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The Updated Zwicky Catalog (UZC)[1,2,3]

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ABSTRACT. The Zwicky Catalog of galaxies (ZC), with $m_{Zw} \leq 15.5$, has been the basis for the Center for Astrophysics (CfA) redshift surveys. To date, analyses of the ZC and redshift surveys based on it have relied on heterogeneous sets of galaxy coordinates and redshifts. Here we correct some of the inadequacies of previous catalogs by providing (1) coordinates with $\lesssim 2''$ errors for all of the 19,369 catalog galaxies, (2) homogeneously estimated redshifts for the majority (98%) of the data taken at the CfA (14,632 spectra), and (3) an estimate of the remaining "blunder" rate for both the CfA redshifts and for those compiled from the literature. For the reanalyzed CfA data we include a calibrated, uniformly determined error and an indication of the presence of emission lines in each spectrum. We provide redshifts for 7257 galaxies in the CfA2 redshift survey not previously published; for another 5625 CfA redshifts we list the remeasured or uniformly rereduced value. Among our new measurements, 1807 are members of UZC "multiplets" associated with the original Zwicky catalog position in the coordinate range where the catalog is 98% complete. These multiplets provide new candidates for examination of tidal interactions among galaxies. All of the new redshifts correspond to UZC galaxies with properties recorded in the CfA redshift compilation known as ZCAT. About 1000 of our new measurements were motivated either by inadequate signal-to-noise in the original spectrum or by an ambiguous identification of the galaxy associated with a ZCAT redshift. The redshift catalog we include here is $\sim$96% complete to $m_{Zw} \leq 15.5$ and $\sim$98% complete (12,925 galaxies out of a total of 13,150) for the right ascension ranges $20^h \geq \alpha_{1950} \leq 4^h$ and $8^h \geq \alpha_{1950} \leq 17^h$ and declination range $-2\overset{\circ}{.}5 \leq \delta_{1950} \leq 50^\circ$. This more complete region includes all of the CfA2 survey as analyzed to date. The Great Wall structure persists throughout the northern survey region.

1. INTRODUCTION

During the last 15 years, wide-angle redshift surveys of the nearby universe have provided a basis for statistical characterization of the local large-scale structure of the universe. The CfA (Huchra, Vogeley, & Geller 1998; Huchra, Geller, & Corwin 1995; Geller & Huchra 1989; Huchra et al. 1990; Huchra et al. 1983; Davis et al. 1982) and SSRS surveys (da Costa et al. 1988, 1994a) cover more than a third of the sky and reach to a limiting apparent magnitude $m_B \sim 15.5$.

There is a rich literature analyzing these surveys to extract, for example, the galaxy luminosity function (Marzke & da Costa 1997; Marzke, Huchra, & Geller 1994), the power spectrum for the galaxy distribution (da Costa et al. 1994b; Marzke et al. 1995; Park et al. 1994), and the velocity moments (Marzke et al. 1994). One factor limiting these analyses is the inhomogeneous nature of the databases. Here we take a step toward remedying that situation for the CfA surveys, which are based on the ZC (Zwicky et al. 1961, 1965; Zwicky & Herzog 1962–1965; Zwicky & Kowal 1968).

Measurement of redshifts for the CfA surveys began in 1978. The ZC provided an obvious and, at that time, seemingly adequate source of positions for galaxies in the northern hemisphere. The accuracy of the Zwicky catalog coordinates (3′ at the 3 σ confidence level) was comparable with the typical pointing accuracy of the Tillinghast Reflector on Mount Hopkins, the workhorse for the CfA surveys. Nowadays, more comprehensive scientific goals and significantly improved telescope pointing make arcsecond coordinates imperative. Fortunately, the general availability of the digitized POSS plates (DSS; Lasker et al. 1990) enables us to revise the ZC by providing $\sim 2''$ coordinates for each galaxy. Here we provide these coordinates for 19,369 galaxies with $m_{Zw} \leq 15.5$ which we were able to identify unambiguously.

[1] Dedicated to the memory of Jim Peters, whose friendship, skill, and dedication were essential to this work.

[2] This research made use of the NASA/IPAC Extragalactic Database (NED), which is operated by the Jet Propulsion Laboratory, Caltech, under contract with the National Aeronautics and Space Administration.

[3] We have made use in part of finder chart(s) obtained using the Guide Stars Selection System Astrometric Support Program developed at the Space Telescope Science Institute (STScI is operated by the Association of Universities for Research in Astronomy, Inc., for NASA).

The measurement of a redshift for a nearby galaxy is now a rapid, routine process. However, at the start of the CfA surveys, the much slower pace made it seem judicious to accumulate redshifts from the literature. Given the effort required to construct the UZC, it is now clear that it would have been better to remeasure the redshifts to provide a uniform database. Approximately 30% of the redshifts in the catalog we describe here are from the literature; the rest were measured at the CfA. Most of the CfA measurements were made with two very different spectrographs, the Z-machine (Latham 1982) and FAST (Fabricant et al. 1998). We have rereduced all of the Z-machine and FAST data and have determined a uniformly calibrated error (Kurtz & Mink 1998, hereafter KM98).

The UZC contained here includes redshifts for 96% of the galaxies with $m_{Zw} \leq 15.5$ along with ~ 1400 additional redshifts for galaxies within multiplets in the region $20^h \geq \alpha_{1950} \leq 4^h$ and $8^h \geq \alpha_{1950} \leq 17^h$, both for $-2\overset{\circ}{.}5 \leq \delta_{1950} \leq 50^\circ$ (where our completeness is 98%; hereafter we refer to this region as the CfA2 region). We define UZC multiplets as galaxies with magnitude differences $\Delta m < 0.5$ mag and positional differences $\Delta\theta < 3'$. The catalog is suitable for a wide range of statistical analyses.

Section 2 describes the contents of the original Zwicky-Nilson merged catalog (ZNCAT). Section 3 describes the ZCAT compilation. Section 4 outlines our procedure for matching galaxies in ZNCAT and ZCAT with the *HST* Guide Star catalog (GSC), as a first pass to obtain accurate coordinates, and a subsequent refinement that improved the yield of matched galaxies. Section 5 describes the CfA redshift observations and reduction procedures. Section 6 outlines the procedures we used for blunder identification and for blunder rate evaluation. Section 7 contains the catalog and comments on its possible applications and limitations.

2. THE ZWICKY CATALOG

Our starting point for constructing the UZC is the database of properties of galaxies in the ZC, the Zwicky-Nilson catalog (ZNCAT; Tonry & Davis 1979, hereafter TD79). ZNCAT was created in preparation for the first CfA Redshift Survey (Davis et al. 1982); it covers the entire northern sky and contains the union of CGCG galaxies in the Zwicky catalogs (Zwicky et al. 1961–1968) and UGC galaxies in the Nilson catalog (Nilson 1973). ZNCAT contains position, magnitude, and some morphology entries for 30,813 galaxies. We restrict ourselves to the 18,901 objects with $m_{Zw} \leq 15.5$, the limit where Zwicky estimated that his catalog was complete. The CfA redshift surveys include redshifts for nearly all of the galaxies to this limit over large areas.

Each galaxy in ZNCAT is described by a "Zwicky Number," another catalog label such as NGC or IC, its B1950 coordinates, Zwicky's estimate of its Johnson m_B magnitude, m_{Zw}, and, if known, its morphological type and its position angle on the sky and *B*- and *R*-band diameters in arcseconds. The errors in the galaxy magnitudes are 0.3 mag (Bothun & Cornell 1990; Huchra 1976); the 3 σ error circle for the galaxies has a radius of $\sim 3'$ (Zwicky & Kowal 1968).

3. ZCAT

ZCAT (Huchra et al. 1992) is a compilation of redshift data for galaxies that currently contains approximately 100,000 entries. ZCAT includes positions, redshifts, magnitudes, and types from a variety of sources. We used ZCAT as an initial list of redshifts to construct a complete catalog for part of the northern sky. The coordinates of ~ 9600 objects in ZCAT are identical to the corresponding ones in ZNCAT; thus, ZCAT coordinates are often accurate to only $\sim 3'$ (3 σ). Revised coordinates in ZCAT frequently remain good to $\sim 1'$ (3 σ) at best. There is also possible confusion with neighboring bright galaxies in $\sim 15\%$ of the entries. Such confusion cannot be eliminated without both accurate coordinates and magnitudes (see de Vaucouleurs et al. 1991, hereafter RC3). Without the latter, the only alternative was to determine accurate coordinates as we do here and remeasure redshifts based on these coordinates. We recently began a program of redshift remeasurement; we include the current results of this program in the UZC.

Magnitudes from the ZC in ZCAT are problematic. In the ZCAT compilation, the magnitudes from the original ZC are often replaced with measurements from a multitude of other sources. In cases of "multiplets" defined as for the UZC, ZCAT often contains eye estimates of split magnitudes. For the UZC, we restore the original Zwicky magnitudes m_{Zw} because they are the only system uniformly available for all of the galaxies and because they determined the original selection of galaxies for inclusion in the CfA surveys. In the catalog, we flag these multiples; the split magnitudes are available for reference in ZCAT (Huchra et al. 1992). The arcsecond coordinates we provide make it easy to measure and/or include better magnitudes if more reliable sources of photometry are available (see also RC3).

In using the UZC for statistical analyses, it should be noted that the flagged magnitudes of multiplets could be systematically too bright for each galaxy at the coordinates listed in the catalog. A careful reading of Zwicky, Herzog, & Wild (1961) reveals that magnitudes in the Zwicky catalog were not compiled for multiplets in a uniform fashion. In cases where the multiplet is unresolved, the magnitude listed by Zwicky et al. (1961) is probably too bright for any single component. In resolved cases, the listed magnitude may be that for the brightest member alone. In the absence of a clear indication of the procedure of Zwicky et al. (1961),

the safer alternative that we followed was to list only the original Zwicky et al. (1961) magnitude along with the brightest member. Furthermore, ours is not an exhaustive catalog of multiplets: those listed in the UZC were included because the magnitudes (m_{Zw}) of the components differed by less than ~ 0.5 mag. However, the UZC is a source for further searches for and statistical studies of multiplets.

4. MATCHING CATALOGS TO OBTAIN ARCSECOND POSITIONS

We compared the positions of galaxies in ZNCAT and ZCAT with an independent source of accurate coordinates, the *HST* Guide Star Catalog (GSC). The GSC contains coordinates for stars and for extended objects ("nonstars"). Typical accuracies for all GSC coordinates are $\sim 1''$. However, the main focus of the GSC was on $V < 14$ mag stars. Thus, the magnitudes and identifications of galaxies are less reliable than for the stars (see, e.g., Lasker et al. 1990; Alonso, da Costa, & Pellegrini 1993; Alonso et al. 1994). With these limitations in mind, we selected objects from the GSC that match the positions of the objects in ZNCAT.

We matched GSC and ZNCAT positions with software written for this task. From a list of ZNCAT and GSC coordinates, we calculated the Cartesian distance on the sky between objects in ZNCAT and in the GSC and searched for matches within a $6' \times 6'$ box centered on each ZNCAT position; we found 19,878 matches. Out of these, 1854 were duplicates due to overlaps of the digitized sky survey plates, for a total of 18,024 nonduplicate matches.

We made $6' \times 6'$ finding charts extracted from the DSS, centered on each original ZNCAT position. Our software classified these charts as follows:

Class Z.—A GSC class 3 (a "nonstar") object appears within a $6' \times 6'$ box centered on the Zwicky position. For the 16,268 fields in this category, there is a high likelihood that each GSC object is the Zwicky galaxy.

Class N.—No GSC class 3 object appears within $6' \times 6'$ box centered on the Zwicky position, but one GSC class 0 object (a "star") is within the box. For the 3363 fields in this category, the object nearest the Zwicky position is probably a star in the GSC.

Class B.—No GSC object of any class appears within the $6' \times 6'$ box centered on the Zwicky position. There are 247 fields in this category. Here, either through an error in the GSC classification, or through an error in the ZNCAT coordinates, there is no obvious candidate galaxy at the ZNCAT position.

We printed DSS finding charts for all the objects in our sample. Charts of type Z and N are centered on the matching GSC coordinates. Charts of type B are centered on the ZNCAT coordinates. To each matched object, we assigned a running index increasing with apparent magnitude. Ordered in this way, objects of similar apparent brightness are sequentially indexed close together. Thus, the visual classification described below remains consistent as a function of decreasing apparent brightness.

We also matched objects in ZCAT and ZNCAT by searching each $6' \times 6'$ coordinate box (centered on each ZNCAT object with $m_{Zw} \leq 15.5$ mag) with corresponding objects in ZCAT (with no restriction on the magnitudes). We found 19,584 matches, a number exceeding our total count (18,024) of matched nonduplicate ZNCAT objects within our magnitude limit. The mismatch occurred because (1) there were multiple matches within our matching box and (2) there were matches with ZCAT objects fainter than our choice of magnitude limit.

Because there are significant errors in both the GSC classification and in the ZNCAT coordinates, we could not be certain that our Z or N-class field classifications corresponded to the actual Zwicky galaxies. However, we had a preliminary ranking of galaxies in order of decreasing likelihood (from Z to N to B) of matching a ZNCAT galaxy. We therefore examined all of the Z, N, and B fields visually, to determine a second classification of the objects. This time-consuming classification substantially improved the likelihood that a matched object in the GSC is actually a ZNCAT galaxy. The new classification consisted of numerical indices 0–4:

Code 0.—A "hit," where the GSC and ZNCAT objects are separated in position by $\Delta\theta \leq 180''$, are comparable in brightness as determined visually, and there is no other object within the field that could be a ZC galaxy. Our indexing scheme furnished a qualitative estimate for the range of magnitudes expected for each galaxy, which we used as a guide during the visual inspection. Note that the magnitudes m_{Zw} (B band) and m_{GSC} (V or J bands) can differ significantly, because the expected colors for these galaxies are in the range ~ 0.3–1.0 mag (Frei & Gunn 1994).

Code 1.—A "hit" with $\Delta\theta \leq 180''$, again with a GSC brightness in the vicinity of the ZNCAT value. However, the field is centered on a GSC "star" rather than on a "nonstar," but there is only one possible ZC galaxy nearby, within the field. Thus, index 1 merely indicated that the nearest GSC object to the ZCAT coordinates is a star rather than the appropriate galaxy.

Code 2.—A near "hit" with $\Delta\theta \leq 180''$. However, there is confusion because there are at least two galaxies with an estimated spread in magnitudes $|\Delta m|$ within the expected range, either of which could be a ZC galaxy.

Code 3.—Also a near "hit" with $\Delta\theta \leq 180''$ but with $|\Delta m|$ outside the expected range, raising suspicions about the match of the GSC object to the ZC galaxy.

Code 4.—No "hit" at all for $\Delta\theta \leq 180''$; i.e., there is no match for a ZC galaxy.

One of us (B. E.) examined each chart and assigned it a code of 0–4, according to these criteria. Our strategy was to

TABLE 1

SAMPLE UZC CATALOG

R.A. (J2000) Decl. (hhmmss.s ddmmss)	B (mag)	cz (km s^{-1})	Δcz (km s^{-1})	T	U	N	ZNCAT Name	Ref. Code	Ref.	Other Name	UZC Mult.	NED Mult.
130007.3+084155.....	15.2	13893	53	B	0	0	125736+08580	Z		12576+0858		T
130003.5+265353.....	14.7	5898	70	...	0	0	125736+27100		0000	N4892		
130002.1+332613.....	15.2	7253	35	E	0	0	125742+33420	Z	2700	12577+3342		
130004.7+275914.....	15.1	6412	25	A	0	1	125739+28153	F		N4886	*	
130010.5+122900.....	13.3	1516	71	A	0	0	125742+12450	Z	2700	N4880		
125956.4+471221.....	15.5	8696	46	A	0	0	125742+47280	Z		N4901		
130007.8+275838.....	13.0	6502	48	A	0	2	125742+28150	Z		N4889	*	
130013.9+284943.....	15.4	7365	24	A	2	0	125748+29060	F		12578+2906		
130017.5+275720.....	15.0	6848	15	...	0	1	125753+28135		3606	N4898W	*	P
130017.8+281210.....	14.3	8430	48	A	0	0	125753+28281	Z		N4895		
130016.1+361515.....	15.5	8297	47	B	0	0	125754+36310	Z	2700	I4028		
130024.9+134013.....	15.4	2030	40	E	1	0	125754+13570	Z	0625	12579+1357		
130022.0+280250.....	15.5	8153	55	...	0	0	125757+28189		1823	I4026		
130025.6+285206.....	15.4	6812	59	...	0	0	125800+29080		4200	I4032		
130033.2+100748.....	15.1	7169	42	B	0	0	125800+10240	Z		12580+1024		
130029.2+264031.....	15.2	7208	100	...	0	0	125800+26560		1502	12580+2656		
130039.1+023000.....	12.8	936	36	E	0	0	125806+02460	Z	0611	N4900		
130030.8+282047.....	15.1	5998	28	A	0	0	125806+28370	F		N4896		
130033.7+273816.....	15.4	7495	15	E	0	0	125806+27550	F		12581+2755		
130037.7+280329.....	15.1	7840	5	...	0	0	125813+28196		9000	I4040		
130039.7+275528.....	15.2	7505	15	...	0	1	125815+28116		3606	N4906	*	
130039.6+290110.....	14.6	7289	3	...	0	0	125812+29170		0661	I 842		
130042.6+275819.....	15.5	6255	70	...	0	1	125818+28142		0000	I4042	*	
130047.6+154217.....	15.5	6503	49	B	0	0	125818+15590	Z		12583+1559		
130054.5−012048.....	15.2	6813	42	B	0	0	125818−01050	Z	2774	12583−0105		
125956.2+734133.....	14.7	1665	5	...	1	0	125818+73580		2218	12583+7358		
130042.7+362044.....	15.3	8311	52	A	0	0	125824+36370	Z	2700	I4049		
130042.9+371855.....	12.7	4660	43	A	0	0	125824+37350	Z	2700	N4914		
130048.5+280528.....	15.1	6855	15	...	0	1	125824+28215		3606	I4045	*	
130048.7+280931.....	14.6	5879	10	...	0	0	125824+28255		9000	N4907		
130050.0+272420.....	15.5	6629	36	A	0	0	125824+27400	F		12584+2740		
130059.0−000145.....	13.2	1153	44	B	1	0	125824+00140	Z	2700	N4904		
130051.4+280235.....	14.9	8841	70	...	0	2	125827+28186		3900	N4908	*	
130052.0+282159.....	14.9	7665	23	A	2	0	125830+28380	F		12585+2838		
130103.6−015712.....	15.3	1419	10	...	0	0	125830−01420		3000	12585−0142		P
130054.6+280026.....	14.8	5050	30	A	0	1	125829+28165	F		I4051	*	
130055.9+274728.....	13.7	7939	51	A	0	0	125830+28030	Z		N4911		
130055.6+471320.....	15.0	7381	58	A	0	0	125842+47300	Z	2700	N4917		
130029.9+701155.....	15.3			...	2	0	125848+70280			12588+7028		
130106.7+395029.....	15.0	10620	46	A	0	0	125848+40070	Z	2700	12588+4007		
130122.4+071907.....	15.5	13576	59	A	0	0	125848+07350	Z	2774	12588+0735		
130117.5+274834.....	14.9	7344	31	A	2	0	125854+28040	F		N4919		
130124.3+291832.....	14.2	7187	24	A	2	0	125900+29350	F		N4922A		P
130125.1+284038.....	15.3	8775	82	B	0	0	125906+28570	F		12591+2857		
130126.1+275309.....	13.7	5480	31	A	0	1	125900+28080	F		N4921	*	
130116.6+480337.....	15.1	8975	14	E	3	1	125900+48190	F		12590+4819	*	P
130118.3+480332.....	15.1	8888	14	E	3	1	125900+48190	F		12590+4819	*	P
130131.7+275052.....	14.7	5469	31	A	2	1	125906+28060	F		N4923	*	
130141.5+044050.....	15.4	11458	47	B	0	0	125912+04570	Z	2774	12592+0457		
130133.6+290750.....	14.8	7387	25	...	0	0	125912+29240		2315	I 843		

NOTE.—Table 1 is presented in its entirety in the electronic edition of PASP. A portion is shown here for guidance regarding its form and content.

print finding charts in order of increasing magnitude; thus, we always knew the range of brightness being examined.

The visual examination yielded refined, accurate estimates for the appropriate object to match to the ZC coordinates. There were three distinct outcomes:

1. For perfect "hits," there is no doubt that the Zwicky galaxy is matched. The coordinates are those of the matching object in the GSC. We examined our printed DSS finding charts to confirm the match visually. These 12,154 galaxies are in class 0 above.

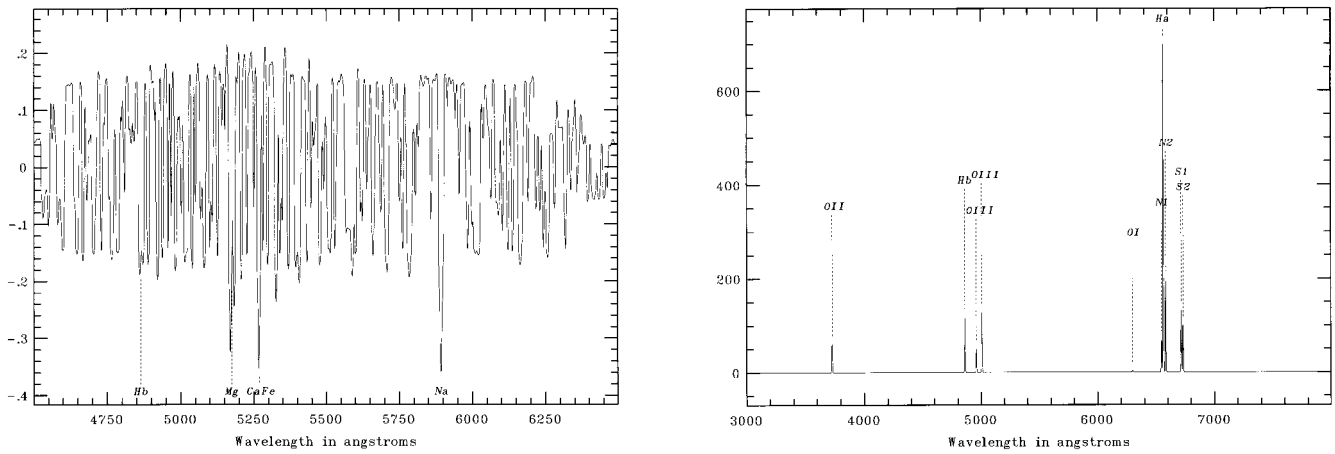

FIG. 1.—(*a*) Absorption template ztemp. Prominent metal and Balmer absorption lines are labeled. The less prominent but prevalent absorption lines in the absorption template are real features. (*b*) Emission template femtemp97. Prominent metal and Balmer emission lines are labeled.

2. For near "hits" in class 1, there is no doubt that we have a match for the ZC galaxy, but the GSC coordinates did not fall within $\sim 2''$ of the center of brightness of the ZC galaxy. One of us (J. P.) confirmed the identification with software that allowed interactive examination of the DSS finding charts for the coordinates of each ZC galaxy. These 2799 galaxies were in class 1 above.

3. For confused "hits" in classes 2–4, there is more than one possible match. In these cases, we have three sources of confusion: (*a*) at least two objects of approximately the expected magnitude lie within the 3′ error circle; (*b*) the nearest match to the ZNCAT position has the wrong magnitude (invariably fainter); and (*c*) the 3′ error circle is empty. We found 4631 galaxies in these classes, leading to a second round of visual examination using software in the WCStools package (Mink 1999). We examined the original finding charts used for the redshift measurements to associate the galaxy with its ZC position and with its measured redshift. When a match was found, the coordinates were determined interactively, with WCStools software. The success rate for this procedure was low, only $\sim 30\%$, because of the nonuniformity of the record keeping and because of poorly marked or missing charts. Furthermore,

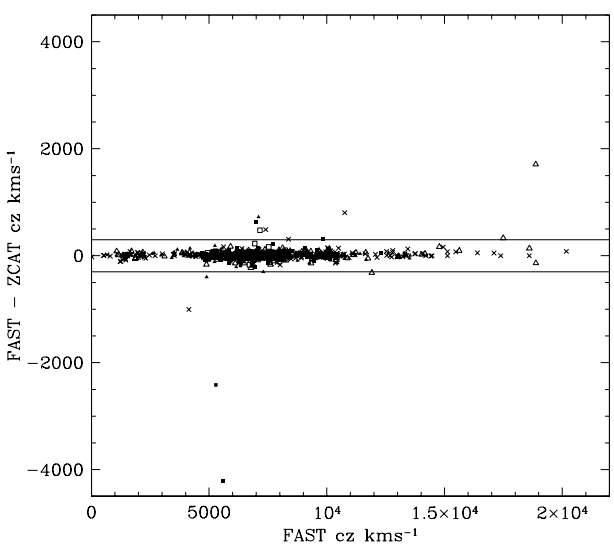

FIG. 2.—Differences between ZCAT and FAST redshifts, plotted as a function of FAST redshift. The symbols are as follows: *open triangles*, Century survey; *filled triangles*, Comparison survey; *open squares*, Mahdavi survey; *filled squares*, Grogin survey; *crosses*, Carter survey. We chose the limits for clarity; therefore, a few "blunders" are outside the plot. Horizontal lines at ± 300 km s^{-1} are intended to guide the eye and provide a comparison across the plot.

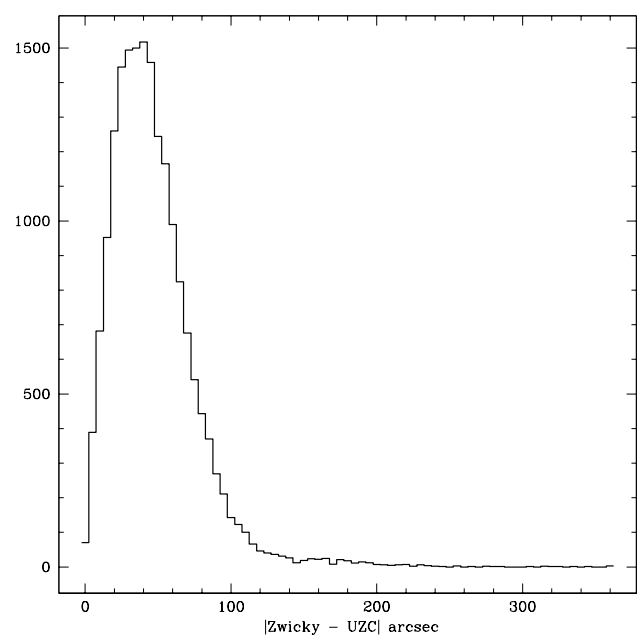

FIG. 3.—Distribution of the absolute value of the differences between UZC and Zwicky coordinates.

TABLE 2

VELOCITY SOURCES FOR THE UZC

ID	Bibliographic Reference
0000.....	de Vaucouleurs, de Vaucouleurs, & Corwin 1976
0001.....	Corwin & Emerson 1982
0002.....	de Vaucouleurs et al. 1991 (RC3)
0004.....	de Vaucouleurs, de Vaucouleurs, & Nieto 1979
0005.....	Kelton 1980
0100.....	Sandage & Tammann 1981
0104.....	Sandage 1976
0105.....	Sandage 1978
0109.....	Binggeli, Sandage, & Tammann 1985
0200.....	Fisher & Tully 1981
0302.....	Huchra & Sargent 1973
0400.....	Rubin et al. 1976a
0402.....	Rubin et al. 1976b
0501.....	Arakelyan, Dibai, & Esipov 1975a
0502.....	Arakelyan, Dibai, & Esipov 1975b
0503.....	Arakelyan, Dibai, & Esipov 1976a
0504.....	Arakelyan, Dibai, & Esipov 1976b
0505.....	Arkhipova & Esipov 1979
0506.....	Arkhipova, Esipov, & Savel'eva 1976
0508.....	Denisyuk & Lipovetskii 1977
0509.....	Denisyuk, Lipovetskii, & Afanasiev 1976
0510.....	Dibai, Doroshenko, & Terebizh 1976
0511.....	Doroshenko & Terebizh 1975
0512.....	Kopylov et al. 1976
0513.....	Markaryan, Lipovetskii, & Stepanyan 1980a
0514.....	Markaryan, Lipovetskii, & Stepanyan 1980b
0515.....	Petrosyan, Saakyan, & Khachikyan 1979
0516.....	Stephanyan 1984
0517.....	Markaryan, Lipovetskii, & Stepanyan 1984a
0521.....	Kazaryan 1987
0522.....	Lipovetskii et al. 1989
0523.....	Kazaryan & Kazaryan 1987
0525.....	Denisyuk & Lipovetskii 1974
0526.....	Arakelyan, Dibai, & Esipov 1972b
0527.....	Arakelyan, Dibai, & Esipov 1972c
0528.....	Arakelyan, Dibai, & Esipov 1970
0529.....	Arakelyan, Dibai, & Esipov 1972
0530.....	Arakelyan, Dibai, & Esipov 1970b
0600.....	Giovanelli & Haynes 1981, private communication
0601.....	Giovanelli & Haynes 1985a
0602.....	Williams & Lynch 1991
0604.....	Chincarini, Giovanelli, & Haynes 1983
0605.....	Haynes & Giovanelli 1991a
0606.....	Gordon & Gottesman 1981
0607.....	Freudling, Martel, & Haynes 1991
0609.....	Krumm & Salpeter 1979
0610.....	Salzer 1992
0611.....	Krumm & Salpeter 1980
0612.....	Helou, Salpeter, & Krumm 1979
0613.....	Peterson 1979
0614.....	Olson 1979, private communication
0615.....	Schombert et al. 1992
0616.....	Williams & Kerr 1981
0617.....	Haynes & Giovanelli 1984
0618.....	Fontanelli 1984
0619.....	Bothun et al. 1985b
0620.....	Giovanardi & Salpeter 1985
0621.....	Scholl & Grayzeck 1984
0622.....	Giovanelli & Haynes 1985

TABLE 2—*Continued*

ID	Bibliographic Reference
0623.....	Bicay & Giovanelli 1986
0624.....	Giovanelli et al. 1986
0625.....	Hoffman et al. 1987
0626.....	Gavazzi 1987
0627.....	Bicay & Giovanelli 1987
0628.....	Jackson et al. 1987
0631.....	Haynes et al. 1988
0633.....	Freudling, Haynes, & Giovanelli 1988
0634.....	Hoffman et al. 1989
0636.....	Sulentic & Arp 1983
0637.....	Eder et al. 1989
0639.....	Schneider et al. 1990
0642.....	Giovanelli & Haynes 1989
0643.....	Lewis, Helou, & Salpeter 1985
0644.....	Lu et al. 1990
0645.....	Mould et al. 1993
0647.....	Freudling, Haynes, & Giovanelli 1992
0649.....	Wegner, Haynes, & Giovanelli 1993
0650.....	Giovanelli & Haynes 1993
0651.....	Lu et al. 1993
0653.....	Hoffman, Lewis, & Salpeter 1995
0654.....	Pantoja et al. 1997
0656.....	Giovanelli, Avera, & Karachentsev 1997
0658.....	Nordgren et al. 1998
0660.....	Binggeli, Popescu, & Tammann 1993
0661.....	Haynes et al. 1997
0662.....	Scodeggio et al. 1995
0802.....	Huchtmeier, & Bohnenstengel 1975
0803.....	Huchtmeier, Tammann, & Wendker 1976
0805.....	Richter, & Huchtmeier 1982
0809.....	Huchtmeier 1997
0810.....	Huchtmeier & Skillman 1998
0811.....	Huchtmeier, Hopp, & Kuhn 1997
0900.....	Knapp 1978, private communication
0902.....	Giovanelli & Haynes 1982
0906.....	Romanishin 1980, private communication
0908.....	Shostak 1978
0909.....	Thonnard et al. 1978
0910.....	Richter & Huchtmeier 1987
0912.....	Tifft & Cocke 1988
0913.....	Haynes & Giovanelli 1991
0923.....	Dickey 1997
0930.....	Schneider et al. 1992
1001.....	Bohuski, Fairall, & Weedman 1978
1009.....	Peterson 1978b
1023.....	Vader & Chaboyer 1992
1032.....	Kirhakos & Steiner 1990
1105.....	Hintzen 1980
1108.....	Kirshner Oemler & Schechter 1978
1109.....	Kirshner 1977
1111.....	Peterson 1978
1114.....	Ulrich 1978
1118.....	Keel 1985
1119.....	Schweizer 1987
1143.....	Willmer et al. 1996
1149.....	Slinglend et al. 1998
1154.....	Owen, Ledlow, & Keel 1995
1155.....	Caldwell & Rose 1997
1203.....	González-Serrano & Valentijn 1991
1207.....	Huchtmeier & Richter 1984

TABLE 2—*Continued*

ID	Bibliographic Reference
1231.....	Richter 1987
1235.....	Schulte-Ladbeck 1988
1243.....	De Grijp, Miley, & Lub 1985
1244.....	Moorwood, Véron-Cetty, & Glass 1987
1261.....	Stickel et al. 1991
1300.....	Davis 1979, private communication
1301.....	Schild & Davis 1979
1502.....	Gregory 1976
1503.....	Gregory & Thompson 1978
1507.....	Hintzen et al. 1983
1514.....	Tarenghi et al. 1979
1516.....	Thompson, Welker, & Gregory 1978
1520.....	Tifft & Gregory 1976
1521.....	Tifft & Gregory 1979
1524.....	Tifft & Gregory 1988
1526.....	Stocke et al. 1987
1528.....	Kailey & Lebofsky 1988
1537.....	Ledlow et al. 1996
1538.....	Pinkney et al. 1993
1602.....	Chincarini & Rood 1972
1604.....	Chincarini & Rood 1976
1605.....	Chincarini & Rood 1977
1606.....	Dickel & Rood 1978
1609.....	Rood & Dickel 1976
1733.....	Caganoff, Bicknell, & Carter 1985
1802.....	Afanasiev et al. 1980
1803.....	Arkhipova et al. 1981
1804.....	Karachentsev 1980
1805.....	Karachentsev & Karachentseva 1981
1806.....	Karachentsev & Karachentseva 1982
1810.....	Karachentsev, Pronik, & Chuvaev 1975
1811.....	Karachentsev, Pronik, & Chuvaev 1976
1814.....	Kostyuk, Karachentsev, & Kopylov 1981
1815.....	Kostyuk & Kopylov 1982
1818.....	Markaryan, Lipovetskii, & Stepanyan 1984b
1819.....	Lipovetskii & Stepanyan 1986
1820.....	Kostyuk 1975
1822.....	Karachentsev 1983
1823.....	Karachentsev & Kopylov 1990
1824.....	Karachentsev 1981
1901.....	Ulrich 1975
1908.....	Wills & Wills 1982
2000.....	Zwicky 1971
2101.....	Eastmond & Abell 1978
2102.....	Faber & Dressler 1977
2109.....	Shuder & Osterbrock 1981
2118.....	Willick, Brodie, & Bowyer 1990
2134.....	Dey, Strauss, & Huchra 1989
2139.....	Martel & Osterbrock 1994
2200.....	Bottinelli, Gouguenheim, & Paturel 1981
2201.....	Balkowski, Chamaraux, & Weliachew 1978
2204.....	Bottinelli, Gouguenheim, & Paturel 1980
2205.....	Bottinelli, Gouguenheim, & Paturel 1982
2208.....	Chamaraux 1987–1988, private communication
2210.....	Hamabe et al. 1988
2212.....	Bottinelli et al. 1990
2214.....	Garcia et al. 1994
2216.....	Tamazian, Theureau, & Coudreau-Durand 1997
2218.....	Theureau et al. 1998

TABLE 2—*Continued*

ID	Bibliographic Reference
2306.....	Leech et al. 1988
2308.....	Lawrence et al. 1989
2315.....	Lucey et al. 1991
2324.....	Smith et al. 1997
2334.....	Clements et al. 1996
2407.....	Karachentsev, Sargent, & Zimmerman 1979
2408.....	Kent 1978
2411.....	Kunth & Sargent 1979a
2412.....	Kunth & Sargent 1979b
2417.....	Sulentic 1980
2422.....	Kirshner et al. 1987
2430.....	Sargent 1968
2443.....	Sargent 1970
2449.....	Small, Sargent, & Hamilton 1997
2452.....	Dale et al. 1998
2454.....	Dale et al. 1997
2457.....	Schweizer 1996
2600.....	Allen & Shostak 1979
2602.....	Shostak & Allen 1980
2605.....	van Driel & van Woerden 1989
2606.....	Bosma, van der Hulst, & Sullivan 1977
2607.....	Bosma, van der Hulst, & Athanassoula 1988
2608.....	van Driel, Davies, & Appleton 1988
2609.....	Kamphuis, Sijbring, & van Albada 1996
2700.....	Huchra et al. 1983
2706.....	Elvis et al. 1981
2707.....	Huchra, Wyatt, & Davis 1982
2709.....	Schwartz et al. 1980
2710.....	Shectman, Stefanick, & Latham 1983
2712.....	White et al. 1982
2714.....	Bothun et al. 1983
2715.....	Geller et al. 1984
2716.....	Huchra & Brodie 1984
2717.....	Beers et al. 1984
2718.....	Huchra et al. 1985
2720.....	Foltz & Chaffee 1987
2722.....	Fabricant et al. 1986
2724.....	Smith et al. 1987
2725.....	Chapman, Geller, & Huchra 1987a
2728.....	Chapman, Geller, & Huchra 1987b
2729.....	Strauss & Huchra 1988
2731.....	Zabludoff, Huchra, & Geller 1990
2732.....	Michel & Huchra 1988
2733.....	Ostriker et al. 1988
2734.....	Fabricant, Kent, & Kurtz 1989
2736.....	Huchra et al. 1990
2740.....	Rawlings, Eales, & Warren 1990
2743.....	Beers et al. 1991
2748.....	Hickson et al. 1992
2754.....	Strauss et al. 1992
2755.....	Beers et al. 1992
2760.....	Zabludoff et al. 1993
2761.....	Dell'Antonio, Geller, & Fabricant 1994
2762.....	Huchra et al. 1993
2764.....	Beers et al. 1995
2765.....	Fisher et al. 1995
2766.....	Marzke, Huchra, & Geller 1996
2767.....	Ramella et al. 1995
2769.....	Barmby & Huchra 1998

TABLE 2—*Continued*

ID	Bibliographic Reference
2773.....	Hughes & Birkinshaw 1998
2774.....	Grogin, Geller, & Huchra 1998
2777.....	Barton, de Carvalho, & Geller 1998
2802.....	Staveley-Smith, Davies, & Kinman 1992
2812.....	Hurley 1988, private communication
2813.....	Axon 1988
3000.....	Thuan & Seitzer 1979
3114.....	Metcalfe 1989
3118.....	Fairall et al. 1992
3200.....	Bothun et al. 1985
3200.....	Bothun 1981
3201.....	Heckman, Balick, & Sullivan 1978
3203.....	Sullivan et al. 1981
3300.....	Rood 1981, private communication
3501.....	Barbieri et al. 1979
3502.....	Merighi et al. 1991
3505.....	Malamuth & Kriss 1986
3506.....	Quintana et al. 1985
3507.....	Vennik & Kaazik 1985
3508.....	Proust et al. 1987
3509.....	Focardi, Marano, & Vettolani 1986
3517.....	Kulessa & Lyndon-Bell 1992
3520.....	Stickel & Kuhr 1993
3527.....	Davoust & Considère 1995
3528.....	Di Nella et al. 1995
3542.....	Impey et al. 1996
3601.....	Barbon et al. 1982
3604.....	Davis, Sargent, & Tonry 1989, private communication
3606.....	Davies et al. 1987
3608.....	Augarde et al. 1987
3611.....	Dressler & Shectman 1988
3624.....	Zaritsky et al. 1997
3700.....	Palumbo, Tanzella-Nitti, & Vettolani 1983
3800.....	Huchtmeier & Richter 1989
3900.....	da Costa et al. 1984
3905.....	da Costa et al. 1988
4001.....	Bothun et al. 1989
4002.....	Salzer MacAlpine & Boroson 1989
4005.....	Fabricant et al. 1993
4007.....	Mohr, Geller, & Wegner 1996
4105.....	Hill et al. 1988
4200.....	Wegner et al. 1990
4201.....	Wegner, Haynes, & Giovanelli 1993
4300.....	Davis & Strauss 1990, private communication
4302.....	Strauss et al. 1992
4701.....	Lawrence et al. 1994
4730.....	Paturel et al. 1989
4900.....	Bothun & Mould 1992, private communication
5011.....	Hardin & Benetti 1997
5502.....	Bottinelli et al. 1993
5507.....	Lanzetta, Webb, & Barcons 1996
5510.....	Veron-Cetty & Véron 1993
5511.....	Augarde et al. 1994
5519.....	Ebeling, Mendes de Oliveira, & White 1995
5521.....	Jorgensen, Franx, & Kjaergaard 1995
5523.....	Vettolani et al. 1998
5600.....	The NED Team 1998
9000.....	Casoli et al. 1996

we found many cases ($\sim$20% of the charts we examined) in which the redshift in ZCAT did not match the entry on the finding chart.

The total number of galaxies in classes 0–4 matches the total count of 19,584. At this stage we eliminated duplicates and thus pared the total number of entries to the number of unique ZNCAT galaxies. This total number is the count of galaxies in ZNCAT with nonzero magnitudes after eliminating (1) a small number of duplicate entries; (2) 19 entries for which no clear galaxy was found within 30′ of the Zwicky position; and (3) the matches for 063024+44480 (NGC 2242), a known planetary nebula, and for 065012+16590, a known open cluster, both of which were mistakenly included in the ZC. The completeness values reported above are slightly higher if we take into account the ZC entries that we eliminated.

5. REDSHIFTS IN THE UZC

The redshifts and errors listed for CfA data here take precedence over values published previously, including those measured with the Z-machine. All the CfA redshifts in the UZC were determined from observations made at Mount Hopkins with the MMT, or with the Z-machine or FAST spectrographs on the 1.5 m Tillinghast reflector at the Whipple Observatory.

We include in the UZC 4465 redshifts measured with FAST. Of these, 1905 are previously unpublished redshifts in the CfA2 region, and the rest are in the remaining regions of the northern sky, as well as remeasurements. About 1000 of the remeasurements were necessary in cases where there was ambiguity in the identification of unresolved galaxies even after looking at historical records. Our source of UZC redshifts from the literature was ZCAT; about 25% of the redshifts in ZCAT were compiled from the literature. In the CfA2 survey region, CfA measurements make a slightly larger contribution, with 1.4% of the redshifts from the MMT, 61% from the Z-machine and 17% from FAST.

The Z-machine (Latham 1982) measurements were made between 1978 and 1993. For these observations, a 600 lines mm^{-1} grating yielded a resolution of 5 Å in first order over the wavelength range 4500–7100 Å. The typical integration time for each object was 15–50 minutes. In 1993, the FAST spectrograph (Fabricant et al. 1998) was first mounted on the 1.5 m Tillinghast. The FAST spectra have 6 Å resolution and coverage of 3700–7500 Å. Typical integration times were 3–10 minutes.

For our FAST observations, when there was more than one galaxy near the ZNCAT position and within $\sim$0.5 mag of the original Zwicky magnitude, we measured redshifts for all of the galaxies. We began the observing program in 1996 September and completed it in 1997 October. All of these new redshift measurements are included in the UZC (see

Table 1). We also updated the coordinates of all of these remeasured galaxies, using the DSS finding charts, with an estimated positional uncertainty of $\sim 2''$. FAST measurements (from our own and from other projects) replaced any previously measured redshifts, e.g., with the Z-machine, in the UZC.

6. RELIABILITY OF THE REDSHIFTS IN THE UZC

In many cases where the GSC galaxy is an unambiguous match to ZNCAT, we checked our DSS finding charts against those used for the CfA Redshift Survey. We corrected obvious typos found in this way. This procedure underscored our awareness of inadequacies in the reduction and record keeping, and spurred us to make an objective *measurement* of the error rate in redshifts from the literature and from our own facilities by remeasuring redshifts for a significant number of objects chosen with a variety of criteria.

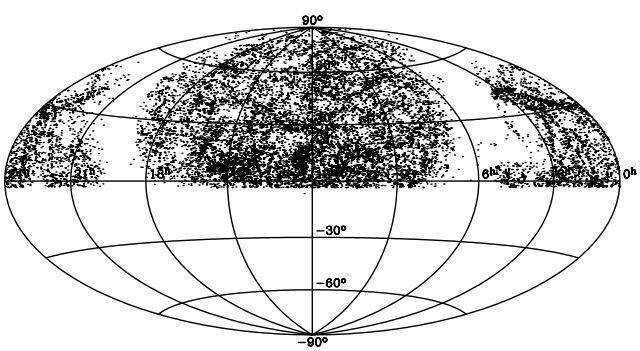

FIG. 4.—Distribution on the sky of the UZC galaxies. The Galactic plane appears as an empty band.

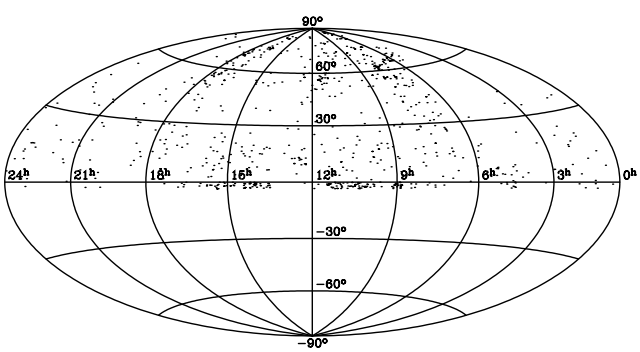

FIG. 5.—Distribution on the sky of Zwicky galaxies without measured redshifts in the UZC.

We first used our current archive of repeat measurements with FAST to estimate the error rate in these new data. For 620 pairs of FAST measurements, there were no blunders (KM98). Thus, we only have an upper limit of $\sim 0.2\%$ for the error rate, which is attributable to the much better pointing of the Tillinghast 1.5 m, much improved observing protocols, and better record keeping and archiving procedures. We are thus confident that for the FAST redshifts in the UZC, the blunder rate is essentially zero.

We reduced the 4366 FAST spectra of galaxies in our sample in a uniform manner, using the IRAF task **rvsao** (KM98). All spectra were cross-correlated with two templates, fabtemp97, a composite absorption line spectrum (KM98), which is generally used for all FAST redshifts, and femtemp97, a synthetic emission line template (KM98). We estimated the errors for our FAST spectra as in KM98: the values are obtained by dividing a constant by $1 + R$ (R values are a measure of the quality of fit of a template and of S/N for the spectra, see TD79 and KM98), and adding $20/\sqrt{2}$ km s^{-1} in quadrature. For fabtemp97 the constant is 350 km s^{-1}, and for femtemp97 the constant is 220 km s^{-1}. These constants were selected from Figures 10 and 12 of KM98, to optimize the contributions of statistical and systematic errors from cross-correlation with each template. We required $R > 3$ for all the redshifts we report here. In cases where the difference for the two templates is less than 300 km s^{-1}, the redshift in Table 1 is the error-weighted combination of the two, as is its error. Of the 4366 spectra, 30 were of insufficient quality, 1872 matched the absorption line template fabtemp97, 692 matched the emission line template femtemp97, and 1772 matched both templates.

We also rereduced the 10,051 Z-machine spectra of the galaxies in our sample in a uniform manner with **rvsao** (KM98). All spectra were cross-correlated with the templates ztemp, a composite absorption line spectrum that has been used for all Z-machine redshifts since TD79, and femtemp97. Figure 1 shows spectrograms of ztemp and femtemp97 (compare with Fig. 11 of KM98).

The Z-machine spectra do not have sufficient quality to permit fully automatic reduction; the initial reduction required visual inspection of every spectrum. We compared the new redshifts, obtained by correlation with the absorption and emission line templates, with those from the original reduction; we also checked for sufficient signal to noise, requiring $R > 3$. We accepted a redshift if it fell within 300 km s^{-1} of the original reduction; of the 10,080 Z-machine spectra we accepted 9936. We found that 4424 matched with the absorption line template, ztemp, 2507 matched with the emission line template femtemp97, and 3005 matched both templates. Among the remaining 156 low-S/N spectra (FAST and Z-machine), 125 are in our 98% complete region. These galaxies are flagged in Table 1;

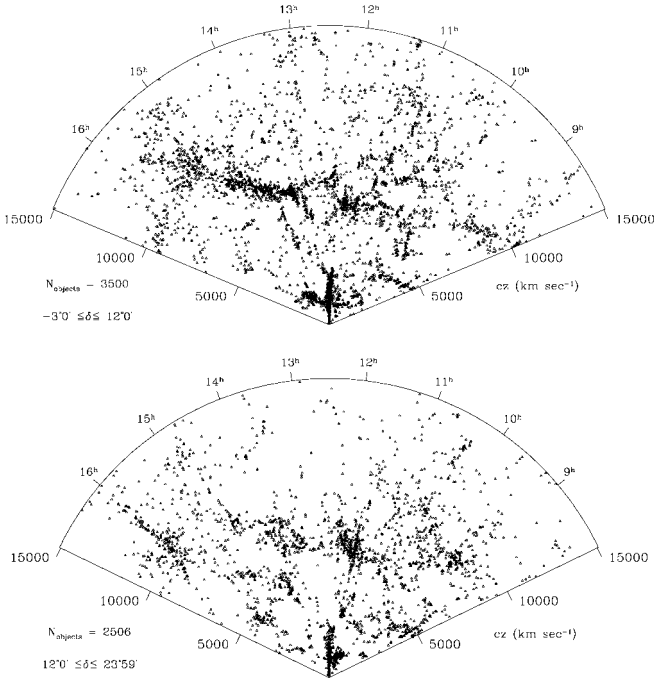

FIG. 6*a*

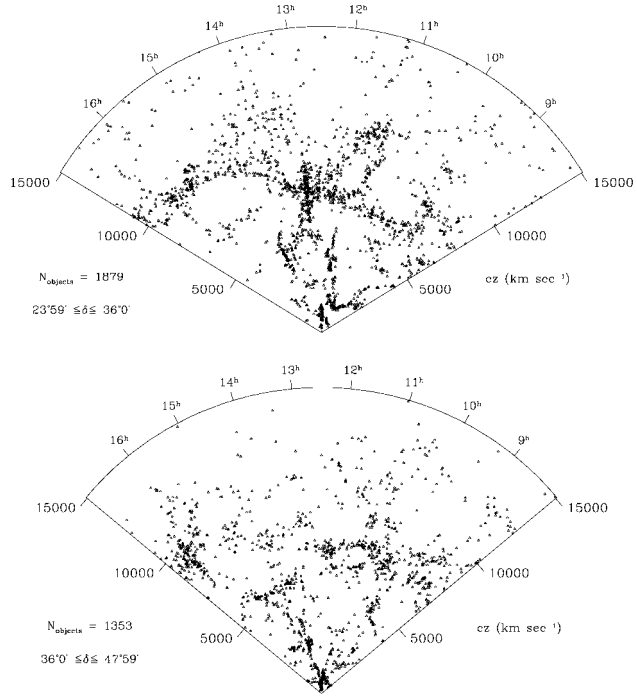

FIG. 6*b*

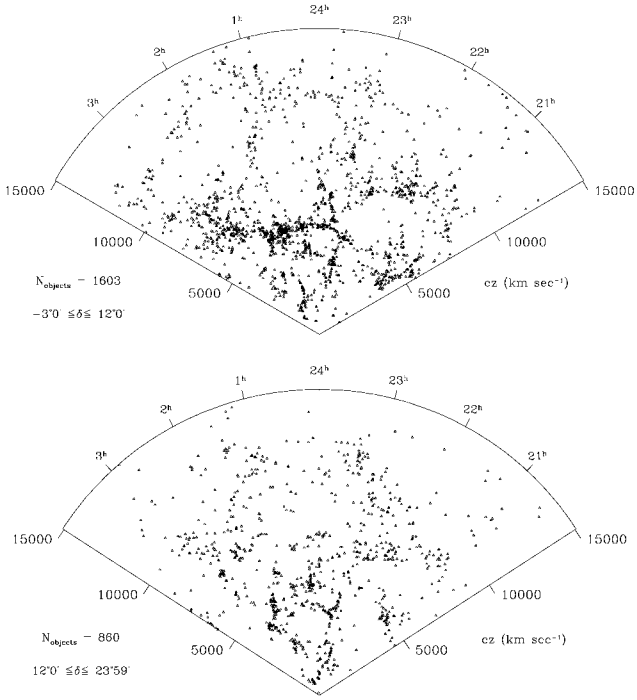

FIG. 6*c*

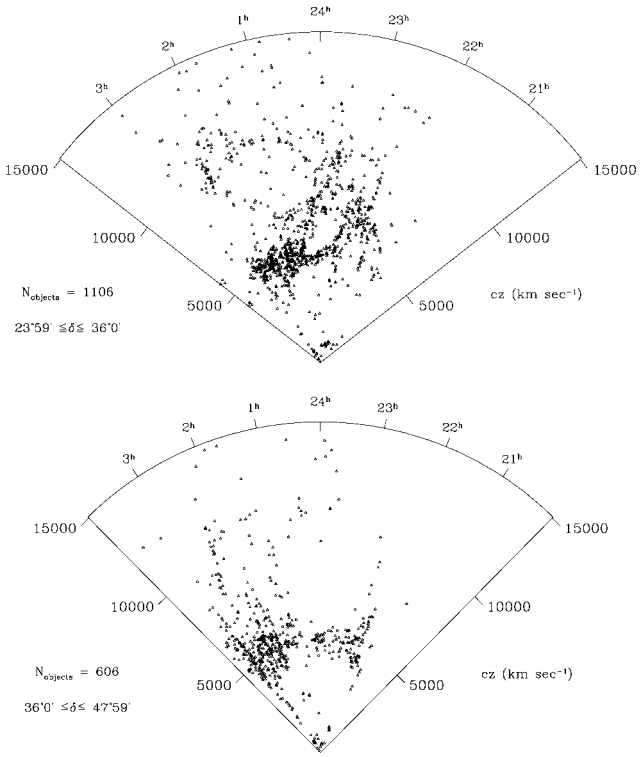

FIG. 6*d*

FIG. 6.—(*a*) Cone diagrams for $8^h \leq \alpha_{1950} \leq 17^h$. Each UZC galaxy is represented by a small triangle. The thickness of each "slice" is $\Delta\delta_{1950} \approx 12°$. (*b*) Cone diagrams for $8^h \leq \alpha_{1950} \leq 17^h$. Each UZC galaxy is represented by a small triangle. The thickness of each "slice" is $\Delta\delta_{1950} \approx 12°$. (*c*) Cone diagrams for $20^h < \alpha \leq 24^h$ and $0^h < \alpha \leq 4^h$. Each UZC galaxy is represented by a small triangle. The thickness of each "slice" is $\Delta\delta_{1950} \approx 12°$. (*d*) Cone diagrams for $20^h < \alpha \leq 24^h$ and $0^h < \alpha \leq 4^h$. Each UZC galaxy is represented by a small triangle. The thickness of each "slice" is $\Delta\delta_{1950} \approx 12°$.

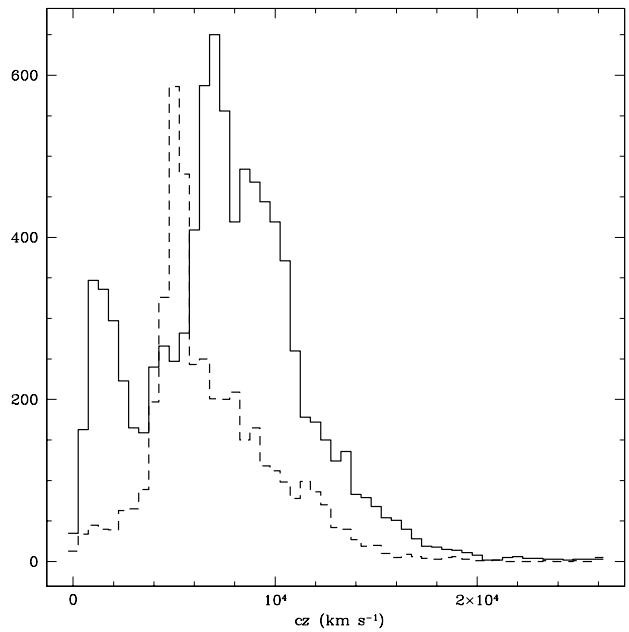

FIG. 7.—Number of galaxies $N(cz)$ per redshift bin for the north (*solid line*) and south (*dashed line*) Galactic hemispheres. Note the prominence of the Great Wall structure at $cz = 7000$–$10{,}000$ km s^{-1}, and of the Virgo cluster at $cz \sim 1000$ km s^{-1}. Perseus-Pisces is also noticeable in the south at $cz \sim 5000$ km s^{-1}. The differences between north and south reflect the inhomogeneities on the scale of these large surveys.

we plan to update their redshifts with FAST.

In the cases where a single template matches the original reduction, the redshift in Table 1 is that obtained from that template, and the error is calculated with the methods outlined in KM98. The table also indicates which template matched best, with a label of A for ztemp, E for femtemp97, and B for both. We calculated the error as for FAST but with appropriate constants, again by dividing a constant by $1 + R$, and adding 35 km s^{-1} in quadrature. For ztemp the constant is 212 km s^{-1}, and for femtemp97 the constant is 140 km s^{-1}; these constants are 3/8 of the median width of correlation peaks where $R > 4$ (KM98). In cases where both templates match the original reduction, the redshift in Table 1 is the error-weighted combination of the two, as is the error. In cases where the match with the original reduction failed, we estimated errors individually to match the system defined by successful cross-correlation. ZCAT contains another 670 low-S/N spectra that would be included in the UZC if their S/N were sufficiently high. Any galaxy that was identified unambiguously but whose redshift remains unknown is entered in Table 1 with accurate coordinates, with nothing in its redshift column. Galaxies for which spectra were obtained at CfA but where the S/N was below our acceptance criterion are flagged in Table 1.

Even after the new measurements for ambiguous cases, the blunder rate in ZCAT is significant for the Z-machine data and for data from the literature. For evaluation of the reliability of redshift measurements including those obtained with the Z-machine and those compiled from the literature, we extracted a random sample of 129 galaxies from ZCAT and remeasured their redshifts with the FAST spectrograph. We also assembled several samples of FAST redshifts acquired for other projects: the Century Survey (106 galaxies: Geller et al. 1997); studies of groups of galaxies (66 galaxies: A. Mahdavi 1998, private communication); galaxies in voids (226 galaxies: Grogin, Geller, & Huchra 1998); and other galaxy surveys (315 galaxies: B. Carter 1998, private communication). The total number of remeasured redshifts is 843. In the UZC, we have replaced the ZCAT redshift with the corresponding FAST measurement in all cases (the number of FAST redshifts discussed above includes these measurements and remeasurements).

For each sample, Figure 2 shows the differences between the FAST measurements of redshifts and the corresponding original ZCAT entry, plotted against the FAST redshifts represented as cz. The "blunder" rate for the overall test sample, as well as for the individual samples, is stable at $\lesssim 3\%$ for measurements not made with FAST. We find the same rate regardless of the origin of the redshift in ZCAT (the literature, or Z-machine for example). An oddly large number of redshifts in ZCAT from the literature differ by 1000 km s^{-1} from FAST measurements (only one of which happened to be included in Fig. 2), making us suspect typographical errors or confusion of Hα (6563 Å) with [N II] (6548 Å, 6584 Å) emission lines as major sources for the discrepancy.

7. DISCUSSION

We have assembled a new version of the Zwicky Catalog (ZC), the Updated Zwicky Catalog (UZC), with a magnitude limit of $m_{Zw} = 15.5$ mag. The UZC is a 98% complete redshift catalog to this magnitude limit, in the CfA2 region with $20^h \geq \alpha_{1950} \leq 4^h$ and $8^h \geq \alpha_{1950} \leq 17^h$ and $-2\overset{\circ}{.}5 \leq \delta_{1950} \leq 50°$. The completeness of the UZC is lower at the northernmost declinations, e.g., if we restrict $\delta_{1950} \geq 50°$, it falls to 90%. The main advantages of the UZC over previous compilations are (1) uniformly accurate coordinates at the $\leq 2''$ level; (2) a robust estimate of the accuracy of the CfA redshifts in the range $cz = 0$–$25{,}000$ km s^{-1}, with a current total of $\sim 25\%$ of redshifts with essentially no "blunders"; (3) an estimate of the reliability of catalog redshifts for data from the literature and from the Z-machine: the remaining 75% of the redshifts have a blunder rate of $\lesssim 3\%$. A continuing problem with the UZC is that magnitudes for the galaxies in the sample are still the original Zwicky magnitudes, which have ~ 0.3 mag errors. Multiples are flagged in the UZC (see Table 1), because we have not split the Zwicky magnitudes of their components. These magnitudes may be systematically too bright for each com-

ponent of an unresolved UZC multiplet (§ 3).

Table 1 contains a sample listing of the UZC. Column (1) ("R.A. (J2000) Decl.") shows the right ascension and declination (J2000) of each galaxy. Column (2) ("B") shows the B-band magnitude m_{Zw} from ZNCAT. Columns (3) ("cz") and (4) ("Δcz") show the heliocentric redshift and its error in km s^{-1}. Column (5) ("T") indicates the type of the redshift for each galaxy, E (emission), A (absorption), or B (both emission and absorption). Column (6) ("U") shows the UZC code (0–4) assigned to each galaxy, according to the quality of the match with DSS galaxies (see § 4). Column (7) ("N") shows the number of UZC neighboring galaxies to the current entry, within 3′. Galaxies in the UZC with a number of neighbors larger than 0 are thus in UZC "multiplet" systems. All entries with $N > 0$ are flagged with a star in Column (12), to indicate membership in a UZC "multiplet." Column (8) ("ZNCAT Name") shows the ZNCAT or Zwicky label; multiplets generally share a single such label. Column (9) ("Ref. code") indicates the origin of the redshift measurement, for data taken at the CfA: Z for Z-machine, M for the MMT, and F for FAST spectra taken for our (other) project(s). The label "X" flags a low-S/N spectrum for Z-machine (FAST) measurements and indicates a low S/N match with a spectrum at $cz < 100$ km s^{-1}, an indication that no redshift could be determined. Column (10) ("Ref.") shows a ZCAT literature reference number (in turn listed in Table 2), or a blank for CfA unpublished data. Column (11) ("Other Name") shows any other name may be associated with the current entry, such as an NGC number, as listed in ZCAT. Column (13) indicates whether the galaxy is a member of a Zwicky multiplet, as reported by NED ("P," "T," and "G" for pairs, triples, and groups, respectively). Because of the size and limited utility of a printed version, the full table is available only with the electronic edition of PASP.[4]

Figure 3 shows the distribution of the magnitude of the differences between UZC and Zwicky coordinates. The mode of the histogram is at $\sim 40''$, slightly better than the 1′ (1 σ) errors claimed by Zwicky. For additional confirmation of our positional accuracy, we matched the FIRST 1.4 GHz catalog (White et al. 1997) with the UZC, using a search radius of 10″. We found matches for 1347 FIRST sources. The distribution of coordinate differences for these sources has a narrow peak at $\sim 1''$, with a width $\sigma = 1''.45$. Thus, for these FIRST matches, the UZC positional uncertainty is less than 1″.5, which confirms the significant improvement in positional accuracy that we have achieved with the UZC.

Figure 4 shows the sky distribution of UZC galaxies with measured redshifts, as listed in Table 1. The UZC covers only the northern sky; regions devoid of galaxies result from obscuration by the Milky Way. Figure 5 shows the sky distribution of galaxies without measured redshifts, also as listed in Table 1. A comparison of Figures 4 and 5 shows that there are no significant patterns in the distribution of galaxies without measured redshifts, other than, e.g., those north of $+50°$ and south of the equator, with a known lack of coverage. Figure 6 shows cone diagrams for the distribution of galaxies in the UZC as a function of α, δ, and cz in km s^{-1}. Each "slice" spans $\sim 10°$ of declination and right ascension ranges of 8^h–17^h in the northern Galactic polar region and 20^h–4^h in the south Galactic cap. These slices cover the CfA2 region of the redshift survey.

The known structure of the distribution of galaxies is readily apparent in these diagrams (Geller & Huchra 1989). The large voids and coherent sheetlike structures appear in adjacent sets of the "slices." Figure 7 shows histograms of the number of galaxies $N(z)$ as a function of redshift for both polar Galactic regions in the UZC. The structure known as the Great Wall (Geller & Huchra 1989) that persists at 7000–10,000 km s^{-1} in each of the 8^h–17^h slices in Figure 6, as well as in Figure 7. The latter figure shows significant peaks at the redshifts of the Great Wall and the Virgo cluster in the north, and at the redshift of Perseus-Pisces in the south Galactic hemisphere. Such peaks confirm the presence of these large-scale structures, and demonstrate their narrowness in redshift space. These in turn are characteristic of the sheetlike structures in Figure 6.

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[4] This table, as well as additional measurements we will carry out with FAST, will also be available at http://tdc-www.harvard.edu.

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