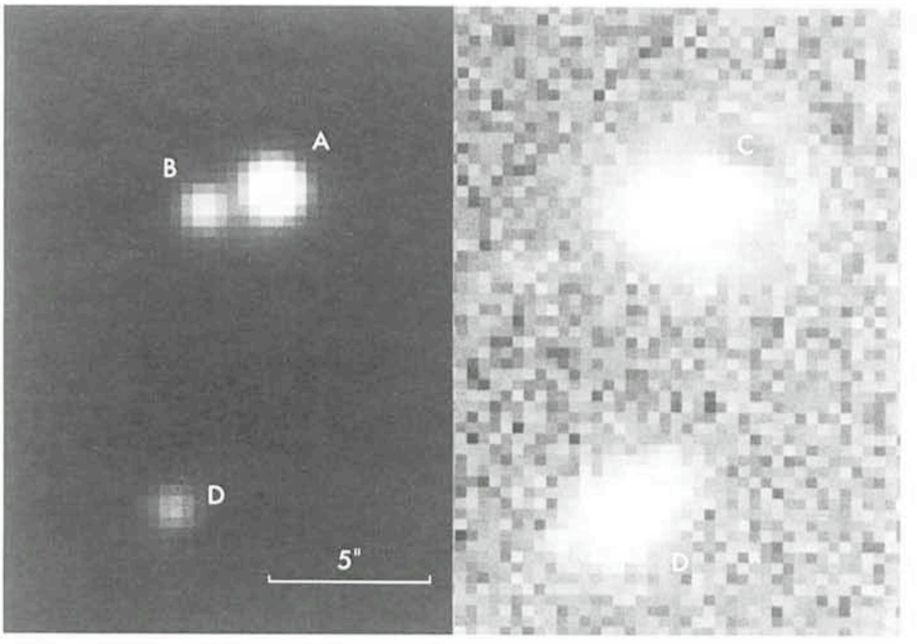
# Discovery of a New Gravitational Lens System

From detailed observations of several of the most luminous quasars, it has been found that the QSO UM 673 (z = 2.72) is a gravitational lens system (Surdej, J., Magain, P., Swings, J.-P., Borgeest, U., Courvoisier, T.J.-L., Kayser, R., Kellermann, K.I., Kuehr, H., and Refsdal, S., 1987, *Nature* **329,** 695; Surdej, J., Magain, P., Swings, J.-P., Borgeest, U., Courvoisier, T.J.-L., Kayser, R., Kellermann, K.I., Kuehr, H., and Refsdal, S., 1987, submitted to *Astronomy and Astrophysics*). This observational programme is designed to estimate how many of the highly luminous quasars are so luminous because of amplification effects by gravitational lensing. It is mostly conducted at ESO by the team who wrote the quoted papers.

Spectral and imaging observations of UM 673 were obtained at ESO in late 1986. They showed that both images have nearly the same spectra, and that the difference can be explained if the observed light from the fainter object is contaminated by an intervening galaxy at redshift z = 0.49. This finding considerably strengthens the identification of the double image of UM 673 as a new case of a gravitational lens system. The intervening galaxy can also be seen directly, when the two images of the QSO are removed by computer processing.




The left half of the figure shows the central part of an EFOSC CCD frame, exposed 2 min through a Bessel R filter. The two QSO images are marked A (mag. 17) and B (mag. 19); the separation is only 2.2 arcsec. The right half shows the same frame after the two point-like images have been removed and the intensity interval near the sky has been significantly stretched. The intervening 19th magnitude lensing galaxy is clearly visible as extended residual emission (C). The object D is another galaxy, possibly in the same cluster.

Modelling of the geometrical properties of the lens system allows to compute the mass of the galaxy ($\sim 2.4 \cdot 10^{11}$ solar masses), as well as the most probable time difference along the two light paths, ~ 7 weeks (with $H_0$ = 75 km/s/Mpc and $q_0$ = 0). This time difference is short enough to be measured in one observing season, provided the QSO is cooperative and varies intrinsically on a sufficiently short time scale. Such measurements are particularly important, since they may give independent information about the absolute size of the system and therefore also about the Hubble parameter. A corresponding, observational campaign has already been started at ESO.

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# Deep LMC Images

One of the most observed objects in the southern sky is the Large Magellanic Cloud. It is easily seen as a naked-eye object near the southern celestial pole together with its less conspicuous neighbour, the Small Magellanic Cloud. Looking at the LMC, the casual observer discerns the elongated bar and the bright 30 Doradus nebula and, since February this year, the famous Supernova 1987 A.

We show here two unusual views of the LMC, obtained with special equipment at the ESO La Silla observatory, in the course of other observing programmes.

Figure 1 is a reproduction of two CCD frames, exposed at UT 08 : 06 to 08 : 39 on February 17, 1986, with the ESO Wide-Field CCD camera, while preparing to observe Comet Halley. The camera consisted of a Canon f : 2.8/100 mm objective at full aperture, with a RCA CCD 503 (high resolution, 640 × 1,024 pixels) behind a BG 39 filter. This corresponds to a very broad wavelength band, extending from the near UV to the CCD cut-off in the near IR. The exposure time was 15 minutes for each frame.

The pixel size is 31 arcseconds, corresponding to a field size of about $5\overset{\circ}{.}5 \times 9^\circ$. After cleaning with MIDAS software on La Silla, the full frames were recorded on 70 mm film at the ESO-Garching Dicomed facility and photographical copies were assembled to give the composite image in Figure 1. No flat-fielding was made, due to lack of adequate exposures, and the frames were not corrected for geometric distortion or vignetting. For these reasons, the two frames do not join perfectly.

The composite field size is $8\overset{\circ}{.}6 \times 9\overset{\circ}{.}6$ and north is up and east to the left. The two bright stars above the left centre are δ Dor (upper) and ε Dor (lower), while the two in the lower right part are β Dor (left) and μ Dor (right).

During the exposure, the minimum counts near the corners of the frames reached 1,500, still above the normal sky background. This indicates that the LMC halo extends beyond the field of

Figure 1.

the composite frame. In this reproduction, the intensity cuts were chosen to show the structure in the area north of the bar.

Figure 2 is a photographic print which has been subjected to diffuse light amplification. In order to show the LMC bar on the same photo, a high contrast positive copy film was sandwiched with a normal contrast negative and printed onto high contrast photographic paper. This photo was originally recorded on Kodak 153-01 emulsion (the on-glass version of TP-2415) with a Hasselblad SWC camera, equipped with a Carl Zeiss Biogon 1 : 4.5/38 mm objective. The plate, which measured 6 × 6 cm, was hypersensitized in 4 % forming gas at 65°C during 11 hours. The camera was attached to the ESO GPO double astrograph; the exposure lasted 90 minutes on March 27, 1985.

The original plate shows serious vignetting over the very large field (more

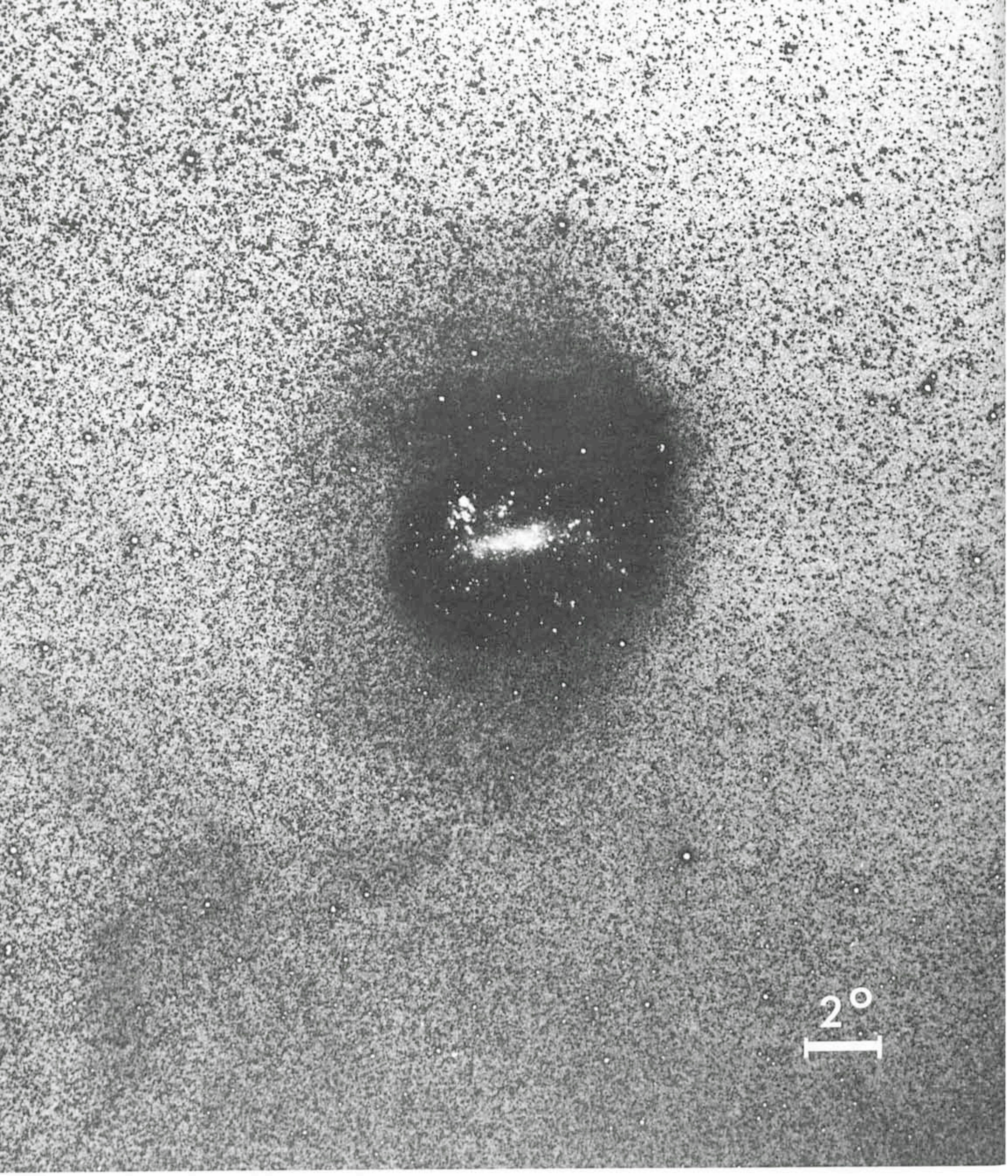


Figure 2.

than 70° × 70°), but part of this effect could be removed by masking. Moreover, the LMC and SMC were not very high in the sky at the time of the exposure; the plate includes part of the horizon. Normal reproductions of this picture have appeared in the ESO Annual Report 1984 (page 4) and also in the recently published ESO book "Exploring the Southern Sky" (see the *Messenger* **49,** 42). Note that Figure 2 is rotated ~ 20° towards East, as compared to Figure 1. The bright star (with white centre) between the LMC and the scale bar is $\gamma$ Hyi; the one of similar brightness in the upper left quadrant is $\alpha$ Pic.

The very deep print reaches a surface brightness around $26^m$(R) per square arcsecond and has a resolution slightly better than 1 arcmin. The LMC halo is well visible and measures about 15° (N-S) by 11° (E-W), corresponding to about 15 × 11 kpc. The overall structure shown here has been known for some time from the work of G. de Vaucouleurs (for a review, see de Vaucouleurs and Freeman, *Vistas in Astronomy,* **14,** 163, 1972). The outer "shells" are particularly well delineated north of the LMC; 4, perhaps 5 rather sharp borders are seen of which the outermost is just beyond the bright star β Dor (some astronomers think these are "spiral" features). Most of the halo light in this photograph is thought to come from a population of faint stars of intermediate age.

Note also how the giant H II region 30 Doradus, seen as the bright spot NE of the bar, on this picture is much closer to the geometric centre of the LMC than in less deep images. Whether or not it is indeed the "nucleus" of the LMC has been a matter of some debate (cf. Feitzinger, *Space Sci. Rev.* **27,** 35, 1980).

The straight shadow, which crosses the field south of the LMC, belongs to the Milky Way and is believed to be a "cirrus" cloud in the galactic halo. High-resolution Schmidt pictures of the SE part of this feature are shown in an article by Johnson and co-authors (*MNRAS,* **198,** 985, 1982).

Both of the prints shown here demonstrate the power of wide-field imaging to very-low surface brightness levels. Whereas the photographic image (Figure 2) has a wider field and can therefore show larger structures more easily, the CCD reaches fainter light levels, has a better resolution and can be well calibrated.

Wide-field imaging has also a potential for discovery of variable stars and moving objects, such as meteors or comets. The comparison CCD images taken at different epochs can be done by computer or by visual inspection.

*R. M. West, H. Pedersen and C. Madsen (ESO)*

## The 3rd ESO/CERN Symposium on Cosmology, Astronomy and Fundamental Physics

**will be held at the Palazzo Re Enzo, Bologna (Italy) from 16 to 20 May 1988**

The preliminary programme includes the following topics and invited speakers:

**Topics**

First results from new colliders – Ultrarelativistic nuclear collisions – Standard model of fundamental interactions – Supernova 1987A: observations and interpretations – Dark matter: evidence, candidates and detection – Large scale structure of the universe – Microwave background radiation – High redshift objects – Dynamical parameters of the universe – Underground laboratories – Perspectives for high energy physics – Beyond the standard model.

**Invited Speakers**

A. Dressler (MWLCO, Pasadena), M. Geller (CfA, Cambridge, MA), W. Hillebrandt (MPPA, Munich), M. Koshiba (CERN, Geneva), R. G. Kron (Yerkes Observ., Univ. of Chicago), L. M. Lederman (Fermilab, USA), D. Lynden-Bell (Univ. of Cambridge, UK), S. Ozaki* (KEK, Japan), F. Pacini (Univ. of Florence), R. B. Partridge (Haverford College, USA), R. D. Peccei (DESY, Hamburg), C. Rubbia (CERN, Geneva), M. Satz (Bielefeld University, FRG), Y. Tanaka* (ISAS, Tokio), M. S. Turner (Univ. of Chicago/Fermilab), N. Vittorio (Univ. of Rome "La Sapienza"), L. Woltjer (ESO), Ya. B. Zeldovich* (USSR Academy of Sciences, Moscow).

* Participation to be confirmed.

The aim of the symposium is to establish the status of our knowledge on the subject and to provide a forum for discussions among people from different disciplines. To this end about equal time will be dedicated to the formal lectures and to the general discussions on each topic. It is also foreseen to hold a poster session. The audience will be mainly composed of about equal numbers of astrophysicists and particle physicists and will be limited to approximately 250 participants.

The participation in the symposium is by invitation only. People who are definitely interested in participating in the symposium should write to the Scientific Secretariat at the address below prior to 31st January 1988:

Scientific Secretariat
3rd ESO/CERN Symposium
Istituto di Fisica "A. Righi"
Via Irnerio, 46
I-40126 Bologna, Italy

Tel. 051/244490 – Telex 520634 – Telefax 247244

# The ESO Exhibition

An ESO Exhibition was open to the public from October 10 to November 11, 1987, at Palais de la Découverte in Paris, France. The next stop will be in the capital of Austria where it opens on December 17, 1987 at the Vienna Planetarium. Negotiations are under way about some possible future exhibition sites, most in the ESO member countries.

With the addition of more panels that describe the newest research results at ESO, the Exhibition has grown during the past year and it has become necessary to put the letting of ESO material to exhibition organizers into system. For this reason, ESO has prepared a pamphlet "The ESO Exhibition – Instructions to Organizers" which gives useful information and serves as a basis for discussion about the details of individual exhibitions.

Potential organizers should contact the ESO Information Service, at least six months before the proposed opening date.

## STAFF MOVEMENTS

### Arrivals

**Europe:**

BÜTTINGHAUS, Ralf (D), Technician in Fine Mechanics/Instrument Maker
GOSSET, Eric (B), Fellow
SRINIVASAN, Ganesan (IND), Associate

**Chile:**

REMY, Marc (B), Associate

### Departures

**Europe:**

JAUCH, Christa (D), Draughtswoman (Graphics)

**Chile:**

MONDEREN, Peter (B), Student

*Model of the ESO VLT* ▶