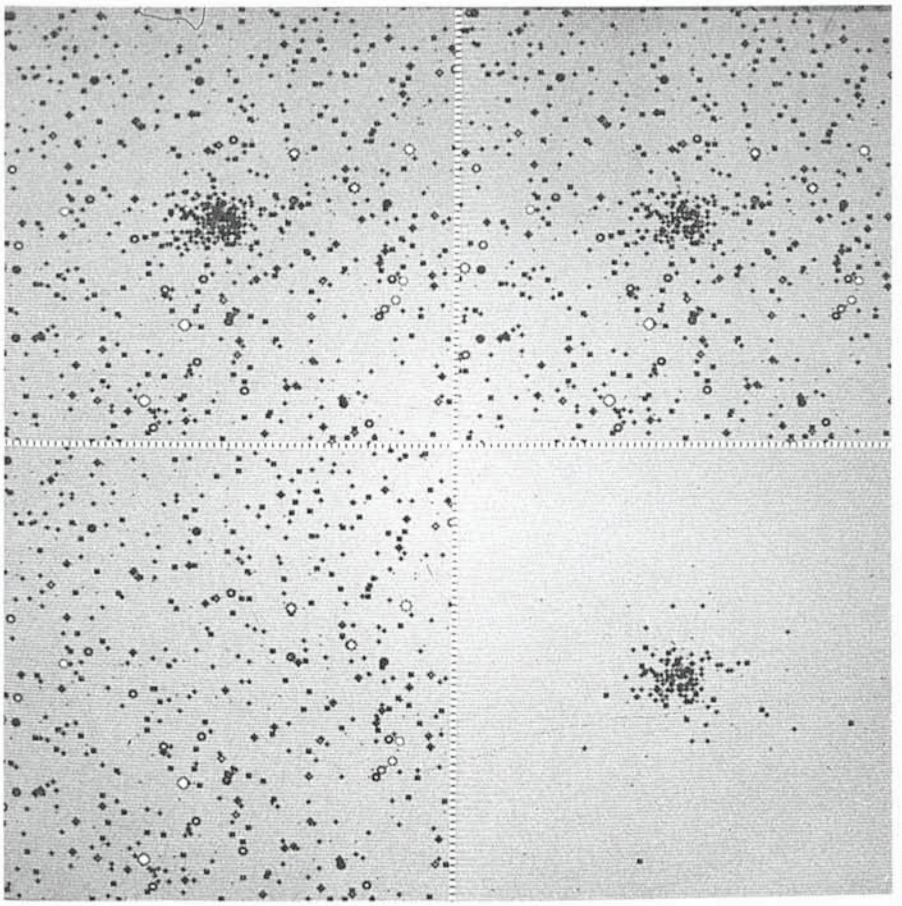

Figure 11: *Same as for Figure 10 for a cluster of richness class R4.*

the same model we have a dispersion of s/n at a given z, an effect which is illustrated in Figure 8 for a cluster at z = 0.6 (the histogram has been derived from the analysis of 800 simulations). Such dispersion must be accounted for when we determine the probability of detecting a cluster at a certain z, and indeed it may reflect the statistics playing in the real universe in the process of cluster formation. A first important result is that, without taking into account any form of evolution, a cluster (in this case of richness class R = 2) is already lost in the background at z = 0.6.

The probability of cluster detection has been computed as a function of the signal to noise s/n (and therefore as a function of z) both analytically and using 3,000 simulations for clusters of various richness and population. The result is illustrated in Figure 9 where the agreement between theory and numerical experiments is excellent. As we have said earlier, however, such probability of detection is a curve of mean values which should be convolved, at each s/n, with the dispersion histogram of Figure 8.

The result of what we have described so far (note that the addition of the detector noise will make detection even morre difficult) is that even unevolved clusters of richness class 4 are hardly detectable for $z \geqslant 0.6/0.7$ (there is some difference between elliptical dominated clusters [T1] and spiral rich clusters [T3]). Since clusters have been detected at $z > 0.8$, then either we are detecting only extremely rich clusters or evolution plays an important role in making a cluster more visible at large z. We may be dealing with a combination of the two effects. (Note that some detection could be due to a projection effect, that is an enhancement of density when two clusters are seen along the same line of sight).

An idea of how the evolution may increase the probability of detection is depicted in Figures 10 and 11. In each figure is reproduced the simulated background (bottom left), the simulated cluster (bottom right), the cluster superimposed on the background (top right) and the evolved cluster superimposed on the background (top left). In each case the evolution has been illustrated by using model C of Bruzual (*Ap. J.* **273,** 105, 1983); that is a burst of star formation lasting about 10^9 years. The limiting magnitude of the simulated sample is J = 25 and the area 10′ × 10′. Each galaxy point is coded, even if not marked in the figure to avoid confusion, in magnitude, colour, galaxy type, position and redshift. Figure 10 refers to a spiral-poor cluster (T2) of richness class 2 (R2) at a redshift z = 0.7 while Figure 11 refers to a spiral-poor cluster of richness class 4 (R4) at a redshift z = 0.7.

The evolution of galaxies enhances the cluster visibility!

The new evolutionary models which are being completed by Buzzoni (Brera Astronomical Observatory, Milano) and the observations and analysis of a fair sample of clusters of galaxies will certainly allow important cosmologiccal conclusions to be drawn.

The Giant Luminous Arc in the Centre of the A 370 Cluster of Galaxies

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Recently, people have been very excited by the announcement of the discovery of two giant luminous arcs in the centre of distant clusters of galaxies, namely A 370 and Cl 2242-02 (1). These structures lie in the proximity of giant E galaxies and extend over about 100 kpc. Their origin is still unknown and controversial, and their nature can be understood in terms of strong star formation in the cluster core (by galaxy/galaxy interactions or by cooling flows from the dense Intra-Cluster Medium) or eventually a gravitational lensing configuration.

Indeed, the arc in A 370 was first discovered by a team from the Toulouse Observatory (B. Fort, G. Mathez, Y.

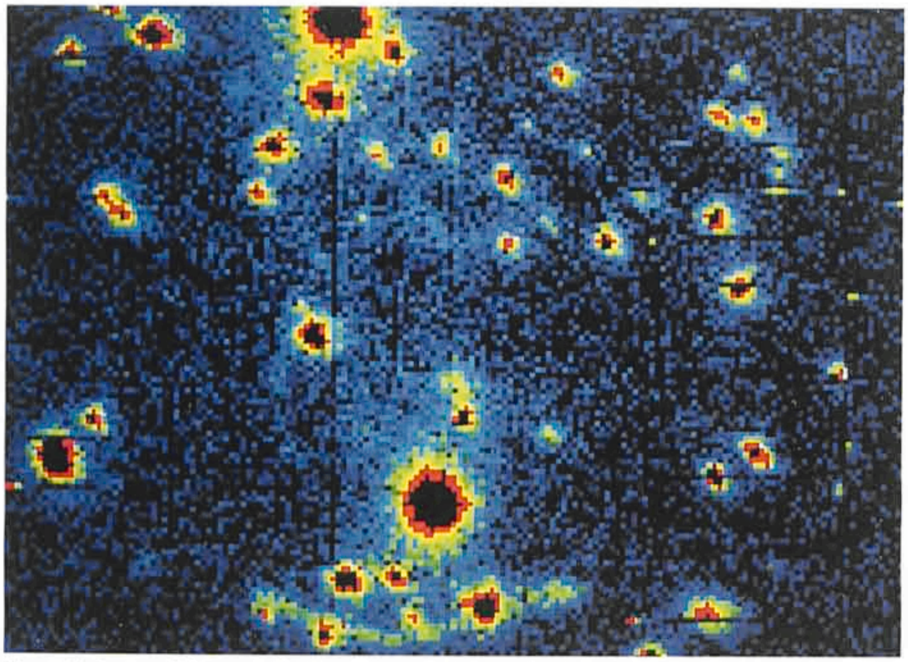

Figure 1: *Image of the core of the cluster of galaxies A 370 (z = O.374), dominated by two giant galaxies (# 20 and # 35). The arc is located southward galaxy # 35 and has a linear size of ~ 8 kpc wide and 160 kpc long. In the lensing hypothesis it is an image of a galaxy at redshift z = 0.59. Note the galaxies superimposed on the arc, especially the brightest one (# 37) whose influence has been taken into account in the lensing model.*

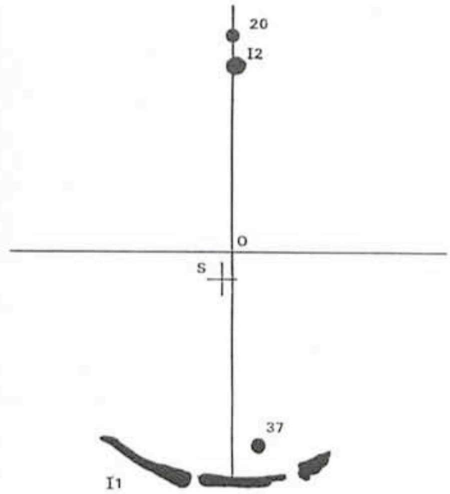

Figure 2: *Schematic diagram of the lensing configuration in a three point mass model: 2.25 10^{14} $M_\odot$ for the cluster core (point 0) 3 · 10^{12} $M_\odot$ for galaxy # 20 and 0.7 10^{12} $M_\odot$ for galaxy # 37. I1 and I2 are the two images of a circular source which would appear in S without lensing. Note the large break to the right of I1. The details of such a configuration will be given in a paper submitted to* Nature.

Mellier and G. Soucail), during an observing run in September 1985 at CFHT. With multi-colour photometry, we have shown that the structure is very thin and blue (2), without being able to determine its physical origin. It was then reobserved in November 1986 at CFHT and at ESO with EFOSC, where the spectrum of the Eastern end of the arc was obtained. After the data reduction, we found that the light probably comes from a galaxy at a redshift of 0.59. So our best interpretation of the phenomenon is that we are observing an exceptional configuration of gravitational lensing, with the whole cluster as the deflector and a galaxy at z = 0.59 as the source, both objects nearly perfectly aligned on the same line of sight.

In collaboration with F. Hammer from Meudon, we have modelled this configuration using a simple multi-point mass model, and compared the predictions with the observed geometry of the arc. If the system source/deflector is perfectly aligned, the theory predicts the formation of a circular ring as it has been discribed by Zwicky in 1937 (3). But if the source lies at 1" from the cluster centre, one can predict the formation of two symmetric arcs. Only one is observed in A 370, but the second one should be located near a very bright galaxy, # 20 (cD type, see Figure 1), and the model must take into account the influence of that massive galaxy as a secondary deflector. If its mass is high enough it is possible to predict the quasi-total fading of the second arc, leading to the geometry observed in A 370. Moreover, we have studied the influence of the brightest galaxy superimposed on the arc, and it is then possible to explain the enlargement of the arc eastwards this galaxy, where the spectrum was obtained (see Figure 2).

All the details of this model have been presented in a paper submitted to *Nature* in April (4), with a discussion of several other possible mechanisms able to create such a structure. In order to confirm or disprove the lensing hypothesis, we need to obtain the spectrum of the entire structure and to test whether the redshift of the light is z = 0.59 or not. We are waiting for this summer when the cluster will be observable again . . .

In the case of the other arc discovered in Cl 2242-02, actually both the redshifts of the cluster and of the arc are unknown so that it is not possible to model a lensing configuration. However, this cluster will be observable this summer too, and we can hope that these data will soon be available.

It should be noted that such a discovery is very important because if the lensing model is confirmed, it leads to the determination of masses in a very original way. For example, in the case of A 370, we are able to "measure" the mass crossed by the light along the line of sight, containing mainly the mass of the cluster core, with a good accurary:

$$M \sim 1 \text{ or } 2 .10^{14} M_\odot$$

Moreover, the model can lead to the determination of the Mass-to-Light ratio in the cluster core ($M/L_R \sim 200$ in A 370) and inside the individual galaxies ($M/L_R \sim 20$). The existence of the dark matter can be confirmed without any physical assumptions such as the virial theorem, and it is possible to study the repartition of the dark matter in the universe.

References

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(2) Soucail, G., Fort, B., Mellier, Y., Picat, J.P.: 1987, *Astron. Astrophys.* **172,** L 14.

(3) Zwicky, F.: 1937, *Phys. Rev.* **51,** 290.

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Latest News about SN 1987 A

After a relatively rapid decline in brightness during the first half of June, the rate levelled off at about 0.01 mag/day in V after June 24. Radio emission at 22 GHz was detected on June 20–22 with the 13.7-m millimetre-wave antenna at Itapetinga, Brazil. The signal strength was 500 ± 70 mJy. From IUE observations it is seen that emission lines are developing in the ultraviolet spectral region. This would indicate that it is now possible to look inside the expanding shell. Infrared speckle observations at ESO appear to show a light echo; the size seems to be smaller than expected (June 29, 1987).