APPLICATIONS OF STRONG-LENSING FOR SOME GRAVITATIONAL LENSES

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Abstract

In our work present, the application of strong-Lensing observations for some gravitational lenses have been adopted to study the geometry of the universe and to explain the physics and the size of the quasars. The first procedure was to study the geometrical of the Lensing system to determine the relation between the redshift of the gravitational observations with its distances. The second procedure was to compare between the angular diameter distances "D_A" calculated from the Euclidean case with that from the Freedman models, then evaluating the diameter of the system lens. The results concluded that the phenomena are restricted to the ratio of distance between lens and source with the diameter of the lens noticing.

Introduction

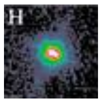
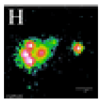
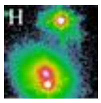
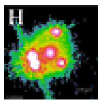
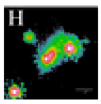
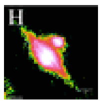
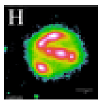
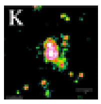
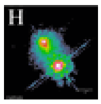
One of the most important tasks that the astronomers have undertaken in the twentieth century is the determination of the distances of the galaxies. This work is of special importance since galaxies and clusters of galaxies make the basic structure of the universe. Thus the ability to answer fundamental questions about the origin and fat of the universe depends on how well we know the distances of galaxies [1].

Source of observations

All the information of the gravitational lens systems, were taken from the CfA-Arizona Space Telescope Lens Survey of gravitational lenses (CASTLES survey), which including images and data observed by Hubble Space Telescope "HST" and radio images [2].

We select observations of nine gravitational lens systems, which contain enough information, available and enable, for implementing calculations. The data of observation for these nine lenses are given in Table (1). Where G denotes the accuracy of the observed data, that is type A means an accurate Lensing system, Z_s is the red shift of the source, and z_L is the red shift of the Lens.

Table (1)
The observational data for nine lenses.

Image	Lens Name	G	z_s	z_l
	B0218+357	A	0.96	0.68
	RXJ0911+0551	A	2.80	0.77
	Q0957+561	A	1.41	0.36
	PG1115+080	A	1.72	0.31
	SBS1520+530	A	1.86	0.72
	B1600+434	A	1.59	0.41
	B1608+656	A	1.39	0.63
	PKS1830-211	A	2.51	0.89
	HE2149-2745	A	2.03	0.50

Geometrical Lensing system

In this section, we use the gravitational Lensing phenomena to determine the distance of the object. For this aim, we adapted Freedman model. Freedman model can be expressed in Euclidean space by three factors $(\mathbf{z,h,q})$. Where, z is the red shift, h is a constant proportional to the Hubble constant H_o, and q is the acceleration parameter.

Freedman model in Euclidean space at K=0, where K is Freedman's constant, take the form [1]:

$$D_A = \frac{2c}{H_0}\left\{(1+z)^{-1} - (1+z)^{\frac{-3}{2}}\right\} \quad \text{.................}(1)$$

Where c is the speed of light, H_0 is the Hubble constant, and z is the red shift.

Equation **(1)** take three forms, once for the lens determine the relation between the angular diameter distances of lenses "$\mathbf{D_L}$" with the red shift of the lens "$\mathbf{z_L}$". Second one for the source, determine the relation between the angular diameter distances of the sources "$\mathbf{D_s}$" with the red shift of source "$\mathbf{z_s}$", and third one for the distance between the source and lens "$\mathbf{D_{A(L,s)}}$". These forms are given as follows **[1]**:

- **For the lens:**

$$D_L = \frac{2c}{H_0}\left\{(1+z_L)^{-1} - (1+z_L)^{\frac{-3}{2}}\right\} \quad \text{..........}(2)$$

- **For the source:**

$$D_s = \frac{2c}{H_0}\left\{(1+z_s)^{-1} - (1+z_s)^{\frac{-3}{2}}\right\} \quad \text{............}(3)$$

- **For the distance between source and lens:**

$$D_{A(L,s)} = \frac{2c}{H_0}\left\{(1+z_{Ls})^{-1} - (1+z_{Ls})^{\frac{-3}{2}}\right\} \quad \text{.......}(4)$$

From equations 2, 3 and 4, we can determine the relation between the redshift (that have been taken from the observation systems) and distance [3].

Fig. (1) shows the relation between the angular diameter distances of the lenses "$\mathbf{D_L}$" with the red shift of the lens $\mathbf{z_L}$. Figure (2) shows the relation between the angular diameter distances of the source "$\mathbf{D_s}$" with the red shift of the source "$\mathbf{z_s}$".

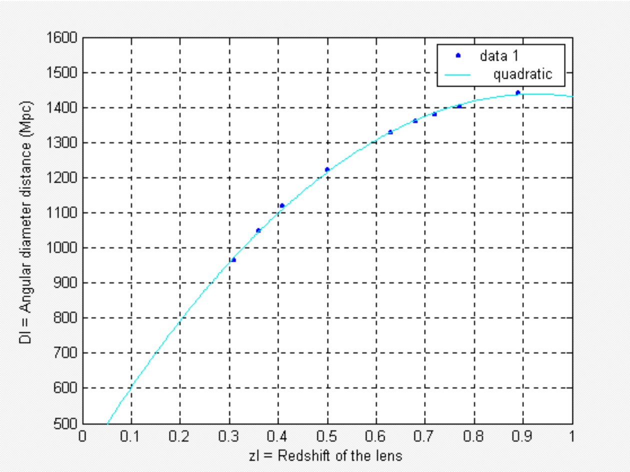


Fig.(1) : The relation between the angular diameter distances of the lenses "D_L" with the red shift of the lens "z_L".

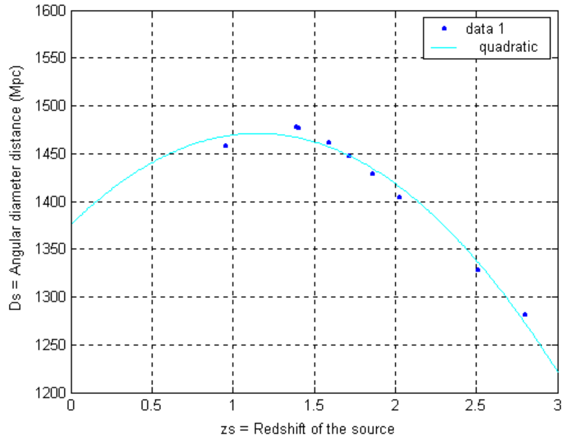


Fig.(2) : The relation between the angular diameter distances of the sources "D_s" with the redshift of the source "z_s".

Diameter of Lens

Since the galaxies are far from the earth, then we can determine the diameter of the galaxy "G" by a very small separation angle "$\mathbf{\Delta\theta}$" measured in arcsecond units, given by [4]**:**

$$\Delta\theta \approx \sin\Delta\theta \approx \frac{d}{D_A} \quad \text{............................}(5)$$

Where:

$$D_A = \frac{d}{\Delta\theta} \quad \text{.......................................}(6)$$

Where D_A is the angular diameter distance, d is the diameter of the lens, $\Delta\theta$ is the separation of lens.

From equation (6) we can study the relation between the redshift "z_L" and the diameter of lens "d" using the units transformation, equation (6) in Mpc units given by [3]:

$$D_A = 206265 \frac{d}{\Delta\theta} \quad \text{.............................(7)}$$

Results and Discussion

In this section, we adopted the image size in arcsecond (″) from the Castles survey and illustrated it as a function of the red shift "z_L", and this is represent the practical form. Then, compare it with the diameter of the lens that is obtained from the theoretical equations. We found a good agreement between the practical results with our results. Fig. (3) shows the probability of the lens diameter "d" as a function of the red shift of lenses "z_L". Fig.(4) shows the probability of the image size (") of lens as a function of the redshift of lens "z_L". Fig.(5) shows the probability of the lens diameter "dL" as a function of the redshift of lenses "z_L". The arbitrary values.

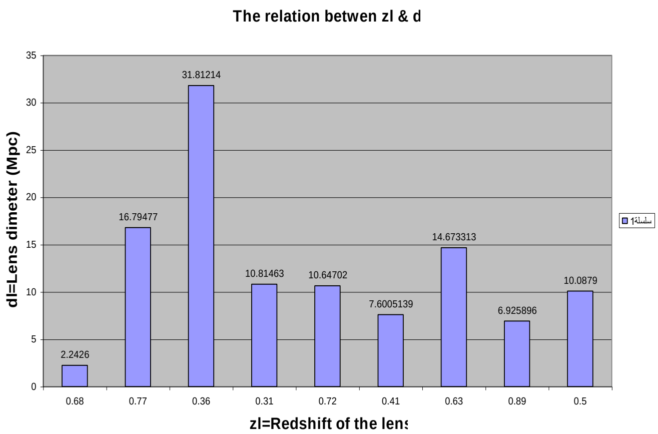


Fig. (3) : The probability of the lens diameter "d" as a function of the red shift of the lenses "z_L".

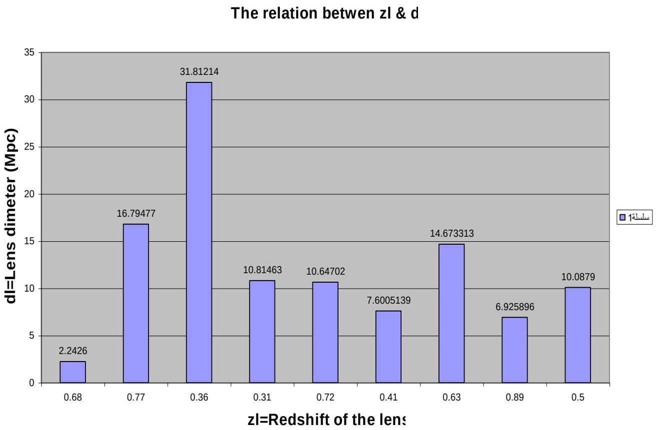


Fig.(4) : The probability of the image size (") of lens as a function of the red shift of the lens "z_L".

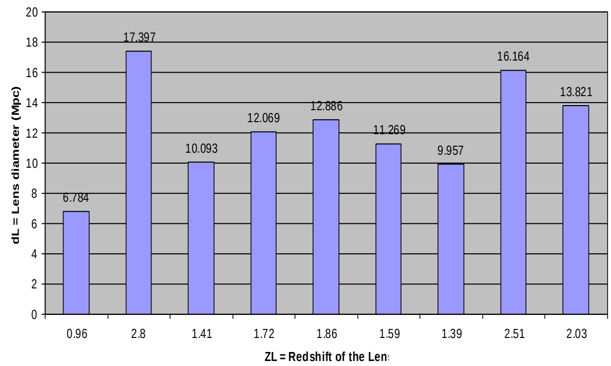


Fig. (5): The probability of the lens diameter "dL" as a function of the red shift of the lenses "z_L".

Fig. (6) sShows the relation between the ratio of D_L/D_s with the diameter of the lens "d".

From Fig.(6) we conclude that the distance between the lens and the source is proportional with the diameter of the lens. Moreover, as the distance between the lens and the source increased we need lens with large diameter to get gravitational Lensing system.

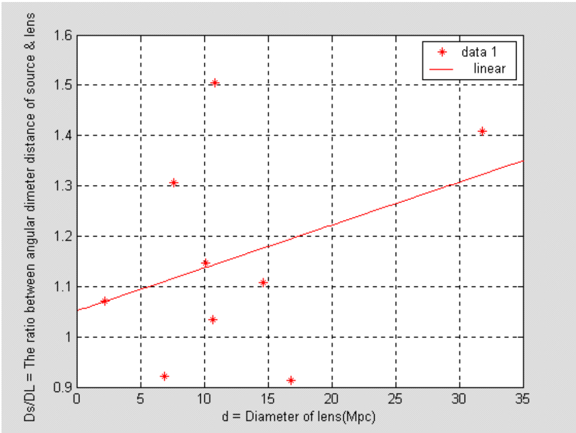


Fig. (6) : The relation between the ratio of D_L/D_s with the diameter of the lens "d".

Conclusions

From the above results, we can conclude that:

Studying the gravitational Lensing analytically, using Freedman model, is very useful to study the behavior of the universe.

We can study the geometrical system, then adapt a formula describe the relation between the red shift of gravitation observation with their distances.

Making a comparison study between the conventional method and freedman model for calculating the diameter D_A.

We can calculate the diameter of the lens by using strong gravitational Lensing phenomena.

The gravitational Lensing phenomena is correlated and limited with the distance between the lens and the source with the diameter of the lens.

References

[1] D. F. Joan, 1995, "Astronomy: Journey to the Cosmic Frontier", 1st. ed p.531.

[2] CASTLES Survey Web Site: CFA WWW. Harvard. edu / Castles.

[3] V. N. Jayant, 1993, "Introduction to Cosmology", Cambridge University press.

[4] W. S. Robert, 2000, "Cosmological applications of gravitational Lensing", Ph.D. thesis, Potsdam University, London, Britain.