which is enveloping the nucleus (circles in Figure 8) does not fit as easily with such a model. Other types of grains may be required, perhaps of higher albedo. Water ice may be considered.

Reference

Dollfus, A., Suchail, J.-L., Crussaire, D., Killinger, R. (1987): Comet Halley: Dust characterization by photopolarimetry. To be published in Proc. ESA Symposium Exploration of Halley's Comet, Heidelberg, FRG, 27–31 Oct. 1986.

MESSENGER INDEX

An index of all contributions published in the Messenger from No. 1 to No. 46 (1974–1986) has been compiled and will be distributed with this issue of the Messenger.

The index consists of three parts. The first part – the Subject Index – lists the contributions grouped by 20 subject titles. In the second part – the Author Index – the articles are listed by authors, in alphabetical order. The third part contains the Spanish summaries, grouped by subject titels and in chronological order.

Although the division of the contributions into 20 subjects and their assignment to these subjects may not be perfect, it is hoped that the index will help the reader to obtain a better overview of the articles which have appeared in the Messenger and permit him to find them more easily.

In the future, annual indexes will be compiled.

Multiple Object Redshift Determinations in Clusters of Galaxies Using OPTOPUS

A. MAZURE and D. PROUST, DAEC, Observatoire de Meudon, France
L. SODRE, IAG, São Paulo, Brasil
H. CAPELATO, São Jose dos Campos, Brasil
G. LUND, Département d'Astrophysique de l'Université de Nice, France

Introduction

From recent developments of observational astronomy, the overall view of the structure of the universe appears to be very different from the homogeneous and isotropic one claimed by traditional cosmology. The hypothesis of long, interconnected linear filaments or even large "bubbles" characterizing the concentration of galaxies now seems to be well established, these regions being separated by large voids empty of bright galaxies.

One of the fundamental factors in the understanding of such formations is the determination of their structure in the third dimension as opposed to their flat "projected" appearance.

If the redshift determinations represent virtually the only tool giving access to the third dimension, they are also essential to the understanding of structural dynamics because they provide us with a wealth of information concerning the velocity dispersion in particle systems. Radial velocity measurements are essential to the understanding of structures such as galaxy clusters, as dynamic analysis of their velocity distribution can lead to mass determinations and to an estimate of the missing mass in the universe.

Analyses of some Abell clusters have recently been published; as an example it has been shown that the A496 cluster has a complex structure formed essentially by a main cluster (or main subcluster), and another small sub-cluster,

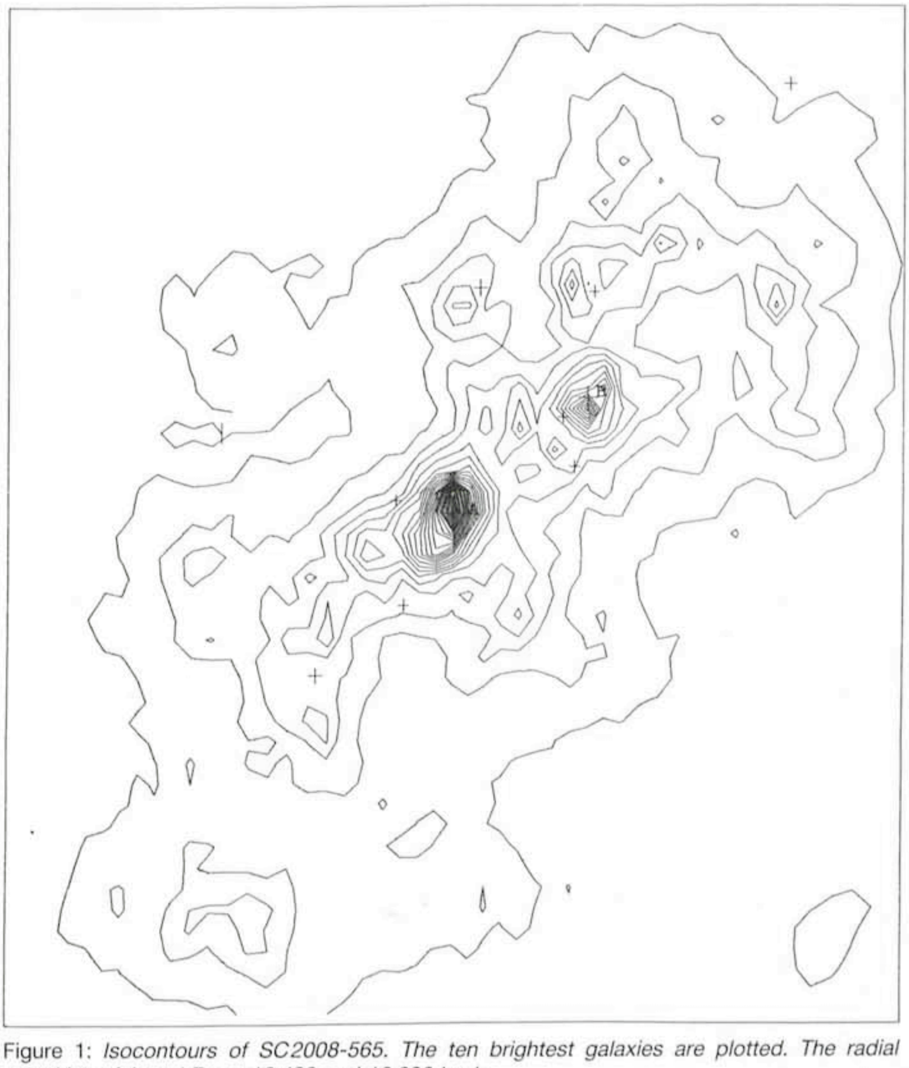

Figure 1: *Isocontours of SC2008-565. The ten brightest galaxies are plotted. The radial velocities of A and B are 16,490 and 16,890 km/s.*

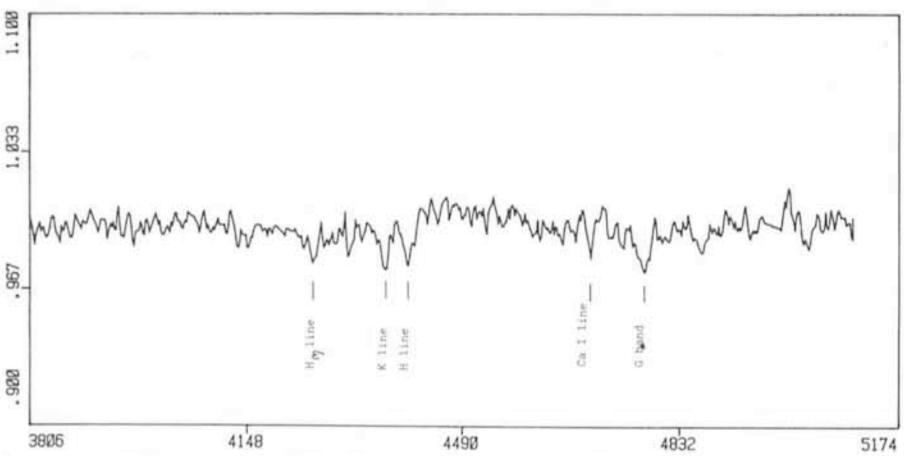

Figure 2: *Spectrum of an elliptical mb 17.26 galaxy in the SC 0004.8-345 cluster.*

with the cD in its centre, at the same distance (Mazure et al., 1986).

The well-known Coma cluster has also been reinvestigated by Mellier et al. (1987). The isopleth map of 'sequence' galaxies determined from a colour-magnitude strip (Visvanathan and Sandage, 1977) to magnitude 20 shows the presence of several secondary density peaks in the vicinity of bright galaxies and a double structure in the core of the cluster. The distribution of velocities relative to the brightest galaxies indicates also a composite population, one with a velocity dispersion as small as σ = 350 km/s.

Using the ESO multi-object facility. OPTOPUS, we have observed a sample of galaxy clusters such as SC 2008-565 (Fig. 1) in order to collect a large set of individual radial velocities, and to pursue similar analyses.

Instrumentation

The observations were carried out during two nights at the end of July 1986 at the 3.6-m telescope, using the multi-object spectrograph OPTOPUS. The characteristics of the instrument are summarized in the *Messenger* No. 41, page 25 and No. 43 p. 1, and in the corresponding ESO Operating Manual. For each exposure, 32 separate optical fibres were available due to the use of an f/2.5 dioptric camera, slower than the usual Schmidt camera, in a field of 33 arcminutes diameter. The aluminium starplates were prepared at ESO Garching using X-Y Schmidt plate coordinates measured with the Optronics-3000 facility, converted into (1950) alpha, delta coordinates using the POS software and standard stars from the Perth 70 catalogue. At least 3 stars were selected on each plate, in order to check its position and orientation, and the rms residual position error corresponded to 0.25 arcsec.

A dispersion of 114 Å/mm was used, providing spectral coverage from 3800 to 5180 Å. With the fibre spaghetti correctly entangled with the appropriate plates, cooking times ranging from 90 minutes to 150 minutes were needed, according to the average blue magnitude of each cluster.

In all cases, observations were made in the vicinity of the meridian plane in order to minimize refraction effects which can lead to small fibre/image offsets during the course of observations. The second half of the last night was almost completely lost because of cloudy conditions.

Data Reduction and Results

Data reduction was carried out using the IHAP image-processing software at ESO Garching. The programme automatically identifies the positions of the spectra on the CCD frame and extracts them by adding the contribution of the brightest columns. Wavelength calibration was performed using the He-Ar lamp reference exposures obtained immediately after each cluster exposure through the same OPTOPUS configuration, at the same sky position. The redshifts were determined by measuring the most prominent absorption lines and systematically cross-correlating them with a template spectrum of known radial velocity.

For a cluster like SC 0004.8-345 (Carter, 1980), we derived 28 reliable redshifts from 32 raw galaxy spectra ranging in blue magnitude between 17.0 and 18.8, obtained with an exposure time of 150 minutes Figures 2 and 3 show two spectra of resp. mb 17.26 and 18.79 galaxies of this cluster. The signal-to-noise ratio in the latter case is around five. It represents the extreme case of redshift determination using the cross-correlation procedure. The same number of redshifts was achieved for the galaxy cluster DC 1842. However, in the case of SC 2008-565, the poorly known photometry of this cluster led to an underestimation of the required exposure time, and thus to a considerable degradation in the proportion of accurately determined redshifts. We were nevertheless extremely pleased to obtain a total of 100 well-determined redshifts from 1½ nights of observation.

In conclusion, OPTOPUS appears to be a particularly well-adapted instrument for the rapid and simultaneous determination of redshifts in catalogued galaxy clusters.

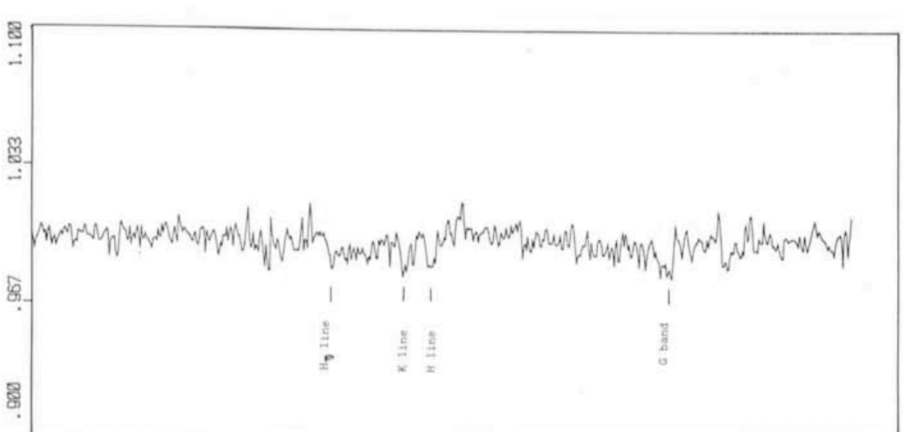

Figure 3: *Same as Figure 2 for an mb 18.79 galaxy.*

References

Carter, D.: 1980, *Mon. Not. Roy. Astron. Soc.*, **190,** 307.
Mazure, A., Gerbal, D., Proust, D., Capelato, H.V.: 1986, *Astron. Astrophys.* **157,** 159.
Mellier, Y., Mazure, A., Mathez, G., Chauvineau, B., Proust, D.: 1987, preprint.
Visvanathan, N., Sandage, A.R.: 1977, *Astrophys. J.*, **216,** 214.