On discussion

THE HISTOGRAM OF PULSARS' PERIODS DISTRIBUTION

Vladimir P. Bezdenezhnyi
Department of Astronomy, Odessa National University
T.G.Shevchenko Park Odessa 270014 Ukraine
astro@paco.odessa.ua

ABSTRACT. In considering of the distribution of periods for pulsars taken from Smith (1979) and GCVS (1976) data 20 peaks are found: at 0.672 sec, 0.450 sec, 0.403 sec, 0.270 sec, 0.191 sec and other smaller peaks. Identifications and comparison with the distribution of periods for δ Scuti stars are carried out.

Key words: Stars: pulsars, δ Scuti, RR Lyrae, Cepheids.

In Table 1 a histogram of pulsars' periods distribution (n=105 stars) based on the data taken from the book "Pulsars" by Smith (1979) is presented.

The intervals of periods ΔP are taken as 0.05 sec. For control we give a histogram with intervals ΔP=0.1 sec (see Figure 1). In Table 2 and in Figure 2 the same histograms based on the data (n=147 stars) taken from "Third supplement to the third edition of the General Catalogue of Variable stars" (Kukarkin et al., abbreviation: GCVS, 1976) are given.

Table 1: The histogram of pulsars' periods distribution (n=105 stars)

ΔP	n_{puls}	ΔP	n_{puls}
0.00-0.05	1	1.20-1.25	4
0.05-0.10	1	1.25-1.30	4
0.10 0.15	0	1.30-1.35	1
0.15-0.20	6	1.35-1.40	3
0.20-0.25	4	1.40-1.45	1
0.25-0.30	4	1.45-1.50	0
0.30-0.35	3	1.50-1.55	1
0.35-0.40	7	1.55-1.60	1
0.40-0.45	6	1.60-1.65	0
0.45-0.50	6	1.65-1.70	1
0.50-0.55	5	1.70-1.75	0
0.55-0.60	5	1.75-1.80	0
0.60-0.65	2	1.80-1.85	0
0.65-0.70	8	1.85-1.90	1
0.70-0.75	6	1.90-1.95	0
0.75-0.80	3	1.95-2.00	1
0.80-0.85	4	2.00-2.05	0
0.85-0.90	1	2.05-2.10	0
0.90-0.95	1	2.10-2.15	1
0.95-1.00	0	2.15-2.20	0
1.00-1.05	2	2.20-2.25	1
1.05-1.10	2	2.25-2.30	1
1.10-1.15	0	2.30-2.35	1
1.15-1.20	1	3.70-3.75	1

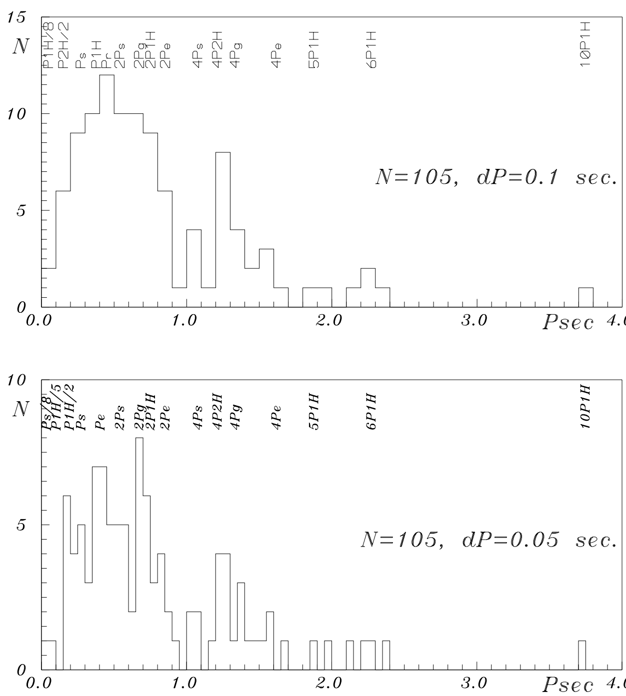

Figure 1: The distribution of pulsars' periods based on the data of the sampling according to Smith (1979).

We used intervals ΔP=0.02 sec for control of our results too. On the base of our analyses of these histograms 20 peaks (maxima) at the following periods P_i and frequencies f_i corresponding to them are obtained (see Table 3). As it can be seen from figures and Table 3, the highest peaks are: P_{11}=0.672 sec, P_8=0.403 sec, P_9=0.448 sec, P_6=0.270 sec and P_5=0.191 sec. The ratios of the periods show that all periods are commensurable (often - multiple ones), as in the case of pulsating stars: δ Sct, bimodal Cepheids, RR Lyrae and other types. The histogram of pulsars' periods distribution is similar to one of δ Scuti stars

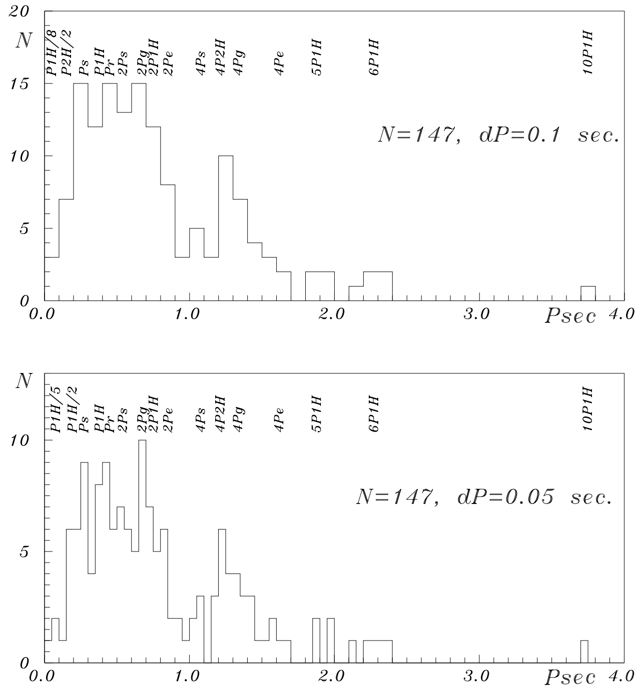

Figure 2: The distribution of pulsars' periods based on the data of the sampling according to GCVS (1976).

(Bezdenezhnyi, 1994b).

We can see five sequences of multiple periods. The first sequence is: $P_7 = 8P_2 = 5P_3 = 2P_5 = P_{12}/2 = P_{18}/5 = P_{19}/6 = P_{20}/10$. Eight periods are connected with multiple relation, and moreover the period P_7 is favoured one. We accept it for the main period and make up the ratios of every period P_i to the period P_7. The second sequence is: P_6=$8P_1$= $P_{10}/2$=$P_{14}/4$. And three more multiple relations are: $4P_8$=$2P_{13}$= P_7, P_{15}=$8P_4$ and $2P_{11}$=P_{16}. Only period P_9 has no multiple ones in this table. Thus, we have five groups of periods, inside of wich multiple relations take place. The primary periods are: P_7, P_6, P_8 and $P_{11}/2$ (because period P_{11} lies between two double periods P_{10}=$2P_6$ and P_{12}= $2P_7$. We add two periods P_9 and $2P_4$ to these primary ones as the period P_4 lies beside half period P_5. These six periods give us chance to make identifications as in the case of pulsating stars. We accept period P_7 as P_{1H} one - the first overtone of some fundamental period that is not seen in our histograms. The last column of Table 3 contains possible interpretations of these peaks.

From our list of periods we have probable identifications: P_6=P_s, P_8=P_e, P_9=P_r and $P_{11}/2$=P_g. These are periods introduced by the author earlier (Bezdenezhnyi, 1994a, 1994b, 1997) for RR Lyr -type and δ Sct stars. And period $2P_4$ is identified as P_{2H} (the second overtone). At such identifications the theoretical ratios k_{theor}= P_i/P_{1H} are given in the fifth column of Table 3. The observed P_i/P_7 ratios are close

Table 2: The histogram of pulsars' periods distribution (n=147 stars)

ΔP	n_{puls}	ΔP	n_{puls}
0.00-0.05	1	1.20-1.25	6
0.05-0.10	2	1.25-1.30	4
0.10 0.15	1	1.30-1.35	4
0.15-0.20	6	1.35-1.40	3
0.20-0.25	6	1.40-1.45	3
0.25-0.30	9	1.45-1.50	1
0.30-0.35	4	1.50-1.55	1
0.35-0.40	8	1.55-1.60	2
0.40-0.45	9	1.60-1.65	1
0.45-0.50	6	1.65-1.70	1
0.50-0.55	7	1.70-1.75	0
0.55-0.60	6	1.75-1.80	0
0.60-0.65	5	1.80-1.85	0
0.65-0.70	10	1.85-1.90	2
0.70-0.75	7	1.90-1.95	0
0.75-0.80	5	1.95-2.00	2
0.80-0.85	6	2.00-2.05	0
0.85-0.90	2	2.05-2.10	0
0.90-0.95	2	2.10-2.15	1
0.95-1.00	1	2.15-2.20	0
1.00-1.05	2	2.20-2.25	1
1.05-1.10	3	2.25-2.30	1
1.10-1.15	0	2.30-2.35	1
1.15-1.20	3	2.35-2.40	1
–	–	3.70-3.75	1

Table 3: Results of identifications of pulsars' periods

i	P_i(sec)	f_i(1/sec)	P_i/P_7	k_{theor}	ident.
1	0.033	30.303	0.087	0.089	$P_s/8$
2	0.047	21.277	0.124	0.125	$P_{1H}/8$
3	0.075	13.333	0.199	0.200	$P_{1H}/5$
4	0.150	6.667	0.397	0.400	$P_{2H}/2$
5	0.191	5.236	0.506	0.500	$P_{1H}/2$
6	0.270	3.704	0.715	0.711	P_s
7	0.3775	2.649	1	1	P_{1H}
8	0.403	2.481	1.068	1.067	P_e
9	0.448	2.232	1.187	1.185	P_r
10	0.538	1.859	1.425	1.422	$2P_s$
11	0.672	1.488	1.780	1.778	$2P_g$
12	0.750	1.333	1.987	2	$2P_{1H}$
13	0.801:	1.248	2.122	2.133	$2P_e$
14	1.075	0.930	2.848	2.844	$4P_s$
15	1.210:	0.826	3.205	3.200	$4P_{2H}$
16	1.332:	0.751	3.528	3.556	$4P_g$
17	1.616:	0.619	4.281	4.264	$4P_e$
18	1.875	0.533	4.970	5	$5P_{1H}$
19	2.270	0.441	6.010	6	$6P_{1H}$
20	3.745:	0.267	9.920	10	$10P_{1H}$

to theoretical ones from multiplicity viewpoint. In 19 cases of 20 the observed period ratios are different from theoretical ones within 0.03.

Thus, similarly to pulsating stars, the periods of pulsars are close to periods P_{1H}, P_{2H}, P_r, P_e, P_g, P_s and multiple to them ones. It is curiously that fundamental period P_f is absent in this range.

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