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► **To cite this version:**

Gilles Theureau, N. Coudreau, N. Halle, M. Hanski, L. Alsac, et al.. Kinematics of the local universe : XII. 21-cm line measurements of 586 galaxies with the new Nançay receiver. *Astronomy and Astrophysics - A&A*, 2005, 430 (1), pp.373-383. 10.1051/0004-6361:20047152 . insu-02520415

**HAL Id: insu-02520415**

**<https://insu.hal.science/insu-02520415>**

Submitted on 27 Mar 2020

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## Kinematics of the local universe

### XII. 21-cm line measurements of 586 galaxies with the new Nançay receiver<sup>★</sup>

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Received 27 January 2004 / Accepted 16 August 2004

**Abstract.** This paper presents 586 new 21-cm neutral hydrogen line measurements carried out with the FORT receiver of the meridian transit Nançay radiotelescope in the period July 2000–March 2003. This observational programme is part of a larger project aiming at collecting an exhaustive and magnitude-complete HI extragalactic catalogue for Tully-Fisher applications. It is associated with the building of the MIGALE spectroscopic archive and database.

**Key words.** astronomical data bases: miscellaneous – surveys – galaxies: kinematics and dynamics – radio lines: galaxies

### 1. Introduction

The present paper complements the KLUN<sup>1</sup> data-series (I: Bottinelli et al. 1992; II: Bottinelli et al. 1993; III: di Nella et al. 1996, VII: Theureau et al. 1998) with a collection of HI line measurements acquired with the new Nançay radiotelescope receiver (FORT). This programme has received the label of key project of the instrument and is allocated on average 20% of observing time since the first light in mid 2000.

The input catalogue has been carried out from a compilation of the HYPERLEDA extragalactic database completed by the 2.7 million galaxy catalogue extracted from the DSS (Paturel et al. 2000), and the successive releases of DENIS (DEep Near Infrared Survey, Mamon et al. 2004) and 2MASS (2 Micron All Sky Survey, Jarret et al. 2000) near infrared CCD surveys. The aim of the programme is to build a large all sky sample of spiral galaxies, complete down to well defined magnitude limits in the five photometric bands *B*, *I*, *J*, *H* and *K*, and to allow peculiar velocity mapping of galaxies up to 10 000 km s<sup>-1</sup> in radial velocity, i.e. up to a scale greater than the largest structures of the Local Universe

(Hanski 2003). This programme is unique and complementary to other HI projects such as HIPASS in Parkes (Barnes et al. 2001) which is very shallow and restricted to the very close universe or the future ALFA-project in Arecibo<sup>2</sup> which will cover only a small portion of the sky for the deepest survey. It also complements the Fundamental Plane surveys (6dF<sup>3</sup>, Jones et al. 2004, FP200<sup>4</sup> survey, Hudson et al. 2004) already in progress which are mainly concerned with cluster galaxies and shorter scales (see e.g. Mamon 2000; or Willick 2000). This kind of data is crucial for mapping the total mass distribution and for providing strong constraints on cosmological models and large scale structure formation.

From our 586 HI detections, we extract a high quality subsample of 368 21-cm line profiles suitable for a Tully-Fisher analysis. Adding these to our last general compilation presented in Paturel et al. (2003), we obtain a catalogue of more than 17 200 galaxies having an HI line measurement in the MIGALE/HYPERLEDA database<sup>5</sup>.

The paper is structured as follows: the Nançay radiotelescope and processing chain are briefly presented in Sect. 2. The

<sup>★</sup> Tables 2, 3 and HI-profiles and corresponding comments are only available in electronic form at the CDS via anonymous ftp to [cdsarc.u-strasbg.fr](ftp://cdsarc.u-strasbg.fr) (130.79.128.5) or via <http://cdsweb.u-strasbg.fr/cgi-bin/qcat?J/A+A/430/373>, or directly at our web site <http://klun.obs-nancay.fr>

<sup>1</sup> for Kinematics in the Local Universe.

<sup>2</sup> <http://alfa.naic.edu/>

<sup>3</sup> <http://www.mso.anu.edu.au/6dFGS/>

<sup>4</sup> <http://astro.uwaterloo.ca/~mjhudson/fp200>

<sup>5</sup> Multiparametric virtual instrument to study galaxy evolution; <http://www-obs.univ-lyon1.fr/hypercat/> and <http://www.cai-mama.obspm.fr/migale/>

**Table 1.** Template radio sources; Col. 1: source index; Col. 2: source name; Col. 3: reference for flux measurement; Col. 4: reference flux at 1380 MHz; Col. 5: reference flux at 1420 MHz; Col. 6: object type from Veron et al. (1972) or Kuhr et al. (1981).

	Name	Ref.	1380 MHz	1410 MHz	Object type
1	0023-26	Kuhr et al. (1981)	8.84	8.71	
2	0134+32 3C 48	Baars et al. (1977)	16.12	15.85	quasi-stellar source
3	0237-23	Kuhr et al. (1981)	6.58	6.55	quasi-stellar source
4	0316+16 CTA 21	Kuhr et al. (1981)	8.18	8.09	“empty field”
5	0356+10 3C 98	Kuhr et al. (1981)	12.00	11.82	galaxy
6	0433+29 3C 123	Baars et al. (1977)	49.23	48.41	galaxy
7	0710+11 3C 175	Witzel et al. (1970)	2.59	2.543	quasi-stellar source
8	0809+48 3C 196	Witzel et al. (1970)	14.32	14.08	quasi-stellar source
9	0915-11 3C 218	Baars et al. (1977)	43.62	42.78	galaxy
10	1005+07 3C 237	Kuhr et al. (1981)	6.86	6.731	“empty field”
11	1040+12 3C 245	Kuhr et al. (1981)	3.27	3.23	quasi-stellar source
12	1127-14	Gardner et al. (1975)	6.78	6.76	quasi-stellar source
13	1151-34	Kuhr et al. (1981)	6.68	6.04	quasi-stellar source
14	1245-19	Kuhr et al. (1981)	5.60	5.54	
15	1328+30 3C 286	Baars et al. (1977)	14.94	14.78	quasi-stellar source
16	1409+52 3C 295	Baars et al. (1977)	22.60	22.20	galaxy
17	1425-01 3C 300.1	Witzel et al. (1970)	2.93	2.89	“empty field”
18	1514+07 3C 317	Witzel et al. (1970)	5.50	5.38	galaxy
19	1602-28	Gardner et al. (1975)	2.85	2.77	
20	1641+39 3C 345	Witzel et al. (1970)	6.80	6.77	quasi-stellar source
21	2117+60 3C 430	Witzel et al. (1970)	7.56	7.44	galaxy
22	2203-18	Gardner et al. (1975)	6.74	6.68	quasi-stellar source
23	2314+03 3C 459	Kuhr et al. (1981)	4.64	4.54	galaxy

characteristics of the input catalogue are listed in Sect. 3, the flux calibration is described in Sect. 4 and the data processing is given in Sect. 5.

## 2. Observations

The Nançay radiotelescope (France) is a single dish antenna with a collecting area of 6912 m<sup>2</sup> (200 × 34.56) equivalent to that of a 94 m-diameter parabolic dish. The half-power beam width at 21-cm is 3.6 arcmin (EW) × 22 arcmin (NS) (at zero declination). The minimal system temperature at  $\delta = 15^\circ$  is about 35 K in both horizontal and vertical polarizations. The spectrometer is a 8192-channel autocorrelator offering a maximal bandwidth of 50 MHz. In this mode, and with two banks in vertical and horizontal polarizations counting 4096 channels each, the spacing of the channels corresponds to 2.6 km s<sup>-1</sup> at 21 cm. After boxcar smoothing the final resolution is typically  $\sim 10$  km s<sup>-1</sup>. The 50 MHz bandwidth is centered on  $\sim 1387$  MHz, thus corresponding to an interval of 10 500 km s<sup>-1</sup> centered on a velocity of 7000 km s<sup>-1</sup> (except for the few objects with a radial velocity known to be less than 2000 km s<sup>-1</sup>, for which the observing band was centered on 5000 km s<sup>-1</sup>). The gain of the antenna has been calibrated according to Fouqué et al. (1990); the final HI-fluxes (Table 1)

are calibrated using as templates a set of well-defined radio continuum sources observed each month. Since the exposure time of an object is often spread over several weeks or months, the total integration is also controlled afterwards by using a set of 58 calibrator galaxies observed over a shorter time scale (see Sect. 5.3).

We used the Nançay processing packages NAPS (Nançay Preprocessing Software) and SIR (Système Interactif de Réduction). The former allows us to reduce, calibrate, integrate and clean the series of elementary spectra acquired during one meridian transit. The latter allows us to integrate several meridian transit spectra, to produce the final reduced spectrum, and to extract the useful astrophysical parameters. One “observation” is a series of ON/OFF observational sequences; each sequence is made of ten elementary integrations of 4 s each, plus a set of 3 integrations of 2 s for the calibration, adding up in each cycle to 40 + 6 s for the source and 40 + 6 s for the comparison field (hereafter cf). The cf is taken at exactly the same positions of the focal track as the source in the same cycle. In this way one minimizes efficiently the difference between ON and OFF total power. A typical meridian transit observation lasts about 35 min and is centered on the meridian, where the gain is known to be at its maximum; it contains a series of  $\sim 20$  ON/OFF cycles.

**Table 2.** Astrophysical HI-parameters (excerpt). Column 1: PGC or LEDA galaxy name; Col. 2: most usual galaxy name; Col. 3: J2000 equatorial coordinates; Col. 4: systemic heliocentric radial velocity ( $\text{km s}^{-1}$ ); Col. 5: rms error ( $\text{km s}^{-1}$ ); Col. 6: total line width at 20% of the maximum intensity ( $\text{km s}^{-1}$ ); Col. 7: total corrected line width at 20% ( $\text{km s}^{-1}$ ); Col. 8: rms error ( $\text{km s}^{-1}$ ); Col. 9: total line width at 50% of the maximum intensity ( $\text{km s}^{-1}$ ); Col. 10: total corrected line width at 50% ( $\text{km s}^{-1}$ ); Col. 11: rms error ( $\text{km s}^{-1}$ ); Col. 12: observed HI-flux ( $\text{Jy km s}^{-1}$ ); Col. 13: beam-filling corrected HI-flux ( $\text{Jy km s}^{-1}$ ); Col. 14: rms error ( $\text{Jy km s}^{-1}$ ); Col. 15: signal to noise ratio; Col. 16: quality code (see Sect. 4) Col. 17: flag (“\*” marks a second independent measurement of lower quality, the 21-cm profile is not plotted in Fig. 4).

pgc/leda	Name	RA (2000) Dec	$V_{20}$	$\sigma_V$	$W_{20}$	$W_{20c}$	$\sigma_{W20}$	$W_{50}$	$W_{50c}$	$\sigma_{W50}$	$F(\text{HI})$	$F(\text{HI})_c$	$\sigma_F$	$S/N$	$Q$	dblc
pgc0000040	PGC 000040	J000035.6-014549	7274.	10.	314.	307.	30.	288.	286.	20.	4.91	4.98	1.10	5.2	B	
pgc0000068	ESO 538-017	J000055.3-185733	7679.	21.	269.	262.	62.	215.	213.	41.	1.53	1.54	0.49	3.6	B	
pgc0000287	NGC 7813	J000409.2-115904	9096.	13.	391.	384.	39.	376.	374.	26.	4.92	4.98	1.41	3.0	B	
pgc0000312	PGC 000312	J000505.3-070537	3807.	3.	331.	324.	8.	310.	308.	5.	16.48	16.99	0.99	17.7	A	
pgc0000325	PGC 000325	J000445.8-160151	10092.	19.	293.	286.	57.	204.	202.	38.	4.77	4.92	1.21	5.0	B	
pgc0000367	NGC 7821	J000516.5-162835	7412.	10.	536.	529.	29.	525.	523.	20.	4.85	4.88	1.07	3.4	C	
pgc0000483	NGC 7828	J000626.9-132454	5729.	15.	404.	397.	46.	342.	340.	30.	4.14	4.27	0.76	5.2	C	
pgc0000637	PGC 000637	J000835.8-051301	–	–	–	–	–	–	–	–	–	–	–	–	E	
pgc0000743	PGC 000743	J001036.7-063824	8166.	13.	311.	304.	38.	294.	292.	25.	3.21	3.25	1.03	3.3	B	
pgc0000817	ESO 409-026	J001146.9-300804	7788.	19.	370.	363.	57.	326.	324.	38.	5.86	5.99	1.71	3.5	B	
pgc0000902	PGC 000902	J001334.3-050534	5404.	11.	332.	325.	34.	306.	304.	23.	4.09	4.19	0.92	4.5	A	
pgc0000902	PGC 000902	J001334.3-050534	5398.	9.	392.	385.	26.	371.	369.	17.	5.06	5.18	0.91	5.4	A	*
pgc0000916	PGC 000916	J001347.8-042831	11189.	29.	454.	447.	86.	425.	423.	57.	1.12	1.15	0.57	1.9	E	
pgc0001012	PGC 001012	J001506.8-240542	7705.	25.	396.	389.	75.	363.	361.	50.	3.87	3.90	1.60	2.3	C	
pgc0001022	PGC 001022	J001517.3-062044	7781.	12.	339.	332.	36.	319.	317.	24.	2.55	2.60	0.69	3.8	B	
pgc0001085	NGC 0061B	J001624.4-061922	8152.	20.	362.	355.	61.	360.	358.	41.	0.36	0.37	0.62	0.7	E	
pgc0001149	NGC 0064	J001730.4-064930	7309.	10.	422.	415.	29.	402.	400.	20.	5.64	5.78	1.13	4.6	B	
pgc0001152	PGC001152	J001736.3-043735	6007.	10.	261.	254.	31.	223.	221.	20.	3.64	3.68	0.69	6.1	B	
pgc0001173	ESO 350-007	J001804.6-335229	7383.	26.	604.	597.	77.	593.	591.	51.	8.09	8.30	4.63	1.3	D	
pgc0001206	PGC 001206	J001836.1-061805	6422.	5.	287.	280.	15.	268.	266.	10.	6.24	6.26	0.80	8.6	A	
pgc0001234	IC 0008	J001902.4-031322	6002.	10.	552.	545.	31.	525.	523.	21.	4.52	4.56	0.81	5.0	C	
pgc0001288	PGC 001288	J002000.1-062002	3707.	9.	302.	295.	28.	288.	286.	19.	2.10	2.13	0.70	4.0	C	
pgc0001299	IC 0012	J002015.1-023908	6044.	11.	374.	367.	34.	356.	354.	22.	3.81	3.82	0.93	3.8	B	
pgc0001404	PGC 001404	J002151.1-092932	6269.	7.	333.	326.	21.	321.	319.	14.	3.17	3.18	0.73	4.9	B	
pgc0001453	PGC 001453	J002238.1-240733	9911.	29.	271.	264.	88.	252.	250.	58.	1.86	1.86	1.69	1.5	D	
pgc0001566	UGC 00237	J002459.8+063953	–	–	–	–	–	–	–	–	–	–	–	–	E	
pgc0001606	NGC 0107	J002542.1-081658	6289.	10.	282.	275.	31.	208.	206.	20.	5.92	5.96	0.88	8.5	C	
pgc0001693	NGC 0120	J002730.1-013048	3984.	12.	524.	517.	37.	505.	503.	24.	4.49	4.70	1.08	3.6	C	
pgc0001759	IC 0018	J002835.1-113509	–	–	–	–	–	–	–	–	–	–	–	–	E	
pgc0001833	ESO 410-013	J002955.7-272948	7331.	11.	348.	341.	32.	304.	302.	22.	4.66	4.76	0.84	6.2	B	
pgc0001886	PGC 001886	J003058.8-071258	7817.	8.	399.	392.	24.	387.	385.	16.	4.48	4.52	1.04	4.4	B	
pgc0001995	PGC 001995	J003320.5-095408	10566.	5.	340.	333.	16.	328.	326.	11.	3.38	3.42	0.53	6.6	A	
pgc0002086	PGC 002086	J003502.9-092208	6872.	15.	342.	335.	44.	308.	306.	29.	2.91	2.96	0.72	4.0	B	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

The processing chain consists of selecting good elementary integrations or cycles, masking and interpolating areas in the time-frequency plane, straightening the base-line by a polynomial fit, and applying a boxcar smoothing. The maximum of the line profile is determined by eye as the mean value of the maxima of its two horns after taking into account the medium

noise (estimated in the base-line). The widths, measured at the standard levels of 20% and 50% of that maximum, correspond to the “distance” separating the two external points of the profile at these intensity levels.

The total list of corrected HI-astrophysical parameters (Table 2), 21-cm line profiles (Fig. 4), and comments

**Table 3.** Notes on HI-observations (excerpt). Column 1: PGC or LEDA galaxy name; Col. 2: morphological type as known in HYPERLEDA; Col. 3: isophotal diameter  $D_{25}$  in arcmin; Col. 4: position angle counted from the North ( $pa = 0$ ) toward East between 0 and 180; Col. 5: quality code (see Sect. 2); Col. 6: comments; conf = “HI confusion”, comp = “companion”, cf = “comparison field”, poss = “possible”, w = “with”.

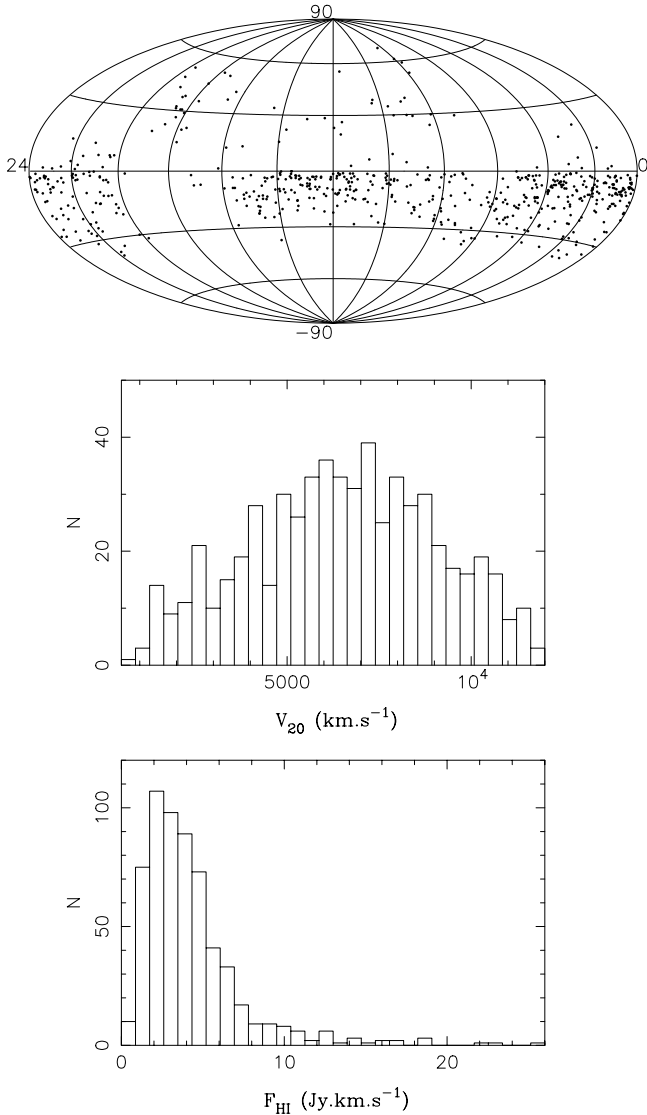
pgc/leda	Morph.	$D_{25}$ (arcmin)	pa (deg)	$Q$	Comments
pgc0000040		0.79	125	B	
pgc0000068	Sc	0.77	10	B	Possibly dbl, comp. not seen in DSS
pgc0000287	Sb	0.78	158	B	Low velocity edge not well defined
pgc0000312	Sb	2.28	75	A	
pgc0000325	SBc	1.36	100	B	
pgc0000367	Sc	1.17	111	C	Disturbed profile, prob dble w p3093868
pgc0000483	Scd	1.38	140	C	Close comp p488 (n7829) at $V = 5694$ , interacting gal.(?)
pgc0000637	Sa	1.10	155	E	Behind interference at $V = 11\,500$
pgc0000743	Sbc	0.90	42	B	
pgc0000817	Scd	1.22	125	B	
pgc0000902	Sb	1.09	170	A	
pgc0000902	Sb	1.09	170	A	
pgc0000916	Sa	0.89	145	E	No detection
pgc0001012	Sb	0.77	110	C	galaxy group, poss conf w ESO473-004 $V = 7644$
pgc0001022		0.93	76	B	
pgc0001085	SO	1.16	0	E	
pgc0001149	SBbc	1.41	30	B+	
pgc0001152	Sc	0.87	142	B	
pgc0001173	SO-a	1.30	90	D	Too noisy baseline and too few integrations
pgc0001206	Sc	0.54	0	A	
pgc0001234	Sc	0.74	128	C	Confused profile, p1228 (E?) at $V = 6186$ , p1076207 also in beam
pgc0001288	Sab	1.52	35	C	
pgc0001299	Sab	0.81	19	B	
pgc0001404	Sc	1.02	156	B	
pgc0001453		0.22	0	D	
pgc0001566	SBa	0.99	70	E	
pgc0001606	Sbc	0.79	25	C	Poss conf w pgc143534
pgc0001693	SO	1.52	73	C	
pgc0001759	SBb	1.44	15	E	Conf w pgc0001762?
pgc0001833	Sb	1.04	82	B	
pgc0001886	Sb	1.11	32	B	
pgc0001995		0.89	69	A	
pgc0002086	S?	0.84	35	B	
...	...	...	...	...	...

concerning the profiles (Table 3), are available in electronic form at the CDS. As an example, the first page of each are presented at the end of this paper.

### 3. Sample characteristics and input catalogue selection

The **KLUN+** sample has been collected and selected on the basis of the whole sky photometrical surveys **DENIS** ( $I$ ,  $J$  and  $K$  bands, 95% of the southern sky), **DSS** ( $B$  band, whole sky), and **2-MASS** ( $J$ ,  $H$  and  $K$  bands, whole sky). Basically,

we chose as a reference the completeness of the DENIS survey in the  $I$ -band, that is  $I = 14$  mag for a very conservative magnitude limit. From the observed mean color indexes of spiral galaxies, we determined equivalent flux limits in the other bands, giving  $J \leq 13.7$ ,  $H \leq 13.0$  and  $K \leq 12.7$ . We also restricted the sample according to axis ratios ( $R = \frac{a_{25}}{b_{25}}$ ), eliminating both face-on galaxies ( $\log R \leq 0.15$ ) and very edge-on objects ( $\log R \geq 0.48$ ) to avoid the largest relative errors on the maximum of rotation velocity  $\log V_m$  (deduced from 21-cm line widths), in particular through large uncertainties on inclinations, which are generally calculated from axis



**Fig. 1.** Aitoff projection of the observed sample in J2000 equatorial coordinates, histogram of radial velocities  $V_{20}$  and HI fluxes (see Table 2).

ratios and morphological type. The remaining 48 422 selected objects have been inspected by eye on DSS images in order to keep only fair spiral galaxies (this morphological information will be published elsewhere). The HI survey was designed to observe a range of radial velocities of  $1800\text{--}12\,300\text{ km s}^{-1}$  and an extra cut-off in redshift is applied afterwards. Taking into account that the Nançay RT field of view is limited to declinations greater than  $-40$  degrees, thus to 83% of the sky, we are left with a sample of  $\sim 10\,000$  spiral galaxies among which  $\sim 4100$  already have an HI measurement from the literature and our previous programmes.

In the first two years of observations, we have observed 1528 galaxies, detected 870 of them and fully reduced 682 HI profiles. We present here the spectra obtained for 758 of these observed galaxies. The majority of the objects observed are in the range  $(-30^\circ, +0^\circ)$  in declination, favouring galaxies having an *I*-band magnitude in DENIS and thus also the declination range unreachable by Arecibo.

#### 4. Flux calibration

The way the calibration is performed is the following: pass-band filter data are acquired simultaneously with the spectra and are digitalized with a 12-bit converter so that the fluxes are first all expressed in bits ( $\text{bit}_{\text{fil}}$ ). Each series of 10 integrations (ON or OFF) starts with a calibration phase counting three measurements: one with the noise diode switched off and two with the noise diode on. All are done through the filter. From the former is derived the system temperature ( $T_{\text{sys}}$ ), from the average of the two latter, one gets the deviation of the noise diode  $\Delta\text{ND}$ . The noise diode deviation in Jy, for a given filter, wavelength and polarization, is controlled and measured regularly using as templates a set of well-defined radio continuum sources. The corresponding data are stored in a calibration table available to all instrument users.

The final spectrum in Jy is given by:

$$\text{spectrum}(\text{Jy}) = S_{\text{autocor}} \times \frac{T_{\text{sys}}(\text{bit}_{\text{fil}})}{\Delta\text{ND}(\text{bit}_{\text{fil}})} \times \Delta\text{ND}(\text{Jy})$$

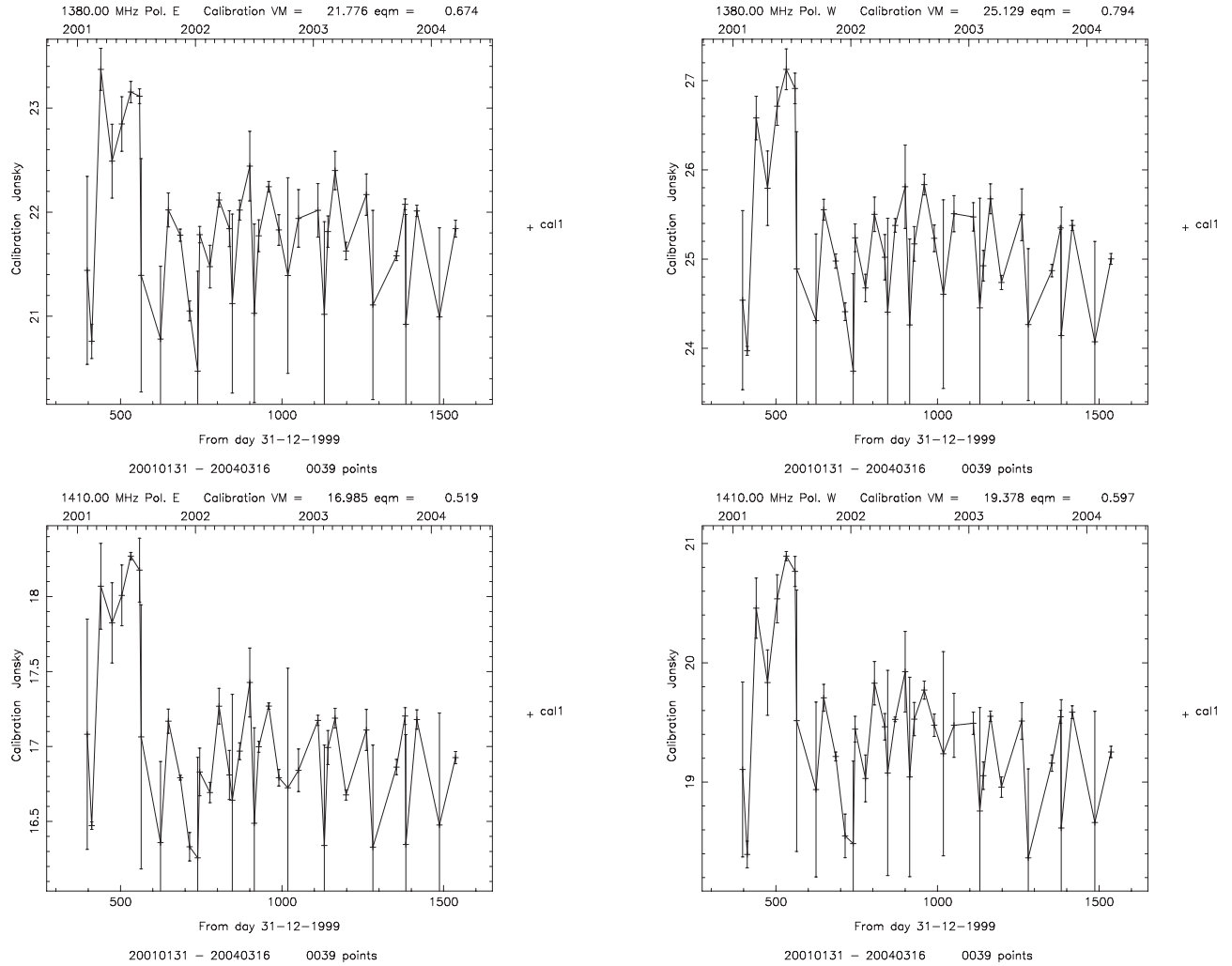
$S_{\text{autocor}}$  is the normalized spectrum corresponding either to one ON or one OFF elementary integration (the spectrum is normalized by its own total power; in practice it is obtained by Fourier Transform (FFT) using a normalized autocorrelation function), and the term  $\Delta\text{ND}(\text{Jy})$  is taken from the instrument calibration table using the closest date of measurement. The advantage of this method is to provide conditions for a robust FFT estimation.

We show in Table 1 the 23 template sources used for the absolute calibration. These sources are point-like and either QSOs or radiogalaxies. Their flux at various wavelength or polarization is directly taken from the cited publication or eventually interpolated from it. In practice, the full set of templates is observed every 3 months over 16 frequencies spread between 1250 MHz and 3349 MHz and over 4 polarizations. One source, 3C123, is observed each month in the above conditions. The fluxes are obtained by drift scans, always within an interval of  $\pm 25$  m around the meridian. The maximum of intensity is obtained by a Gaussian fit and is compared to the reference table after correcting for the gain curve (as a function of declination, see Fig. 3). Figure 2 shows the mean value of the template's fluxes as a function of time (on the bottom horizontal axis, the number of days after January 31st 2001).

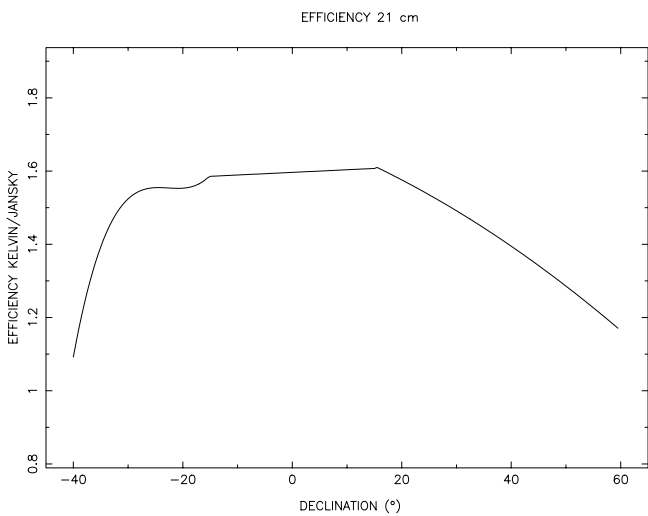
#### 5. Data description

Table 2 contains all the reduced HI parameters. Table 3 provides corresponding comments, when necessary, for each galaxy. As in Paturel et al. (2003), we have chosen to classify the spectra and the extracted data according to their quality. We define five classes as follows:

- A: high quality spectrum, high signal to noise and well defined HI profile.
- B: good signal to noise ratio, line border well defined, still suitable for Tully-Fisher applications.
- C: low signal to noise, noisy or asymmetrical profile, well detected but one should not trust the line width. The radial velocity is perfectly determined.



**Fig. 2.** Summary of template radio source flux measurement in period 2001–2002. The four panels show the mean value of the observed fluxes for the 23 templates as a function of date for two frequencies (1380 MHz and 1410 MHz) and two polarization (E and W).



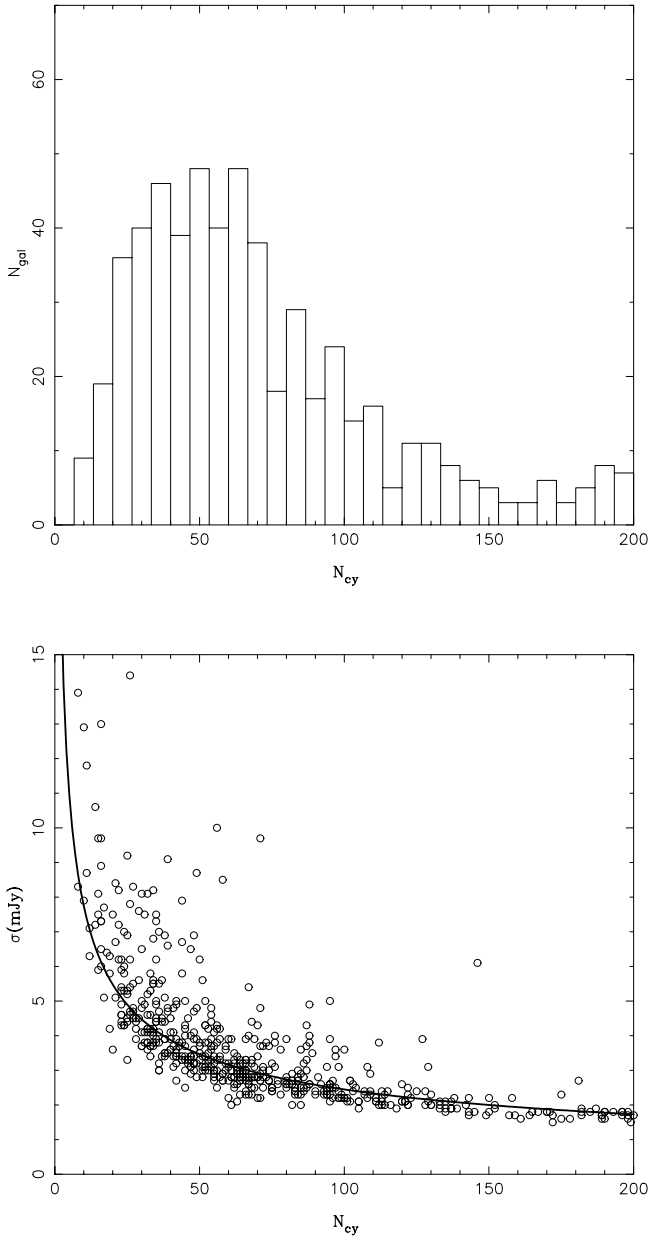
**Fig. 3.** Gain curve of the antenna as a function of declination.

– D: low signal to noise, noisy profile at the limit of detection. Probably detected, but even radial velocity could be doubtful.

– E: not detected. When “no detection” is stated, the line was expected to fall within the observed frequency band and the value of the noise gives a fair upper limit for the HI signal.

We present in Table 1 the results of the observations concerning a total of 758 galaxies, among which 586 have been successfully detected at 21-cm, in the frequency band we were sampling. The absence of detection, corresponding to the “E” code in the notes, is due to several possible reasons: either the object was too faint in HI to be detected within a reasonable integration time (120 full ON/OFF cycles, equivalent to 3 meridian transit), which is probably the major case, or we did not know its radial velocity and it fell outside the frequency range, or the HI line was always behind a radar emission or an interference... Among the detected objects, 46 were assigned to the “D” class, 172 to the “C” class, and respectively 220 and 148 to either the “B” or “A” class. For a few objects, a second independent measurement, taken in another run, is also given (marked with a star in the last column of Table 2). For these we show only the best quality HI profile in Fig. 7.

The Aitoff projection of the catalogue in J2000 equatorial is seen in Fig. 1, together with the distribution of the radial

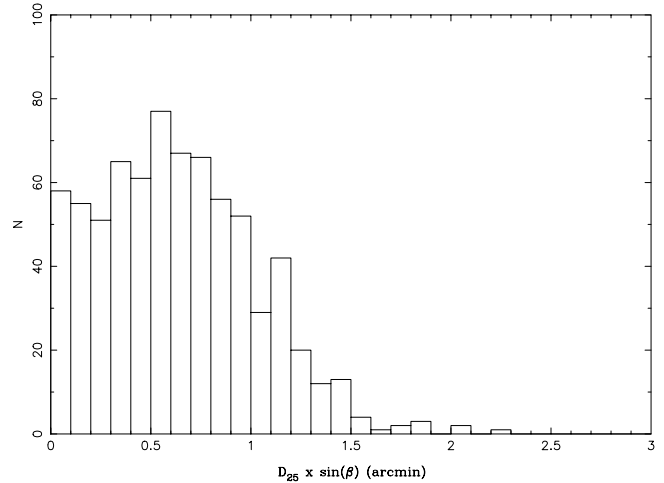


**Fig. 4.** *Upper panel:* distribution of integration time per galaxy in units of ON/OFF cycles number. *Lower panel:* rms noise  $\sigma$  in mJy as a function of integration time expressed in number of integration cycles; the solid line is the function  $24.5 / \sqrt{N_{cy}}$ .

velocities and HI fluxes. Most of the observed objects are in the range 4000–10 000 km s<sup>-1</sup> where the lack of Tully-Fisher measurements in the literature is the most critical.

The general statistics of the survey are the following:

- On average, from the allocated time that has been actually used for observing, about one third was lost due to RFI (Radio Frequency Interferences) or receiver problems.
- 41% of final HI spectra have a signal to noise ratio (S/N) greater than 5, while 78% have a SNR greater than 3.
- The upper panel of Fig. 4 shows the histogram of integration time in units of ON/OFF cycles number. Most of the galaxies were measured in less than 75 cycles,



**Fig. 5.** Projection of the major axis  $D_{25}$  on the East-West direction.

equivalent to about 75 min tracking in two polarizations (typically 2.5 meridian transits).

- The lower panel of the same figure shows the rms noise in mJy against the integration time. We reach a 2 mJy rms in 150 cycles, thus in 2.5 h of tracking, while 3.2 mJy is reached in one hour (observing  $\pm 15$  min around the meridian).

### 5.1. Radial velocities

Our observed radial velocities are listed in Table 2 (Col. 4) and correspond to the median point of the 21-cm line profile measured at 20% of maximum intensity.

The internal mean error on  $V_{20}$  is calculated according to Fouqué et al. (1990) as follows:

$$\sigma(V_{20}) = \frac{4 \cdot (R \cdot \alpha)^{1/2}}{S/N}$$

where  $R$  is the actual spectral resolution,  $\alpha = (W_{20} - W_{50})/2$  is the slope of the line profile, and  $S/N$  is the signal to noise ratio. The average of  $\sigma(V_{20})$  is about 8 km s<sup>-1</sup>.

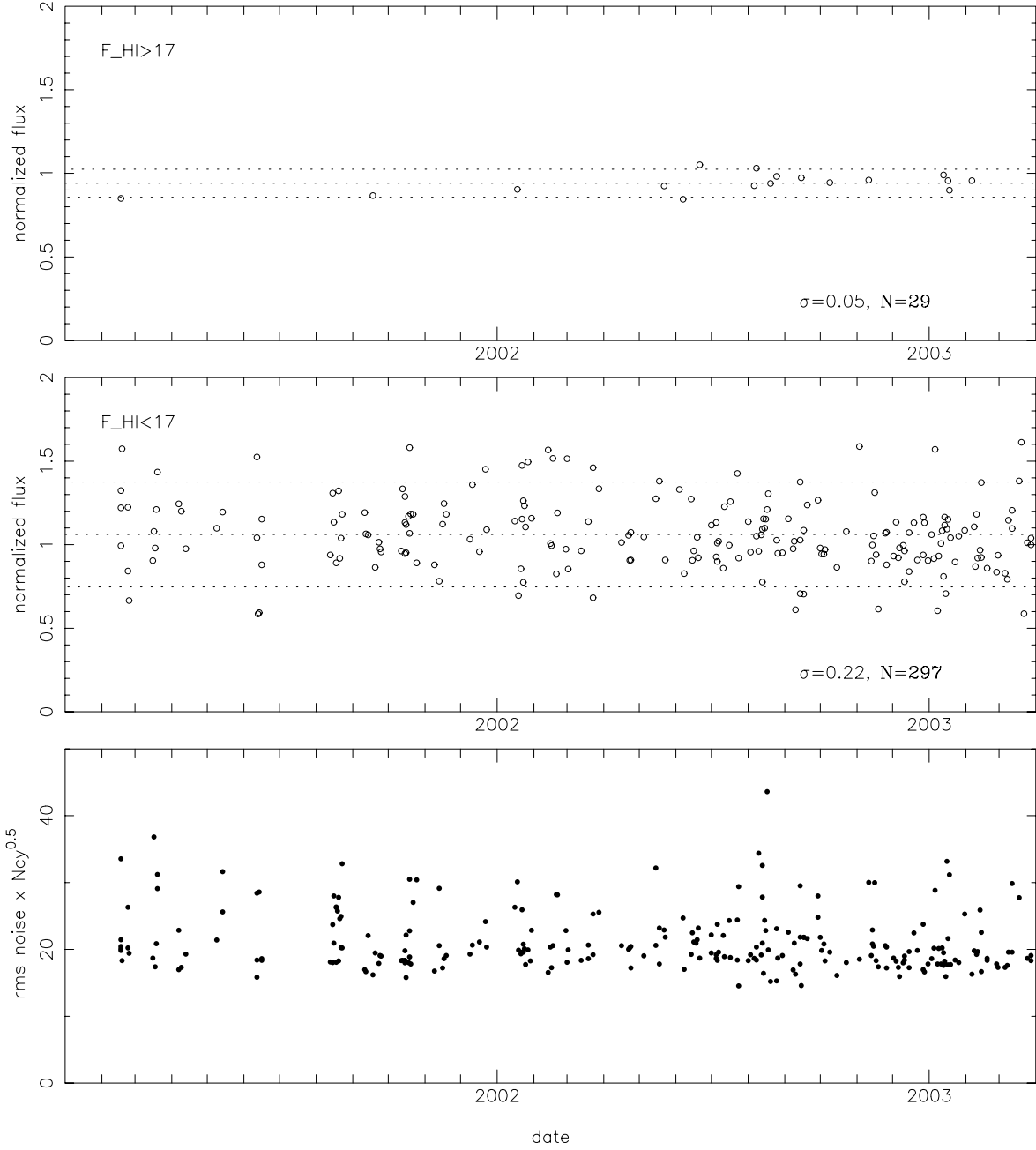
### 5.2. Line widths

Line widths are measured on the observed profile at two standard levels corresponding to 20% and 50% of the maximum intensity of the line. The results listed in Table 2, Cols. 6 and 9, have been corrected to the optical velocity scale. We also provide line widths corrected for resolution effect (Fouqué et al. 1990) in Cols. 7 and 10. The mean measurement error is taken equal to  $3 \cdot \sigma(V_{20})$  and  $2 \cdot \sigma(V_{20})$  for the 20% and 50% widths, respectively. The data presented here are not corrected for internal velocity dispersion. Details about these corrections can be found in Bottinelli et al. (1990), Fouqué et al. (1990) or in Paturel et al. (2003).



**Table 4.** Template galaxies: Col. 1: PGC or HYPERLEDA galaxy name; Col. 2: right ascension (2000); Col. 3: declination (2000); Col. 4: morphological type; Col. 5:  $\log D_{25}$  isophotal diameter; Col. 6:  $\log R_{25}$  axis ratio; Col. 7: total  $B$  magnitude; Col. 8: total line width at 20% of the maximum intensity ( $\text{km s}^{-1}$ ) (HYPERLEDA); Col. 9: 21-cm magnitude (HYPERLEDA); Col. 10: HI-flux in  $\text{Jy km s}^{-1}$ ; (Theureau et al. 1998); Col. 11: systemic heliocentric radial velocity ( $\text{km s}^{-1}$ ) (Theureau et al. 1998).

pgc/leda	RA (2000) Dec	type	$\log D$	$\log R$	$B_r$ (mag)	$W_{20}$ ( $\text{km s}^{-1}$ )	$m_{21}$ (mag)	$F_0$ ( $\text{Jy km s}^{-1}$ )	$V_h$ ( $\text{km s}^{-1}$ )
pgc0000878	00 13 03 14 24 32	Sc	0.97	0.27	14.8	128.8	15.37	6.2	2026.
pgc0001715	00 27 52 -1 48 37	Sc	1.12	0.24	14.0	265.5	14.62	8.0	4059.
pgc0001909	00 31 13 -10 28 58	Sbc	1.05	0.17	14.3	307.0	14.72	11.7	3588.
pgc0002138	00 35 40 -20 07 35	Sb	1.31	0.39	13.7	331.5	14.11	20.8	3295.
pgc0002806	00 47 54 19 35 48	Sc	1.35	0.16	14.1	361.0	14.54	11.5	4560.
pgc0009355	02 27 34 41 58 39	Sb	0.92	0.17	14.4	279.5	14.66	12.5	5652.
pgc0009800	02 34 24 -10 50 38	Sbc	1.38	0.41	14.0	390.5	14.22	15.2	4767.
pgc0010029	02 38 51 27 50 51	Sb	1.21	0.39	14.5	335.5	15.25	7.3	4578.
pgc0010324	02 43 36 -16 17 48	Sab	1.20	0.22	15.1	311.5	15.41	6.3	7663.
pgc0010669	02 49 07 -16 59 34	Sc	1.28	0.40	13.1	371.5	15.00	7.8	3465.
pgc0013194	03 33 51 -21 27 17	Scd	1.12	0.16	15.1	171.5	15.31	6.9	4063.
pgc0019512	06 44 00 12 24 10	Sbc	1.14	0.44	14.9	425.5	15.23	6.6	3941.
pgc0019549	06 45 41 22 25 45	Sbc	0.98	0.40	16.5	233.5	15.50	5.8	4466.
pgc0020256	07 09 10 28 41 43	Scd	0.89	0.18	16.7	82.5	16.25	2.9	4980.
pgc0021161	07 30 18 -31 35 54	Sb	1.22	0.32	14.2	298.4	13.80	19.4	2087.
pgc0021687	07 44 34 -13 06 48	Sc	1.19	0.19	0.0	126.5	14.39	16.0	2306.
pgc0023723	08 27 34 -12 45 23	Sc	1.37	0.21	13.2	221.5	14.92	9.9	2801.
pgc0025221	08 58 46 -3 42 38	Sbc	1.29	0.24	13.5	253.5	14.99	7.1	2760.
pgc0025231	08 58 56 -4 54 04	Sbc	1.33	0.15	13.0	344.2	14.16	15.4	3714.
pgc0027045	09 31 36 -30 18 28	Sc	1.10	0.46	14.3	242.5	14.77	11.3	2577.
pgc0027810	09 43 17 -9 56 44	Scd	1.36	0.34	13.9	322.5	14.56	17.0	2699.
pgc0028366	09 51 06 9 00 29	Sc	1.30	0.17	14.0	319.5	15.08	8.2	5198.
pgc0028376	09 51 15 -32 45 17	Sb	1.42	0.25	12.4	403.4	14.40	13.0	2785.
pgc0029298	10 05 39 -37 05 15	Sc	1.07	0.41	14.6	337.5	15.61	5.2	4808.
pgc0031493	10 36 52 -32 20 53	Sab	1.38	0.48	13.5	385.1	14.37	9.7	2861.
pgc0031653	10 38 50 -11 38 54	Sc	1.40	0.31	13.7	274.9	14.09	18.0	2488.
pgc0035123	11 25 30 63 26 45	Sbc	1.27	0.17	13.2	499.5	16.01	5.5	3480.
pgc0035669	11 33 15 24 26 49	Sb	1.25	0.21	14.8	424.5	16.18	12.5	6974.
pgc0038250	12 04 59 58 06 24	Sbc	1.04	0.18	15.5	114.5	15.01	9.1	2605.
pgc0038667	12 09 46 25 01 34	Sc	1.01	0.35	14.6	219.5	15.13	8.1	2573.
pgc0038799	12 11 07 -31 07 35	Sab	1.28	0.37	13.6	195.5	14.46	15.0	2119.
pgc0044761	13 00 26 -15 17 00	Sab	1.36	0.40	13.1	637.5	14.39	16.0	4925.
pgc0046321	13 17 58 4 24 12	Sb	1.21	0.31	14.8	454.5	15.87	4.1	6244.
pgc0050784	14 13 16 27 00 30	Sb	1.25	0.28	14.5	376.8	14.66	11.1	5307.
pgc0051471	14 24 42 -3 12 44	Sa	1.27	0.27	13.5	328.5	14.11	12.3	2747.
pgc0051851	14 30 43 -27 27 16	Sbc	1.10	0.15	14.2	216.5	15.39	6.4	4383.
pgc0051890	14 31 22 -28 45 00	Sbc	1.24	0.41	13.7	552.5	14.71	12.0	6572.
pgc0051900	14 31 29 -22 22 01	Sbc	1.04	0.22	14.5	292.5	15.52	5.7	7164.
pgc0052811	14 47 25 -13 42 57	Sb	1.33	0.47	13.4	402.5	14.95	9.6	2908.
pgc0054393	15 14 15 20 28 42	Sb	1.08	0.29	15.0	319.5	15.23	7.2	4681.
pgc0054754	15 20 45 -18 20 57	Sc	1.11	0.38	15.1	227.5	14.87	10.3	2211.
pgc0056023	15 46 58 17 53 04	Sc	1.21	0.27	13.4	184.8	14.42	14.9	3301.
pgc0057205	16 07 13 7 58 45	Sc	1.23	0.29	14.2	283.5	15.25	6.8	2847.
pgc0057891	16 21 01 -36 08 31	Sbc	1.01	0.47	15.6	426.5	13.97	23.7	4448.
pgc0058336	16 29 27 21 20 12	Sc	1.22	0.46	15.9	242.5	14.50	15.5	2988.
pgc0061165	17 57 14 12 10 45	Sc	1.29	0.37	13.3	306.5	14.76	12.5	2867.
pgc0061836	18 24 19 71 36 06	Sbc	1.16	0.30	14.5	407.5	14.80	9.0	5768.
pgc0062338	18 44 15 24 08 32	Sab	1.29	0.29	14.6	405.3	14.69	12.2	3831.
pgc0062380	18 46 17 22 36 55	Sc	1.10	0.15	15.0	345.5	14.98	9.3	4698.
pgc0062548	18 54 23 24 39 08	Sc	1.11	0.34	15.4	319.5	15.06	8.7	4319.
pgc0062781	19 07 03 29 00 24	Sbc	1.34	0.22	13.6	415.7	15.32	9.9	3912.
pgc0063711	19 49 35 -26 25 55	Sbc	1.34	0.18	14.1	410.5	14.95	9.6	5960.
pgc0064458	20 18 37 0 09 02	Sc	1.32	0.48	14.4	524.3	13.93	15.8	5410.
pgc0067373	21 48 04 -36 46 19	Sc	1.13	0.41	15.1	189.5	15.19	7.7	2547.
pgc0067347	21 47 16 72 28 18	Sc	1.09	0.15	15.4	304.9	13.75	22.0	2403.
pgc0068861	22 26 11 -31 08 49	Sb	1.15	0.37	14.2	278.5	14.54	14.0	4001.
pgc0069132	22 33 16 -27 14 47	Sb	1.22	0.35	13.7	337.3	14.58	14.8	3544.
pgc0071430	23 26 20 -17 57 24	Sa	1.09	0.23	14.2	215.5	14.92	9.9	2873.



**Fig. 6.** Evolution of the normalized HI-flux ( $F_{\text{HI}}/F_0$ ) and rms noise in the baseline for our 58 template galaxies during the survey: **a)** template galaxies with  $F_{\text{HI}} > 17 \text{ Jy km s}^{-1}$ , the dashed lines shows the  $1.5\sigma$  levels, **b)** template galaxies with  $F_{\text{HI}} < 17 \text{ Jy km s}^{-1}$ , **c)** rms noise  $\times \sqrt{N_{\text{cy}}}$ , i.e. rms noise for one single cycle of ON/OFF integration, for all template galaxy measurements.

### 5.3. HI-fluxes

HI-fluxes  $F_{\text{HI}}$  (Table 2, Col. 12) are expressed in  $\text{Jy km s}^{-1}$ . The values given in Col. 13 are corrected for beam-filling according to Paturel et al. (2003):

$$F_{\text{HIc}} = B_f \cdot F_{\text{HI}}$$

where  $F_{\text{HI}}$  is the observed raw HI-flux,

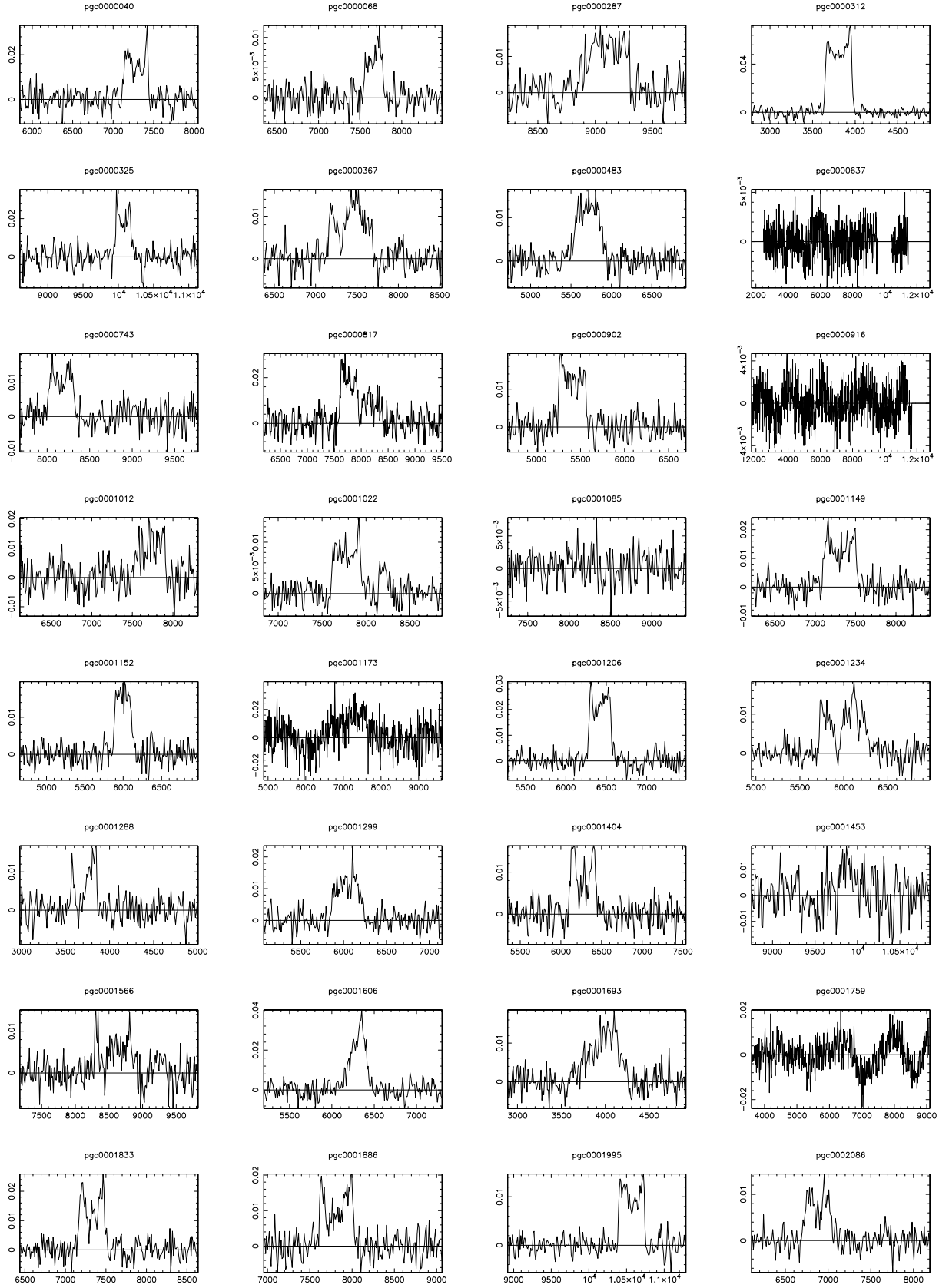
$$B_f = \sqrt{(1 + xT)(1 + xt)}$$

$$T = (a_{25}^2 \sin^2 \beta + b_{25}^2 \cos^2 \beta) / \theta_{EW}^2$$

$$t = (a_{25}^2 \cos^2 \beta + b_{25}^2 \sin^2 \beta) / \theta_{NS}^2$$

$\theta_{EW}$  and  $\theta_{NS}$  are the half-power beam dimensions of the Nançay antenna,  $\beta$  is the position angle of the galaxy defined north-eastwards,  $a_{25}$  and  $b_{25}$  are the photometric major and minor axis respectively. The parameter  $x$  is  $x = 0.72 \pm 0.06$  (Bottinelli et al. 1990). The distribution of the East-West projection of  $D_{25}$  diameters is shown in Fig. 5. This is to be compared to the 4 arcmin width of the half-power beam.

The total exposure time of a target is often spread over several weeks or months. The flux integration is controlled afterwards according to a set of 58 HI-template galaxies regularly observed during the period covered by our programme. These HI-template galaxies are used exclusively to control the gain



**Fig. 7.** -excerpt. 21-cm line profiles of galaxies listed in Table 2; profiles are classified according to their PGC name appearing in the top right corner of each panel. The usual name of the galaxy (NGC, UGC, IC, ESO, MCG...) is written above each panel. Ordinate and abscissae axes are graduated respectively in  $\text{km s}^{-1}$  and mJy. Note that heliocentric radial velocities are expressed in terms of optical redshift  $c \frac{\Delta\lambda}{\lambda}$ . The horizontal line represents the baseline of the profile, from which the maximum is estimated.

stability over short time scales, allowing us to verify that the gain factor has not changed from one meridian transit of the scientific target to another. They were chosen to be as representative as possible of the survey galaxies, covering a wide range of radial velocities and HI fluxes. They have also the great advantage of being distributed over the whole sky, in particular at all right ascensions, providing a large flexibility in observation scheduling, and to be measurable in HI within a 10 min meridian transit... Their HI-fluxes  $F_0$  (see Table 4) were accurately measured with the same instrument by Theureau et al. 1998. Note that here, it is not the absolute flux which is supervised, but the variations of its measurement with time, the calibration itself being done by the above continuum sources (Sect. 4).

The evolution of the normalized HI flux  $F_{\text{HI}}/F_0$  with time is seen in Fig. 6 (upper two panels) separately for the four templates which had the largest flux (pgc21161, pgc27810, pgc31653 and pgc57891) and for low flux galaxies ( $F_{\text{HI}} < 17 \text{ Jy km s}^{-1}$ ). The brightest objects at the 21-cm wavelength (first panel) show a very narrow distribution around unity along the whole period, with a dispersion  $\sigma = 5\%$ . Fainter objects also show a regular and constant distribution with time, but with a much larger  $\sigma$  of 22%, which could be understood as the mean actual error on our flux measurements for the whole survey. Note that the template galaxy sample allows us to control the instrument calibration over a wide time scale, showing that it was very stable during the whole period of observation. In the bottom panel of Fig. 6, we show the rms noise measured in the spectrum base-line (outside the line and occasional interferences) multiplied by the square root of time in units of ON/OFF integration cycles. It shows the rms noise normalized to one cycle of integration. It was again very stable around 20 mJy during the entire period, perhaps showing a slight decrease of a few percent since mid 2002.

*Acknowledgements.* We have made use of data from the Lyon-Meudon Extragalactic Database (HYPERLEDA). We would like to acknowledge the scientific and technical staff of the Nançay radiotelescope.

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