STANDARD PULSARS: PROBES FOR THE CALIBRATION OF THE GALACTIC CONTINUUM BACKGROUND TEMPERATURE AND THE ELECTRON DENSITY OF THE INTERSTELLAR MEDIUM

M. Fracassini and L. E. Pasinetti

Department of Physics, University of Milan

ABSTRACT. From the list of observed and derived parameters of 330 pulsars published by Manchester and Taylor (1981), we have selected sixteen "standard" pulsars whose position and radio luminosity fit well a statistical relation found by Antonello and Fracassini (1984). This relation shows also that these pulsars may be considered as probes of the galactic places where the observed 408 MHz continuum background temperature, T_{408}, and the computed electron densities, n_e, of the interstellar medium, ISM, are best correlated.

1. INTRODUCTION

A Symposium devoted to the calibration of fundamental stellar quantities should consider also the ISM where the stars are born and die. The knowledge of the physical properties of the ISM is undoubtedly necessary for the understanding of these important stages of the stellar evolution.

A large contribution to this knowledge (space distribution, chemical composition, temperature, density, magnetic field, polarization, etc.) is due to the radioastronomy and, in particular to the discovery of pulsars. In the present paper we consider the "standard" pulsars, probes of the galactic places where some physical properties of the ISM (temperature and electron density) may be considered as standards: namely, the galactic places where the observed T_{408} are best correlated to the n_e derived from the adopted models (Lyne, 1982).

2. STATISTICAL ANALYSIS AND RESULTS

Two papers were of primary importance for the present study: a) the observed and derived parameters for 330 pulsars published by Manchester and Taylor (1981), at present the most complete and updated compilation of the principal observational parameters of pulsars; b) the 408 MHz All-Sky Continuum Survey, Atlas of Contour Maps, published by Haslam et Al. (1982), which provides an accurate and complete data base for large-scale

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comparisons with other observations (see f.i. Phillipps et Al. 1981).

Our study began with a preliminary multivariate analysis of the parameters reported in a) (Fracassini et Al., 1983). A linear correlation ($R = 0.60$) between the T_{408} observed in the direction of the pulsars and their dispersion measures, DM, was found. A subsequent multiple stepwise regression analysis (Antonello and Fracassini, 1984) gave the best relation ($R = 0.90$) between T_{408} and DM, the position (Z, R) and radio luminosity (L) of the pulsars.

On the ground of the scattering around this relation (O-C = $\log T_{obs} - \log T_{calc}$) we have selected the following groups:

1) peculiar pulsars ($|O-C| > 2.5\sigma$), which are set in the galactic places where the observed T_{408} and derived n_e are higher or lower than the averaged ones;
2) normal pulsars ($|O-C| < 2.5\sigma$), which are set in the galactic places where the observed T_{408} and derived n_e are in agreement on the average;
3) standard pulsars ($|O-C| < 0.01$), which are set in the galactic places where the observed T_{408} and derived n_e are in good agreement.

The list of sixteen "standard" pulsars and the corresponding parameters are reported in Table I.

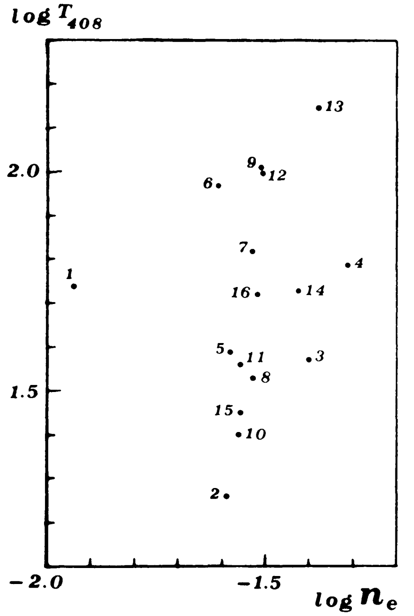

Fig. 1. The relation $\log T_{408}$ vs. $\log n_e$. Note that the pulsars numbered 1 and 6, which should have good distance estimates (Manchester and Taylor 1981), deviate from the average relation.

3. DISCUSSION AND CONCLUSION

Several papers concerning the distribution (homogeneity and cloudiness) of the ISM have been published recently. One of them in particular, regarding the variation of a scattering index parameter related to the existence of a three-phase structure of the ISM (Akujor and Okeke, 1982), is related to our results.

As a matter of fact this index is proportional to the mean n_e and

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TABLE I. "Standard" Pulsars

N	PSR	l	b	T_{408}	DM	Z	R	log L	n_e	d
1	0138+59	129.1	- 2.1	55	34.80	-0.11	12.12	28.26	0.0116	3.00
2	0447-12	211.1	-32.6	18	39	-0.82	11.12	27.23	0.0260	1.50
3	0808-47	263.3	- 8.0	37	228.3	-0.78	12.02	29.18	0.0401	5.70
4	0840-48	267.2	- 4.1	62	197.0	-0.28	10.93	27.42	0.0493	4.00
5	1119-54	290.1	+ 5.9	39	204.7	+0.78	10.27	28.77	0.0269	7.60
6	1240-64	302.1	- 1.5	94	297.4	-0.32	10.80	29.72	0.0248	12.00
7	1256-67	303.7	- 4.8	66	95	-0.27	8.65	27.08	0.0297	3.20
8	1604-00	10.7	+35.5	34	10.72	+0.21	9.71	26.27	0.0298	0.36
9	1647-52	335.0	- 5.2	114	179.1	-0.52	5.34	28.44	0.0309	5.80
10	1811+40	67.4	+24.0	25	44	+0.67	9.53	26.69	0.0275	1.60
11	1839+56	86.1	+23.9	36	27	+0.40	9.98	27.35	0.0276	0.98
12	1900-06	28.5	- 5.7	104	190	-0.62	5.43	28.71	0.0306	6.20
13	1924+16	51.9	+ 0.1	140	178	0.00	8.10	27.79	0.0414	4.30
14	1944+17	55.3	- 3.5	54	16.3	-0.03	9.76	26.80	0.0379	0.43
15	2043-04	42.7	-27.4	28	36	-0.61	9.17	26.68	0.0277	1.30
16	2224+65	108.6	+ 6.8	53	36.5	+0.14	10.43	27.12	0.0304	1.20

PSR = Pulsar, l = Galactic Longitude, b = Galactic Latitude, T_{408} = 408 MHz Galactic Background Continuum Temperature, DM = Dispersion Measure, Z = Distance from the Galactic Plane (kpc), R = Distance from the Galactic Axis (kpc), L = Absolute Radio Luminosity, n_e = Electron Density, d = Heliocentric Distance (kpc)

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seem to show that the galactic places with mean values of T_{408} and n_e, located by the "standard" pulsars, should belong to the phase II (warm phase) of the ISM. This phase includes regions of different properties: the ionized hydrogen HII regions, which mainly contribute to the average electron density of the ISM, and the intercloud medium.
Therefore, the above-mentioned large-scale physical properties could be considered as characteristic ones of what we have found and meant as the standard ISM.

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