Rev. Mexicana Astron. Astrof. **12**, 63-72 (1986)

THE OBSERVATORIO NACIONAL-CENTER FOR ASTROPHYSICS REDSHIFT SURVEY. A STATUS REPORT

L.N. da Costa, P. S. Pellegrini, C. Willmer and M. A. Nunes

Department of Astronomy, CNPq-Observatório Nacional
Brasil

ABSTRACT. In this paper we briefly report on the present status of the ongoing redshift survey of the southern sky.

I. INTRODUCTION

For the past two years we have been commited to complete a moderately deep wide-angle redshift survey of nearby southern galaxies. This project, a joint effort of the Observatório Nacional (ON) and the Harvard-Smithsonian Center for Astrophysics (CfA), is an extension of the recently completed CfA Redshift Survey of the northern skies. Together these surveys will provide valuable information concerning the properties of the nearby distribution of matter and contribute to our understanding of the large-scale structure of the universe.

The ON-CfA Redshift Survey is still in progress and so far we have accumulated some 600 redshifts. We antecipate that with the participation in the survey effort of other groups, such as the one in Las Campanas, the observed sample in the south will match that available in the north within the next two years, at least for galaxies brighter than m_B=14.5. New redshifts have also become available from the work of Sadler (1984) on bright (14.0) early-type galaxies and from the work of Fairall (1983, and references therein) on compact and bright-nucleus galaxies. In this paper we briefly describe the instrumentation utilized in this project and present some preliminary results of the ongoing survey.

II. THE DATA

The observations for the ON-CfA Redshift are made using a Cassegrain spectrograph and an intensified photon-counting Reticon detector, especially developed for this project (da Costa et al. 1985), on the 1.6 m telescope of the ON. The observations are made through a pair of 3" x 12" slits, with a center to center separation of 30", utilizing a 900 1/mm grating. The dispersion is 100 Å with a typical resolution of 6 Å (FWHM). The wavelength coverage is

from 4700 Å to 7100 Å. The detector is controlled by a Data General Nova which also allows real-time data assessement. The organization of the integrated system is illustrated in figure 1.

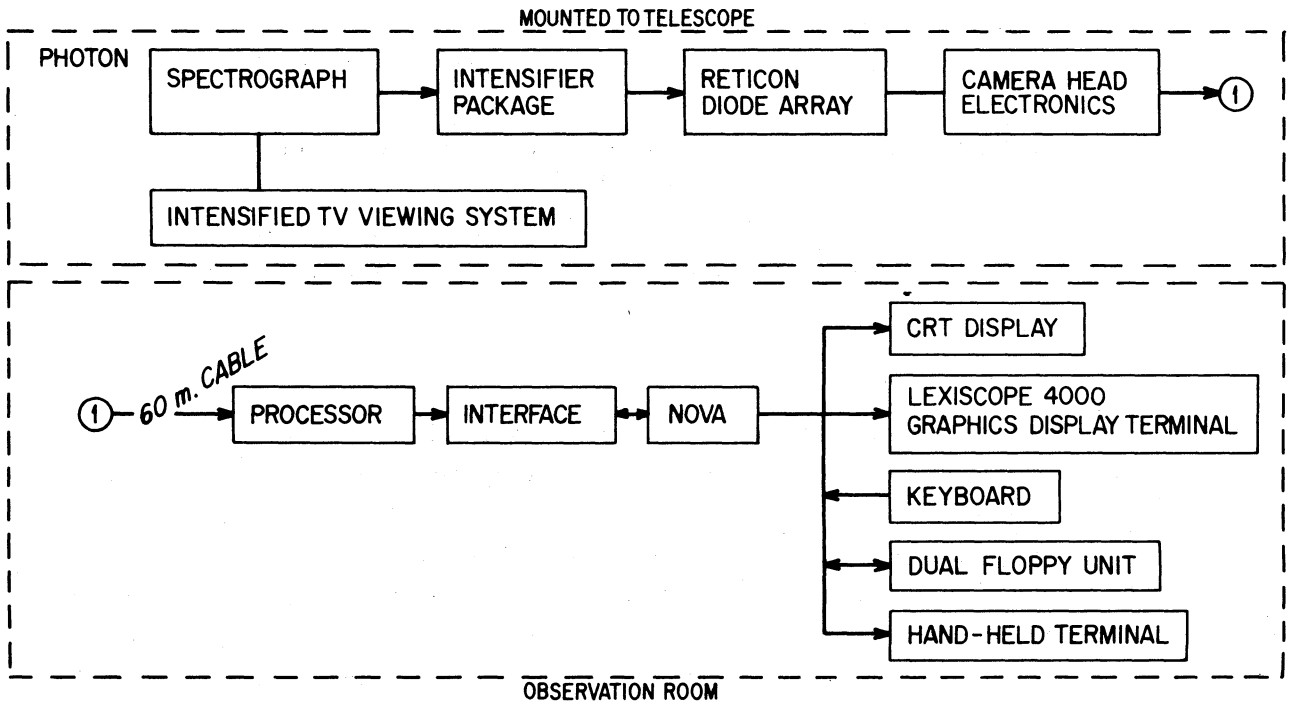

Fig. 1 Schematic Diagram of the Reticon detector and associated computer system

Data analysis is carried out also using a Nova available in Rio de Janeiro. The data-analysis system, developed at the CfA, takes the raw data to automatically create reduced files containing normalized sky-subtracted spectra in intensity-wavelength form. Later these files are used to carry out the radial-velocity and line strength analyses, which are also performed automatically. Final radial velocities are weighted means of the velocity determined from the emission lines and the correlation velocity obtained by cross correlating the galaxy spectrum against a high signal-to-noise template, as described in detail by Tonry and Davis (1979).

Da Costa et al. (1984) have recently determined the accuracy of our redshifts from the comparison with 21-cm radial velocity measurements. This comparison has shown that our velocities are in the mean shifted by -4.4 km s^{-1} with respect to the radio data, with a standard deviation in the differences of 39.6 km s^{-1}. Both values are very close to those determined by Rood (1980) for the CfA sample.

Our sample is drawn from the ESO/Uppsala Survey of the ESO(B) Atlas (Lauberts 1982), covering the region south of declination -30^{o} and below galactic latitude -30^{o}. To select galaxies brighter than m_B=14.5 we have assigned magnitudes to the listed galaxies using for separate morphological type groups the approximate relation between diameters and magnitudes, given by the expression (de Vaucouleurs et al. 1976).

$$\log D(0) = \log D_1 - 0.235 \times \log R,$$

where

$$\log R = A(T) \times \log (D_1/D_2)$$

with

$$A(T) = 0.95 \text{ for } T<0 \text{ and } A(T) = 0.894 \text{ for } T>0$$

In the above expressions D_1 and D_2 are the apparent major and minor diameters of the galaxy, and T denotes the morphological types as given by de Vaucoleurs et al. (1976). The estimated mean error in this determination is in the range 0.5-0.6 mag., when the following groups are used: i)E, E-SO; ii) SO, SOa; iii) Sa, Sab, Sb; iv) Sbc, Sc; v) S/Irr, Irr; vi) Dwarfs. The morphological classifications were taken from the ESO/Uppsala list.

In figure 2 we show the distribution on the sky, projected onto galactic coordinates, of the 1764 galaxies that constitute our tentative sample of galaxies brighter than 14.5 in the survey region defined above. Filled symbols indicate available radial velocities, including those obtained by the ON staff. In order to avoid overlap with Las Campanas observations we are presently concentrating our observations north of declination -47.5^{o}.

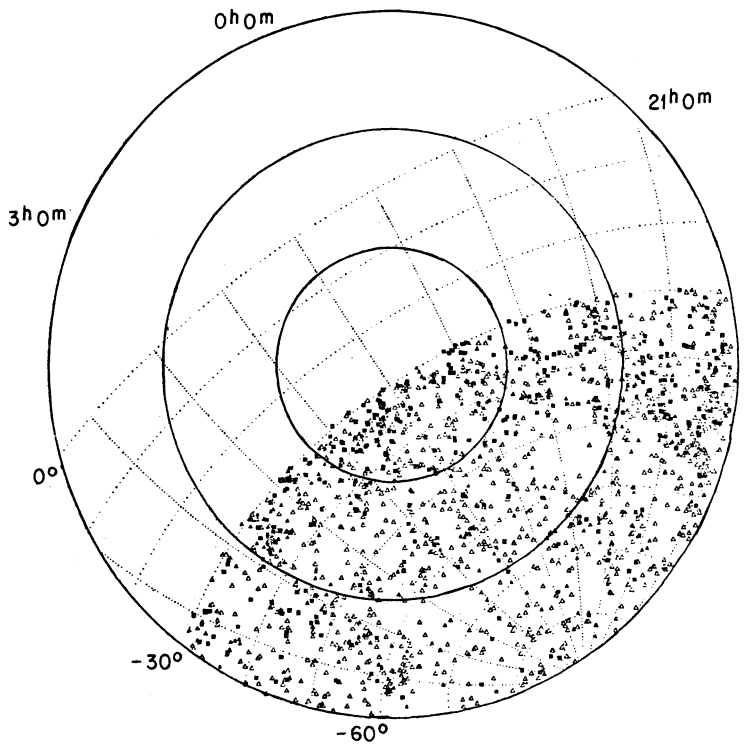

Fig. 2 The 14.5 south sample displayed in galactic coordinates. The south galactic pole is at the center and the circles denote galactic latitude -70^{o}, -50^{o} and -30^{o}. The dotted curves are lines of constant declination and right ascension. The different symbols denote: ( ) galaxies observed by the ON-CfA Redshift Survey; (Δ); redshifts available in the literature; ( ) galaxies with $m_B < 14.5$ without redshifts.

III. RESULTS

Although the observed sample is far from complete, the general characteristics of the spatial distribution of galaxies can be qualitatively analyzed by examining different redshift windows and redshift-space maps presented below

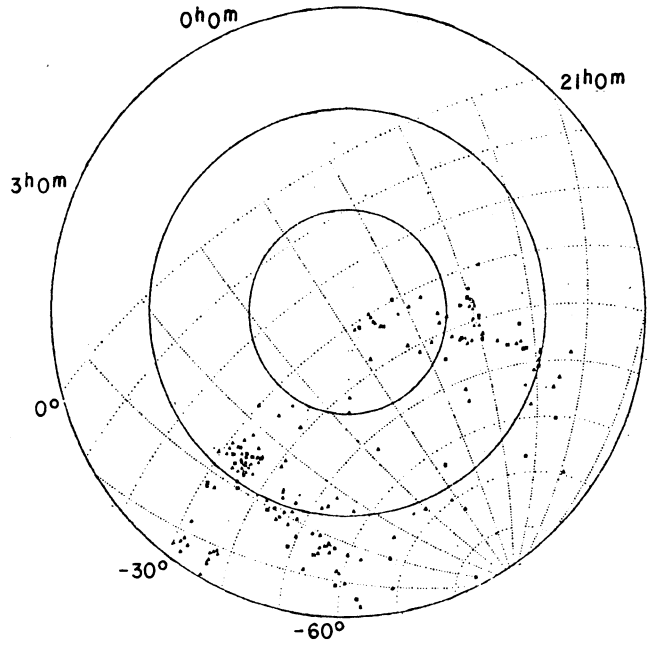

Fig. 3a Distribution of galaxies in the velocity range $0 < v < 2000$ km s^{-1}.

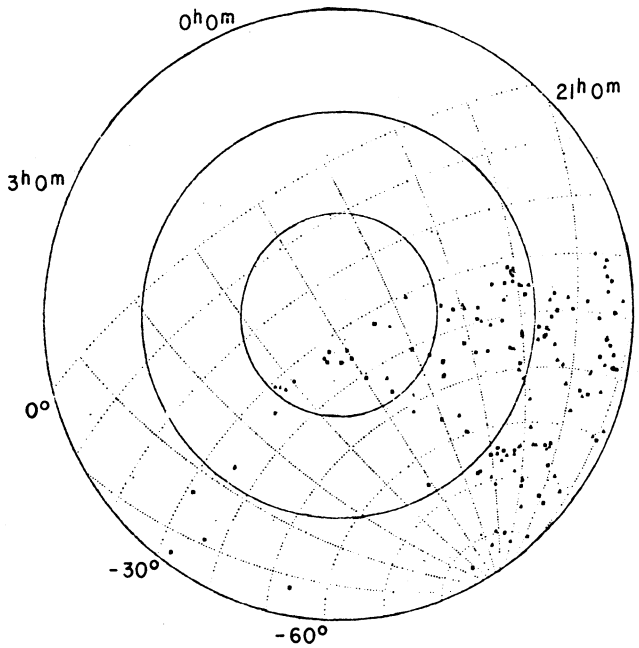

Fig. 3 b Distribution of galaxies in the velocity range $2000 < v < 4000$ km s^{-1}.

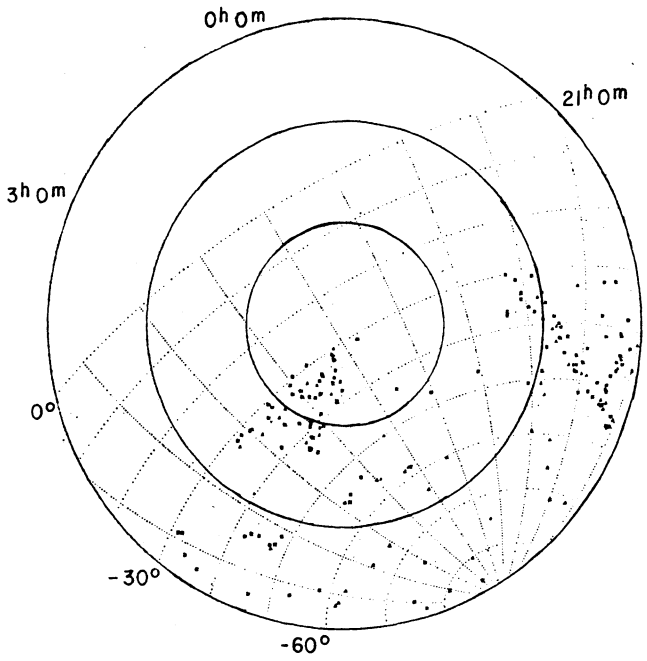

Fig. 3c Distribution of galaxies in the velocity range $4000 < v < 6000$ km s^{-1}

In figure 3a we plot the distribution of galaxies for the nearest redshift window, $0 < v < 2000$ km s^{-1}, showing the Fornax cluster ($\alpha = 3^h36^m$, $\delta = 35^o$) and several well-known nearby groups of galaxies, studied earlier by several authors (de Vaucouleurs 1975, Sandage 1975, Huchra and Geller 1982). Most of these groups are located southward of Fornax and in the region of right ascension between 22^h and 0^h and declination between -30^o and -50^o.

The general appearance of the distribution in the redshift window $2000 < v < 4000$ km s^{-1} (figure 3b) is quite different. It is mainly populated by small groups scattered over a large area of sky, which in most cases can be identified with groups determined in previous works (e.g. Klemola 1969, Sersic 1974, Rose 1976, Duus and Newell 1977, Braid and MacGillivray 1978). It is also interesting to note in the figure the apparently empty region behind Fornax and the concentration of galaxies between 21^h and 22^h. This concentration seems to be the front end of the large and clumpy Indus complex, which stretches in redshift to at least 6000 km s^{-1}, as shown in figure 3c. Another prominent structure in figure 3c, apparently composed of several distinct groups, is located in the Fornax-Sculptor direction covering two hours of right ascension between 1^h and 3^h. More distant windows are not shown

because selection effects become severe even for a qualitative description such as presented here.

An histogram of all the currently available velocities in the south is shown in figure 4. Its general form reflects the presence of the structures discussed above and represents a considerable improvement over the data presented by Davis et al. (1978), where only the nearby structures were apparent.

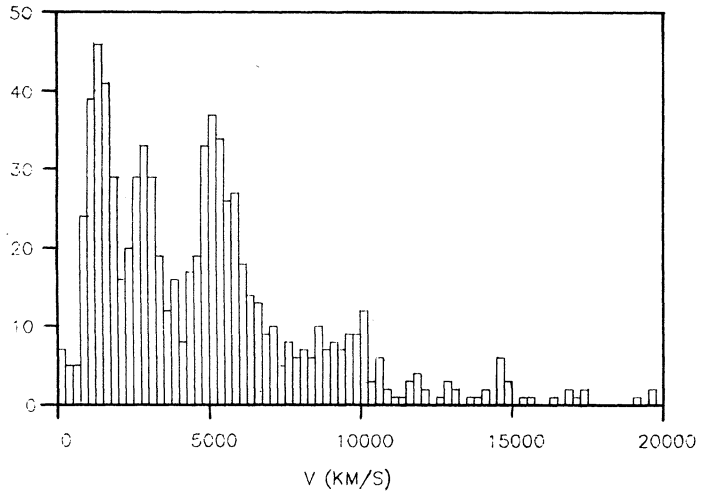

Fig. 4 Velocity distribution of the available southern sample.

The best description for the overall nature of the observed distribution, in the declination range -30^{o} to $-47^{o}.5$ seems to be of two sheets separated by a void, which has also been tentatively identified by Fairall (1984). This interpretation stems from the inspection of the redshift-space maps shown in figure 5. These are plots of the velocity versus right ascension, for the declination wedge defined between -30^{o} and $-47^{o}.5$ and velocity versus declination, respectively.

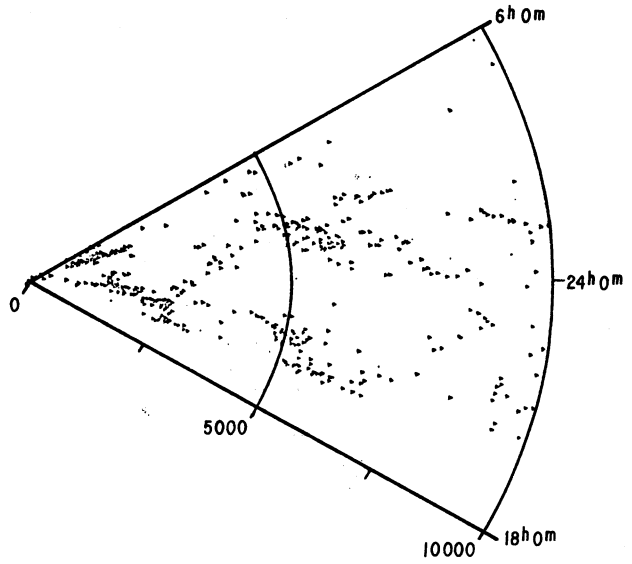

Fig. 5a Redshift-right ascension map.

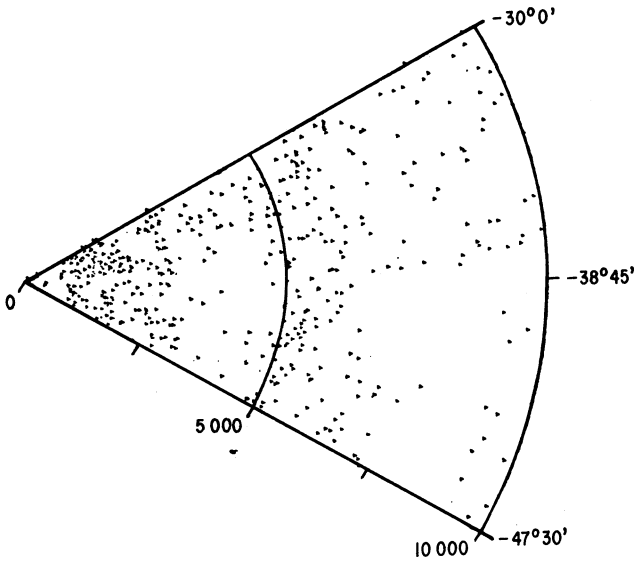

Fig 5b Redshift - declination map.

In the region $-47^{o}.5 < \delta < -30^{o}$ the sample is approximately 90% complete to $m_B = 13.8$, allowing a preliminary study of the density distribution within this region. Following Davis and Huchra (1982) the space density distribution, n(r), can be estimated from

$$n(r) = \frac{N(r)/\psi(r)}{\Omega r^2 \Delta r}$$

where N(r) is the number of galaxies observed in a shell of thickness Δr (2 MPc) at radius r and Ω (0.56 steradians) is the solid angle subtended by the sub-sample considered. In the above expression the selection function ψ (r) is the fraction of the actual number of galaxies at distance r which have been observed and is calculated following Davis and Huchra (1982), but considering only galaxies brighter than $M_B = 19.2$. The density distribution (figure 6) shows the presence of localized density enhancements, associated to the main structures described above, and a large underdense region extending over approximately 20 Mpc.

In order to calculate the mean density of galaxies in the partial volume considered we use the estimate n_1 introduced by Davis and Huchra (1982)

$$n_1 = \frac{1}{\text{VOLUME}} \Sigma\, N(r)/\psi\,(r)$$

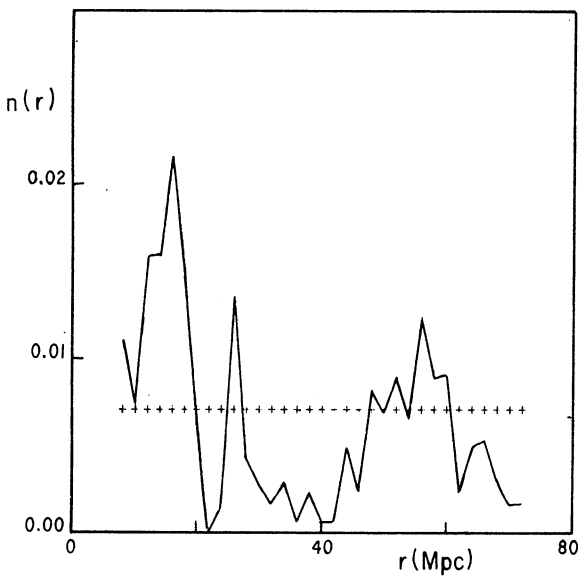

Fig. 6 Radial density distribution n(r) in the sub-region described in the text. The crosses represent the mean density estimate n_1 defined below.

or the restricted sample we obtain n_1=7.0 galaxies/Mpc^3. Although not directly omparable, this value is consistent with the estimates obtained by Davis and luchra (1982), based on the CfA south sample. A more detailed analysis of these esults will be presented in a future contribution.

CKNOWLEDGEMENTS

his work has been possible thanks to our CfA collaborators D. Latham, .Geary, J. Huchra. We also thank M. Davis for his continuous interest in the roject. We also thank M. Maia and R. de Carvalho for participating in some bservations and the ON technical staff specially D.Nascimento and C.Rite.

EFERENCES

raid, M. K., and MacGillivray, H. T. 1978, M.N.R.A.S. 182, 241.
la Costa, L. N., Pellegrini, P. S., Nunes M. A., Willmer, C. and Latham, D. W. 1984, Astr. J., 89, 1310.
a Costa, L. N., Nunes, M. A. and Geary, J. 1985, in preparation
avis, M., Geller, M. J., and Huchra, J. 1978, Ap. J., 221, 1
avis, M., and Huchra, J. 1982, Ap. J., 254, 437

de Vaucouleurs, G. 1975, in Galaxies and the Universe, ed. by A. Sandage, M. Sandage, and J.Kristian (Chicago: University of Chicago)

de Vaucoleurs, G., de Vaucouleurs, A., and Corwin, W. G., 1976 Second Reference Catalogue of Bright Galaxies (Austin: University of Texas Press)

Duus, A., and Newell, B. 1977, Ap. J. Suppl., 35, 209

Fairall, A. P. 1983, M.N.R.A.S., 203, 47

Fairall, A. P. 1984, Publ. of the Dep. of Astronomy of the University of Cape Town, n 6.

Huchra, J., and Geller, M. J. 1982, Ap. J., 257, 423

Klemola, A. R. 1969, Astr. J., 74, 804

Lauberts, A. 1982, The ESO/Uppsala Survey of the ESO (B) Atlas, Published by the European Southern Observatory

Rood, H. J. 1982, Ap. J. Suppl., 49, 111

Rose, J.A. 1976, Astr. and Ap. Suppl., 23, 109

Sadler, E. M. 1984, Astr. J., 89, 23

Sandage, A. 1975, Ap. J., 202, 563.

Sersic, J. L. 1974, Ap. Space Sci., 28, 365.

Tonry, J. and Davis, M. 1979, Astr. J., 84, 1511.

L.N. da Costa, M.A. Nunes, P.S. Pellegrini, and C. Willmer: CNPq/Observatório Nacional, Rua Gen. Bruce 586, São Cristóvão 20921 Rio de Janeiro RJ, Brasil.