21 COM - PHOTOMETRY AT Hβ

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ABSTRACT. The narrow-band Hβ photometric observations of the CP2 star 21 Com obtained on 8 nights during 1978 - 1979 are presented. A tentative period analysis confirmed the existence of short-time variations and, in addition to those hitherto published, our data indicate a period of about 1.5 hour. As to long periodicity, the data fit the best value P_{rot} = 1.83736 d, which is as much as the seventh estimation of the rotational period of this star.

21 COM - ФОТОМЕТРИЯ В Hβ. В работе опубликованные узкополосные фотометрические наблюдения CP2-звезды 21 Com в фильтре Hβ, которые приобретились в 1978-79 годах. Пробный периодовый анализ подтвердил существование коротковременных изменений блеска. Всё ещё наши наблюдения указывают период около 1.5 часа. Что касается долговременных изменений, наши ночные среднее лучше всего удовлетворяют величине P = 1.83736 суток, которая является уже седьмой оценкой периода вращения.

21 COM - FOTOMETRIA V Hβ. Sú publikované úzkopásmové fotoelektrické pozorovania CP2-hviezdy 21 Com vo filtri Hβ , získané v 8 nociach v rokoch 1978 a 1979. Potvrdila sa existencia krátkoperiodických variácií a naviac sa indikovala perióda okolo 1,5 h. Z nočných priemerov sa určila perióda P_{rot} = 1.83736 d, čo už je siedmy odhad rotačnej periódy pre túto hviezdu.

1. INTRODUCTION

The CP2 star 21 Com (HD 108 945, HR 4776, UU Com, m_V = 5.46, A3p) has been attracting observers' attention for its enigmatic photometric behaviour. The star displays a photometric variability on a scale of tens of minutes, however, the results of different observers are remarkably diverse. Periodicities of 30 - 40 mins have been found most frequently (see Tab. 1). Despite inhomogeneity of the data from different sources, one can assume these variations to be of a transient nature. There is also an ambiguity in the value of the rotational period. The individual estimates range from about one to eleven days. Weiss et al. (1980) and Weiss (1983) gave a thorough review of the photometric observations. Percy (1975) in his study included this star among the low-harmonic radially pulsating CP2 stars, however, none of the photometric observation so far obtained has indicated a periodicity corresponding to the fundamental period, which for a main-sequence A-star is about 1.5 h (Weiss et al., 1980, Petersen and Jorgensen, 1972). Aslanov et al. (1978) obtained spectrophotometric observations in Hα and detected a variable emission in the red wing of the Hβ-line and overall variability in the equivalent width of the line. Unfortunately, the time span of their observations was only sufficient to estimate the lower limit of this periodicity, P>1.5 h.

21 Com was included in the observation program of the 0.6 m photometric telescope at the Skalnaté Pleso Observatory during 1978 - 79. Although the distribution of the observations over 483 days resulted in a complex spectral window implying some ambiguity of the rotation period derived, and the sequence of the observational nights did not allow us to check the temporary occurrence of short-time periodicities, we decided to publish these data, because they could stimulate observers in attempting to confirm or exclude the 1.5 h fundamental period and to resolve the problem of the rotational period.

2. OBSERVATIONS

The observations were performed with the photoelectric photometer attached to the 0.6 m reflector. The Hδ filter has a central wavelength of 486.2 nm, halfwidth 19 nm and maximum transparence 33%. The comparison star was HD 108 722 (18 Com, m_V = 5.47, F5 IV), and the observations were made in the sequence 2xC - 5xV - 2xC ... . Each observation of the star was followed by a recording of the sky background lasting 40 and 20 secs, respectively.

Circumstances such as the scope of observational programmes, the way in which the observing time was alloted as well as the weather conditions enabled us to obtain observations in as few as 8 nights during period from February 1978 to June 1979. Moreover, typically a one-night observation on the average took 2 hours, the shortest was 45 mins, the longest 160 mins. Table 2 lists the observations with the date in the first column, the night average in the second and its r. m. s. in the third, the number of measurements in the fourth and the duration in the fifth. The raw data are listed in Table 3, where the time in JD(hel) and the magnitude difference 18Com - 21Com are given.

TABLE 1

Reference	Period	Note
	(d)	
Provin (1953)	7.75	Spectroscopy
Deutsch (1955)	1.0256	Spectroscopy
Bahner, Mavridis (1957)	11. 2.1953 1.10	V photometry
Blanco, Catalano (1972)	2.1953	UBV photometry
Weiss et al. (1980)	0.9178	
	(min)	
Bahner, Mavridis (1957)	32	V photometry
Percy (1973, 1975)	30, 30.4+39.5	BV photometry
Aslanov et al. (1978)	36 90	Spectrophotometry
Weiss et al. (1980)	36	Breger's V photometry
Totochava, Zhiljaev (1981)	22	Photometry
Musielok, Kozar (1982)	5.4, 5.9	
Jarzebowski (1982)	constant	Photometry
Garrido, Sanchez (1983)	5.9	
Weiss (1983)	constant at ≈30 48	Rakosch's U photometry

TABLE 2

DATE JD	$\overline{\Delta m}$ (mag)	σ (mmag)	N	Duration (min)	Night No.
1978 Feb 6 2 443 545.70	-.1663	± 1.4	26	45	1
1978 May 18 2 443 647.45	-.1751	1.2	61	160	2
1978 May 19 2 443 648.49	-.1675	1.2	66	111	3
1979 Feb 27 2 443 931.64	-.1666	0.5	105	130	4
1979 Apr 4 2 443 967.58	-.1844	1.1	64	133	5
1979 Apr 8 2 443 972.46	-.1722	0.8	70	130	6
1979 May 14 2 444 008.39	-.1759	1.5	50	104	7
1979 Jun 3 2 444 028.41	-.1826	0.9	95	136	8
Mean	-.1738				
Amplitude	.0181				

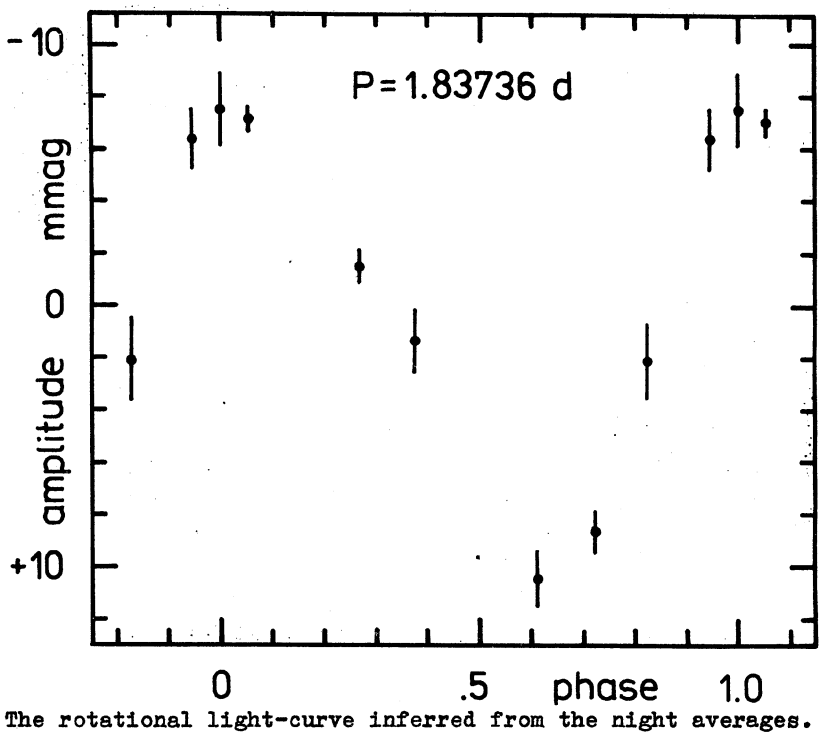

Fig. 1. The rotational light-curve inferred from the night averages. The semi-amplitude estimated from sinusoidal fitting is 9.4 mmag.

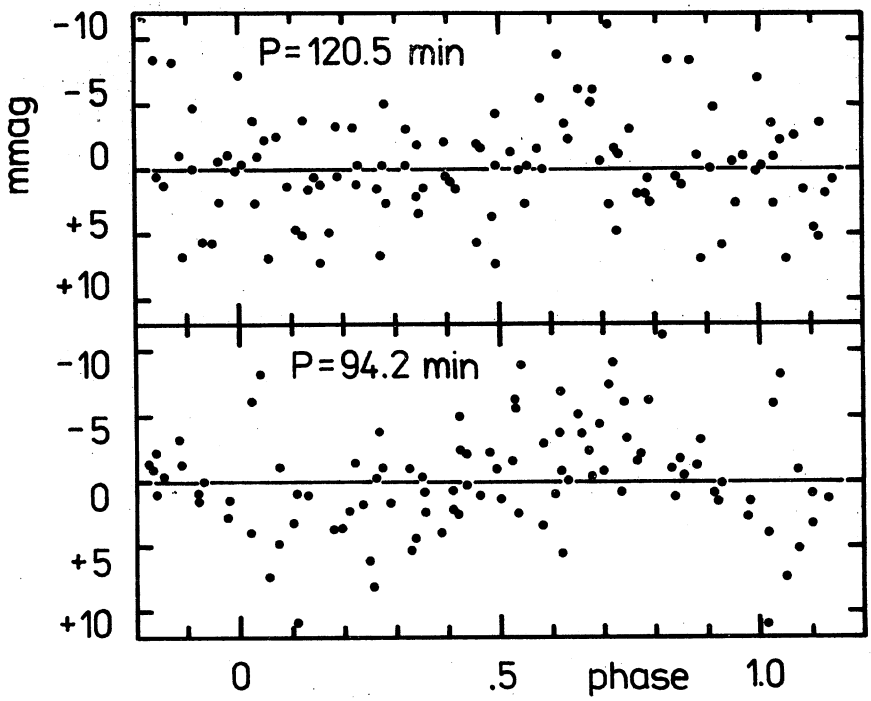

Fig. 2. The short period of 120 min (upper - PDM) and of 94 min (lower - FTT) after removing the period of 1.83736 d.

3. CONSIDERATIONS ON PERIODICITIES

We have already mentioned above the inauspicious influence of scarcely covered observation period upon the results of period analyses. The unique value of the rotation period can not be derived due to the complicated pattern of the spectral window. Since our night averages do not fit any of the periods published we subjected the observations to period analyses. Three methods were employed: (1) the Morbey's method (1978), (2) Fourier analysis (FTT) according to Deeming (1975) using the efficient algorythm by Kurtz (1985), and (3) the phase dispersion minimization (PDM) method of Stellingwerf (1978). The best period for the rotation is P_{rot} = 1.83736 d of a sine-semiamplitude 9.4±1.8 mmag (Fig. 1). This value is nearly double the one derived by Weiss et al. (1980), P = 0.9178 d, which, of course, does not agree with our data. Two additional but less significant periods are indicated, first, P = 2.178 d close to that of Bahner and Mavridis (1957) and Catalano and Blanco (1980), P = 2.1953 d, and the second, P = 3.5 d, both with a lower amplitude and a higher scatter.

The FTT and PDM methods were used to look at short period variations. Five-measurement cycle averages were applied as input data. Periodicities of the order of 10 mins were indicated on individual nights. However, the duration of the runs was not long enough for the exact period to be determined, nor does the time sequence allow the transiency of the frequencies indicated to be monitored. Periodicities of 72 to 126 mins proved to be the most persistent, on 6 nights. On five nights a periodicity of 14 - 15 mins occured, on on three nights a periodicity of 31 - 44 mins. Our observations thus fit the diversity pattern in the period spectrum as known from previous observations. The new feature is the existence of the 1.5 h periodicity, close to the expected fundamental period of radial oscillations. This attracts attention and deserves further study. The period analysis of the complete data of 8 nights leads to the following values: the FTT results in values of practically equal significance, 89 and 94 min, the PDM method yields 120 min (Fig. 3) and admits a less significant value of 95 min. This, of course, should be considered from the point of view that the FTT method, as distinct from the PDM, is suitable mainly if the studied variations are of sinusoidal form.

TABLE 3 * ORIGINAL DATA * JD = 2 440 000 + TIME * DM = 18 COM - 21 COM

TIME	DM	TIME	DM	TIME	DM
1978 FEB 6					
3545.6804	0.164	3545.6812	0.163	3545.6819	0.162
3545.6826	0.162	3545.6833	0.160	3545.6865	0.155
3545.6875	0.161	3545.6880	0.156	3545.6887	0.162
3545.6897	0.157	3545.6904	0.158	3545.6951	0.165
3545.6958	0.167	3545.6963	0.170	3545.6970	0.161
3545.6978	0.166	3545.7019	0.175	3545.7026	0.176
3545.7034	0.172	3545.7041	0.166	3545.7046	0.177
3545.7085	0.173	3545.7095	0.174	3545.7102	0.169
3545.7112	0.173	3545.7119	0.179		

TABLE 3 * ORIGINAL DATA - CONTINUED

TIME	DM	TIME	DM	TIME	DM
1978 MAY 18					
3647.3826	0.170	3647.3835	0.184	3647.3843	0.186
3647.3850	0.188	3647.3855	0.189	3647.3879	0.159
3647.3887	0.174	3647.3894	0.186	3647.3901	0.178
3647.3909	0.188	3647.3977	0.156	3647.3984	0.166
3647.3989	0.175	3647.3997	0.168	3647.4004	0.187
3647.4011	0.196	3647.4033	0.170	3647.4041	0.172
3647.4048	0.185	3647.4053	0.181	3647.4060	0.169
3647.4082	0.168	3647.4087	0.181	3647.4109	0.190
3647.4128	0.168	3647.4138	0.173	3647.4485	0.191
3647.4492	0.179	3647.4497	0.179	3647.4504	0.161
3647.4512	0.169	3647.4534	0.169	3647.4541	0.177
3647.4546	0.183	3647.4553	0.194	3647.4561	0.182
3647.4583	0.160	3647.4590	0.173	3647.4595	0.167
3647.4602	0.164	3647.4609	0.166	3647.4631	0.178
3647.4639	0.166	3647.4646	0.171	3647.4651	0.166
3647.4658	0.164	3647.4702	0.174	3647.4707	0.174
3647.4714	0.183	3647.4722	0.174	3647.4729	0.176
3647.4812	0.160	3647.4817	0.174	3647.4824	0.177
3647.4832	0.183	3647.4839	0.181	3647.4907	0.178
3647.4915	0.170	3647.4922	0.167	3647.4929	0.169
3647.4934	0.177				
1978 MAY 19					
3648.4504	0.150	3648.4512	0.155	3648.4519	0.158
3648.4526	0.155	3648.4546	0.152	3648.4553	0.158
3648.4568	0.154	3648.4575	0.155	3648.4595	0.167
3648.4602	0.164	3648.4609	0.161	3648.4617	0.161
3648.4624	0.151	3648.4629	0.159	3648.4756	0.153
3648.4763	0.158	3648.4785	0.175	3648.4790	0.181
3648.4797	0.177	3648.4805	0.173	3648.4832	0.166
3648.4839	0.172	3648.4846	0.168	3648.4854	0.174
3648.4873	0.155	3648.4880	0.157	3648.4888	0.166
3648.4895	0.168	3648.4900	0.174	3648.4922	0.172
3648.4929	0.171	3648.4934	0.173	3648.4944	0.164
3648.4951	0.172	3648.4956	0.163	3648.4978	0.163
3648.4985	0.168	3648.4993	0.170	3648.4998	0.174
3648.5005	0.172	3648.5027	0.169	3648.5034	0.171
3648.5039	0.172	3648.5046	0.186	3648.5054	0.178
3648.5076	0.187	3648.5083	0.178	3648.5088	0.173
3648.5095	0.173	3648.5103	0.177	3648.5110	0.171
3648.5132	0.159	3648.5139	0.162	3648.5144	0.156
3648.5151	0.162	3648.5159	0.168	3648.5186	0.168
3648.5193	0.154	3648.5200	0.166	3648.5208	0.176
3648.5215	0.183	3648.5249	0.185	3648.5254	0.174
3648.5261	0.187	3648.5269	0.170	3648.5276	0.169
1979 FEB 27					
3931.5972	0.156	3931.5981	0.159	3931.5989	0.158
3931.5996	0.161	3931.6003	0.162	3931.6016	0.162
3931.6023	0.166	3931.6028	0.170	3931.6035	0.168
3931.6042	0.166	3931.6062	0.170	3931.6069	0.169
3931.6077	0.171	3931.6084	0.174	3931.6091	0.170
3931.6099	0.174	3931.6106	0.169	3931.6111	0.172
3931.6118	0.168	3931.6125	0.162	3931.6133	0.167
3931.6140	0.159	3931.6162	0.171	3931.6167	0.168
3931.6174	0.164	3931.6184	0.164	3931.6189	0.164
3931.6196	0.163	3931.6204	0.164	3931.6211	0.167

TABLE 3 * ORIGINAL DATA - CONTINUED

TIME	DM	TIME	DM	TIME	DM
3931.6218	0.168	3931.6223	0.161	3931.6245	0.160
3931.6252	0.166	3931.6260	0.161	3931.6267	0.164
3931.6272	0.162	3931.6279	0.157	3931.6287	0.156
3931.6294	0.161	3931.6299	0.161	3931.6306	0.160
3931.6328	0.164	3931.6335	0.170	3931.6343	0.170
3931.6350	0.166	3931.6362	0.157	3931.6370	0.161
3931.6377	0.167	3931.6384	0.164	3931.6392	0.165
3931.6399	0.161	3931.6406	0.167	3931.6426	0.174
3931.6433	0.166	3931.6440	0.166	3931.6448	0.170
3931.6455	0.171	3931.6460	0.171	3931.6470	0.167
3931.6475	0.171	3931.6482	0.163	3931.6487	0.169
3931.6494	0.170	3931.6501	0.173	3931.6523	0.165
3931.6531	0.164	3931.6538	0.169	3931.6543	0.165
3931.6550	0.162	3931.6558	0.166	3931.6565	0.162
3931.6570	0.160	3931.6575	0.163	3931.6580	0.166
3931.6587	0.160	3931.6594	0.166	3931.6602	0.165
3931.6621	0.176	3931.6628	0.171	3931.6638	0.177
3931.6643	0.174	3931.6650	0.174	3931.6655	0.170
3931.6663	0.166	3931.6670	0.172	3931.6716	0.173
3931.6736	0.173	3931.6743	0.170	3931.6750	0.171
3931.6758	0.171	3931.6765	0.172	3931.6770	0.174
3931.6777	0.171	3931.6785	0.167	3931.6792	0.170
3931.6797	0.170	3931.6819	0.159	3931.6826	0.164
3931.6836	0.169	3931.6846	0.173	3931.6853	0.170
3931.6860	0.170	3931.6868	0.171	3931.6875	0.165
1979 APR 4					
3967.5403	0.174	3967.5410	0.176	3967.5420	0.177
3967.5427	0.182	3967.5435	0.178	3967.5459	0.187
3967.5466	0.190	3967.5476	0.186	3967.5486	0.185
3967.5493	0.177	3967.5520	0.184	3967.5527	0.186
3967.5535	0.186	3967.5542	0.188	3967.5549	0.175
3967.5630	0.175	3967.5637	0.176	3967.5647	0.174
3967.5657	0.187	3967.5667	0.184	3967.5693	0.179
3967.5703	0.179	3967.5710	0.174	3967.5718	0.168
3967.5728	0.170	3967.5757	0.170	3967.5769	0.176
3967.5776	0.170	3967.5786	0.174	3967.5793	0.175
3967.5820	0.191	3967.5833	0.199	3967.5850	0.193
3967.5859	0.191	3967.5869	0.190	3967.5894	0.185
3967.5903	0.182	3967.5913	0.182	3967.5923	0.180
3967.5930	0.174	3967.6033	0.201	3967.6040	0.190
3967.6050	0.189	3967.6057	0.188	3967.6079	0.189
3967.6106	0.202	3967.6118	0.194	3967.6128	0.198
3967.6135	0.204	3967.6162	0.186	3967.6172	0.186
3967.6179	0.183	3967.6189	0.183	3967.6196	0.182
3967.6230	0.194	3967.6238	0.198	3967.6252	0.191
3967.6262	0.192	3967.6270	0.175	3967.6294	0.181
3967.6301	0.185	3967.6311	0.185	3967.6318	0.194
3967.6328	0.206				
1979 APR 8					
3972.4106	0.168	3972.4116	0.171	3972.4126	0.187
3972.4136	0.178	3972.4146	0.180	3972.4170	0.167
3972.4180	0.167	3972.4189	0.171	3972.4202	0.173
3972.4209	0.173	3972.4233	0.176	3972.4246	0.168
3972.4255	0.179	3972.4265	0.171	3972.4272	0.177
3972.4297	0.176	3972.4307	0.179	3972.4316	0.183

TABLE 3 * ORIGINAL DATA - CONTINUED

TIME	DM	TIME	DM	TIME	DM
3972.4326	0.175	3972.4336	0.184	3972.4358	0.189
3972.4368	0.174	3972.4375	0.176	3972.4382	0.166
3972.4392	0.172	3972.4478	0.179	3972.4485	0.189
3972.4495	0.179	3972.4502	0.186	3972.4512	0.181
3972.4536	0.177	3972.4546	0.178	3972.4556	0.179
3972.4597	0.163	3972.4604	0.163	3972.4612	0.171
3972.4619	0.170	3972.4626	0.174	3972.4646	0.171
3972.4653	0.166	3972.4661	0.164	3972.4668	0.162
3972.4675	0.171	3972.4695	0.164	3972.4705	0.165
3972.4717	0.166	3972.4727	0.168	3972.4751	0.174
3972.4758	0.172	3972.4766	0.169	3972.4773	0.160
3972.4780	0.173	3972.4805	0.162	3972.4814	0.168
3972.4822	0.166	3972.4832	0.170	3972.4868	0.165
3972.4875	0.169	3972.4883	0.173	3972.4893	0.173
3972.4900	0.171	3972.4922	0.170	3972.4929	0.169
3972.4946	0.166	3972.4956	0.169	3972.4978	0.170
3972.4985	0.169	3972.4995	0.171	3972.5002	0.170
3972.5012	0.172				
1979 MAY 14					
4008.3535	0.173	4008.3545	0.193	4008.3555	0.178
4008.3564	0.163	4008.3574	0.166	4008.3640	0.175
4008.3647	0.185	4008.3657	0.180	4008.3665	0.171
4008.3674	0.190	4008.3699	0.165	4008.3706	0.158
4008.3716	0.168	4008.3723	0.207	4008.3733	0.197
4008.3765	0.165	4008.3772	0.172	4008.3779	0.168
4008.3787	0.158	4008.3794	0.164	4008.3821	0.173
4008.3828	0.191	4008.3838	0.170	4008.3845	0.180
4008.3872	0.174	4008.3909	0.173	4008.3918	0.188
4008.3926	0.197	4008.3933	0.188	4008.3943	0.171
4008.3972	0.176	4008.3982	0.183	4008.3989	0.187
4008.3999	0.188	4008.4009	0.190	4008.4089	0.174
4008.4099	0.178	4008.4109	0.177	4008.4119	0.175
4008.4128	0.170	4008.4153	0.168	4008.4163	0.175
4008.4175	0.171	4008.4185	0.169	4008.4192	0.174
4008.4221	0.168	4008.4231	0.167	4008.4238	0.165
4008.4246	0.165	4008.4258	0.175		
1979 JUN 3					
4028.3677	0.195	4028.3684	0.190	4028.3689	0.158
4028.3696	0.183	4028.3704	0.178	4028.3726	0.185
4028.3733	0.167	4028.3738	0.183	4028.3745	0.191
4028.3752	0.182	4028.3772	0.164	4028.3779	0.186
4028.3787	0.175	4028.3794	0.162	4028.3801	0.159
4028.3828	0.159	4028.3835	0.159	4028.3843	0.171
4028.3850	0.183	4028.3855	0.180	4028.3877	0.190
4028.3884	0.197	4028.3892	0.186	4028.3899	0.183
4028.3904	0.167	4028.3926	0.191	4028.3933	0.189
4028.3940	0.184	4028.3948	0.185	4028.3955	0.192
4028.3982	0.194	4028.3987	0.185	4028.3994	0.198
4028.4001	0.180	4028.4009	0.183	4028.4031	0.183
4028.4038	0.170	4028.4043	0.179	4028.4050	0.171
4028.4058	0.187	4028.4065	0.182	4028.4092	0.183
4028.4099	0.186	4028.4106	0.190	4028.4114	0.190
4028.4121	0.196	4028.4141	0.175	4028.4148	0.182
4028.4155	0.181	4028.4163	0.187	4028.4170	0.184
4028.4189	0.186	4028.4197	0.185		

TABLE 3 * ORIGINAL DATA - CONTINUED

TIME	DM	TIME	DM	TIME	DM
4028.4204	0.193	4028.4209	0.187	4028.4216	0.189
4028.4246	0.175	4028.4253	0.179	4028.4258	0.174
4028.4265	0.185	4028.4272	0.191	4028.4292	0.178
4028.4299	0.175	4028.4307	0.193	4028.4314	0.197
4028.4321	0.183	4028.4348	0.187	4028.4355	0.188
4028.4363	0.193	4028.4375	0.174	4028.4397	0.185
4028.4404	0.182	4028.4412	0.186	4028.4419	0.171
4028.4424	0.189	4028.4448	0.196	4028.4458	0.186
4028.4465	0.193	4028.4473	0.185	4028.4480	0.184
4028.4502	0.186	4028.4507	0.182	4028.4514	0.182
4028.4521	0.184	4028.4529	0.184	4028.4551	0.185
4028.4556	0.185	4028.4563	0.183	4028.4570	0.181
4028.4578	0.171	4028.4597	0.182	4028.4604	0.180
4028.4612	0.185	4028.4619	0.183	4028.4626	0.181

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