IS THE GIANT LUMINOUS ARC IN A370 A GRAVITATIONAL LENSING EFFECT?

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ABSTRACT. A gravitational lensing model is proposed to explain the giant arc structure we observed in September 1985 in the distant cluster of galaxies Abell 370 (z=0.374).

1. INTRODUCTION

From the data we obtained at the 3.60m CFH telescope and ESO with the multiaperture spectroscopic system PUMA developed at the Toulouse Observatory (Fort et al, 1986), a possible interpretation in terms of gravitational lensing of a background galaxy by the cluster center is proposed. A370 is a very rich cluster, dominated by two bright galaxies. Thanks to the 84 spectra we obtained on this cluster, we deduce a velocity dispersion of 1500 Km/s and a virial mass of 1.5 10^{15} M_0 or $M/L_R \approx 60$ (Mellier et al 1987). This type of clusters probably is the best one for such rare cases of lensing effect.

2. DESCRIPTION OF THE ARC

The structure is located near one on the brightest cluster members and extends on 20" (150 kpc, assuming $H_0=50$ Km/s/Mpc and $q_0=0$). Its shape is quasi-circular and subtends an angle of 60° centered 25" northward, near the cluster center. In spite of good CCD frames obtained at the CFHT (seeing: 0.8"), the width of the arc remains unresolved except for the very east part.

This object is very luminous and extremely blue (Soucail et al 1987a). Its surface brightness is rather constant: the "blobs" observed on the arc probably are superimposed cluster galaxies. A comment has to be done concerning the structure near galaxy #37 (a cluster member): from Fig. 1, we observe a break just eastward this galaxy. This break is real since we have observed it on three different CCD frames of the arc.

We obtained some spectra of galaxies located on the arc or in the

J. Audouze et al. (eds.), Large Scale Structures of the Universe, 463–465

neighbourhood (Fig. 1). A first low signal-to-noise spectrum of the east part of the arc was obtained at ESO: no emission lines have been observed on this spectrum, so the interpretation in terms of star formation in the cluster center can be ruled-out. Moreover, this spectrum looks like a galaxy one at a redshift of 0.59 (Soucail et al, 1987b). We suggest that it could be a gravitational lensing effect by the cluster core on a galaxy at 0.59, aligned with the cluster.

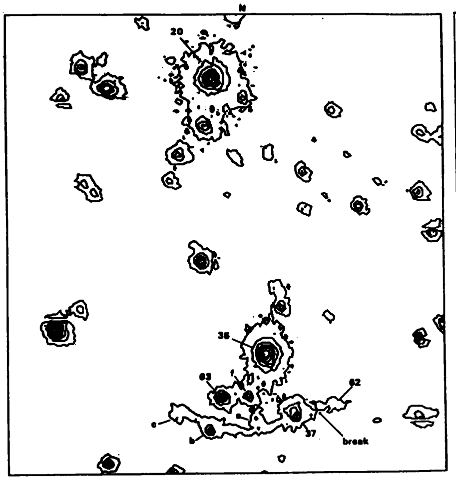

FIG. 1

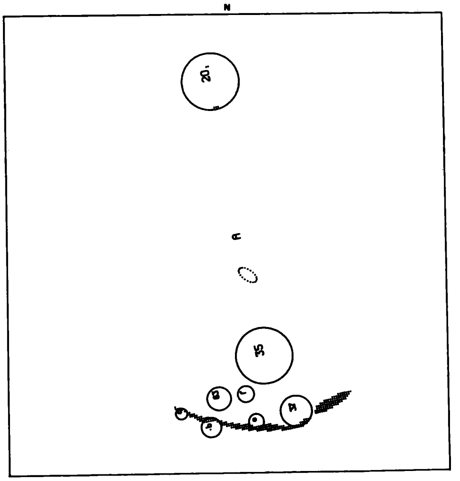

FIG. 2

Fig. 1: Map of the cluster center of A370. Galaxies #20 and #35 are the 2 brightest cluster members. Note the break at the east of the #37 galaxy. Galaxies with a number are those for which we have a redshift.

Fig. 2: Result of the simulation with a multi-point-mass model. The masses of the galaxies #35 and #20 is 1 10^{13} $M_\odot$. The "A" point represent the cluster center. The true position of the deflected galaxy is represented as an ellipse near the center.

4. A MULTI-POINT-MASS MODEL

In order to reproduce the arc, we have performed a multi-point-mass model (Soucail et al, 1987b) to represent the cluster and the neighbouring galaxies. Taking into account the observational constraints describe above, the masses of the cluster core and the galaxies as well as the position, ellipticity and orientation of the source are deduced. The fit is very good although the model has only 2 free parameters (Fig. 2): the mass within the 2 cones subtended by the circle which contains the arc is 2 10^{14} M_0. This leads to a mass-to-light ratio of 130 in R. The second image expected in a gravitational lensing model is not observable due to the influence of the galaxy #20 (Soucail et al, 1987b). One can see on Fig. 2 the thickness variation of the arc in the presence of the neighbouring galaxies.

Some details of the arc are not yet fully explained. A better model with smooth profiles for the cluter and the galaxies is on progress. The very first results are very encouraging and leads to a better fit especially for the east part of the arc.

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