SECULAR DECREASE IN THE BRIGHTNESS OF SHORT-PERIOD COMETS

J. Svoreň
Astronomical Institute of the Slovak Academy of Sciences, Skalnaté Pleso Observatory, 059 60 Tatranská Lomnica, Czecho-Slovakia

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ABSTRACT. Secular changes in the absolute brightness of short-period comets are investigated on the basis of their maximum apparent magnitudes in individual returns. The sample contains 405 observed returns of 61 short-period comets. It is found that the data on the maximum apparent brightness are affected by systematic errors. Omission of the discovery apparitions and of estimates of the brightness of the nuclear condensation lead to considerably lower values of the secular decrease. For all the comets of Jupiter family, the weighted average of the secular brightness decrease was found to be + 0.05 magnitude per revolution, i.e. approximately 0.6 magnitude per century. This value corresponds to a mean total active lifetime of about 90 revolutions. It was confirmed that the secular brightness decrease is conspicuously more rapid for comets with longer orbital periods, comets fainter in maximum and comets with longer perihelion distances.

1. INTRODUCTION

The secular variations in the brightness are important quantitative indicators of cometary evolution and their lifetimes in the region of terrestrial planets. Progressive loss of mass, associated with a brightness decrease, and gravitational capture from outer orbits are basic factors determining the quasi-equilibrium state of short-period cometary population. Determination of the rate of aging of short-period comets, along with a better knowledge of the perturbational capture mechanism, is the only way to answer the fundamental question about the rate of replenishment of comets in the inner Solar System. As pointed out Meech (1990) in her very valuable and exhaustive review paper the better understanding of physical aging in comets depends on sufficient amount of systematic data sets. This paper is one of attempts to present the relevant data.

Our approach differs from that of some other studies of this problem in not introducing instrumental corrections. Instead, the changes of the maximum apparent brightness in individual returns reduced to a unit distance from the Sun and Earth are investigated. The application of the maximum brightness is of certain advantage, because this value was less influenced by the development of the instrumental equipment, and by the variety of photometric methods (Kresák, 1965). Vsekhsvyatsky's catalogue of physical characteristics of comets (Vsekhsvyatsky, 1958) was the main source of reference; for the period after 1958 other sources were used, processed by the same method. These were mainly Vsekhsvyatsky's Supplements, Porter's and Marsden's Annual Reports on Comets, and photometric data from the IAU Circulars, Minor Planet Circulars and International Comet Quarterly.

2. OBSERVATIONAL DATA AND METHOD OF PROCESSING

The present paper deals with periodic comets of Jupiter family observed by December 31, 1987 in three returns at least. P/Encke, investigated in detail by many authors (Kresák, 1965; Vanýsek, 1965; Kamél, 1990), has not been included. Our sample thus contains following objects (the numbers of observed returns are given in parentheses):

Pons-Winnecke (19)
Faye (18)
Tempel 2 (17)
Grigg-Skjellerup (16)
D'Arrest (14)
Brooks 2 (13)
Wolf (13)
Kopff (12)
Borrelly (11)
Giacobini-Zinner (11)
Finlay (10)
Schwassmann-Wachmann 2 (10)
Tuttle (10)
Whipple (9)
Comas Solá (8)
Schaumasse (8)
Daniel (7)
Forbes (7)
Holmes (7)
Honda-Mrkos-Pajdušáková (7)
Reinmuth 1 (7)
Reinmuth 2 (7)
Tempel 1 (7)
Wolf-Harrington (7)
Arend-Rigaux (6)
Ashbrook-Jackson (6)
Biela (6)
Johnson (6)
Tuttle-Giacobini-Kresák (6)
Wirtanen (6)
Arend (5)
Brorsen (5)
Crommelin (5)
Harrington-Abell (5)
Neujmin 1 (5)
Perrine-Mrkos (5)
Väisälä 1 (5)
Gunn (4)
Harrington (4)
Jackson-Neujmin (4)
Shajn-Schaldach (4)
Tempel-Swift (4)
Tsuchinshan 1 (4)
Tsuchinshan 2 (4)
Clark (3)
Du Toit-Hartley (3)
Du Toit-Neujmin-Delporte (3)
Churyumov-Gerasimenko (3)
Kearns-Kwee (3)
Klemola (3)
Kohoutek (3)
Kojima (3)

Neujmin (3)
Oterma (3)
Slaughter-Burnham (3)
Smirnova-Chernykh (3)
Swift-Gehrels (3)
Taylor (3)
Van Biesbroeck (3)
De Vico-Swift (3)
West-Kohoutek-Ikemura (3)

41 comets of the sample were included in a previous paper (Svoreň, 1979) too. Not only an extended observational period (additional 13 years) but also more accurate heliocentric and geocentric distances obtained by calculation from the Catalogue of Cometary Orbits (Marsden, 1989), were used. It was noted (Kresák, 1987) that some distances given by Vsekhsvyatsky are inaccurate, being based on preliminary or incorrect ephemerides.

For all the apparitions the maximum apparent magnitudes M_m were collected. The absolute magnitudes M_{42} were obtained assuming a photometric exponent equals to 4.

For each apparition of a comet it was stated whether the comet was rediscovered independently, or according to an ephemeris. Pittich (1971) pointed out that independent discoveries are much more probable after a sudden increase of brightness. Next, the values of M_E, M_T and M_R were determined. The following apparitions were omitted in computing them: the discovery and independent rediscovery apparitions for M_E (85 cases omitted), the brightness estimates referring to the central condensation for M_T (39) and both of these cases for M_R (123). Absolute magnitudes referring to the nuclear condensation may occur in calculating secular changes of M_R and M_T, because they were discarded only if this was explicitly mentioned by the observer. All other values, regardless of the size of the instrument used, were taken into account in calculating M_R and M_T.

3. THE SECULAR CHANGES IN ABSOLUTE MAGNITUDES OF INDIVIDUAL COMETS

The successive columns in Tables 1-61 include

n - the serial number of the observed return,

N - the serial number of the return, regardless of unobserved returns,

Comet - definitive designation,

T - the date of perihelion passage (the first two figures denote the day and the next the month),

t - the date of observation of maximum brightness (the first two figures denote the day, the next the month and year, respectively),

t-T - the difference between the date of observation and the date of perihelion passage, in days,

r - the heliocentric distance,

d - the geocentric distance,

M_m - the maximum apparent magnitude,

M'_{42} - the absolute magnitude derived assuming a photometric exponent equals to 4,

M_{42} - the average value of M'_{42}, in case that the same maximum apparent magnitude was estimated several times,

M_R - the absolute magnitude M_{42}, if the comet was recovered according to an ephemeris, and the magnitude did not refer to the nuclear condensation only (capital letter J indicates the magnitude of the nuclear condensation and capital letter N an independent discovery).

The secular variations of the absolute brightness were determined by a least square solution, assuming a linear dependence of the magnitude on time. After the tables mean annual changes are given together with the respective coefficients of correlation r (in brackets).

Table 1 - P/Pons-Winnecke magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	$*M_R$
1	1	1819 III	1907	150719	-004	0.776	0.462	6.0	8.8	8.8	N
2	8	1858 II	0205	150458	-017	0.824	0.644	6.5	8.3	8.3	N
3	10	1869 I	3006	080569	-053	1.157	0.566	7.0	7.6	7.6	7.6
4	11	1875 I	1203	090275	-031	0.970	1.364	7.5	7.0	7.0	7.0
5	13	1886 VI	0409	250886	-010	0.902	1.123	8.5	8.7	8.7	8.7
6	14	1892 IV	0107	210692	-010	0.901	0.214	6.5	10.3	10.3	10.3
7	15	1898 II	2003	110298	-037	1.081	1.384	12.0	11.0	11.0	11.0
8	17	1909 II	0910	081209	+060	1.280	1.738	9.5	7.2	7.2	7.2
9	18	1915 III	0209	281015	+056	1.245	1.172	9.3	8.0	8.0	8.0
10	19	1921 III	1306	140621	+001	1.041	0.142	6.9	11.0	11.0	11.0
11	20	1927 VII	2106	240627	+003	1.040	0.045	3.7	10.3	10.3	10.3
12	21	1933 II	1805	230633	+036	1.197	0.619	9.5	9.8	9.8	9.8
13	22	1939 V	2206	270639	+005	1.103	0.113	6.2	10.5	10.5	10.5
14	23	1945 IV	1007	070645	-033	1.237	0.552	11.4	11.8	11.8	11.8
15	24	1951 VI	0809	200851	-019	1.188	1.414	14.0	12.5	12.5	12.5
16	26	1964 I	2403	210364	-003	1.231	1.477	14.5	12.8	12.8	12.8
17	27	1970 VIII	2107	020770	-019	1.269	0.658	15.0	14.9	14.9	J
18	28	1976 XIV	2811	250376	-248	2.810	2.147	21.0	14.9	14.9	J
19	29	1983 IV	0704	240583	+047	1.374	1.253	11.9	10.0	10.0	10.0

Secular brightness of P/Pons-Winnecke (Fig. 1):

$M_{42}(t) = 6.5 + 0.038\ (t-1819.537)$ (r = 0.71)

$M_T\ (t) = 7.3 + 0.027\ (t-1819.537)$ (r = 0.63)

$M_E\ (t) = 7.5 + 0.051\ (t-1869.351)$ (r = 0.76)

$M_R\ (t) = 8.0 + 0.037\ (t-1869.351)$ (r = 0.66)

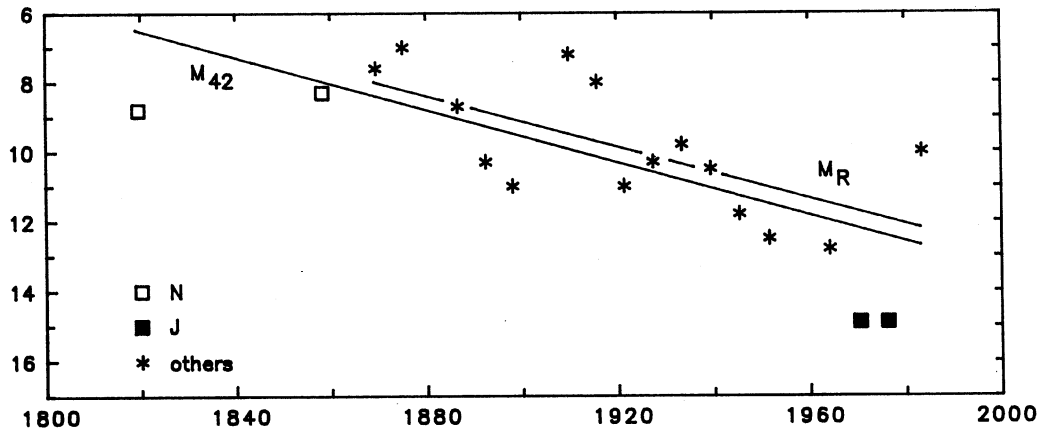

Fig. 1. P/Pons–Winnecke

Table 2 - P/Faye magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1843 III	1710	251143	+039	1.734	0.787	5.8	3.9	3.9	N
2	2	1851 I	0204	240151	-068	1.825	2.347	9.5	5.0	5.1	5.1
				270151	-065	1.815	2.358	9.5	5.0		
				040351	-029	1.724	2.476	9.5	5.2		
3	3	1858 V	1309	150958	+002	1.694	1.451	10.5	7.4	7.4	7.4
4	4	1866 II	1402	121265	-064	1.797	1.638	9.5	5.9	5.9	5.9
5	5	1873 III	1807	030973	+047	1.742	2.077	11.5	7.5	7.4	7.4
				291173	+134	2.105	1.622	11.5	7.2		
6	6	1881 I	2301	020880	-174	2.355	1.533	10.5	5.9	6.9	6.9
				280980	-117	2.057	1.095	10.5	7.2		
				081080	-107	2.011	1.092	10.5	7.3		
				011180	-083	1.910	1.159	10.5	7.4		
				220181	-001	1.738	1.719	10.5	6.9		
7	7	1888 IV	2008	040289	+168	2.324	1.405	9.5	5.1	5.1	5.1
8	8	1896 II	1903	211095	-150	2.225	1.660	11.5	6.9	6.9	6.9
9	10	1910 V	0211	081110	+006	1.656	0.678	9.5	8.2	8.2	N
10	12	1925 V	0708	201025	+074	1.778	1.567	13.0	9.5	9.5	9.5
11	13	1932 IX	0612	221032	-045	1.684	0.715	9.5	8.0	8.0	8.0
12	14	1940 II	2404	141239	-132	2.093	2.448	15.0	9.8	9.9	9.9
				040140	-111	1.982	2.525	15.0	10.0		
13	15	1947 IX	2809	201247	+083	1.851	0.899	10.0	7.6	7.6	7.6
14	16	1955 II	0403	241254	-070	1.795	1.942	15.0	11.0	11.0	11.0
15	17	1962 VII	1405	031161	-192	2.434	2.518	17.8	11.9	11.9	11.9
16	18	1969 VI	0710	011269	+055	1.708	0.752	10.4	8.7	8.7	8.7
17	19	1977 IV	2702	110177	-047	1.682	2.030	12.5	8.7	8.7	8.7
18	20	1984 XI	0907	290884	+051	1.675	2.056	12.0	8.2	8.2	8.2

Secular brightness of P/Faye (Fig. 2):

$M_{42}(t) = M_T(t) = 5.4 + 0.034\ (t-1843.901)$ (r = 0.76)

$M_R(t) = M_E(t) = 6.0 + 0.030\ (t-1851.104)$ (r = 0.71)

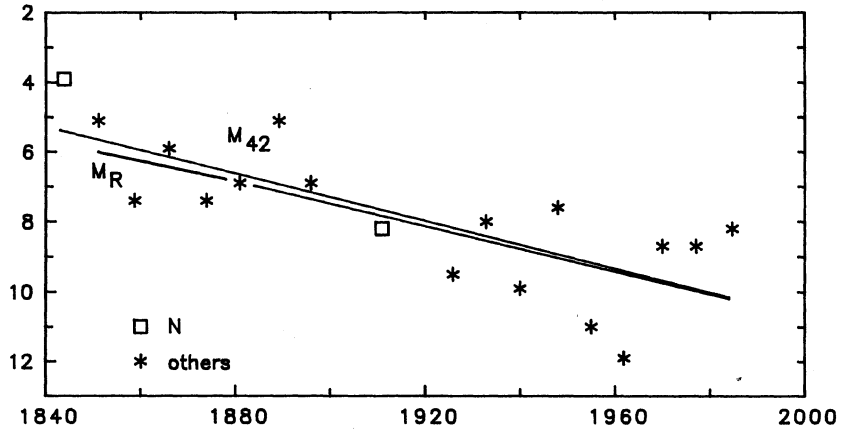

Fig. 2. P/Faye

Table 3 - P/Tempel 2 magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1873 II	2506	050773	+010	1.348	0.693	8.5	8.0	8.0	N
2	2	1878 III	0709	151078	+038	1.401	1.039	6.5	5.0	5.0	5.0
3	5	1894 III	2304	170594	+024	1.374	1.673	10.5	8.0	8.0	8.0
4	6	1899 IV	2907	190799	-010	1.393	0.382	8.5	9.2	9.2	9.2
5	7	1904 III	1011	301004	+020	1.394	1.823	12.5	9.8	9.8	9.8
6	9	1915 I	1404	160515	+032	1.363	1.802	12.5	9.9	9.9	9.9
				200515	+036	1.375	1.801	12.5	9.8		
7	10	1920 II	1006	200720	+040	1.386	0.912	9.0	7.8	7.8	7.8
8	11	1925 IV	0708	310725	-007	1.316	0.322	6.6	7.9	7.9	7.9
9	12	1930 VII	0510	151030	+010	1.323	1.299	10.0	8.2	8.2	8.2
10	15	1946 III	0207	270746	+025	1.418	0.659	8.0	7.4	7.3	7.3
				300846	+059	1.525	0.639	8.0	7.1		
11	16	1951 VIII	2510	311051	+006	1.393	1.600	12.0	9.5	9.4	9.4
				251151	+031	1.430	1.731	12.0	9.3		
12	17	1957 II	0502	050556	-276	2.820	2.054	19.0	12.9	12.9	12.9
13	18	1962 VI	1205	050562	-007	1.367	1.558	12.5	10.2	10.2	10.2
14	19	1967 X	1408	040967	+021	1.385	0.500	7.8	7.9	7.9	7.9
15	20	1972 X	1511	160572	-183	2.247	1.388	18.2	14.0	14.0	J
16	21	1978 V	2002	270377	-330	3.121	2.152	19.5	12.9	12.9	J
17	22	1983 X	0106	070783	+036	1.433	1.138	8.2	6.4	6.4	6.4

Secular brightness of P/Tempel 2 (Fig. 3):

$M_{42}(t) = 7.3 + 0.031\ (t-1873.510)$ $(r = 0.45)$

$M_T(t) = 7.8 + 0.013\ (t-1873.510)$ $(r = 0.23)$

$M_E(t) = 7.2 + 0.034\ (t-1878.789)$ $(r = 0.45)$

$M_R(t) = 7.9 + 0.013\ (t-1878.789)$ $(r = 0.22)$

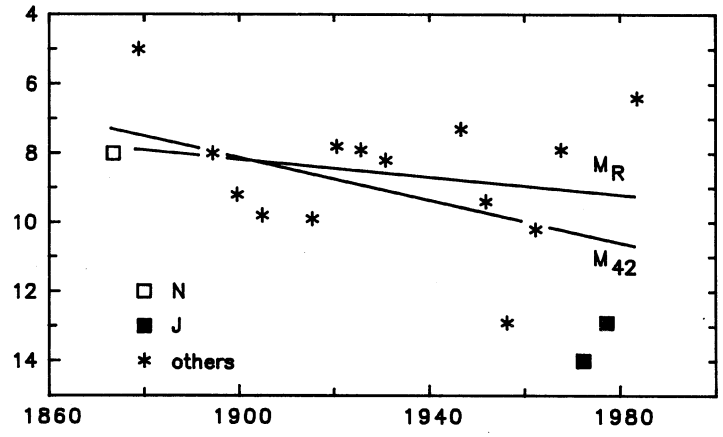

Fig. 3. P/Tempel 2

Table 4 - P/Grigg-Skjellerup magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1808 III	1503	060208	-038	0.990	0.117	7.5	12.2	12.2	N
				090208	-035	0.959	0.124	7.5	12.2		
2	20	1902 II	0307	220702	+019	0.815	0.828	9.5	10.8	10.7	N
				030802	+031	0.908	0.754	9.5	10.5		
3	24	1922 I	1505	290522	+014	0.912	0.311	10.0	12.9	12.9	N
4	25	1927 V	1005	010627	+022	0.951	0.205	8.5	12.2	12.2	12.2
5	26	1932 II	1205	300532	+018	0.944	0.259	9.5	12.7	12.7	12.7
6	27	1937 III	2305	030537	-020	0.956	0.669	12.0	13.1	13.1	13.1
7	28	1942 V	2305	150642	+023	0.925	0.349	9.1	11.7	11.7	11.7
8	29	1947 II	1804	180447	000	0.853	0.169	9.0	13.6	13.6	13.6
9	30	1952 IV	1103	210452	+041	1.056	1.001	11.2	11.0	11.0	11.0
10	31	1957 I	0202	060157	-027	0.955	1.066	13.0	13.1	13.1	13.1
11	32	1961 IX	3112	150162	+015	0.887	1.618	13.5	13.0	13.0	13.0
12	33	1967 I	1601	191266	-028	1.078	1.496	16.0	14.8	14.8	14.8
13	34	1972 II	0203	260172	-036	1.122	0.862	15.5	15.3	15.3	15.3
14	35	1977 VI	1104	200477	+009	1.001	0.242	8.9	12.0	12.0	12.0
15	36	1982 IV	1405	160582	+002	0.989	0.368	9.3	11.5	11.5	11.5
16	37	1987 X	1806	150787	+027	1.062	0.866	11.0	11.1	11.1	11.1

Secular brightness of P/Grigg-Skjellerup (Fig. 4):

$M_{42}(t) = M_T(t) = 11.9 + 0.005\ (t-1808.105)$ (r = 0.16)

$M_R(t) = M_E(t) = 12.8 - 0.002\ (t-1927.416)$ (r = 0.04)

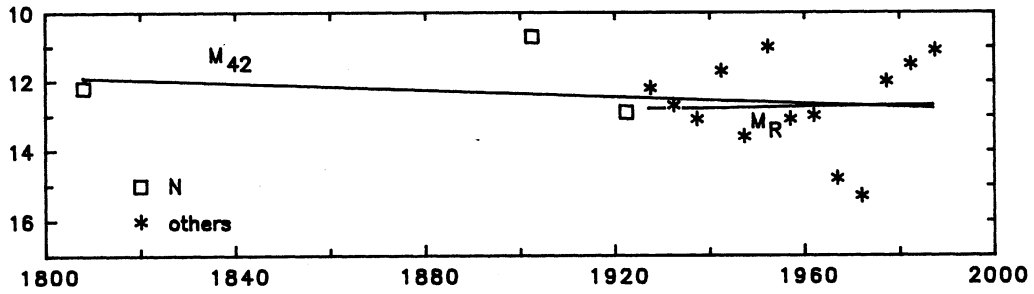

Fig. 4. P/Grigg-Skjellerup

Table 5 - P/D'Arrest magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1851 II	0907	280651	-011	1.182	0.711	10.0	10.0	9.6	N
				310851	+053	1.350	0.766	10.0	9.3		
2	2	1857 VII	2811	061257	+008	1.174	1.700	9.5	7.7	7.7	7.7
3	4	1870 III	2309	250970	+002	1.280	0.845	8.5	7.8	7.6	7.6
				181070	+025	1.315	0.934	8.5	7.5		
4	5	1877 IV	1005	090777	+060	1.487	1.595	10.0	7.3	7.3	7.3
5	7	1890 V	1809	171090	+029	1.364	0.907	9.5	8.4	8.4	N
6	8	1897 II	2305	280697	+036	1.389	1.418	10.0	7.8	7.8	7.8
7	10	1910 III	1609	231010	+037	1.343	0.849	10.5	9.6	9.6	9.6
8	12	1923 II	1509	101123	+056	1.498	1.150	11.0	8.9	8.9	8.9
9	15	1943 III	2209	041043	+012	1.392	0.955	13.0	11.7	11.7	11.7
10	16	1950 II	0606	210650	+015	1.388	1.244	10.5	8.6	8.6	8.6
11	18	1963 VII	2310	060164	+075	1.608	1.960	17.0	13.5	13.5	J
12	19	1970 VII	1805	080670	+021	1.196	1.477	11.0	9.4	9.0	9.0
				150770	+058	1.374	1.549	11.0	8.7		
13	20	1976 XI	1208	050876	-007	1.168	0.162	2.8	6.1	6.1	6.1
14	21	1982 VII	1409	210982	+007	1.294	0.758	7.9	7.4	7.4	7.4

Secular brightness of P/D'Arrest (Fig. 5):

$M_{42}(t) = 8.3 + 0.007\ (t-1851.578)$ (r = 0.18)

$M_T\ (t) = 8.5 - 0.001\ (t-1851.578)$ (r = 0.03)

$M_E\ (t) = 8.0 + 0.012\ (t-1857.932)$ (r = 0.25)

$M_R\ (t) = 8.1 + 0.003\ (t-1857.932)$ (r = 0.09)

Table 6 - P/Brooks 2 magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1889 V	3009	310889	-030	1.967	0.995	8.8	5.9	5.9	N
2	2	1896 VI	0411	080996	-057	2.018	1.037	10.5	7.4	7.4	7.4
				120996	-053	2.010	1.043	10.5	7.4		
3	3	1903 V	0612	191003	-048	2.001	1.453	12.5	8.7	8.7	8.7
4	4	1911 I	0801	280910	-102	2.139	1.586	15.5	11.2	11.2	11.2
5	6	1925 IX	0111	081025	-024	1.874	0.927	12.0	9.4	9.4	9.4
6	7	1932 VIII	0910	201032	+011	1.872	0.900	10.5	8.0	8.0	8.0
7	8	1939 VII	1509	071039	+022	1.881	0.918	12.5	9.9	9.9	9.9
8	9	1946 IV	2508	151146	+082	2.005	1.024	12.6	9.5	9.5	9.5
9	10	1953 V	0708	010953	+025	1.879	1.395	16.9	13.4	13.4	13.4
10	11	1960 VI	1706	040860	+048	1.817	2.028	17.8	13.7	13.7	13.7
11	13	1974 I	0301	030973	-122	2.125	1.221	18.7	15.0	15.0	J
12	14	1980 IX	2511	090980	-077	1.970	0.979	16.5	13.6	13.6	13.6
13	15	1987 XXIV	1610	181087	+002	1.845	0.873	12.4	10.0	10.0	10.0

Secular brightness of P/Brooks 2 (Fig. 6):

$M_{42}(t) = 7.3 + 0.063\ (t-1889.666)$ (r = 0.74)

$M_T\ (t) = 7.5 + 0.056\ (t-1889.666)$ (r = 0.71)

$M_E\ (t) = 8.2 + 0.056\ (t-1896.694)$ (r = 0.67)

$M_R\ (r) = 8.4 + 0.046\ (t-1896.694)$ (r = 0.62)

Table 7 - P/Wolf magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1884 III	1811	210984	-058	1.680	0.813	6.5	4.7	4.7	N
2	2	1891 II	0309	051191	+063	1.711	0.805	8.4	6.5	6.5	6.5
3	3	1898 IV	0507	160798	+011	1.607	1.939	11.0	7.5	7.5	7.5
				130998	+070	1.749	1.645	11.0	7.5		
4	5	1912 I	2402	160112	-039	1.636	2.243	12.0	8.1	8.1	8.1
5	6	1918 V	1312	231118	-020	1.597	1.256	9.5	7.0	7.0	7.0
6	7	1925 X	0811	280825	-072	2.486	1.588	14.5	9.5	9.5	9.5
7	8	1934 I	2702	250733	-217	2.856	2.006	18.0	11.9	11.9	11.9
8	9	1942 VI	2306	061142	+136	2.611	1.640	18.6	13.4	13.4	13.4
9	10	1950 VI	2310	021150	+010	2.498	1.716	18.0	12.9	12.9	12.9
10	11	1959 II	2103	130658	-281	3.099	2.434	20.4	13.6	13.6	13.6
11	12	1967 XII	3008	051067	+036	2.518	1.529	18.0	13.1	12.3	J
				190168	+142	2.682	2.611	18.0	11.6		
12	13	1976 II	2501	170575	-253	3.000	2.781	21.0	14.0	14.0	J
13	14	1984 IX	3105	010883	-304	3.142	2.371	20.0	13.2	13.2	J

Secular brightness of P/Wolf (Fig. 7):

$M_{42}(t) = 5.8 + 0.092\ (t-1884.724)$ (r = 0.92)

$M_T\ (t) = 5.0 + 0.122\ (t-1884.724)$ (r = 0.95)

$M_E\ (t) = 6.8 + 0.086\ (t-1891.847)$ (r = 0.90)

$M_R\ (t) = 6.0 + 0.119\ (t-1891.847)$ (r = 0.93)

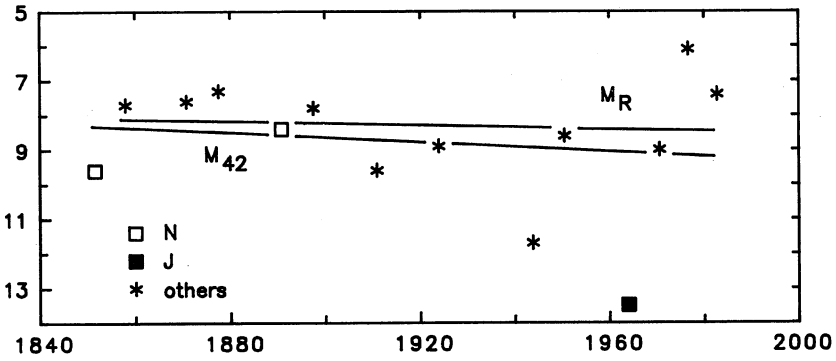

Fig. 5. P/D' Arrest

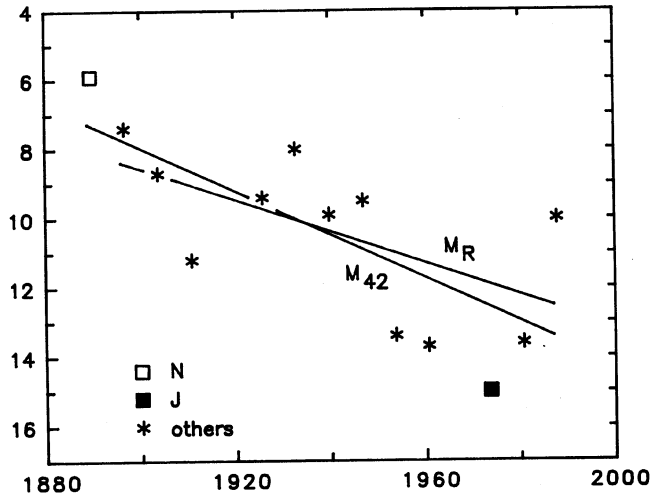

Fig. 6. P/Brooks 2

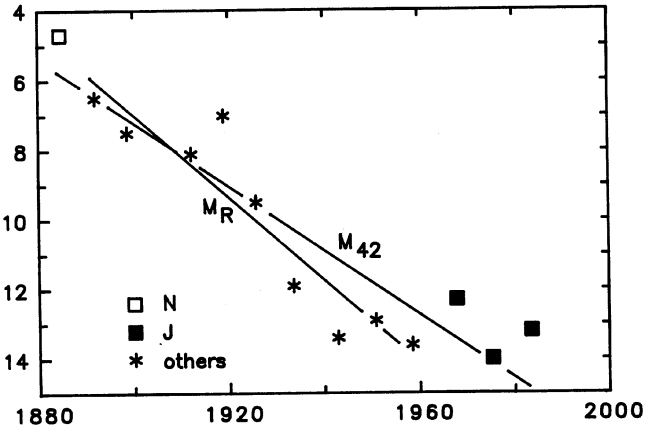

Fig. 7. P/Wolf

Table 8 - P/Kopff magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1906 IV	0305	230806	+112	1.987	1.024	10.5	7.5	7.5	N
2	3	1919 I	2806	260819	+059	1.792	0.899	9.0	6.7	6.7	6.7
3	4	1926 II	2801	130726	+166	2.255	2.100	16.0	10.9	10.7	10.7
				140926	+229	2.600	1.749	16.0	10.6		
4	5	1932 III	2108	230632	-059	1.779	0.886	11.5	9.3	9.3	9.3
5	6	1939 II	1303	220439	+040	1.725	2.062	13.0	9.1	8.9	8.9
				250639	+104	1.941	1.749	13.0	8.9		
				270839	+167	2.256	1.439	13.0	8.7		
6	7	1945 V	1108	050845	-006	1.497	0.836	8.6	7.2	7.2	7.2
7	8	1951 VII	2010	301051	+010	1.498	1.996	10.5	7.2	7.2	7.2
8	9	1958 I	2001	150858	+207	2.459	2.060	18.5	13.0	13.0	13.0
9	10	1964 III	1605	180564	+002	1.520	1.115	9.2	7.1	7.1	7.1
10	11	1970 XI	0210	270770	-067	1.706	1.483	16.8	13.6	13.6	J
11	12	1977 V	0703	120677	+097	1.835	1.874	15.0	11.0	11.0	J
12	13	1983 XIII	1008	160683	-055	1.671	0.728	7.1	5.6	5.6	5.6

Secular brightness of P/Kopff (Fig. 8):

$M_{42}(t) = 8.1 + 0.022\ (t-1906.644)$ $(r = 0.20)$

$M_T(t) = 8.8 - 0.013\ (t-1906.644)$ $(r = 0.13)$

$M_E(t) = 8.6 + 0.016\ (t-1919.652)$ $(r = 0.13)$

$M_R(t) = 9.2 - 0.029\ (t-1919.652)$ $(r = 0.25)$

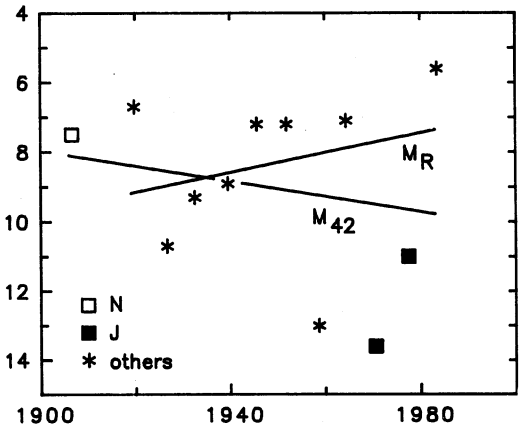

Fig. 8. P/Kopff

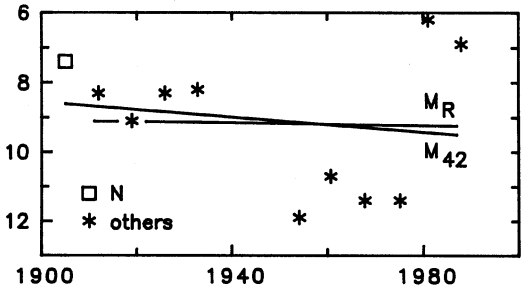

Fig. 9. P/Borrelly

Table 9 - P/Borelly magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1905 II	1701	080105	-009	1.399	0.965	8.8	7.4	7.4	N
2	2	1911 VIII	1812	251111	-023	1.428	0.529	8.5	8.3	8.3	8.3
3	3	1918 IV	1711	061218	+019	1.412	0.476	9.0	9.1	9.1	9.1
4	4	1925 VIII	0710	171125	+041	1.463	1.011	10.0	8.3	8.3	8.3
5	5	1932 IV	2708	280932	+032	1.432	1.699	11.0	8.3	8.2	8.2
				111032	+045	1.476	1.664	11.0	8.2		
6	8	1953 IV	0906	080254	+242	2.756	2.173	18.0	11.9	11.9	11.9
7	9	1960 V	1306	050960	+085	1.713	2.485	15.0	10.7	10.7	10.7
8	10	1967 VIII	1706	051067	+110	1.858	2.453	16.0	11.4	11.4	11.4
9	11	1974 VII	1205	230175	+256	2.861	2.607	18.0	11.4	11.4	11.4
10	12	1981 IV	2002	040181	-047	1.431	1.425	8.5	6.2	6.2	6.2
11	13	1987 XXXIII	1812	201287	+002	1.357	0.507	6.8	6.9	6.9	6.9

Secular brightness of P/Borrelly (Fig. 9):

$M_{42}(t) = M_T(t) = 8.6 + 0.011\ (t-1905.022)$ $(r = 0.16)$

$M_R(t) = M_E(t) = 9.1 + 0.002\ (t-1911.901)$ $(r = 0.03)$

Table 10 - P/Giacobini-Zinner magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1903 III	2811	201200	+022	0.987	0.844	10.5	10.8	10.8	N
2	3	1913 V	0211	181113	+016	1.002	0.508	8.5	10.0	10.0	N
3	5	1926 VI	1112	191226	+008	0.999	1.129	11.0	10.7	10.7	10.7
4	6	1933 III	1507	030733	-012	1.015	1.237	11.5	11.0	11.0	11.0
5	7	1940 I	1702	151039	+241	1.907	2.442	15.0	10.3	10.3	10.3
6	8	1946 V	1809	021046	+014	1.015	0.291	6.1	8.7	8.7	8.7
7	10	1959 VIII	2610	251059	-001	0.936	0.400	7.1	9.4	9.4	9.4
8	11	1966 I	2803	170965	-192	2.526	2.979	19.4	13.0	13.0	J
9	12	1972 VI	0408	110872	+007	0.998	0.958	8.8	8.9	8.9	8.9
10	13	1979 III	1202	031078	-132	1.975	2.418	18.5	13.6	13.6	J
11	14	1985 XIII	0509	180885	-018	1.060	0.513	7.2	8.4	8.5	8.5
				270885	-009	1.037	0.480	7.2	8.6		
				150985	+010	1.038	0.478	7.2	8.6		

Secular brightness of P/Giacobini-Zinner (Fig. 10):

$M_{42}(t) = 10.4 + 0.001\ (t-1900.970)$ $(r = 0.02)$

$M_T(t) = 11.0 - 0.028\ (t-1900.970)$ $(r = 0.80)$

$M_E(t) = 10.4 + 0.002\ (t-1926.967)$ $(r = 0.03)$

$M_R(t) = 10.6 - 0.040\ (t-1926.967)$ $(r = 0.84)$

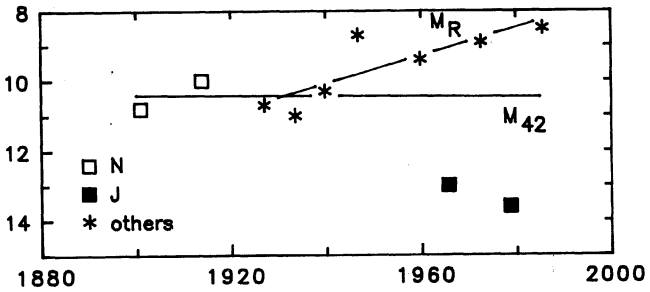

Fig. 10: P/Giacobini-Zinner

Table 11 - P/Finlay magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1886 VII	2211	011286	+009	1.005	0.852	8.0	8.3	8.3	N
2	2	1893 III	1207	240693	-018	1.026	1.189	8.5	8.0	8.0	8.0
3	4	1906 V	0809	270806	-012	0.984	0.318	5.0	7.6	7.6	7.6
4	6	1919 II	1510	131119	+029	1.089	0.218	8.5	11.4	11.2	N
				181119	+034	1.117	0.230	8.5	11.2		
				221119	+038	1.142	0.246	8.5	11.0		
5	7	1926 V	0708	150826	+008	1.066	0.931	11.0	10.9	10.9	10.9
6	11	1953 VII	2512	291253	+004	1.050	1.396	10.5	9.6	9.6	9.6
7	12	1960 VIII	0109	210860	-011	1.088	0.433	10.2	11.7	11.7	11.7
8	13	1967 IX	2807	070867	+010	1.089	1.074	14.0	13.5	13.4	13.4
				130867	+016	1.102	1.096	14.0	13.4		
9	14	1974 X	0307	180674	-015	1.117	1.378	13.5	12.3	12.2	12.2
				240774	+021	1.130	1.460	13.5	12.1		
10	15	1981 XII	2006	070581	-044	1.250	1.650	16.0	13.9	13.9	13.9

Secular brightness of P/Finlay (Fig. 11):

$M_{42}(t) = M_T(t) = 7.9 + 0.056\ (t-1886.918)$ $(r = 0.87)$

$M_R\ (t) = M_E(t) = 7.6 + 0.064\ (t-1893.479)$ $(r = 0.89)$

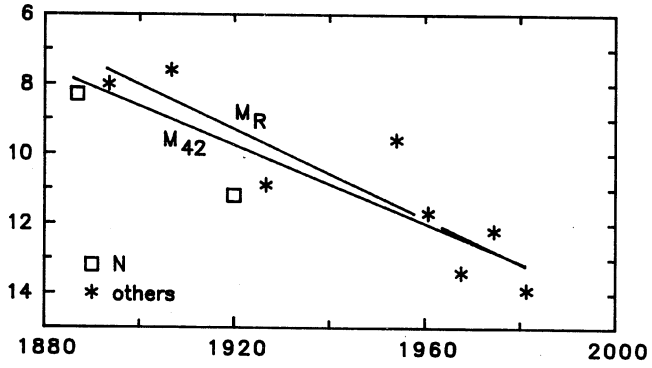

Fig. 11. P/Finlay

Table 12 - P/Schwassmann-Wachmann 2 magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1929 I	2303	310129	-051	2.125	1.317	10.8	6.9	6.9	N
2	2	1935 III	2808	310135	-209	2.568	2.513	14.0	7.9	7.9	7.9
				140435	-136	2.319	3.039	14.0	7.9		
3	3	1942 I	1302	100142	-034	2.159	1.177	11.0	7.3	7.3	7.3
4	4	1948 VII	2308	051048	+043	2.174	2.898	15.0	9.3	9.5	9.5
				020449	+222	2.637	1.642	15.0	9.7		
5	5	1955 I	2702	270255	000	2.150	1.436	12.5	8.4	8.4	8.4
6	6	1961 VII	0509	010362	+177	2.487	1.619	14.4	9.4	9.4	9.4
7	7	1968 II	1403	170268	-026	2.156	1.434	13.0	8.9	8.9	8.9
8	8	1974 XIII	1209	270375	+196	2.541	1.548	13.0	8.0	8.0	8.0
9	9	1981 VI	1703	300181	-046	2.161	1.314	11.8	7.9	7.9	7.9
10	10	1987 XIX	3008	121187	+074	2.143	2.556	11.7	6.4	6.4	6.4

Secular brightness of P/Schwassmann-Wachmann 2 (Fig. 12):

$M_{42}(t) = M_T(t) = 8.1 - 0.001\ (t-1929.085)$ $(r = 0.03)$

$M_R\ (t) = M_E(t) = 8.6 - 0.017\ (t-1935.185)$ $(r = 0.30)$

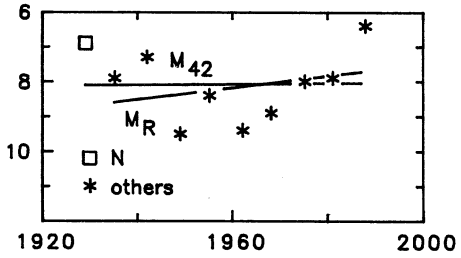

Fig. 12. P/Schwassmann–Wachmann 2

Table 13 - P/Tuttle magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1790 II	3101	100190	-021	1.094	0.389	5.5	7.2	7.2	N
2	6	1858 I	2402	270258	+003	1.027	0.921	6.5	6.6	6.5	N
				020358	+006	1.030	0.941	6.5	6.5		
3	7	1871 III	0212	011271	-001	1.030	0.704	7.5	8.1	8.1	8.1
4	8	1885 IV	1109	100885	-032	1.140	1.905	9.5	7.5	7.5	7.5
5	9	1899 III	0405	050499	-030	1.111	1.737	10.0	8.3	8.2	8.2
				140499	-021	1.062	1.729	10.0	8.6		
				290699	+055	1.312	1.758	10.0	7.6		
6	10	1912 IV	2810	091112	+011	1.044	1.212	7.0	6.4	6.4	N
7	11	1926 IV	2804	120426	-015	1.062	1.670	12.0	10.6	10.6	10.6
8	12	1939 X	1011	111139	+001	1.023	1.026	8.5	8.3	8.3	8.3
9	14	1967 V	3103	030467	+003	1.024	1.357	9.0	8.2	8.2	8.2
10	15	1980 XIII	1412	081280	-006	1.020	0.500	6.3	7.7	7.7	7.7

Secular brightness of P/Tuttle (Fig. 13):

$M_{42}(t) = M_T(t) = 7.0 + 0.007\ (t-1790.027)$ $\quad (r = 0.35)$

$M_R(t) = M_E(t) = 8.3 + 0.001\ (t-1871.918)$ $\quad (r = 0.04)$

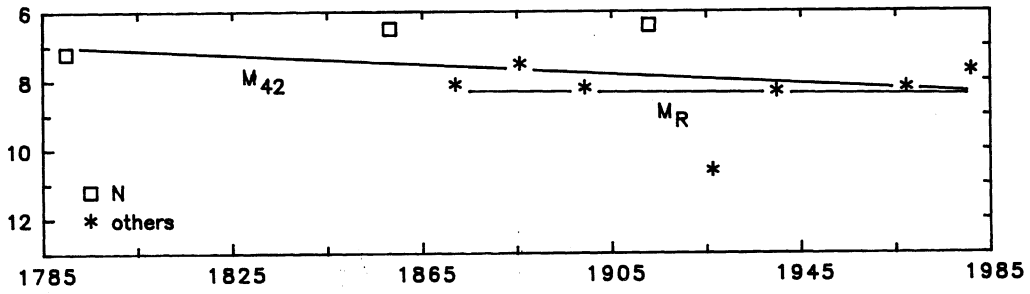

Fig. 13. P/Tuttle

Table 14 - P/Whipple magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1926 VIII	0402	170825	-171	2.709	1.723	13.0	7.5	7.5	N
2	2	1933 IV	0108	211033	+081	2.549	1.613	13.0	7.9	7.9	N
				091133	+100	2.576	1.596	13.0	7.9		
3	3	1941 III	2201	040940	-140	2.640	1.638	14.5	9.2	9.2	9.2
4	4	1948 VI	2506	040948	+071	2.491	2.134	14.0	8.4	8.5	8.5
				011048	+098	2.529	1.868	14.0	8.6		
5	5	1955 VIII	2911	121155	-017	2.452	1.739	13.0	7.9	7.9	7.9
6	6	1963 II	2804	141263	+230	2.856	1.894	17.8	11.9	11.9	11.9
7	7	1970 XIV	0910	290970	-010	2.480	1.504	15.5	10.7	10.7	10.7
8	8	1978 VIII	2703	220877	-217	2.820	1.839	17.0	11.2	11.2	11.2
9	9	1986 XII	2506	041286	+162	3.180	2.257	18.0	11.2	11.2	11.2

Secular brightness of P/Whipple (Fig. 14):

$M_{42}(t) = M_T(t) = 7.5 + 0.069\ (t-1925.627)$ $\quad (r = 0.83)$

$M_R(t) = M_E(t) = 8.6 + 0.067\ (t-1940.678)$ $\quad (r = 0.71)$

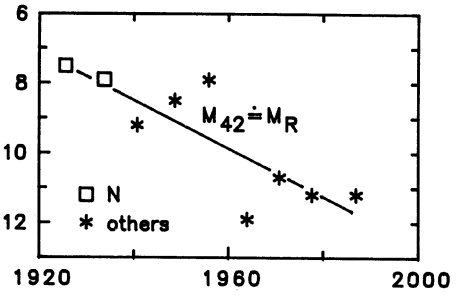

Fig. 14. P/Whipple

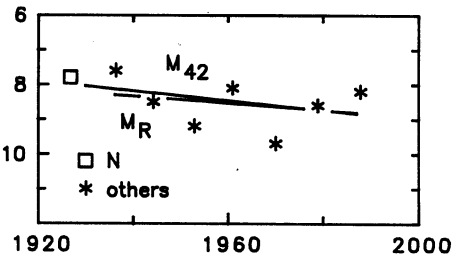

Fig. 15 P/Comas–Sola'

Table 15 - P/Comas Solá magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1927 III	2203	101126	-132	2.170	1.188	11.5	7.8	7.8	N
2	2	1935 IV	0610	090436	+186	2.464	1.575	12.5	7.6	7.6	7.6
3	3	1944 II	1104	120244	-059	1.859	1.752	12.5	8.6	8.5	8.5
				240244	-047	1.827	1.833	12.5	8.6		
				240444	+013	1.771	2.228	12.5	8.3		
4	4	1952 VII	1009	161052	+036	1.800	2.173	13.5	9.3	9.2	9.2
				181052	+038	1.804	2.162	13.5	9.3		
				141152	+065	1.874	2.019	13.5	9.2		
				211252	+102	2.018	1.804	13.5	9.2		
5	5	1961 III	0404	231160	-132	2.173	1.268	12.0	8.1	8.1	8.1
6	6	1969 VIII	2910	151169	+017	1.777	1.529	13.0	9.6	9.7	9.7
				191269	+051	1.837	1.306	13.0	9.8		
				020270	+096	1.996	1.136	13.0	9.7		
7	7	1978 XVII	2409	091078	+015	1.875	2.224	13.0	8.5	8.6	8.6
				101178	+047	1.921	2.006	13.0	8.7		
				291278	+096	2.072	1.673	13.0	8.7		
8	8	1987 XVIII	1808	011087	+044	1.877	2.521	13.0	8.3	8.2	8.2
				301087	+073	1.955	2.401	13.0	8.2		

Secular brightness of P/Comas Solá (Fig. 15):

$M_{42}(t) = M_T(t) = 8.0 + 0.014\ (t-1926.860)$ $(r = 0.42)$

$M_R(t) = M_E(t) = 8.3 + 0.010\ (t-1936.273)$ $(r = 0.27)$

Table 16 - P/Schaumasse magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1911 VII	1311	071211	+024	1.263	1.531	10.5	8.6	8.6	N
2	2	1919 IV	2010	291019	+009	1.173	1.765	10.5	8.6	8.6	8.6
3	3	1927 VIII	0110	041027	+003	1.173	1.952	12.0	9.9	9.8	9.8
				211027	+020	1.201	1.973	12.0	9.7		
4	5	1943 V	2611	240344	+120	1.888	1.279	15.0	11.7	11.7	11.7
5	6	1952 III	1002	010252	-009	1.201	0.270	4.9	6.9	6.9	6.9
6	7	1960 III	1804	260460	+008	1.201	1.284	10.0	8.7	8.5	8.5
				160560	+028	1.251	1.325	10.0	8.4		
7	9	1976 XV	0509	271276	+113	1.839	2.520	18.5	13.8	13.8	J
8	10	1984 XXII	0612	041284	-002	1.213	1.176	9.1	7.9	7.9	7.9

Secular brightness of P/Schaumasse (Fig. 16):

$M_{42}(t) = 8.6 + 0.018\ (t-1911.934)$ $(r = 0.21)$

$M_T(t) = 9.3 - 0.016\ (t-1911.934)$ $(r = 0.26)$

$M_E(t) = 9.1 + 0.015\ (t-1919.827)$ $(r = 0.15)$

$M_R(t) = 9.6 - 0.026\ (t-1919.827)$ $(r = 0.36)$

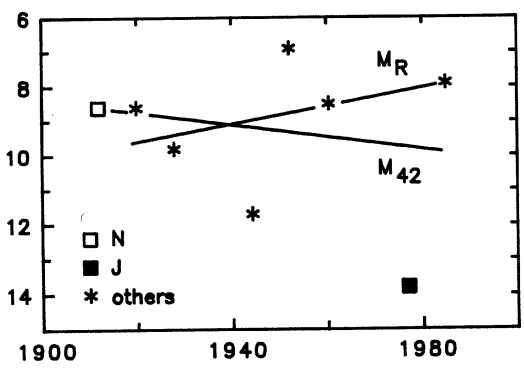

Fig. 16. P/Schaumasse

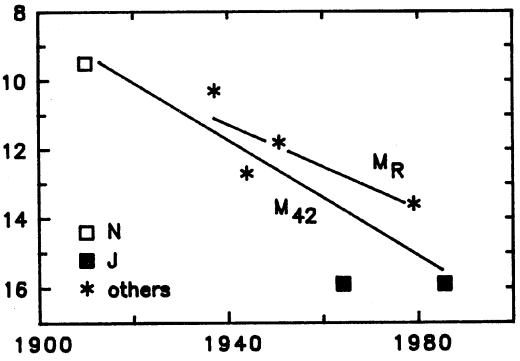

Fig. 17. P/Daniel

Table 17 - P/Daniel magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1909 IV	2911	061209	+007	1.384	0.421	9.0	9.5	9.5	N
2	5	1937 I	2701	020237	+006	1.537	1.240	12.6	10.3	10.3	10.3
3	6	1943 IV	2211	301143	+008	1.529	0.623	13.5	12.7	12.7	12.7
4	7	1950 V	2308	200950	+028	1.494	1.910	15.0	11.9	11.8	11.8
				191050	+056	1.584	1.835	15.0	11.7		
5	9	1964 II	2104	090364	-043	1.715	2.285	20.0	15.9	15.9	J
6	11	1978 XII	0807	020279	+210	2.519	1.873	19.0	13.6	13.6	13.6
				070279	+215	2.548	1.855	19.0	13.6		
7	12	1985 XI	0408	270785	-008	1.653	2.440	20.0	15.9	15.9	J

Secular brightness of P/Daniel (Fig. 17):

$M_{42}(t) = 9.2 + 0.084\ (t-1909.932)$ (r = 0.87)

$M_T\ (t) = 9.5 + 0.061\ (t-1909.932)$ (r = 0.90)

$M_E\ (t) = 11.2 + 0.092\ (t-1937.090)$ (r = 0.80)

$M_R\ (t) = 11.1 + 0.062\ (t-1937.090)$ (r = 0.81)

Table 18 - P/Forbes magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1929 II	2606	010829	+036	1.573	0.567	10.0	9.3	9.3	N
2	3	1942 III	1604	050642	+050	1.629	1.461	14.5	11.6	11.6	11.6
3	4	1948 VIII	1609	020948	-014	1.552	1.423	14.5	11.8	11.8	11.8
4	6	1961 VI	2407	080761	-016	1.554	0.597	10.0	9.2	9.2	9.2
5	8	1974 IX	1905	170774	+059	1.645	0.881	12.6	10.7	10.7	10.7
				210774	+063	1.659	0.870	12.6	10.7		
				220774	+064	1.663	0.868	12.6	10.7		
6	9	1980 VI	2409	180480	-159	2.162	1.165	17.0	13.3	13.3	13.3
7	10	1987 I	0101	161087	+288	2.957	2.024	18.4	12.2	12.2	12.2

Secular brightness of P/Forbes (Fig. 18):

$M_{42}(t) = M_T(t) = 10.0 + 0.038\ (t-1929.584)$ (r = 0.54)

$M_R\ (t) = M_E(t) = 10.9 + 0.023\ (t-1942.427)$ (r = 0.29)

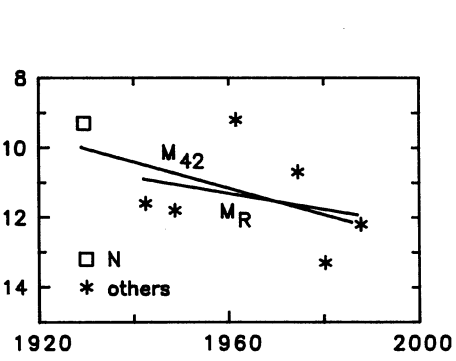

Fig. 18. P/Forbes

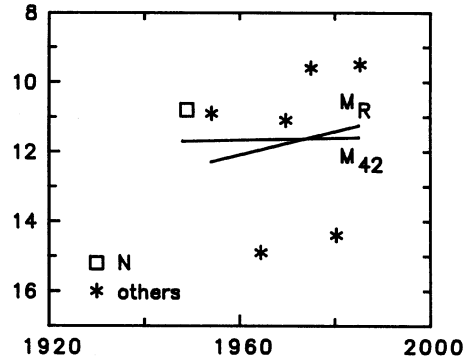

Fig. 20. P/Honda–Mrkos–Pajdusakova

Table 19 - P/Holmes magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1892 III	1306	241192	+164	2.449	1.657	3.5	-1.5	-1.5	N
2	2	1899 II	2804	090799	+072	2.195	2.319	14.0	8.8	8.8	8.8
3	3	1906 III	1403	250906	+195	2.547	2.087	15.0	9.3	9.3	9.3
4	11	1964 X	1511	290964	-047	2.370	1.585	18.8	14.1	14.1	J
5	12	1972 I	3001	130972	+227	2.692	2.596	19.4	13.0	13.0	J
6	13	1979 IV	2202	300779	+158	2.447	2.765	19.0	12.9	12.9	J
7	14	1986 V	1403	090686	+087	2.262	2.923	18.0	12.1	12.1	12.1

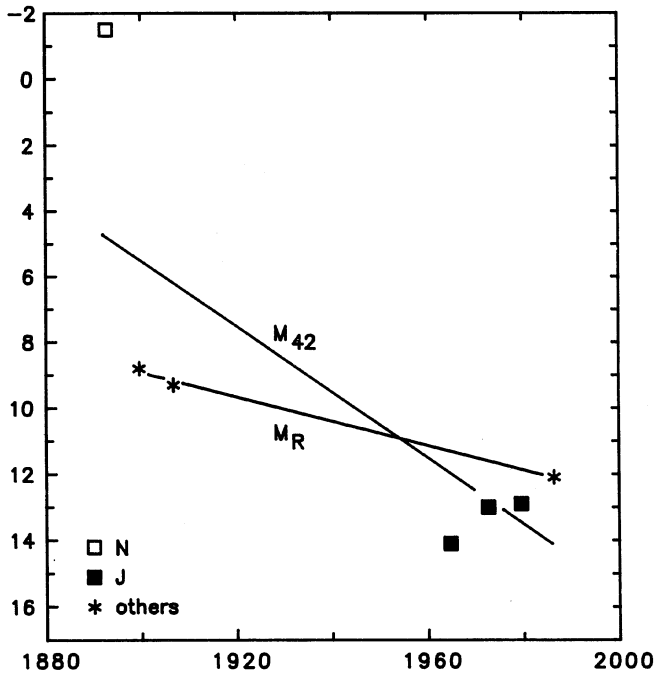

Fig. 19. P/Holmes

Secular brightness of P/Holmes (Fig. 19):

$M_{42}(t) = 4.8 + 0.100\ (t-1892.899)$ (r = 0.77)

$M_T(t) = 4.7 + 0.087\ (t-1892.899)$ (r = 0.64)

$M_E(t) = 9.1 + 0.050\ (t-1899.521)$ (r = 0.89)

$M_R(t) = 8.9 + 0.037\ (t-1899.521)$ (r = 1.00)

Table 20 - P/Honda-Mrkos-Pajdušáková magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1948 XII	1711	071248	+020	0.682	0.596	8.0	10.8	10.8	N
2	2	1954 III	0502	300154	-006	0.570	1.148	8.8	10.9	10.9	10.9
3	4	1964 VII	0607	140664	-022	0.719	1.292	14.0	14.9	14.9	14.9
4	5	1969 V	2209	210969	-001	0.560	0.808	8.1	11.1	11.1	11.1
5	6	1974 XVI	2812	020175	+005	0.587	0.552	6.0	9.6	9.6	9.6
6	7	1980 I	1104	070580	+026	0.771	1.423	14.0	14.4	14.4	14.4
7	8	1985 III	2305	200485	-033	0.865	1.658	10.0	9.5	9.5	9.5

Secular brightness of P/Honda-Mrkos-Pajdušáková (Fig. 20):

$M_{42}(t) = M_T(t) = 11.7 - 0.003\ (t-1948.934)$ (r = 0.02)

$M_R(t) = M_E(t) = 12.3 - 0.034\ (t-1954.082)$ (r = 0.16)

Table 21 - P/Reinmuth 1 magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1928 I	3001	260228	+027	1.875	0.921	12.0	9.4	9.4	N
2	2	1935 II	2904	260235	-062	1.938	1.537	15.0	11.2	11.2	11.2
3	4	1950 IV	2207	291149	-235	2.743	1.785	17.6	12.0	12.0	12.0
4	5	1958 II	2603	150158	-070	2.109	1.137	16.8	13.3	13.3	J
5	6	1965 V	0808	240165	-195	2.540	2.281	18.0	12.2	12.2	12.2
6	7	1973 IV	2103	090173	-071	2.083	1.116	17.0	13.6	13.6	13.6
7	8	1980 VIII	2910	080481	+161	2.380	1.405	18.0	13.5	13.5	13.5

Secular brightness of P/Reinmuth 1 (Fig. 21):

$M_{42}(t) = 10.2 + 0.070\ (t-1928.156)$ (r = 0.90)

$M_T(t) = 10.1 + 0.069\ (t-1928.156)$ (r = 0.94)

$M_E(t) = 11.4 + 0.051\ (t-1935.156)$ (r = 0.86)

$M_R(t) = 11.2 + 0.052\ (t-1935.156)$ (r = 0.94)

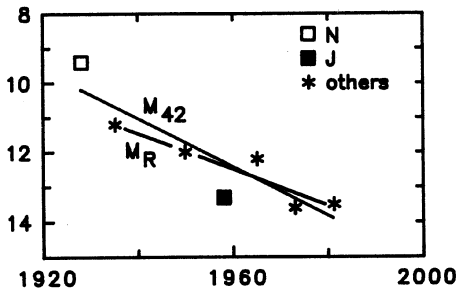

Fig. 21. P/Reinmuth 1

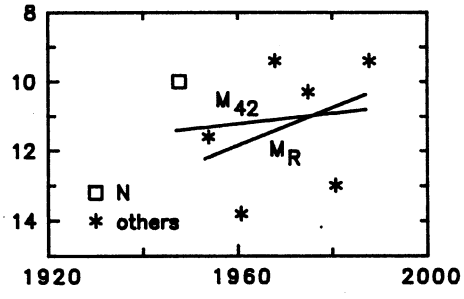

Fig. 22. P/Reinmuth 2

Table 22 - P/Reinmuth 2 magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1947 VII	1908	100947	+022	1.876	0.887	12.5	10.0	10.0	N
2	2	1954 VI	2703	031053	-175	2.356	2.672	17.5	11.6	11.6	11.6
3	3	1960 IX	2411	170860	-099	2.100	1.246	17.6	13.9	13.8	13.8
				260960	-059	1.995	1.506	17.6	13.7		
4	4	1967 XI	1808	061167	+080	2.050	1.264	13.0	9.4	9.4	9.4
5	5	1974 VI	0805	111174	+187	2.441	1.464	15.0	10.3	10.3	10.3
				141174	+190	2.454	1.475	15.0	10.3		
6	6	1981 III	2901	100980	-141	2.258	1.986	18.0	13.0	13.0	13.0
7	7	1987 XXVI	2510	161087	-009	1.938	1.416	13.0	9.4	9.4	9.4

Secular brightness of P/Reinmuth 2 (Fig. 22):

$M_{42}(t) = M_T(t) = 11.4 - 0.015\ (t-1947.693)$ $\quad (r = 0.13)$

$M_R(t) = M_E(t) = 12.2 - 0.055\ (t-1953.756)$ $\quad (r = 0.37)$

Table 23 - P/Tempel 1 magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1867 II	2405	030467	-051	1.640	0.712	9.0	7.6	7.9	N
				030567	-021	1.576	0.580	9.0	8.2		
2	2	1873 I	1005	300573	+020	1.780	0.767	10.0	8.1	8.1	8.1
3	3	1879 III	0705	240479	-014	1.775	0.884	10.5	8.3	8.4	8.4
				190579	+012	1.774	0.779	10.5	8.6		
4	17	1966 VII	120167	080667	+147	2.045	1.921	18.0	13.5	13.5	13.5
5	18	1972 V	1507	120572	-064	1.629	0.821	10.7	9.0	9.0	9.0
6	19	1978 II	1101	170477	-269	2.758	2.583	20.4	13.9	13.9	J
7	20	1983 XI	0907	200583	-050	1.576	0.764	9.0	7.6	7.6	7.6

Secular brightness of P/Tempel 1 (Fig. 23):

$M_{42}(t) = 8.1 + 0.026\ (t-1867.296)$ $\quad (r = 0.52)$

$M_T(t) = 8.2 + 0.016\ (t-1867.296)$ $\quad (r = 0.40)$

$M_E(t) = 8.4 + 0.025\ (t-1873.411)$ $\quad (r = 0.45)$

$M_R(t) = 8.4 + 0.014\ (t-1873.411)$ $\quad (r = 0.32)$

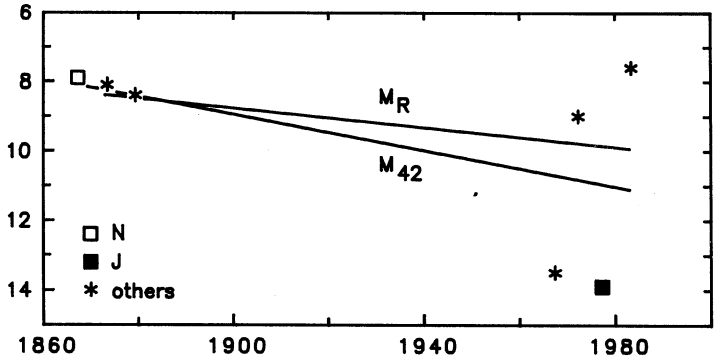

Fig. 23. P/Tempel 1

Table 24 - P/Wolf-Harrington magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1924 IV	110125	261224	-016	2.431	1.527	15.0	10.2	10.2	N
2	5	1952 II	0602	090152	-028	1.625	1.130	11.0	8.6	8.6	N
3	6	1958 V	1108	140958	+034	1.639	2.187	16.2	12.4	12.4	12.4
4	7	1965 III	1502	081164	-099	1.880	1.015	15.0	12.2	12.2	12.2
5	8	1971 VI	0109	151071	+044	1.678	1.870	15.0	11.4	11.4	11.4
6	9	1978 VI	1503	030178	-071	1.761	1.532	14.0	10.6	10.6	10.6
7	10	1984 XVII	2209	311084	+039	1.660	1.536	12.0	8.9	8.9	8.9
				271184	+066	1.738	1.392	12.0	8.9		

Secular brightness of P/Wolf-Harrington (Fig. 24):

$M_{42}(t) = M_T(t) = 10.6 + 0.001\ (t-1924.986)$ $(r = 0.01)$

$M_R(t) = M_E(t) = 12.8 - 0.132\ (t-1958.704)$ $(r = 0.96)$

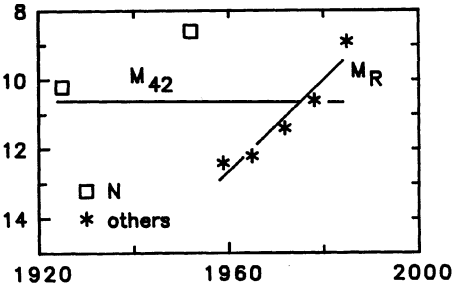

Fig. 24. P/Wolf-Harrington

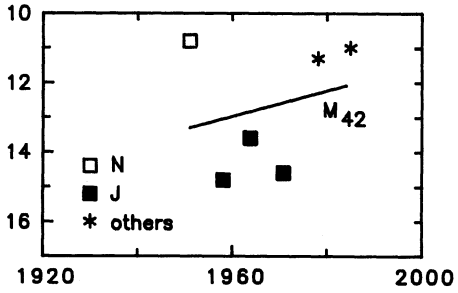

Fig. 25. P/Arend-Rigaux

Table 25 - P/Arend-Rigaux magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1950 VII	1812	080151	+021	1.405	0.436	10.5	10.8	10.8	N
2	2	1957 VII	0609	290158	+145	2.067	1.540	19.0	14.9	14.8	J
				160258	+163	2.193	1.482	19.0	14.7		
3	3	1964 V	0506	181063	-231	2.668	2.005	19.4	13.6	13.6	J
4	4	1971 IV	0604	011170	-156	2.158	1.464	18.8	14.6	14.6	J
5	5	1978 III	0202	090278	+007	1.443	1.000	12.9	11.3	11.3	11.3
6	6	1984 XXI	0112	191284	+018	1.459	0.604	11.5	11.0	11.0	11.0

Secular brightness of P/Arend-Rigaux (Fig. 25):

$M_{42}(t) = 13.3 - 0.037\ (t-1951.022)$ $(r = 0.25)$

$M_T(t) = 10.8 + 0.009\ (t-1951.022)$ $(r = 0.67)$

$M_E(t) = 15.0 - 0.146\ (t-1958.104)$ $(r = 0.87)$

Table 26 - P/Ashbrook-Jackson magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1948 IX	0410	260848	-039	2.328	1.334	11.0	6.7	6.7	N
				300848	-035	2.325	1.325	11.0	6.7		
				100948	-024	2.318	1.319	11.0	6.7		
				130948	-021	2.316	1.323	11.0	6.7		
2	2	1956 II	0604	121055	-177	2.625	2.634	12.0	5.7	5.7	5.7
3	3	1963 VI	0210	150663	-109	2.438	2.026	12.0	6.6	7.2	7.2
				110963	-021	2.319	1.318	12.0	7.7		
4	4	1971 III	1303	070670	-279	2.958	2.044	17.5	11.2	11.2	J
5	5	1978 XIV	1908	041078	+046	2.307	1.311	11.0	6.8	6.8	6.8
6	6	1986 II	2401	081085	-108	2.430	2.080	12.0	6.6	6.6	6.6

Secular brightness of P/Ashbrook-Jackson (Fig. 26):

$M_{42}(t) = 6.9 + 0.024\ (t-1948.678)$ $(r = 0.17)$

$M_T(t) = 6.4 + 0.009\ (t-1948.678)$ $(r = 0.25)$

$M_E(t) = 7.3 + 0.016\ (t-1955.781)$ $(r = 0.09)$

$M_R(t) = 6.3 + 0.019\ (t-1955.781)$ $(r = 0.41)$

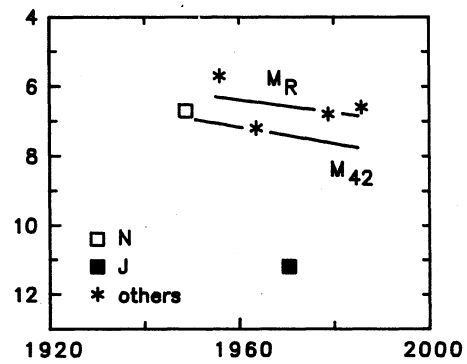

Fig. 26. P/Ashbrook–Jackson

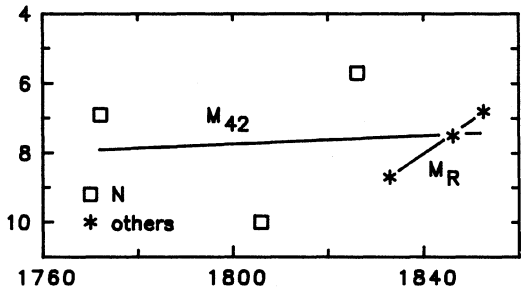

Fig. 27. P/Biela

Table 27 - P/Biela magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1772	1702	080372	+020	1.030	0.626	6.0	6.9	6.9	N
2	6	1806 I	0201	081205	-026	0.988	0.040	3.0	10.0	10.0	N
3	9	1826 I	1803	140326	-004	0.906	1.112	5.5	5.7	5.7	N
4	10	1832 III	2611	201032	-037	1.056	0.557	7.5	8.5	8.7	8.7
				061132	-020	0.937	0.581	7.5	9.0		
5	12	1846 II	1102	260246	+015	0.888	0.458	5.5	7.7	7.5	7.5
				250346	+042	1.076	0.375	5.5	7.3		
6	13	1852 III	2309	260852	-028	0.973	1.442	7.5	6.8	6.8	6.8

Secular brightness of P/Biela (Fig. 27):

$M_{42}(t) = M_T(t) = 7.9 - 0.006\ (t-1772.186)$ $(r = 0.12)$

$M_R(t) = M_E(t) = 8.7 - 0.095\ (t-1832.826)$ $(r = 1.00)$

Table 28 - P/Johnson magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1949 II	1609	150849	-032	2.260	1.273	13.5	9.4	9.4	N
2	2	1956 V	2607	060856	+011	2.260	1.307	13.5	9.4	9.4	9.4
3	3	1963 IV	0906	270863	+079	2.314	1.410	17.6	13.2	13.2	J
4	4	1970 IV	3003	050770	+097	2.306	2.259	18.8	13.4	13.4	J
5	5	1977 I	0801	050576	-248	2.767	1.929	20.5	14.7	14.7	J
6	6	1983 XVIII	0312	100783	-146	2.504	1.504	17.0	12.1	12.1	12.1

Secular brightness of P/Johnson (Fig. 28):

$M_{42}(t) = 9.9 + 0.126\ (t-1949.622)$ $(r = 0.72)$

$M_T(t) = 9.1 + 0.085\ (t-1949.622)$ $(r = 0.98)$

$M_E(t) = 11.2 + 0.104\ (t-1956.598)$ $(r = 0.55)$

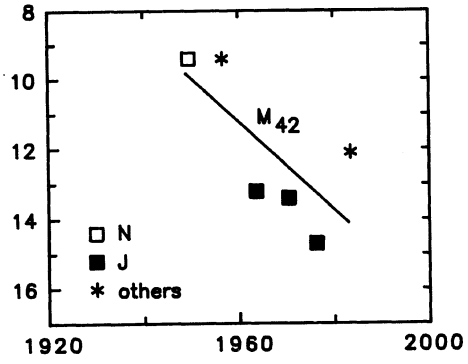

Fig. 28. P/Johnson

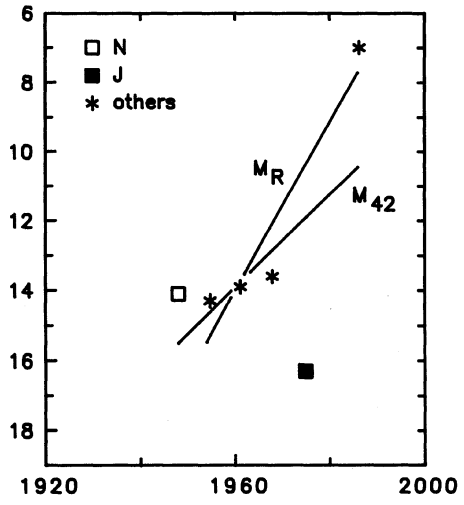

Fig. 30. P/Wirtanen

Table 29 - P/Tuttle-Giacobini-Kresák magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1858 III	0305	020558	-001	1.141	0.459	9.5	10.6	10.6	N
2	10	1907 III	2905	010607	+003	1.165	0.850	13.0	12.7	12.7	N
				040607	+006	1.167	0.851	13.0	12.7		
3	18	1951 IV	0905	120551	+003	1.117	0.496	9.7	10.7	10.7	N
4	20	1962 V	2304	010562	+008	1.126	0.281	9.5	11.7	11.7	11.7
5	22	1973 VI	3005	270573	-003	1.153	0.852	4.0	3.7	3.7	3.7
6	23	1978 XXV	2512	271278	+002	1.124	1.716	11.0	9.3	9.3	9.3

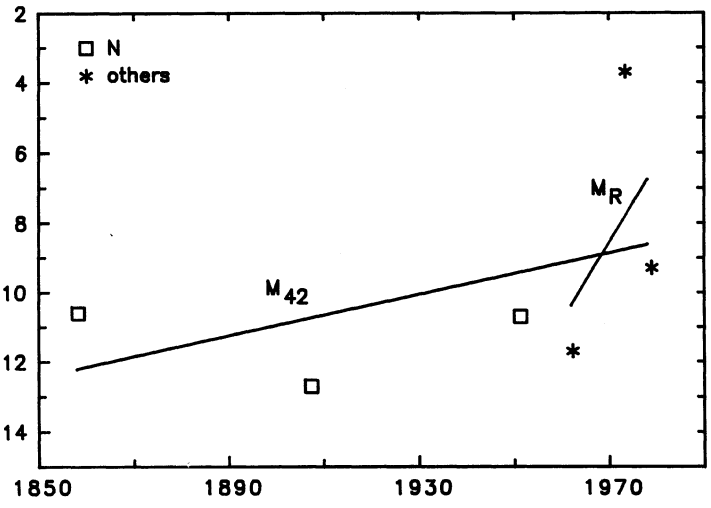

Fig. 29. P/Tuttle-Giacobini-Kresak

Secular brightness of P/Tuttle-Giacobini-Kresák (Fig. 29):

$M_{42}(t) = M_T(t) = 12.2 - 0.030\ (t-1858.334)$ $(r = 0.44)$

$M_R(t) = M_E(t) = 10.3 - 0.226\ (t-1962.332)$ $(r = 0.47)$

Table 30 - P/Wirtanen magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1947 XIII	0212	170148	+046	1.694	0.845	16.0	14.1	14.1	N
2	2	1954 XI	1308	080954	+026	1.645	2.076	18.0	14.3	14.3	14.3
3	3	1961 IV	1504	150261	-059	1.721	2.241	18.0	13.9	13.9	13.9
				090361	-037	1.660	2.308	18.0	14.0		
4	4	1967 XIV	1512	241167	-021	1.627	0.659	14.8	13.6	13.6	13.6
5	5	1974 XI	0507	201274	+168	2.193	2.326	21.5	16.3	16.3	J
6	7	1986 VI	1903	110486	+023	1.126	1.608	8.5	7.0	7.0	7.0

Secular brightness of P/Wirtanen (Fig. 30):

$M_{42}(t) = 15.5 - 0.133\ (t-1948.046)$ $(r = 0.58)$

$M_T(t) = 15.6 - 0.191\ (t-1948.046)$ $(r = 0.90)$

$M_E(t) = 15.6 - 0.183\ (t-1954.688)$ $(r = 0.64)$

$M_R(t) = 15.3 - 0.242\ (t-1954.688)$ $(r = 0.95)$

Table 31 - P/Arend magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1951 X	2311	031151	-020	1.831	0.913	12.5	10.1	10.1	N
2	2	1959 V	0109	251159	+085	1.989	1.219	15.5	12.1	12.1	12.1
3	3	1967 VI	1306	051067	+114	2.094	2.215	18.0	13.1	13.1	13.1
4	4	1975 VI	2405	120176	+233	2.714	1.857	18.0	12.3	12.3	12.3
5	5	1983 VIII	2205	160983	+117	2.134	2.532	20.5	15.2	15.2	J

Secular brightness of P/Arend:

$M_{42}(t) = 10.5 + 0.130\ (t-1951.841)$ $(r = 0.89)$

$M_T(t) = 10.8 + 0.094\ (t-1951.841)$ $(r = 0.76)$

$M_E(t) = 11.9 + 0.105\ (t-1959.901)$ $(r = 0.77)$

$M_R(t) = 12.4 + 0.011\ (t-1959.901)$ $(r = 0.17)$

Table 32 - P/Brorsen magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1846 III	2502	160346	+019	0.734	0.541	6.0	8.7	8.7	N
2	3	1857 II	2903	180357	-011	0.661	1.195	5.5	6.9	7.1	N
				200457	+022	0.742	0.803	5.5	7.3		
3	5	1868 I	1704	110568	+024	0.747	0.959	7.0	8.4	8.4	8.4
4	6	1873 VI	1010	190973	-021	0.733	1.021	7.5	8.8	9.1	9.1
				031073	-007	0.615	1.124	7.5	9.4		
5	7	1879 I	3103	140479	+014	0.652	0.843	7.0	9.2	9.2	9.2

Secular brightness of P/Brorsen:

$M_{42}(t) = M_T(t) = 7.9 + 0.031\ (t-1846.205)$ $(r = 0.49)$

$M_R(t) = M_E(t) = 8.5 + 0.073\ (t-1868.361)$ $(r = 0.91)$

Table 33 - P/Crommelin magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1818 I	0602	240218	+018	0.819	0.686	7.5	9.2	9.2	N
2	3	1873 VII	0212	161173	-016	0.810	0.219	7.0	11.2	11.2	N
3	5	1928 III	0411	191128	+015	0.791	0.863	6.0	7.3	7.3	N
4	6	1956 VI	2510	071156	+013	0.782	0.981	7.3	8.4	8.4	8.4
5	7	1984 IV	2002	240284	+004	0.738	0.929	7.3	8.8	8.8	8.8

Secular brightness of P/Crommelin:

$M_{42}(t) = M_T(t) = 9.9 - 0.010\ (t-1818.151)$ (r = 0.45)

Table 34 - P/Harrington-Abell magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1954 XIII	1212	220355	+100	1.993	1.043	17.0	13.9	13.9	N
2	2	1962 II	2302	260162	-028	1.801	0.915	17.0	14.6	14.6	14.6
3	3	1969 III	1005	231168	-168	2.321	1.422	19.0	14.6	14.7	14.7
				190469	-021	1.785	2.116	19.0	14.9		
4	4	1976 VIII	2104	061075	-198	2.501	1.645	21.0	15.9	15.9	J
5	5	1983 XVII	0112	170983	-075	1.920	2.097	20.5	16.1	16.1	J

Secular brightness of P/Harrington-Abell:

$M_{42}(t) = 13.9 + 0.080\ (t-1955.222)$ (r = 0.96)

$M_T(t) = 14.0 + 0.057\ (t-1955.222)$ (r = 0.91)

$M_E(t) = 14.5 + 0.079\ (t-1962.071)$ (r = 0.93)

Table 35 - P/Neujmin 1 magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1913 III	1608	030913	+018	1.543	0.551	10.0	9.4	9.4	N
2	2	1931 I	3004	170931	+140	2.232	1.853	15.0	10.2	10.2	10.2
3	3	1948 XIII	1512	030948	-103	1.975	1.825	16.0	11.7	12.1	12.1
				301148	-015	1.560	2.035	16.0	12.5		
4	4	1966 VI	0912	240666	-168	2.462	1.594	15.8	10.9	10.9	10.9
5	5	1984 XIX	0810	280884	-041	1.631	0.890	11.5	9.6	9.6	9.6

Secular brightness of P/Neujmin 1:

$M_{42}(t) = M_T(t) = 10.2 + 0.006\ (t-1913.674)$ (r = 0.15)

$M_R(t) = M_E(t) = 11.2 - 0.018\ (t-1931.712)$ (r = 0.37)

Table 36 - P/Perrine-Mrkos magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1896 VII	2511	081296	+013	1.124	0.260	8.0	10.4	10.4	N
2	3	1909 III	0111	150909	-047	1.319	0.505	12.5	12.8	12.8	12.8
3	10	1955 VII	2709	191055	+022	1.188	0.889	9.0	8.5	8.5	N
4	11	1962 I	1202	040362	+020	1.290	1.757	17.5	15.2	15.2	15.2
5	12	1968 VIII	0111	151268	+044	1.377	0.416	12.0	12.5	12.5	12.5

Secular brightness of P/Perrine-Mrkos:

$M_{42}(t) = M_T(t) = 11.2 + 0.017\ (t-1896.937)$ (r = 0.22)

$M_R(t) = M_E(t) = 13.0 + 0.014\ (t-1909.707)$ (r = 0.31)

Table 37 - P/Väisälä 1 magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1939 IV	2604	200339	-037	1.803	0.925	13.2	10.8	10.8	N
2	2	1949 V	1111	191249	+038	1.795	2.353	17.0	12.6	12.6	12.6
3	3	1960 IV	1005	200360	-051	1.822	1.044	14.0	11.3	11.3	11.3
4	4	1971 VII	1209	200471	-145	2.334	2.468	20.4	14.8	14.8	J
5	5	1982 V	3007	311281	-211	2.699	1.727	20.0	14.5	14.5	14.5

Secular brightness of P/Väisälä 1:

$M_{42}(t) = 10.9 + 0.090\ (t-1939.216)$ (r = 0.84)

$M_T(t) = 10.9 + 0.076\ (t-1939.216)$ (r = 0.84)

$M_E(t) = 11.9 + 0.087\ (t-1949.967)$ (r = 0.73)

$M_R(t) = 11.8 + 0.073\ (t-1949.967)$ (r = 0.74)

Table 38 - P/Gunn magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1953 VIII	2005	080854	+445	3.698	2.732	19.0	11.1	11.1	11.1
2	3	1969 II	1804	061170	+567	3.789	2.882	15.0	6.9	6.9	N
3	4	1976 III	1002	210375	-326	3.083	2.112	14.0	7.5	7.5	7.5
4	5	1982 X	2611	230582	-187	2.705	1.872	13.4	7.7	7.7	7.7

Secular brightness of P/Gunn:

$M_{42}(t) = M_T(t) = 10.5 - 0.134\ (t-1954.603)$ (r = 0.83)

$M_R(t) = M_E(t) = 10.9 - 0.134\ (t-1954.603)$ (r = 0.96)

Table 39 - P/Harrington magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1953 VI	2209	140853	-039	1.735	0.791	15.0	13.1	13.1	N
2	2	1960 VII	2806	190860	+052	1.667	1.409	18.9	15.9	15.9	15.9
3	5	1980 XIV	2412	040980	-111	1.942	1.475	18.5	14.8	14.8	14.8
4	6	1987 XXVIII	3110	130987	-048	1.670	0.891	13.0	11.0	10.7	10.7
				261087	-005	1.597	1.116	13.0	10.7		
				221187	+022	1.610	1.311	13.0	10.3		

Secular brightness of P/Harrington:

$M_{42}(t) = M_T(t) = 14.8 - 0.067\ (t-1953.619)$ (r = 0.48)

$M_R(t) = M_E(t) = 16.3 - 0.162\ (t-1960.634)$ (r = 0.83)

Table 40 - P/Jackson-Neujmin magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1936 IV	0310	180936	-015	1.473	0.479	12.0	11.9	11.9	N
				200936	-013	1.471	0.480	12.0	11.9		
				220936	-011	1.468	0.482	12.0	11.9		
2	5	1970 IX	0608	060970	+031	1.471	0.936	14.0	12.5	12.5	12.5
3	6	1978 XXVI	2612	281178	-028	1.462	1.708	19.5	16.7	16.7	16.7
4	7	1987 VIII	2405	250787	+062	1.600	2.034	18.0	14.4	14.4	14.4

Secular brightness of P/Jackson-Neujmin:

$M_{42}(t) = M_T(t) = 11.8 + 0.067\ (t-1936.721)$ $(r = 0.69)$

$M_R(t) = M_E(t) = 13.6 + 0.109\ (t-1970.682)$ $(r = 0.44)$

Table 41 - P/Shajn-Schaldach magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1949 VI	2611	181049	-039	2.253	1.322	11.6	7.5	7.5	N
2	4	1971 IX	0110	290971	-002	2.228	1.300	16.0	12.0	12.0	12.0
3	5	1979 I	0801	030778	-189	2.600	1.971	20.2	14.6	14.6	14.6
4	6	1986 X	2705	250785	-306	3.069	2.058	19.0	12.6	12.6	12.6

Secular brightness of P/Shajn-Schaldach:

$M_{42}(t) = M_T(t) = 7.9 + 0.173\ (t-1949.797)$ $(r = 0.89)$

$M_R(t) = M_E(t) = 12.8 + 0.041\ (t-1971.745)$ $(r = 0.21)$

Table 42 - P/Tempel-Swift magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1869 III	1911	081269	+019	1.093	0.249	8.5	11.1	11.1	N
2	3	1880 IV	0811	241080	-015	1.087	0.168	8.0	11.5	11.5	N
3	5	1891 V	1711	241091	-024	1.135	0.312	10.0	12.0	12.0	12.0
4	8	1908 II	0510	271008	+022	1.186	0.647	12.0	12.2	12.2	12.2

Secular brightness of P/Tempel-Swift:

$M_{42}(t) = M_T(t) = 11.2 + 0.029\ (t-1869.937)$ $(r = 0.96)$

Table 43 - P/Tsuchinshan 1 magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1965 I	2801	010165	-027	1.515	0.532	15.0	14.6	14.6	N
2	2	1971 VIII	1609	201271	+095	1.788	2.016	20.3	16.3	16.3	J
3	3	1978 IX	0705	080378	-060	1.629	1.847	19.5	16.0	16.0	J
4	4	1985 I	0201	180285	+047	1.586	0.625	10.2	9.2	9.2	9.2

Secular brightness of P/Tsuchinshan 1:

$M_{42}(t) = 16.5 - 0.249\ (t-1965.003)$ $(r = 0.65)$

$M_E(t) = 17.4 - 0.548\ (t-1971.970)$ $(r = 0.90)$

Table 44 - P/Tsuchinshan 2 magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1965 II	0902	090365	+028	1.787	0.964	14.0	11.6	11.6	N
2	2	1971 X	2911	220172	+054	1.840	1.204	15.0	11.9	11.9	11.9
3	3	1978 XVI	2009	291078	+039	1.818	2.409	17.5	13.0	13.0	13.0
4	4	1985 X	2107	080585	-074	1.914	2.693	21.5	16.5	16.5	J

Secular brightness of P/Tsuchinshan 2:

$M_{42}(t) = 10.9 + 0.234\ (t-1965.186)$ $(r = 0.90)$

$M_T(t) = 11.5 + 0.102\ (t-1965.186)$ $(r = 0.95)$

$M_E(t) = 11.5 + 0.345\ (t-1972.060)$ $(r = 0.95)$

Table 45 - P/Clark magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1973 V	2405	030773	+040	1.606	0.660	12.0	10.8	10.8	N
2	2	1978 XXIII	2611	130478	-227	2.511	1.757	18.0	12.8	12.8	12.8
				270478	-213	2.433	1.827	18.0	12.8		
3	3	1984 VIII	2905	230684	+025	1.570	0.630	10.4	9.4	9.4	9.4

Secular brightness of P/Clark:

$M_{42}(t) = M_T(t) = 11.8 - 0.147\ (t-1973.504)$ $(r = 0.47)$

Table 46 - P/Du Toit-Hartley magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1945 II	1804	090445	-009	1.255	0.291	10.0	11.7	11.7	N
2	8	1982 II	3003	210582	+052	1.345	0.363	14.0	14.9	14.9	N
3	9	1987 IX	1406	250587	-020	1.223	1.155	17.4	16.2	16.2	16.2

Secular brightness of P/Du Toit-Hartley:

$M_{42}(t) = M_T(t) = 11.6 + 0.099\ (t-1945.271)$ $(r = 0.98)$

Table 47 - P/Du Toit-Neujmin-Delporte magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1941 VII	2107	210741	000	1.305	0.296	9.0	10.5	10.5	N
				250741	+004	1.306	0.297	9.0	10.5		
2	6	1970 XIII	0710	260970	-011	1.676	1.547	18.5	15.3	15.3	15.3
				051070	-002	1.672	1.608	18.5	15.2		
3	8	1983 IX	0106	040983	+095	1.915	0.942	16.0	13.3	13.3	13.3

Secular brightness of P/Du Toit-Neujmin-Delporte:

$M_{42}(t) = M_T(t) = 11.1 + 0.083\ (t-1941.559)$ $(r = 0.74)$

Table 48 - P/Churyumov-Gerasimenko magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1969 IV	1109	151169	+065	1.496	1.317	11.0	8.7	8.7	N
2	2	1976 VII	0704	211075	-168	2.239	1.944	14.8	9.9	9.9	9.9
3	3	1982 VIII	1211	091282	+027	1.345	0.399	8.5	9.2	9.2	9.2

Secular brightness of P/Churyumov-Gerasimenko:

$M_{42}(t) = M_T(t) = 9.1 + 0.034\ (t-1969.874)$ $(r = 0.37)$

Table 49 - P/Kearns-Kwee magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1963 VIII	0712	030164	+027	2.224	1.225	11.1	7.1	7.1	N
2	2	1972 XI	2811	121272	+014	2.231	1.295	12.8	8.8	8.8	8.8
				030173	+036	2.247	1.272	12.8	8.8		
3	3	1981 XX	3011	171281	+017	2.228	1.272	12.3	8.3	8.3	8.3

Secular brightness of P/Kearns-Kwee:

$M_{42}(t) = M_T(t) = 7.5 + 0.067\ (t-1964.008)$ $(r = 0.69)$

Table 50 - P/Klemola magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1965 VI	1808	311065	+074	1.918	1.165	17.0	13.8	14.4	N
				181165	+092	1.996	1.393	17.0	13.3		
				211165	+095	2.010	1.435	17.0	13.2		
2	2	1976 X	1008	220876	+012	1.770	0.791	11.0	9.0	9.0	9.0
3	3	1987 XIV	2207	140987	+054	1.856	0.870	11.6	9.2	9.2	9.2

Secular brightness of P/Klemola:

$M_{42}(t) = M_T(t) = 12.6 - 0.191\ (t-1965.868)$ $(r = 0.84)$

Table 51 - P/Kohoutek magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1975 III	1801	090275	+022	1.583	1.090	14.0	11.8	11.2	N
				030475	+075	1.734	1.611	14.0	10.6		
2	2	1981 IX	1604	160181	-090	1.806	1.956	18.0	14.0	14.0	14.0
3	3	1987 XXVII	3010	161187	+017	1.782	1.218	12.1	9.2	9.2	9.2

Secular brightness of P/Kohoutek:

$M_{42}(t) = M_T(t) = 12.5 - 0.172\ (t-1975.182)$ $(r = 0.45)$

Table 52 - P/Kojima magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1970 XII	0710	020171	+087	1.827	1.844	13.0	9.1	9.0	N
				050171	+090	1.839	1.827	13.0	9.0		
2	2	1978 X	2405	051277	-170	2.664	1.776	18.0	12.5	12.7	12.7
				101277	-165	2.650	1.731	18.0	12.6		
				201277	-155	2.623	1.659	18.0	12.7		
				070178	-137	2.577	1.598	18.0	12.9		
				140178	-130	2.561	1.599	18.0	12.9		
				020378	-083	2.467	1.880	18.0	12.7		
3	3	1986 VII	0404	110286	-052	2.441	1.510	18.1	13.3	13.3	13.3

Secular brightness of P/Kojima:

$M_{42}(t) = M_T(t) = 9.6 + 0.279\ (t-1971.010)$ $(r = 0.91)$

Table 53 - P/Neujmin 3 magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1929 III	2806	020829	+035	2.066	1.058	13.5	10.2	10.2	N
2	3	1951 V	2605	070851	+073	2.137	1.206	16.5	12.8	12.8	12.8
3	5	1972 IV	1605	140872	+090	2.144	1.186	17.7	14.0	14.0	J

Secular brightness of P/Neujmin 3:

$M_{42}(t) = 10.4 + 0.089\ (t-1929.586)$ $(r = 0.98)$

Table 54 - P/Oterma magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1942 VII	2108	030443	+225	3.479	2.486	15.0	7.6	7.6	N
2	2	1950 III	1607	110250	-155	3.448	2.525	14.5	7.1	6.9	6.9
				050251	+204	3.478	2.915	14.5	6.8		
3	3	1958 IV	1006	170158	-144	3.426	2.462	16.0	8.7	8.5	8.5
				120259	+247	3.495	2.934	16.0	8.2		

Secular brightness of P/Oterma:

$M_{42}(t) = M_T(t) = 7.2 + 0.061\ (t-1943.255)$ (r = 0.58)

Table 55 - P/Slaughter-Burnham magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1958 VI	0509	101258	+096	2.646	1.758	16.0	10.5	10.5	N
2	2	1970 V	1304	031070	+173	2.855	2.667	19.9	13.2	13.2	J
3	3	1981 XVIII	1811	281081	-021	2.550	1.590	16.9	11.8	11.8	11.8

Secular brightness of P/Slaughter-Burnham:

$M_{42}(t) = 11.2 + 0.059\ (t-1958.942)$ (r = 0.50)

Table 56 - P/Smirnova-Chernykh magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1967 XV	0702	090367	+030	3.547	2.568	16.0	8.5	8.5	N
2	2	1975 VII	0608	030475	-125	3.593	2.971	14.5	6.6	6.6	N
3	3	1984 V	2102	200384	+028	3.559	2.582	14.5	6.9	6.9	6.9

Secular brightness of P/Smirnova-Chernykh:

$M_{42}(t) = M_T(t) = 8.1 - 0.092\ (t-1967.186)$ (r = 0.76)

Table 57 - P/Swift-Gehrels magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1889 VI	3011	231189	-007	1.360	0.679	10.0	9.5	9.5	N
2	9	1972 VII	3108	090273	+162	2.271	1.321	19.0	14.8	14.8	N,J
				100273	+163	2.279	1.333	19.0	14.8		
3	10	1981 XIX	2711	191281	+022	1.386	0.757	9.5	8.7	8.7	8.7

Secular brightness of P/Swift-Gehrels:

$M_{42}(t) = 9.8 + 0.020\ (t-1889.896)$ (r = 0.31)

Table 58 - P/Taylor magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1916 I	3101	081215	-054	1.653	0.702	7.5	6.1	6.1	N
2	10	1977 II	1101	140177	+003	1.951	0.988	15.0	12.1	12.1	12.1
3	11	1984 II	0601	070184	+001	1.961	0.979	15.5	12.6	12.6	12.6

Secular brightness of P/Taylor:

$M_{42}(t) = M_T(t) = 6.1 + 0.097\ (t-1915.937)$ (r = 1.00)

Table 59 - P/Van Biesbroeck magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1954 IV	2002	010954	+193	2.860	1.852	15.0	9.1	9.1	N
2	2	1966 III	1707	170666	-030	2.423	1.432	14.2	9.6	9.6	9.6
3	3	1978 XXIV	0312	120478	-235	3.033	2.093	15.0	8.6	8.7	8.7
				050578	-212	2.932	1.934	15.0	8.9		

Secular brightness of P/Van Biesbroeck:

$M_{42}(t) = M_T(t) = 9.3 - 0.017\ (t-1954.668)$ $(r = 0.44)$

Table 60 - P/De Vico-Swift magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1844 I	0209	060944	+004	1.187	0.192	5.0	7.8	7.8	N
2	10	1894 IV	1210	011294	+050	1.492	1.110	12.0	10.0	10.0	N
3	21	1965 VII	2308	040865	-019	1.635	0.872	16.0	14.2	14.4	14.4
				030965	+011	1.628	0.716	16.0	14.6		

Secular brightness of P/De Vico-Swift:

$M_{42}(t) = M_T(t) = 7.6 + 0.055\ (t-1844.683)$ $(r = 1.00)$

Table 61 - P/West-Kohoutek-Ikemura magnitudes

n	N	Comet	T	t	t-T	r	d	M_m	M'_{42}	M_{42}	M_R
1	1	1975 IV	2502	280275	+003	1.399	1.475	11.0	8.7	8.7	N
2	2	1981 VIII	1104	121180	-150	2.083	1.733	18.5	14.1	14.1	14.1
3	3	1987 XV	2707	201087	+085	1.781	2.200	14.5	10.3	10.2	10.2
				301087	+095	1.828	2.172	14.5	10.2		

Secular brightness of P/West-Kohoutek-Ikemura:

$M_{42}(t) = M_T(t) = 10.4 + 0.094\ (t-1975.162)$ $(r = 0.21)$

4. THE STATISTICAL DISTRIBUTION OF THE SECULAR CHANGES IN BRIGHTNESS

Secular variations in the brightness per revolution together with mean brightness and some orbital elements are listed in Table 62. The columns include

n - serial number of the comet,

Comet - the name of the comet,

P - mean orbital period,

q - mean perihelion distance,

m_m - the average value of values M_m observed at all the apparitions of the comet,

M_{42}/r, M_E/r, M_T/r, M_R/r - secular changes per revolution.

Table 62 - The secular changes per revolution

n	Comet	P	q	m_m	M_{42}/r	M_E/r	M_T/r	M_R/r	Samples
1	P/Grigg-Skjellerup	4.979	0.90	10.8	+0.02	-0.01	+0.02	-0.01	A C G
2	P/Honda-Mrkos-Pajdušák.	5.216	0.56	9.8	-0.02	-0.18	-0.02	-0.18	A C G
3	P/Tempel 2	5.235	1.36	11.2	+0.16	+0.18	+0.07	+0.07	A C
4	P/Du Toit-Hartley	5.270	1.22	13.8	+0.52	-	+0.52	-	A G
5	P/Tuttle-Giacob.-Kresák	5.484	1.14	9.4	-0.16	-1.24	-0.16	-1.24	A C G
6	P/Clark	5.508	1.56	13.5	-0.81	-	-0.81	-	A
7	P/Brorsen	5.516	0.61	6.6	+0.17	+0.40	+0.17	+0.40	A C G
8	P/Tempel-Swift	5.554	1.09	9.6	+0.16	-	+0.16	-	A C G
9	P/Pons-Winnecke	5.847	1.02	9.8	+0.22	+0.30	+0.16	+0.22	A C G
10	P/Du Toit-Neujmin-Delp.	5.980	1.56	14.5	+0.50	-	+0.50	-	A
11	P/De Vico-Swift	6.049	1.07	11.0	+0.33	-	+0.33	-	A C G
12	P/Tempel 1	6.112	1.58	12.5	+0.16	+0.15	+0.10	+0.09	A
13	P/West-Kohoutek-Ikemura	6.209	1.46	14.7	+0.58	-	+0.58	-	A
14	P/Wirtanen	6.382	1.47	16.1	-0.85	-1.17	-1.22	-1.54	A D
15	P/Forbes	6.391	1.52	13.9	+0.24	+0.15	+0.24	+0.15	A
16	P/Kohoutek	6.391	1.64	14.7	-1.10	-	-1.10	-	
17	P/Kopff	6.439	1.60	12.1	+0.14	+0.10	-0.08	-0.19	
18	P/Schwassmann-Wachm. 2	6.493	2.13	12.7	-0.01	-0.11	-0.01	-0.11	H
19	P/Giacobini-Zinner	6.521	0.98	11.2	+0.01	+0.01	-0.18	-0.26	C G
20	P/Perrine-Mrkos	6.539	1.20	11.8	+0.11	+0.09	+0.11	+0.09	G
21	P/D'Arrest	6.559	1.28	10.1	+0.05	+0.08	-0.01	+0.02	C
22	P/Churyumov-Gerasimenko	6.585	1.30	11.4	+0.22	-	+0.22	-	
23	P/Wolf-Harrington	6.633	1.73	14.0	+0.01	-0.88	+0.01	-0.88	
24	P/Tsuchinshan 1	6.643	1.50	16.2	-1.65	-3.64	-	-	D
25	P/Reinmuth 2	6.697	1.92	15.2	-0.10	-0.37	-0.10	-0.37	
26	P/Biela	6.717	0.90	5.8	-0.04	-0.64	-0.04	-0.64	C G
27	P/Finlay	6.755	1.04	10.5	+0.38	+0.43	+0.38	+0.43	C G
28	P/Arend-Rigaux	6.791	1.42	15.4	-0.25	-0.99	+0.06	-	
29	P/Taylor	6.793	1.82	12.7	+0.66	-	+0.66	-	
30	P/Tsuchinshan 2	6.814	1.78	17.0	+1.59	+2.35	+0.70	-	D
31	P/Harrington	6.821	1.62	16.4	-0.46	-1.11	-0.46	-1.11	D
32	P/Johnson	6.843	2.24	16.8	+0.86	+0.71	+0.58	-	D H
33	P/Daniel	6.880	1.56	15.6	+0.58	+0.63	+0.42	+0.43	D
34	P/Borrelly	6.910	1.39	11.8	+0.08	+0.01	+0.08	+0.01	
35	P/Brooks 2	7.003	1.88	13.6	+0.44	+0.39	+0.39	+0.32	
36	P/Holmes	7.212	2.17	15.4	+0.72	+0.36	+0.63	+0.27	H
37	P/Harrington-Abell	7.243	1.78	18.9	+0.58	+0.57	+0.41	-	D
38	P/Shajn-Schaldach	7.300	2.25	16.7	+1.26	+0.30	+1.26	+0.30	D H
39	P/Gunn	7.380	2.66	15.4	-0.99	-0.99	-0.99	-0.99	H
40	P/Faye	7.407	1.66	11.3	+0.25	+0.22	+0.25	+0.22	C
41	P/Ashbrook-Jackson	7.458	2.30	12.6	+0.18	+0.12	+0.07	+0.14	H
42	P/Reinmuth 1	7.535	1.96	16.3	+0.53	+0.38	+0.52	+0.39	D
43	P/Whipple	7.548	2.54	15.1	+0.52	+0.51	+0.52	+0.51	H
44	P/Wolf	7.656	2.13	15.1	+0.70	+0.66	+0.93	+0.91	H
45	P/Kojima	7.746	2.15	16.4	+2.16	-	+2.16	-	D H
46	P/Arend	7.873	1.84	16.9	+1.02	+0.83	+0.74	+0.09	D
47	P/Oterma	7 902	3.39	15.2	+0.48	-	+0.48	-	B H
48	P/Schaumasse	8.118	1.20	11.3	+0.15	+0.12	-0.13	-0.21	B G
49	P/Jackson-Neujmin	8.440	1.44	15.9	+0.57	+0.92	+0.57	+0.92	B D
50	P/Smirnova-Chernykh	8.519	3.56	15.0	-0.78	-	-0.78	-	B H
51	P/Comas Solá	8.630	1.79	12.6	+0.12	+0.09	+0.12	+0.09	B
52	P/Kearns-Kwee	8.997	2.22	12.1	+0.60	-	+0.60	-	B H
53	P/Swift-Gehrels	9.199	1.36	12.8	+0.18	-	-	-	B
54	P/Neujmin 3	10.721	2.02	15.9	+0.95	-	-	-	B D H
55	P/Väisälä 1	10.815	1.78	16.9	+0.97	+0.94	+0.82	+0.79	B D
56	P/Klemola	10.963	1.77	13.2	-2.09	-	-2.09	-	B
57	P/Slaughter-Burnham	11.602	2.54	17.6	+0.68	-	-	-	B D H
58	P/Van Biesbroeck	12.392	2.41	14.7	-0.21	-	-0.21	-	B H
59	P/Tuttle	13.634	1.03	8.2	+0.10	+0.01	+0.10	+0.01	B C G
60	P/Neujmin 1	17.786	1.54	13.7	+0.11	-0.32	+0.11	-0.32	B
61	P/Crommelin	27.673	0.74	7.0	-0.28	-	-0.28	-	B C G

A histogram of the distribution of the secular changes M_R per revolution is presented in Fig. 31. The blank histogram corresponds to all 37 comets, the shaded areas to those comets for which the secular change of M_R is based on 6 returns at least (15 comets).

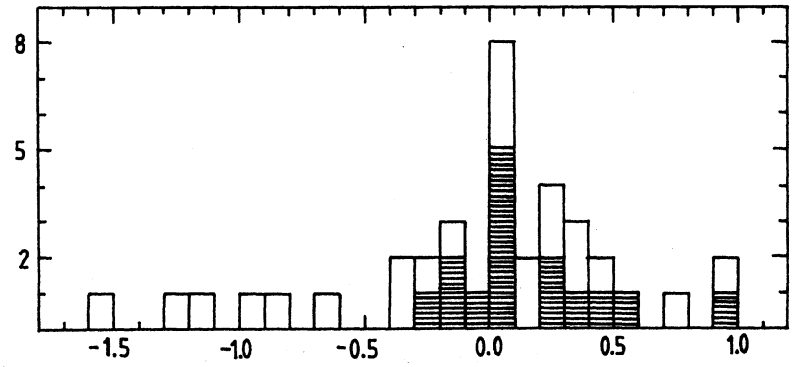

Fig. 31 - The distribution of the secular changes M_R per revolution

The figure shows unambiguously that the large dispersion is due to comets which made only a few apparitions. The values for the comets which returned more than five times are well concentrated.

The mean values of secular changes for different comet samples were determined as weighted means in dependence on the number of apparitions (by the number of magnitude differences between the successive apparitions). The mean secular variation of M_{42} is + 0.196 $\pm$ 0.026 magnitude per revolution. The extension of the interval and a higher accuracy of the data resulted in a decrease of the secular change from + 0.36 magnitude in the previous paper (Svoreň, 1979) to only 54%. The elimination of the independent discoveries gives another reduction by 24%. The average weighted secular change of M_E equals 0.109 $\pm$ 0.037 magnitude per revolution. The effect of elimination of the nuclear magnitude is something smaller. The average weighted secular variation of M_T is + 0.139 $\pm$ 0.026 magnitude per revolution.

The elimination of both the independent discoveries and nuclear magnitudes results in a significant reduction of the secular change. The average weighted secular variation of M_R is only + 0.048 $\pm$ 0.030 magnitude per revolution. This value agrees very well with a result derived by Ferrin and Gil (1988) for P/Halley (0.055 magnitude per revolution). Our values is 6-times smaller than determined by Vsekhsvyatsky (1958), 1.5-times larger than that found by Meisel and Morris (1982), 2-times larger than that calculated by Kresák and Kresáková (1990) with the application of corrections for instrumental effects and 25-times larger than a value accepted by Hughes and Daniels (1983) on the basis of the investigation of nongravitational forces by Yabushita and Hasegawa (1981). For mean orbital period derived from whole the sample (P = 7.825 years) our value makes 0.6 magnitude per century. Dobrovolsky et al (1986) derived the expected

survival time of a comet depending on the value of secular brightness per revolution. The value of + 0.048 magnitude per revolution yields a total active lifetime of about 90 revolutions. This is still shorter than some theoretical predictions (Weissman, 1980; Hughes and Daniels, 1982).

Samples of comets were formed according to the following characteristics (mean elements during the observed period):

A - 15 comets of shortest orbital period (mean $P < 6.40$ yr),
B - 15 comets of longest orbital period (mean $P > 7.90$ yr),
C - 15 brightest comets ($m_m < 11.4$ magnitude),
D - 15 faintest comets ($m_m > 15.5$ magnitude),
G - 15 comets of smallest perihelion distance (mean $q < 1.23$ AU),
H - 15 comets of largest perihelion distance (mean $q > 2.00$ AU).

In all samples the average values of the secular brightness decrease per revolution were determined; the largest and the smallest values in each sample were omitted. Designation of the comets included into the different samples is given in the last column of Table 62.

Table 63 - Selected samples - mean brightness decrease per revolution

Sample	M_{42}	M_R
A	+ 0.11	- 0.13
B	+ 0.21	+ 0.17
C	+ 0.10	- 0.02
D	+ 0.64	+ 0.22
G	+ 0.11	- 0.06
H	+ 0.46	+ 0.22

The results listed in Table 63 show that the secular decrease is more rapid for:
A/B - comets with longer orbital periods,
C/D - comets fainter in maximum,
G/H - comets with larger perihelion distances.

The acceleration of the secular decrease with increasing orbital period and increasing perihelion distance found earlier (Svoreň, 1979; Dobrovolsky et al, 1986; Svoreň, 1990) is now confirmed on the basis of more extensive data. There are two possible ways to explain an acceleration of the secular decrease with increasing perihelion distance.

Firstly, it can be explained on the basis of a connection both perihelion distance and orbital period with the apparent magnitude of the comet and with the influence of instrumental effects upon it (Svoreň, 1990).

Secondly, this dependence can be explained as a consequence of the formation of a mineral crust on nuclei rich on minerals (Dobrovolsky et al, 1986). Present evidence seems to favour the dust coverage model, but only more detailed analysis can found a right scenario of cometary evolution.

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