INVESTIGATING THE GRAVITATIONAL LENS OF THE HELMS18 SYSYEM: A MERGING PAIR OF GALAXY GROUPS AT Z=0.6?

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1. Introduction

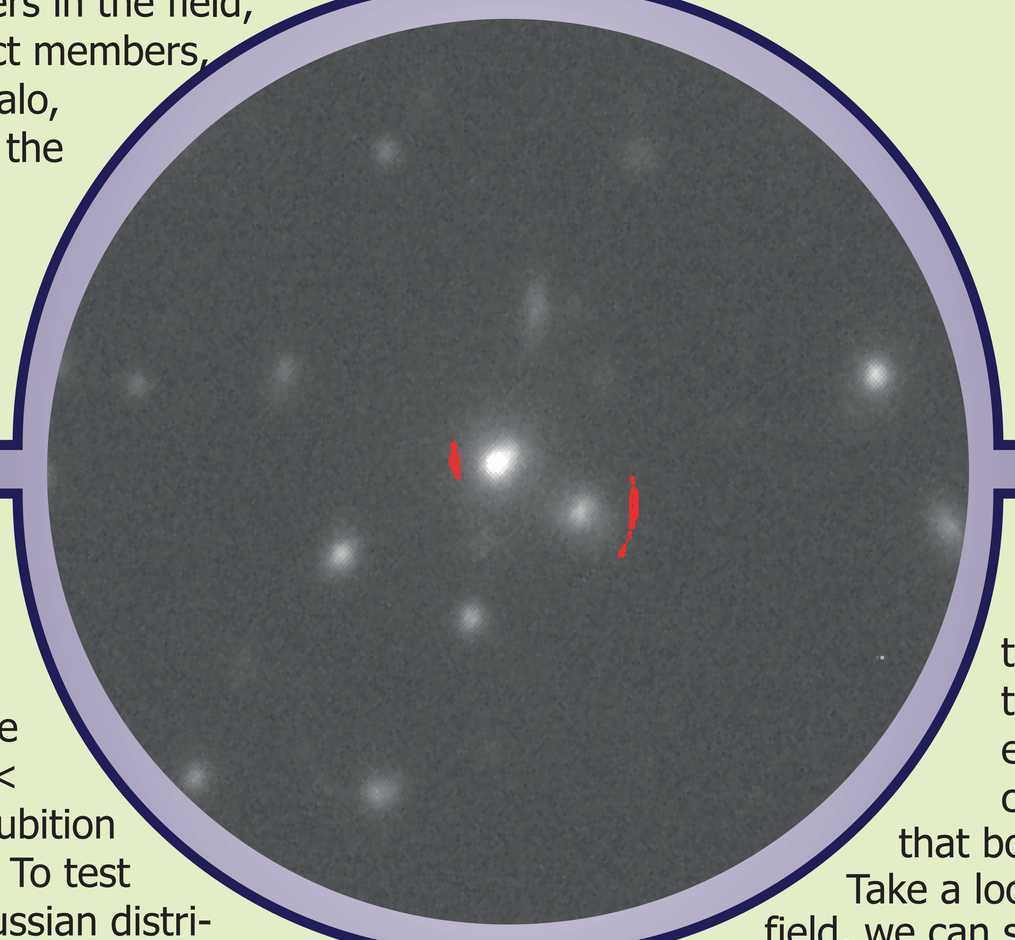
Individual galaxies, groups and clusters are all of great relevance when studying proprieties of large structures in the universe. Knowing that, we analyse the Helms18 system, a structure with two central galaxies, an early-type galaxy and a quasar, both at z = 0.6. This system is lensing a submilimetric galaxy at z = 2.4, generating the gravitational arcs that we can see in the central image.

By analysing the arc distribution, we can see that they are centered in two different points, one of them is centered at the quasar, and the other at the ETG.

With this, we can work with two hypotheses: i) the system consists of a single lens with two objects in the background, i.e., in this case there would be two galaxies at z=2.4; ii) the system consists of two lenses and only one luminous background object.

2. Goals

In this study, we aim to uncover the structure true nature. By analising the central galaxies and others in the field, we initially aim to determine the object members, velocity dispersion, and mass of the halo, all that so we can determine which of the previously cited hypotesis is correct.



3. Observation and Data Reduction

By using the SDSS photometric catalog, we selected galaxies prioritizing:(i) galaxies on the red sequence; (ii) galaxies whose photometric redshift are around the redshift of the ETG central galaxy; (iii) other bright galaxies in the field, regardless of their colour.

76 galaxies that meet these criteria, including the central ones, were selected for a multi-spectroscopic observation using the GMOS@Gemini. We distributed the selected objects in 2 masks, each to be observed with 1200s of exposition time in 740, 750 and 760 nm to cover the instrument's CCD gaps.

The data was handled using the standard GMOS data reduction pipeline, with bias subtraciton; flat field correction; quantum efficiency correction, wavelength and flux calibration; etc.

We used the tasks XCSAO and EMSAO of the RVSAO package in IRAF to determine the redshifts of these candidates. The EMSAO task was mainly used when the analysed galaxy had emission lines while the XCSAO task was used for every other case.

4. Data Analysis

After sucessfully measuring the redshifts of the target galaxies, we set a range of distances that a galaxy can be from the center of the halo: (0.583<z< 0.607). In figure **(1)**, we see the distrubition of the observed galaxies in this range. To test the hypotesis, we make two fits of gaussian distribuitions with respect to the line-of-sight velocitity, to determine which fits better the data.

As we can see in figure **(1)** we make a maximum likelyhood estimate using the L-BFGS-B algorithm to fit both possible configurations, one gaussian curve (dashed), or two. To choose between both fits, we use the **BIC**[1] (Bayesian Information criterion) and the **AIC**[2] (Akaike information criterion). The BIC values for the one and two gaussian fits are respectively BIC_1= 359.6 and BIC_2=356.7. For the AIC values, we have AIC_1= 357.4 and AIC_2=352.4. As lower values are prefered when comparing models by this method, we can conclude that the object is more likely to be composed of two structures.

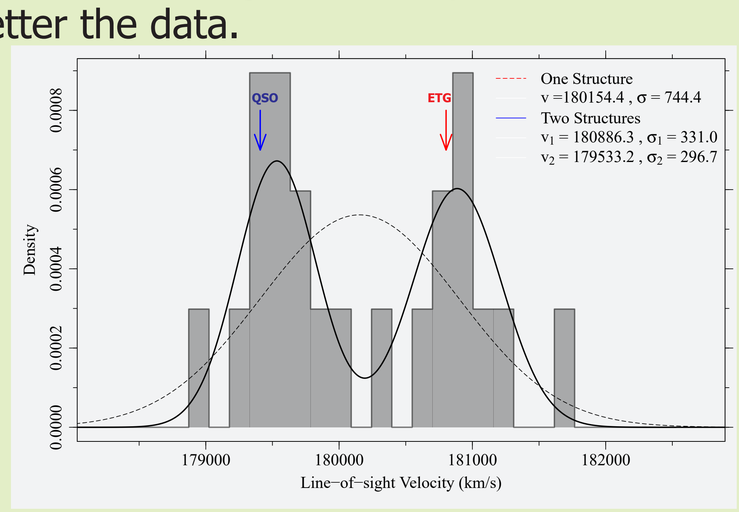


Figure 1: Graph describing the distribuition of galaxies with respect to their line-of sight velocity. We overplot the gaussian distribuition for the two hypoteses and we show the velocity of the group and it's dispertion velocity for each case.

5. Results

With the analisis, we can conclude that we are dealing with not one, but two structures in close proximity with each other, more than that, with the calculated sigma value, it is most likely that both structures are large galaxy groups.

Take a look at the distribution of galaxies in the field, we can see in figure **(2)** both galaxy groups in close proximity with eachother. With the galaxies the left part of the double gaussian distribuition being represented in blue, and the right part of the distribuition being represented in red. In conclusion, we have a intriguing pair of galaxy groups in close proximity with each other. In future work we aim to determine appropriatly the mass of both structures, and do a numerical density profile for the whole system. Finally, we will combine this results with the gravitational lens analysis, in order to get a complete description of the Helms18 system.

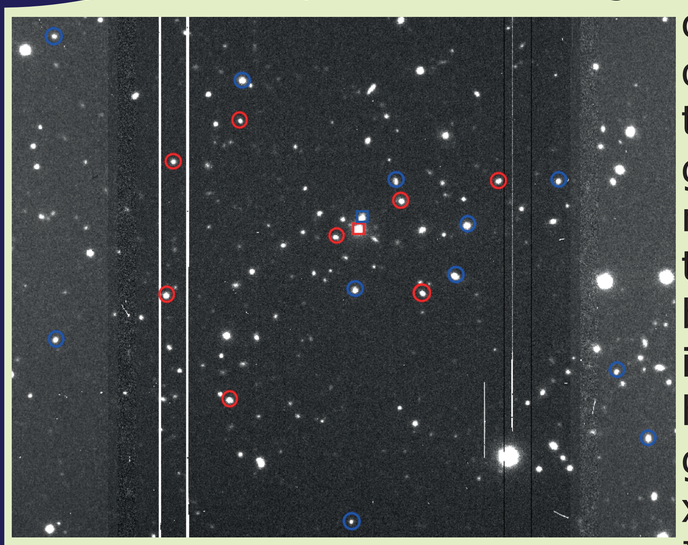


Figure 2: Field image of the lens object in the Helms18 system, the blue and red circles represent the galaxies in the range previously cited, and the central galaxies (also represented in the central image) are marked by squares.

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References

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[2] Y Sakamoto et al. Dordrecht, The Netherlands: D. Reidel 81.10.5555 (1986): 26853.