tions in X-ray carried out with ROSAT. Kreysing et al. (1992) report detection of extended X-ray emission from six planetary nebulae. It appears that these objects tend to have exceptional large temperature fluctuation and belong to a special group in which some unknown process (e.g. shock heating) is playing an important role. This category includes objects such as NGC 2392, NGC 4361, NGC 6543 and J320. Further investigation is required to clarify the problem. It is worth noting that the type of work described above can be accomplished on modest sized telescopes provided there is adequate UV throughput of the system.

References

Barker, T., 1978, *Ap.J.*, **219**, 914.
Barker, T., 1979, *Ap.J.*, **227**, 863.
Bowen, I. S., 1934, *Pub. A. S. P.*, **46**, 146.
Bowen, I. S., 1935, *Ap.J.*, **81**, 1.
Dalgarno, A., Heil, T. G. and Butler, S. E., 1981, *Ap.J.*, **245**, 793 (DHB).
Dalgarno, A. and Sternberg, A., 1982, *M.N.R.A.S.*, **200**, 77P.
Gargaud, M., McCarroll, R. and Opradolce, I., 1989, *Astr. Ap.*, **208**, 251 (GMO).
Harrington, J. P., 1972, *Ap.J.*, **176**, 127.
Harrington, J. P., Seaton, M. J., Adams, S. and Lutz, J. H., 1982, *M.N.R.A.S.*, **199**, 517.
Kallman, T. and McCray, R., 1980, *Ap.J.*, **242**, 615.
Kastner, S. O., Behring, W. E. and Bhatia, A. K., 1983, *Ap.J. (Supplement)*, **53**, 129 (KBB).
Kastner, S. O., and Bhatia, A. K., 1990, *Ap.J.*, **362**, 745 (KB).
Kreysing, H. C., Diesch, C., Zweigle, J., Staubert, R., Grewing, M. and Hasinger, G., 1992, *Astr.Ap.*, **264**, 623.
Likkel, L. and Aller, L. H., 1986, *Ap.J.*, **301**, 825 (LA).
Liu, X. W. and Danziger, I. J., 1993a, *M.N.R.A.S.*, in press.
Liu, X. W. and Danziger, I. J., 1993b, *M.N.R.A.S.*, in press.
Liu, X. W. and Danziger, I. J. and Murdin, P., 1993, *M.N.R.A.S.*, in press.
Luo, D., Pradhan, A. K. Saraph, H. E., Storey, P. J. and Yu Yan, 1989, J. Phys. B., **22**, 389 (LPSSY).
Peimbert, M., 1967, *Ap.J.*, **150**, 825.
Peimbert, M., 1971, *Bol. Observ. de Tonantzintla Y Tacubaya*, **6**, 29.
Peimbert, M., Sarmiento, A. and Fierro, J., 1991, *Pub. A.S.P.*, **103**, 815.
Roueff, E. and Dalgarno, A., 1988, *Phys. Rev.*, A **38**, 93 (RD).
Saraph, H. E. and Seaton, M. J., 1980, *M.N.R.A.S.*, **193**, 617 (SS).
Schachter, J., Filippenko, A. V., and Kahn, S. M., 1989, *Ap.J.*, **340**, 1049.
Schachter, J., Filippenko, A. V., and Kahn, S. M., 1990, *Ap.J.*, **362**, 74.
Schachter, J., Filippenko, A. V., Kahn, S. M. and Paerels, F. B. S., 1991, *Ap.J.*, **373**, 633.
Sternberg, A., Dalgarno, A. and Roueff, E., 1988, *Comments Astrophys.*, **13**, 29.
Torres-Peimbert, S., Peimbert, M. and Peña, M., 1990, *Astr.Ap.*, **233**, 540.
Weymann, R. J. and Williams, R. E., 1969, *Ap.J.*, **157**, 1201.

Two New Catalogues of Small Magellanic Cloud Members Coming Soon

M. AZZOPARDI, ESO and Observatoire de Marseille, France

Within the framework of our studies of the stellar populations of the Small Magellanic Cloud (SMC) two extensive surveys – one for carbon stars and one for point-source Hα emission-line objects – were undertaken in the early eighties. For these surveys we introduced an observing technique which turned out to be very efficient for the detection of the SMC OB and blue supergiant stars (Azzopardi and Vigneau 1975), as well as for the identification of the Magellanic Cloud Wolf-Rayet stars (Azzopardi and Breysacher 1979, 1980). Briefly, the surveys combined a IIa-O emulsion with a suitable interference filter in order to restrict the instrumental spectral range to a selected useful spectral domain, according to the type of object to be detected. By reducing the sky background, the interference filter allowed longer exposures hence reaching fainter stars. Furthermore, since the resulting spectra on the plates were very short, the number of overlaps was kept low enough to make the survey of very crowded SMC regions possible.

Due to the relative faintness of the objects we have detected, which are generally located in very crowded fields, accurate positions and clear finding charts are absolutely necessary to facilitate further observations. For this purpose, the equatorial coordinates (equinox 2000.0) of the objects of interest, in both surveys, were inferred from those of several secondary astrometric reference stars. The positions of these stars were themselves computed with reference to the right ascension and the declination of the stars listed in the Perth catalogue and appearing on the ESO Schmidt telescope plate No. 6266. The transformation of very accurate x-, y-coordinates into equatorial coordinates, for all the stars, was done using special astrometry routines written at ESO by R. West. The objects listed in both catalogues were identified on individual finding charts of 2.25 arcmin square. These have been extracted from scans of a glass copy of the Schmidt red plate No. 6266, processed at the ESO Sky Atlas Laboratory by B. Dumoulin using an improved unsharp masking technique in order to reduce the density range of the deep original plate while keeping the fine details of the image. The plate has been scanned by J. Marchal at Nice Observatory with a PDS 1010A microdensitometer linked to a VAX 785 computer. Extensive photographic work has been done by M. Gerbal and H.H. Heyer when preparing each set of finding charts.

SMC Carbon Star Survey

Earlier detections of carbon stars in the Magellanic Clouds were carried out by Blanco, McCarthy and Blanco (1980) and Blanco and McCarthy (1983). Their survey, in the near infrared spectral domain, of 37 SMC sample regions with the Cerro Tololo Inter-American Observatory (CTIO) 4-m telescope equipped with low-dispersion transmission gratings (grisms) resulted in the identification of 860 carbon stars in the Small Cloud. From the carbon star-count isopleths, based on the sample region surface densities found for these stars, Blanco and McCarthy (1983) estimated the total number of the SMC carbon stars to be 2900.

In the mean time, during the 1981, 1983 and 1984 Magellanic Cloud observing periods, an extensive spectral survey for field carbon stars in the SMC was carried out by B.E. Westerlund, J. Breysacher and the author, in order to get the best possible picture of the distribution of these stars. Adopting the Sanduleak and Philip (1977) survey technique in searching for carbon stars (identification of their pronounced C_2 Swan bands at 4735 Å and especially at 5165 Å), we used the ESO 3.6-m telescope equipped with the large-field triplet adaptor (0.78 degree circular field)

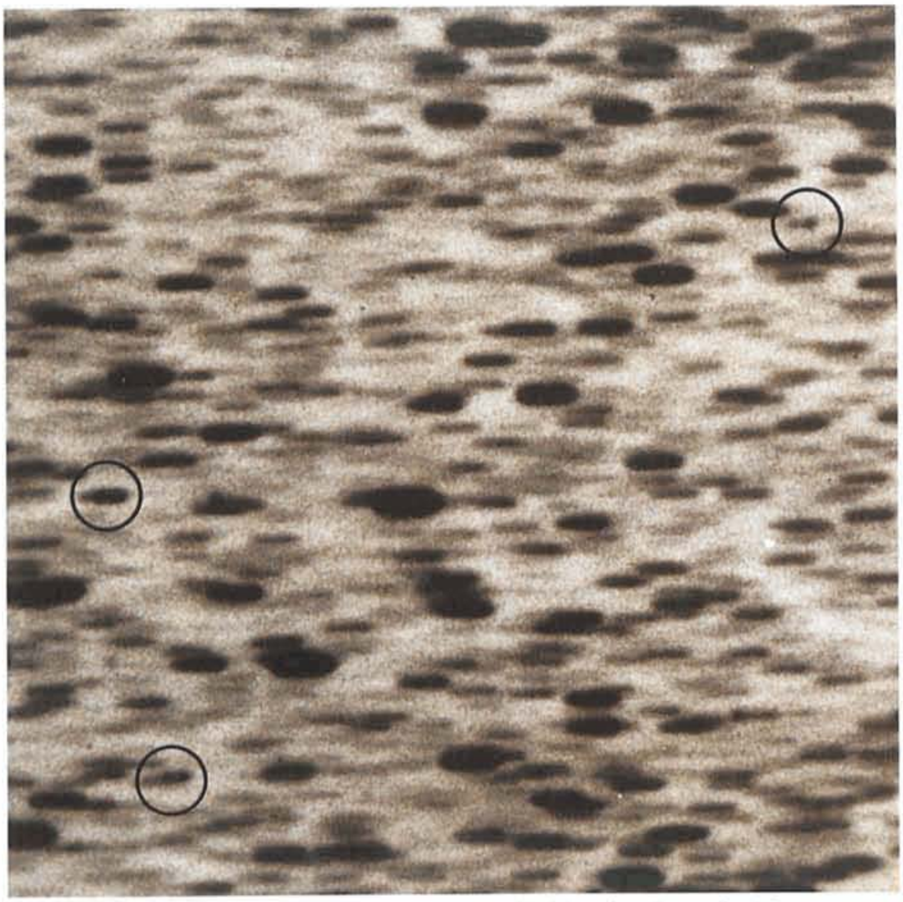

Figure 1: *Crowded field in the southern region of the SMC bar. Small part of a 1-hour exposure ESO grism plate obtained on IIIa-J emulsion through a Schott GG435 filter. The spectra of some newly identified carbon stars are marked with circles.*

and a Hoag grism yielding a dispersion of 2200 Å/mm. The restricted useful range (4350–5300 Å) was obtained, in that case, by combining a IIIa-J emulsion with a Schott GG435 filter (for more information see the paper by Breysacher and Lequeux 1983). 28 plates for 13 partially overlapping fields, which together cover the main body of the SMC, were secured during three observing runs, by J. Breysacher from the outset of the project, and then by myself.

Both 60-min- and 5-min-exposure grism plates were systematically surveyed with a binocular microscope: three fields were first searched for carbon stars by B.E. Westerlund and the author to work out the plate survey procedure and determine the specific spectral features to be measured (Westerlund, Azzopardi and Breysacher 1986), then all plate material was carefully scrutinized and processed by E. Rebeirot at the Marseille Observatory. The spectra of the identified carbon stars were scanned individually, in the density mode, on our deepest exposure plates, using the microdensitometer PDS 1010A of the Laboratoire d'Astronomie Spatiale (LAS) de Marseille; density to intensity transformation, image processing and data reduction were performed as explained by Westerlund et al. (1986). This provided a magnitude, a colour equivalent and two measurements of the strength (equivalent width and depth) of the C_2 band at 5165 Å.

This survey resulted in the identification of 1707 field carbon stars found in the main body of the SMC. A comparison of the near-infrared carbon star survey by Blanco and associates with our survey work, for the fields in common, leads to the conclusion that the detection of those objects in the SMC is reasonably complete. At present, the degree of completeness achieved in the recognition of field carbon stars in the Small Cloud makes possible the study of its large-scale structure and kinematics, as shown, for instance, by the works of Hardy, Suntzeff and Azzopardi (1989), and Azzopardi and Rebeirot (1991). An important result inferred from those studies is that the SMC carbon stars, like the planetary nebulae, form an intermediate-age or old stellar population on the average, lying in an almost elliptical system with no concentration, more especially in the so-called SMC wing (region of the young clusters NGC456, 460 and 465). Consequently, the overall carbon star surface distribution, that resembles the distribution of the red light (de Vaucouleurs and Freeman 1973), is markedly different from that of Population I objects. In addition, subsequent medium resolution spectroscopy of some carbon stars listed in our catalogue, remarkable for their magnitudes and/or colours, led to the discrimination of natural groups of stars, and among other things, to the discovery of a sample of very faint carbon stars ($-3.0 < M_{bol} \leq -1.7$), which are the faintest ever found in a galaxy (Westerlund, Azzopardi, Breysacher and Rebeirot 1991, 1992), except for the galactic bulge (Westerlund, Lequeux, Azzopardi and Rebeirot, 1991).

In order to facilitate further studies, a paper by Rebeirot, Azzopardi and Westerlund (1993) entitled "Carbon Stars in the Small Magellanic Cloud – II. Catalogue of 1707 Objects with Identifications and Spectrophotometry" will appear in the next February issue (Vol. **97**, No. 3) of *Astronomy and Astrophysics Supplement Series*. In this paper accurate positions and finding charts for all the carbon stars we have detected on our grism plates are provided. Also magnitudes, colours, and carbon abundance measurements are given for most of them, as well as cross identifications for all stars previously identified by other authors.

SMC Hα Emission-Line Object Survey

Hα emission-line objects in the SMC have been identified mainly by Henize (1956) and Lindsay (1961). Since no more recent systematic detection for point-source Hα emission-line objects existed, a new extensive objective-prism survey for this kind of object was undertaken by the author in 1982.

This survey for Hα emission-line objects in the SMC was performed with the CTIO Curtis Schmidt telescope when the author was a CNRS/NSF scholarship visitor in the Department of Astronomy of the University of Texas at Austin (Azzopardi and Meyssonnier 1988). Observations were carried out using the 10-degree objective-prism (420 Å/mm dispersion at Hα) in combination with a 110-Å bandwidth interference filter centred at 6565 Å. Exposures of 30 min, 1, 2 and 4 hours on hypersensitized IIIa-F plates allowed us to identify objects λλ 6548–6583 [N II] lines up to a limiting magnitude $m_{pg} \sim 18$ (for stellar continuum), some 2 to 3 magnitudes fainter than those from previous detections.

Hα emission-line objects have been searched for by N. Meyssonnier at the Marseille Observatory, who carefully surveyed all the plates with a binocular microscope; slitless spectra of the objects of interest were classified according to the intensity of the continuum, and the shape and strength of the Hα line. This, added to the presence and appearance of the [N II] lines, led to the discrimination of the Hα emission-line stars from the emission nebulae, and facilitates the identification of planetary nebulae. Furthermore, the detected objects were also scrutinized on the grism plates used for the carbon star survey. This allowed us to confirm the nature of the emission nebulae through the λλ 4959–5007 [O II] lines (for instance selecting the Very Low Excitation objects (VLE) among the planetary nebula candidates), and to establish the emission nature of very faint stars by the observation of a weak continuum underlying the Hβ line.

This survey resulted in the identification of 1898 Hα emission-line objects in the central regions of the Small Cloud, almost quadrupling the number of those found, in the same area, by the previous objective-prism surveys. Among the 178 emission nebulae we have detected, 62 are planetary nebulae (PN) and 81 compact/very small H II regions, the remaining nebulae being bubbles, loops and bright parts of large H II regions or filaments. 15 planetary nebulae (14 confirmed by our subsequent medium-resolution slit spectroscopy) and 25 compact H II regions are newly identified objects. Note that the total number of PN/VLE objects already found in the Small Cloud is about 75 – taking into account those beyond the boundaries of our survey – some 65 % only of the estimated total SMC PN population (116 objects), according to Boroson and Liebert (1989). Three B[e] supergiants (S6, S18 and N82) out of the four presently known in the SMC – S65 is outside the boundaries of our survey – (see Azzopardi, Breysacher and Muratorio 1981; Zickgraf 1986, 1989; Heydari-Malayeri 1990) and the VV Cephei star N55 (Walker 1983) were found again (Henize's identification numbers are given). In addition to the VV Cephei star, 28 other late-type star candidates with emission in the Hα line have been detected. The emission nature of five of them has been confirmed by our subsequent slit spectroscopy, one being a proven symbiotic star independently found by Morgan (1992) (star SMC3 from his Table 2).

The surface distribution of the Hα emission-line stars (Meyssonnier and Azzopardi 1991) resembles the overall distribution of the most luminous blue SMC stars (Azzopardi and Vigneau 1977). That of the small nebulae displays a similar pattern in spite of the smaller sample. It is difficult to draw any definitive conclusion about the surface distribution of the identified SMC planetary nebulae (Meyssonnier and Azzopardi 1991) on account of their restricted number. However, it is only reasonable to postulate that their overall distribution might have the same pattern as that of the carbon stars.

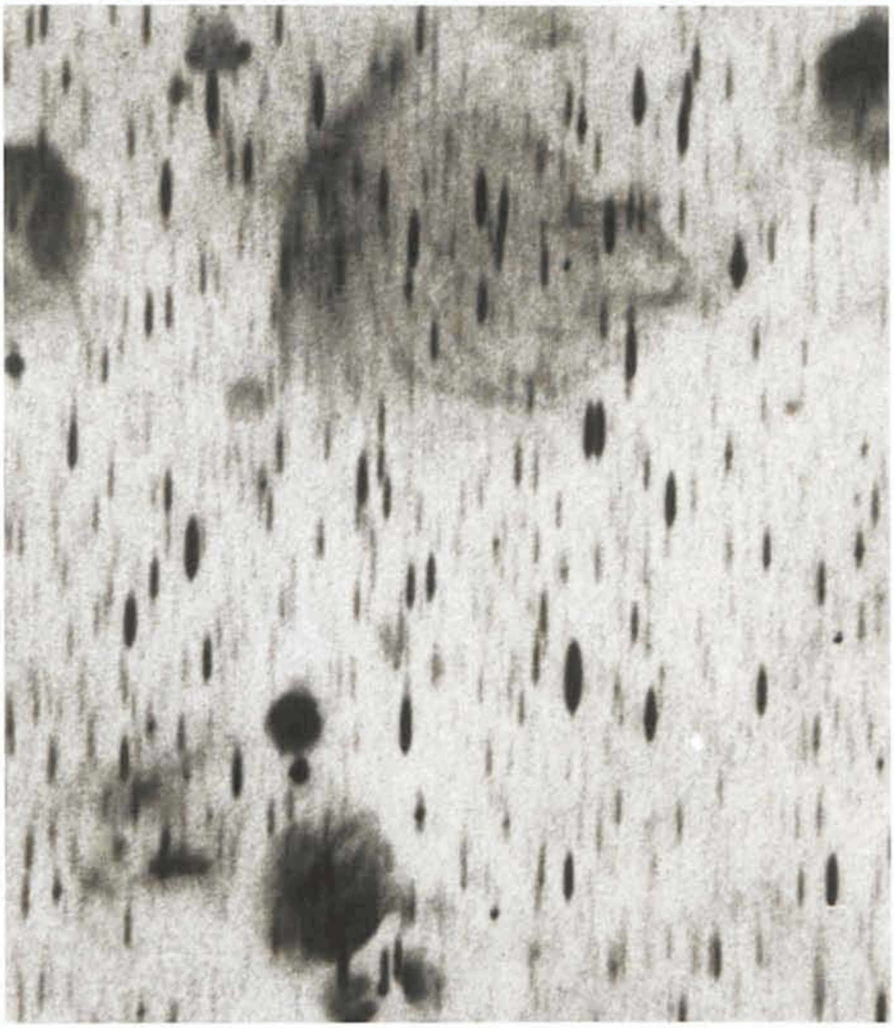

Figure 2: *Field in the southern region of the SMC bar. Part of the 4-hour exposure CTIO Curtis-Schmidt objective-prism plate (420 Å/mm dispersion at Hα)* obtained on IIIa-F emulsion through a 110-Å bandwidth interference filter centred at 6565 Å. Several objects show up strongly due to the emission from Hα and/or [N II] lines.

The identification of the Hα emission-line objects has been a very long task. Now completed, this work will be submitted soon for publication to *Astronomy and Astrophysics Journal.* It is expected that the "New Catalogue of Hα-Emission-Line Stars and Small Nebulae in the Small Magellanic Cloud" by Meyssonnier and Azzopardi will appear by the end of this year.

New Slitless Spectroscopic Surveys in Progress

From the experience we gained from low to very low objective-prism and -grism spectroscopy, we are now using the ESO Faint Object Spectrograph and Camera in the field spectroscopy mode (slitless) at the Cassegrain foci of both ESO 3.6-m and 2.2-m telescopes (EFOSC and EFOSC2, respectively) in order to carry out very deep surveys in selected regions of the Magellanic Clouds. We aim to detect very faint field carbon stars or planetary nebulae as well as Be stars in the centre of young globular clusters (Azzopardi 1993).

Thanks to its flexibility and versatility, an EFOSC-type instrument is especially well adapted, in selecting the best spectral dispersion and domain, to identify the typical spectral feature(s) of the type of object to be detected. For instance, when performing surveys with spectral dispersions lower than ~500 Å/mm we use preferably prisms instead of grisms in order to avoid the disturbing images due to the different grating orders (mainly the direct image or "zero" order). Also, on account of the dispersion achieved, we used 100–150 Å bandwidth to broad-band (~1000 Å) interference filters. Although the field of view of the

(continued on page 34)

Paranal at Sunset

This picture was taken in late October 1992, just before sunset. It shows the new, characteristic profile of the Paranal mountain, after the removal of the uppermost 28 metres of the peak. The huge VLT platform stands out against the transparent evening sky. In the foreground and some hundred metres lower is the VLT Base Camp. The photo was taken with a Hasselblad camera with a 50-mm lens on Kodak Ektachrome 100 film. Photographer: H. Zodet, ESO.

EFOSC CCD camera is restricted to a few (~20) square arcminutes, this survey technique is very efficient to identify objects showing up strongly through either their emission-lines or molecular bands. Concurrently, a semi-automatic procedure has been worked out by G. Muratorio in the MIDAS environment (Muratorio and Azzopardi 1993) to select through an impersonal mode, and more rapidly than by visual examination, the objects of interest.

References

Azzopardi M., 1993, Survey of Carbon Stars and Emission Objects. In: Baschek B., Klare G., Lequeux J. (eds.) Proc. Heidelberg Conference, New Aspects of Magellanic Cloud Research. Springer-Verlag, Heidelberg, p. 86.

Azzopardi M., Breysacher J., 1979, *A&A* **75**, 120.

Azzopardi M., Breysacher J., 1980, *A&A* **39**, 19.

Azzopardi M., Breysacher J., Muratorio G., 1981, *A&A* **95**, 191.

Azzopardi M., Meyssonnier N., 1988, A Curtis Schmidt Survey of Hα-Emission Objects in the Small Magellanic Cloud. In: Blanco V., Phillips M.M. (eds.) Proc. CTIO 25th Anniversary Symp., Progress and Opportunities in Southern Hemisphere Optical Astronomy. Brigham Young University, p. 386.

Azzopardi M., Rebeirot E., 1991, Large Scale Structure and Kinematics of the MCs from Carbon Star Studies. In: Haynes R., Milne D. (eds.) Proc. IAU Symp. 148, The Magellanic Clouds. Kluwer, Dordrecht, p. 71.

Azzopardi M., Vigneau J., 1975, *A&A* **22**, 285.

Azzopardi M., Vigneau J., 1977, *A&A* **56**, 151.

Blanco V.M., McCarthy M.F., Blanco B.M., 1980, *ApJ* **242**, 938.

Blanco V.M., McCarthy M.F., 1983, *AJ* **88**, 1442.

Boroson T.A., Liebert J., 1989, *ApJ* **339**, 244.

Breysacher J., Lequeux J., 1983, *The Messenger* **33**, 21.

de Vaucouleurs G., Freeman K.C., 1972, *Vistas in Astronomy* **14**, 163.

Hardy E., Suntzeff N.B., Azzopardi M., 1989, *ApJ* **344**, 210.

Henize K.G., 1956, *ApJS* **2**, 315.

Heydari-Malayeri M., 1990, *A&A* **234**, 233.

Lindsay E.M., 1961, *AJ* **66**, 169.

Meyssonnier N., Azzopardi M., 1991, A New Survey for Hα-Emission-Line Stars and Related Objects in the SMC. In: Haynes R., Milne D. (eds.) Proc. IAU Symp. 148, The Magellanic Clouds. Kluwer, Dordrecht, p. 196.

Morgan D.H., 1992, *MNRAS* **258**, 639.

Muratorio G., Azzopardi M., 1993, Detection of Faint Hα Emission-Line Objects and Carbon Stars in the Magellanic Clouds. In: Baschek B., Klare G., Lequeux J. (eds.) Proc. Heidelberg Conference, New Aspects of Magellanic Cloud Research. Springer-Verlag, Heidelberg, p. 96.

Rebeirot E., Azzopardi M., Westerlund B.E. 1993, *A&AS* **97**, 603.

Sanduleak N., Philip A.G.D., 1977 *Publ. Warner and Swasey Obs.* **2**, 105.

Walker A.R., 1983, *MNRAS* **203**, 25.

Westerlund B.E., Azzopardi M., Breysacher J., 1986, *A&AS* **65**, 79.

Westerlund B.E., Azzopardi M., Breysacher J., Rebeirot E., 1991, *A&AS* **91**, 425.

Westerlund B.E., Azzopardi M., Breysacher J., Rebeirot E., 1992, *A&A* **260**, L4.

Westerlund B.E., Lequeux J., Azzopardi M., Rebeirot E., 1991, *A&A* **244**, 367.

Zickgraf F.J., Wolf B., Stahl O., Leitherer C., Appenzeller I., 1986, *A&A* **163**, 119.

Zickgraf F.J., Wolf B., Stahl O., Humphreys R.M., 1989, *A&A* **220**, 206.

Study of the Shapley Supercluster

S. BARDELLI [1,4], R. SCARAMELLA [2], G. VETTOLANI [3], G. ZAMORANI [4,3], E. ZUCCA [1,3], C.A. COLLINS [5] and H.T. MACGILLIVRAY [6]

[1] Dipartimento di Astronomia, Università di Bologna, Italy; [2] Osservatorio Astronomico di Roma, Monteporzio Catone, Italy; [3] Istituto di Radioastronomia/CNR, Bologna, Italy; [4] Osservatorio Astronomico, Bologna, Italy; [5] Physics Department, University of Durham, United Kingdom; [6] Royal Observatory, Edinburgh, United Kingdom

1. Introduction

Superclusters (SC's) are the largest physical structures we know of today, and they constitute a very powerful probe for cosmology and extragalactic research. Indeed, some of the important questions which may be answered by studying superclusters concern the formation of galaxies and of galaxy clusters and related astrophysical problems. For example, biasing processes and efficiency of galaxy formation, the large-scale dynamics, power spectra of primordial density fluctuations, trends of M/L with size, and interactions and feedbacks on galaxies from a rich environment can all be investigated through the study of superclusters.

Superclusters are relatively rare objects and therefore are, on average, at large distance from us. This fact makes it difficult to collect the amount of different data which is necessary to perform a detailed analysis of their intrinsic properties. Therefore, a great opportunity is given if one is able to study a not too far but very rich SC. Fortunately, these are the characteristics of the SC discovered by Scaramella et al. (1989), which comprises about 25 rich Abell clusters over ≈ 300 square degrees, located at a distance of ~ 140 h^{-1} Mpc in the Centaurus region. The extreme richness of this SC in terms of galaxies brighter than 17th magnitude is such that its core was already noted in 1930 by Shapley, who reported an excess of counts over ~ 2.2 square degrees. Hence the name of Shapley Supercluster (or Concentration, hereafter SSC).

The SSC is by far the richest (Vettolani et al., 1990) and most interesting SC within 0.1c from us (Zucca et al., 1993). In fact, this concentration appears exceptional also by studying the surface distribution of optical galaxies (Raychaudhury, 1989; Raychaudhury et al., 1991) and by analysing the spatial distribution of IRAS galaxies (Allen et al., 1990). The SSC is also prominent in the X-ray band (Lahav et al., 1989). Indeed, this region contains 6 of the 46 X-ray brightest clusters of the sky at $|b^{II}|>20°$ (Edge et al., 1990), i.e. 13 % of the X-ray brightest clusters reside in only 1.4 % of the sky.

The SSC is also likely to be an important player in explaining the peculiar motion of the Local Group with respect to the Cosmic Microwave Background frame. In fact, Scaramella et al. (1989, 1991) pointed out that the SSC may be responsible for a significant fraction (≲30 %) of the Local Group peculiar motion, adding its dynamical pull on the LG to that from a closer overdensity of galaxies at ~40h^{-1} Mpc. The latter overdensity of galaxies, dubbed "Great Attractor", was suggested to be the source of the Local Group acceleration (Lynden-Bell et al., 1988; Lynden-Bell et al., 1989; Faber&Burstein, 1988; Dressler, 1988). The suggestions of Scaramella et al. (1989, 1991), on the contrary, implied a significantly larger