In addition, the flux and photometric magnitude of the elliptical object of Figure 2 are consistent with those of the dE galaxies at similar redshift. Furthermore, we found from the SDSS database that there are at least a few quasars at redshifts between 0.68 and 0.69 (SDSS J154127.26+405720.2, SDSS J155900.8+062412.0, etc.), whose radio and optical spectral properties are similar to those of SDSS J091949.16+342304.0. Photometric magnitudes of these quasars are between 19.5 and 20.0 mag. In addition, there are many quasars at redshifts between 0.68 and 0.69 whose optical spectral properties are similar to those of SDSS J091949.16+342304.0 and are fainter than 21 mag. All these photometric and spectroscopic results indicate that the central region of Figures 1 and 2 contains a nearby dE galaxy and a quasar. It is important to mention here that these results should be taken cautiously until future high spatial resolution images, preferably with the Hubble Space Telescope, confirm the positions, orientations, and brightness of these objects.

In Figure 2, we have marked two objects with “A” and “B.” It appears that the object “A” could be composed of multiple images. We obtained its optical spectrum on 2007 March 6, using the Low Resolution Spectrograph at the Nasmyth B focus of the Telescopio Nazionale Galileo (TNG) with 2000 s exposure (TNG is a 3.58 m optical/infrared telescope located in the Island of San Miguel de La Palma). This observation was carried out in the Long Slit Spectroscopy mode (LR-R Grism no. 3) with a camera which is equipped with a 2048 × 2048 Loral thinned and back-illuminated CCD. This spectrum is shown in Figure 5 in red (middle plot), without corrections for the atmospheric absorptions which are marked with “T,” and their presence has affected the strengths of some emission lines. For comparison, the SDSS spectrum of the quasar is shown in black. Five redshifted emission lines of [O ii] 3727 Å, [Ne iii] 3869 Å, Hγ (4340 Å), Hβ (4860 Å), and [O iii] 5007 Å that are common between these two spectra are marked with vertical dashed lines. While the spectrum of the object “A” was obtained, the position of the slit of the spectrograph was aligned in such a way that the object “B” was on the slit. We extracted the spectrum of the object “B,” and the highly smoothed spectrum is also shown in Figure 5 (bottom plot in green). Four redshifted
emission lines of [O II] 3727 Å, [Ne III] 3869 Å, [O III] 4959Å, and [O III] 5007 Å are labeled in this figure, and their redshifted wavelengths are same as those of the object “A” and the SDSS quasar. These results indicate that the central quasar and objects “A” and “B” are at the same redshift (0.6842 ± 0.0014). However, these results have to be confirmed with high signal-to-noise ratio spectra.

We also obtained near-infrared spectra of the quasar and the object “A” on 2007 March 7, using the near-infrared camera spectrometer at the TNG with an HgCdTe Hawaii 1024 × 1024 array detector for 500 s exposure. These spectra are shown in Figure 6, with the upper one being the quasar spectrum (black) and the lower one for the object “A” (magenta). A broad emission feature around 1.105 μ is present in both the spectra, and we identify these features as the redshifted Hα emission line with z = 0.684. Again, these results suggest that the quasar and object “A” are at the same redshift.

We searched the 2MASS database for the counterparts of the central objects of the ring system. A central extended blob was detected only in the J-band with a few more objects.

Figure 3. Galactic extinction corrected rest-frame observed spectrum of SDSS J091949.16+342304.0, which is at the redshift of 0.6842 ± 0.0014 (black). For comparison, SDSS composite quasar spectrum at a redshift of 0.5 is shown in magenta. From the comparison of the two spectra, it can be seen that the absorption lines are absent in the SDSS composite quasar spectrum. The vertical dashed lines are drawn at the position of three absorption lines, which correspond to Hβ and two Ca II lines (8542 and 8662 Å) of the foreground galaxy, which is at a redshift of 0.0375 ± 0.002.

(A color version of this figure is available in the online journal.)

Figure 4. Upper plot shows the residual spectrum between SDSS J091949.16+342304.0 and the SDSS composite quasar spectrum. The lower plot shows the SDSS composite spectrum of the dwarf elliptical galaxy at a redshift of 0.037, which we generated using the spectra from the SDSS database. Hβ and two Ca II lines (8542 and 8662 Å) are marked with vertical dashed lines. The residual spectrum has been shifted up for clarity.

(A color version of this figure is available in the online journal.)
within a circle of 30′ radius. The positions of these objects coincide with the bright optical counterparts present in the SDSS images. The central objects were also detected in the VLA/ FIRST and NVSS surveys (1.4 GHz) with peak flux densities at 2.15 ± 0.13 and 2.3 ± 0.45 mJy, respectively. We make the reasonable assumption that the radio emission comes mainly from the quasar with negligible contributions from the dwarf spheroid lens galaxy or other nearby galaxies. Then, using the VLA/FIRST flux density, the SDSS i-band magnitude, and Equation (3) of Shen et al. (2006), we find that this quasar is a radio-loud object with radio-loudness index ∼1.3. Figure 7 shows the ROSAT/PSPC image of the ring system, which has been adaptively smoothed. It can be clearly seen from this figure that bright X-ray emission is present in and around the ring system. This is indicative of X-ray emission from the quasar, its images, and from the surroundings, which may contain

Figure 5. Observed spectra of the objects “A” and “B,” in red and green, respectively, at the bottom. The atmospheric telluric bands are marked with “T.” For comparison, the spectrum of the quasar SDSS J091949.16+342304.0 is shown in black at the top. Four emission lines, which are at the same positions between the three spectra, are marked with vertical dashed lines. In addition, the Hγ line is marked between object “A” and the quasar. This shows that the quasar and the objects “A” and “B” are at the same redshift.

(A color version of this figure is available in the online journal.)

Figure 6. Observed near-infrared spectra of the quasar SDSS J091949.16+342304.0 (black) and its image, “A” (magenta). The broad emission lines around 11000 Å are the redshifted Hα line.

(A color version of this figure is available in the online journal.)
X-ray emitting group of galaxies or similar objects. This image was located on the outer part of the ROSAT PSPC detector. The point-spread function (PSF) of the PSPC detector varies too much across the field of view, and in the outer parts it shows strong nonsymmetric features. This did not permit us to deconvolve this image in a meaningful way (F. Haberl 2008, private communication). Future, high spatial resolution X-ray observations will reveal the details of this ring system. In this system, we do not see the source quasar, its lens could increase. In this model, the central cusp-like mass is most likely composed of two or more images. In the outer regions of the galaxy or additional galaxies is of the minimum mass in the absence of large-scale shear due to external shear without observational information about the orientation along which the double images in A merge, or their substructures. Consequently, we have constructed a model for a spheroidal lens with ellipticity to match the approximate image configuration could render this system a valuable probe of the dynamical mass distribution in elliptical galaxies and at larger scales.

4.1. Model 1: Model-Independent Minimal Limits for Lens Mass

A single-component spherical mass at a redshift of 0.0375 (distance of the order of 160 Mpc), acting as a gravitational lens for a background source of redshift 0.68, and producing three images at approximately 6 arcsecond from the lens center should have a minimum mass given by

\[ M_{\text{min}} = \frac{D_{\text{eff}} c^2 \theta_E^2}{4G} \]

where \( D_{\text{eff}} \) is the combination of distances to the source \( D_S \), to the lens \( D_L \), and the distance from the source to the lens \( D_{\text{LS}} \), is essentially the distance to the lens in this case. \( c \) is the velocity of light, \( G \) is the gravitational constant, and \( \theta_E \) is the Einstein radius, which is about 5 arcseconds. Consequently, the minimum mass in the absence of large-scale shear due to the outer regions of the galaxy or additional galaxies is of the order of \( 9 \times 10^{11} M_\odot \). However, the ellipticity of the lens can reduce the minimum surface mass required for multiple image formation (Subramanian & Cowling 1986). At present, we cannot determine the ellipticity of the lens or the importance of external shear without observational information about the orientation along which the double images in A merge, or their substructures. Consequently, we have constructed a model for a spheroidal lens with ellipticity to match the approximate positions of the images “A” and “B,” and the apparent direction along which two subimages appear to be merging in image “A” (Narasimha et al. 1982). In Figure 8, a single lens produces the essentials of the model, though due to limitations of data the model is just indicative. For instance, the high eccentricity of 0.9 used to get the curvature of the ring near the images will change with better quality data on the images, and then the mass of the lens could increase. In this model, the central cusp-like mass profile is simulated through a 200 pc bulge of mass \( 10^{10} \) solar mass, and a truncated King profile has a core radius of 1.2 kpc, eccentricity of 0.9, and mass of \( 6 \times 10^{11} M_\odot \) as expected from the simplistic considerations. For the observed luminosity of the order of \( 10^9 L_\odot \), the mass-to-light ratio is substantial. Such a model cannot be completely ruled out, especially in view of the almost perfect 360° ring of radius \( \sim 0.06' \). We can identify at least three distinct images of the quasar, though their positions are not robust. Due to poor seeing, we cannot resolve the images fully, but the configuration is similar to the well studied systems B1422+231 and Q1938+666 (see Narasimha & Patnaik 1993). We believe that the brightest image, “A,” is probably a double, which should be resolvable under improved signal-to-noise and a seeing of better than 1 arcsec. The position of an image at arcsecond separation from the center of the lens galaxy is still very uncertain, and its flux cannot be determined accurately with the present set of data since the galaxy at a redshift of 0.038 is much brighter than any of the images.

The lens is at a very low redshift and, hence, its surface mass density is not much greater than the critical value for multiple imaging. Consequently, the central region of the lens galaxy turns out to be important in determining the characteristics of the inner image. The profile of the Einstein Ring of radius \( 6'0 \) is determined by the large-scale shear produced by the main galaxy or any galaxy groups. Consequently, a good map of the image configuration could render this system a valuable probe of the dynamical mass distribution in elliptical galaxies and at larger scales.

4. MODELS

The system consists of a quasar and its host at a redshift of 0.6842 ± 0.0014, lensed by a dwarf spheroid galaxy at a redshift of 0.038, forming multiple images of the quasar and an object “A” and “B” at the redshift of 0.6842 ± 0.0014.
massive low surface brightness galaxies observed (Impey et al. 1988; Bothun et al. 1997), but from the observed optical flux distribution, the lens galaxy is unlikely to be of that type.

However, a configuration with three images forming almost an extended arc and another image close to the center of the main lensing galaxy can be a natural result when shear due to many galaxies en route to a background source qualitatively modifies the lensing action due to a foreground galaxy. Formation of multiple images and arc-like features due to shear-dominated gravitational lens action is discussed by Narasimha (1993) and Narasimha & Chitre (1993), who studied the effects of the central mass and the large-scale shear when the lens can barely form multiple images. The essential features of such a configuration can be studied by taking the gravitational lens action of a spherical mass along with a constant shear. This will reduce the mass of the main lensing galaxy, and the ellipticity of the model is a natural consequence of the shear due to the surrounding mass distribution. But we cannot get any idea of the shear up to when we isolate the central faint image and resolve the double image “A”. However, we should add that such configurations are likely to be detectable in surveys extending to fainter levels, because at arcsecond scales the gravitational pull due to multiple galaxies at cosmological distances en route to a distant source become important.

In our system, there is indeed evidence for the existence of at least three groups of galaxies along three directions around the observed foreground galaxy. We believe that their combined action is likely to be responsible for the observed multiple images. When two lenses of equal strength are located at two vertices of a triangle and additional lenses are distributed along the third direction, the midpoint of the first two lenses and surrounding regions have nearly constant shear due to the combined action of the lenses. This scenario is not as unlikely as it might appear. The central region of a weak group of galaxies could produce this configuration, or meeting points of filaments in large-scale structures have similar morphology. Even by pure coincidence sometimes a large number of galaxies can simulate this effect, since the bending angle drops very slowly as the inverse of distance, while the number of lenses that can act at a point, which is proportional to the area of the region, increases as the square of the distance to the line of sight to the background source. If indeed this is the scenario, it will affect both inferences of cosmological matter power density based on multiply imaged large separation lenses as well as estimation of masses of the individual lenses.

5. SIGNIFICANCE OF SDSS J091949.16+342304.0 AS A DIAGNOSTIC TOOL TO PROBE MASS INHOMOGENEITIES AT SMALL AND LARGE SCALES

We have only preliminary data for this powerful lens system, and, consequently, the model given in the previous section should be treated as illustrative. But the shear-dominated lens system and its diagnostic power should not be overlooked while analyzing images from deep surveys. We could speculate as to some of the results expected from a detailed multifrequency study of this system.

5.1. Large-Scale Mass Distribution in the Main Lens

The object appearing as the main lens is a dwarf spheroid of magnitude 18 at a distance of 160 Mpc and hence at absolute $R$ magnitude of $-18.1$. It would be very difficult to have reliable direct observation and analysis of such an object in a lens system if it were, say, at a redshift of 0.3, because the lens will be typically 5 mag fainter, and the images of the background source will dominate at almost all wavelengths. However, for the present system, we have the lens five times brighter than the background images in optical bands and extending over a few arcseconds. At a distance of 160 Mpc, 1 arcsecond corresponds to about 800 pc and hence, with deeper optical and infrared images, we can obtain high dynamical range images of the galaxy to determine the scale length at which the flux from the lens decreases. A good model of the lens system can independently give an idea of how the gravitational mass drops off, if we have good radio images of the system, showing the details of the curvature of the Einstein Ring at subarcsecond scales, or we can map the images at radio to determine the shape of the merging images.

At this distance, galaxy clusters of even moderate masses can be studied in X-ray, and the temperature of the intracluster gas can be estimated. If we have a good X-ray map, showing the massive objects in the field and their temperature, we can determine the mass distribution at 100 s of kpc, corresponding to an arcminute scale, or rule out the possibility of any cluster of galaxies associated with the main lens. If indeed we are able to detect any warm X-ray corona at a few tens of arcseconds, which can satisfactorily explain the observed image configuration, it might open up the possibility of dwarf-like galaxies being the centers of massive dark elliptical halos.
5.2. Small-Scale Mass Distribution

At present, we have limited information about the inner image, though we can determine its separation from the lens center of 0.85 arcsecond. However, further details should await better quality data. If we have an accurate position of this image and magnification with respect to image “B,” it could provide some constraints on the cusp-like mass distribution at the center of the dwarf galaxy as well as the possible presence of a bulge component at a kiloparsec scale.

Ideally, we expect the image “A” to be double, and from an inspection of the available images, we feel they are separated by 0.5–0.7. If radio, optical, and X-ray observations confirm this hypothesis and their relative flux ratios are consistent, we should expect a smooth mass distribution at scales of 1 kpc in the lens. But a million solar mass globular cluster at 160 Mpc has an Einstein radius of 6 mas. Consequently, any possible mass inhomogeneity of this scale along with the main lens can introduce microimages separated by a few tens of milliarcseconds, and their signature can be seen in the high-resolution radio image. Certainly, a high-sensitivity radio image of the Einstein Ring should show the signatures of such mass inhomogeneity, mainly due to the proximity of the lens. We feel that this system, due to its proximity, radio-loudness, and the Einstein Ring of a large radius, is an ideal candidate to probe inhomogeneities at tens of the millions of solar mass at 100 parsec scale.

5.3. Role of Other Massive Galaxies in the Field

It is not clear if many other galaxies within an arcminute are a part of the group or cluster of galaxies or other normal field galaxies at various redshifts which happen to be near the line of sight to the Einstein Ring. The radius of the Einstein Ring is not small, and we do expect a few tens of galaxies in the field within 10^3 arcsec^2 area. Consequently, statistics do not help us differentiate between the possibilities in the absence of redshift or X-ray flux measurements. But, even if the galaxies are chance coincidence, their role in the formation of the Einstein Ring is important. The bending angle drops off as 1/b, where b is the impact parameter of the photon path with respect to any such galaxy. The number of lenses in the plane of the sky will increase as the square of the impact parameter, if the lenses are homogeneously distributed. Consequently, if there is an extra concentration of mass along some direction even at tens of arcseconds away, it can have noticeable effect on the image formation, which might dominate over the gravitational effects of the main dwarf galaxy lens. This might not have been the case for a typical giant elliptical galaxy at a redshift of 0.3, acting as the lens, producing an arcsecond scale ring mainly due to the central mass of the galaxy and shear due to its large-scale mass. For the present lens configuration, even if there is no extra concentration along a specific direction, we can still have a fairly wide region where an almost constant shear due to many of these galaxies acts. This appears to be likely because there are about a dozen or more galaxies at 10–30 arcsecond away. We do not have redshift or other details of these galaxies, but from an inspection of the position and brightness of these galaxies, the Einstein Ring appears to be almost at the centroid of a triangle formed by these galaxies. If indeed this is a chance coincidence and we notice it only due to the proximity of the main lens, the possibility of many of the multiple-image systems reported in the literature being artifacts of the specific large-scale galaxy distribution along their line of sight should be taken into account while constructing their model as well as estimating the amplitude of matter power fluctuation based on the statistic of image separation in strong lens systems.

6. DISCUSSION AND CONCLUSIONS

We have discovered a gravitational lens system consisting of possibly four images of a quasar and an almost perfect Einstein Ring of radius nearly 6′. The quasar has a redshift of 0.684, and the main lens appears to be an 18.1 magnitude galaxy at a redshift of 0.0375. Since the lens is at a very low redshift and the source is radio-loud and X-ray luminous, the system provides a powerful tool to study mass distribution within the lens galaxy, especially in the central regions. A detailed observation and analysis of the system could provide many direct tests or confirmations in lensing as well as the structure of galaxies; e.g. the ring morphology as well as the imaging of the field of galaxies around could give an indication of the importance of groups of galaxies at even very low redshifts as powerful lenses, possible chance coincidences producing many of the eye-catching lens configurations, mass-to-light ratio of lens galaxy as a function of radial distance, and the possible existence of large-scale magnetic fields in the elliptical lens galaxy are some of the important problems that can be addressed with this system, simply because of its proximity, scale and being loud in radio, optical as well as X-ray.

Though we have only preliminary data for this system, it could have some important implications to cosmology.

1. If a single galaxy is the main lens, it should have a mass-to-light ratio of upward of 500 M_☉/L_☉. This will possibly be a new result for a dwarf spheroid of similar luminosity.
2. If the lens consists of a group of galaxies, the possibility of some of the weak groups of galaxies having high surface mass density to produce multiple images and extended arcs even at a very low redshift of 0.0375 should be considered while estimating the matter power density from a survey like SDSS, even though those groups may not be conspicuous in optical luminosity. In this context, the lensing due to filaments along favorable directions should be taken into account while estimating cosmological parameters, for instance, from cosmic shear data.
3. If the lens shear is due to the chance location of many galaxies along the line of sight to a distant background source, this fact should be taken into account while using gravitational lens systems of large angular separation to estimate the mass of very massive objects. This will have far-reaching implications when a gravitational lens is used to calibrate, for instance, masses of galaxy clusters, and hence the σ parameter for the amplitude of matter power is derived.

Our sincere thanks to the referee for valuable comments and suggestions that helped to improve the paper. We thank Carlos M. Gutierrez de la Cruz and Martin Lopez-Corredoira, who obtained the optical and near-infrared spectra of the quasar and its images, presented in this paper, during their observations. In this paper, we have extensively used data from the Sloan Digital Sky Survey (SDSS). Funding for the SDSS has been provided by the Alfred P. Sloan Foundation, the Participating Institutions, the National Aeronautics and Space Administration, the National Science Foundation, the U. S. Department of Energy, the Japanese Monbuka-gakusho, and the Max Planck Society. The
REFERENCES

Belokurov, V., et al. 2007, ApJ, 671, L9
Bolton, A. S., et al. 2004, AJ, 127, 1860
Bothun, G. D., Impey, C. D., & McGaugh, S. 1997, PASPS, 109, 745
Cabana, R. A., et al. 2007, A&A, 461, 813
Djorgovski, S. G., Perley, R., Meylan, G., & McCarthy, P. 1987, ApJ, 321, L17
Djorgovski, S. G., et al. 2007, ApJ, 662, L1
Gavazzi, R., et al. 2008, ApJ, 677, 1046
Hennawi, J., et al. 2006, AJ, 131, 1
Impey, C. D., Bothun, G. D., & Malin, D. F. 1988, ApJ, 330, 63445
Keeton, C. R., Kochanek, C. S., & Seljak, U. 1997, ApJ, 482, 604
Kochanek, C., Falco, E., & Muno, J. 1999, ApJ, 510, 580
Kochanek, C. S., Falco, E. E., Impey, C. D., Lehár, J., McLeod, B. A., & Rix, H.-W. 1999, in AIP Conf. Ser. 470, After the Dark Ages: When Galaxies Were Young (the Universe at $2 < z < 5$), ed. S. Holt, & E. Smith (New York: AIP), 163
Kochanek, C. S., Keeton, C. R., & McLoed, B. A. 2001, ApJ, 547, 50
Meylan, G., Djorgovski, S. G., Weir, N., & Shaver, P. 1990, in Lecture Notes in Physics 360, Gravitational Lenses in the Universe, ed. Y. Mellier et al. (Berlin: Springer), 111
Mortlock, D., Webster, R., & Francis, P. 1999, MNRAS, 309, 836
Narasimha, D. 1993, Current Science, 64, 725
Narasimha, D., & Chitre, S. M. 1993, J. Astrophysics & Astronomy, 280, 57
Narasimha, D., & Patnaik, A. R. 1993, in Proc. 31st Liege Int. Astrophys. Colloq., Gravitational Lenses in the Universe, ed. J. Surdej et al. (Liege: University of Liege), 295
Narasimha, D., Subramanian, K., & Chitre, S.M. 1982, MNRAS, 200, 941
Schlegel, D. J., et al. 1998, ApJ, 500, 525
Shen, S., et al. 2006, MNRAS, 369, 1369
Sochting, I. K., et al. 2008, MNRAS, 386, L57
Subramanian, K., & Cowling, S.A. 1986, MNRAS, 219, 333
Vestergaard, M., & Wilkes, B. J. 2001, ApJS, 134, 1
Warren, S. J., & Dye, S. 2003, ApJ, 590, 673
Warren, S. J., et al. 1996, MNRAS, 278, 139