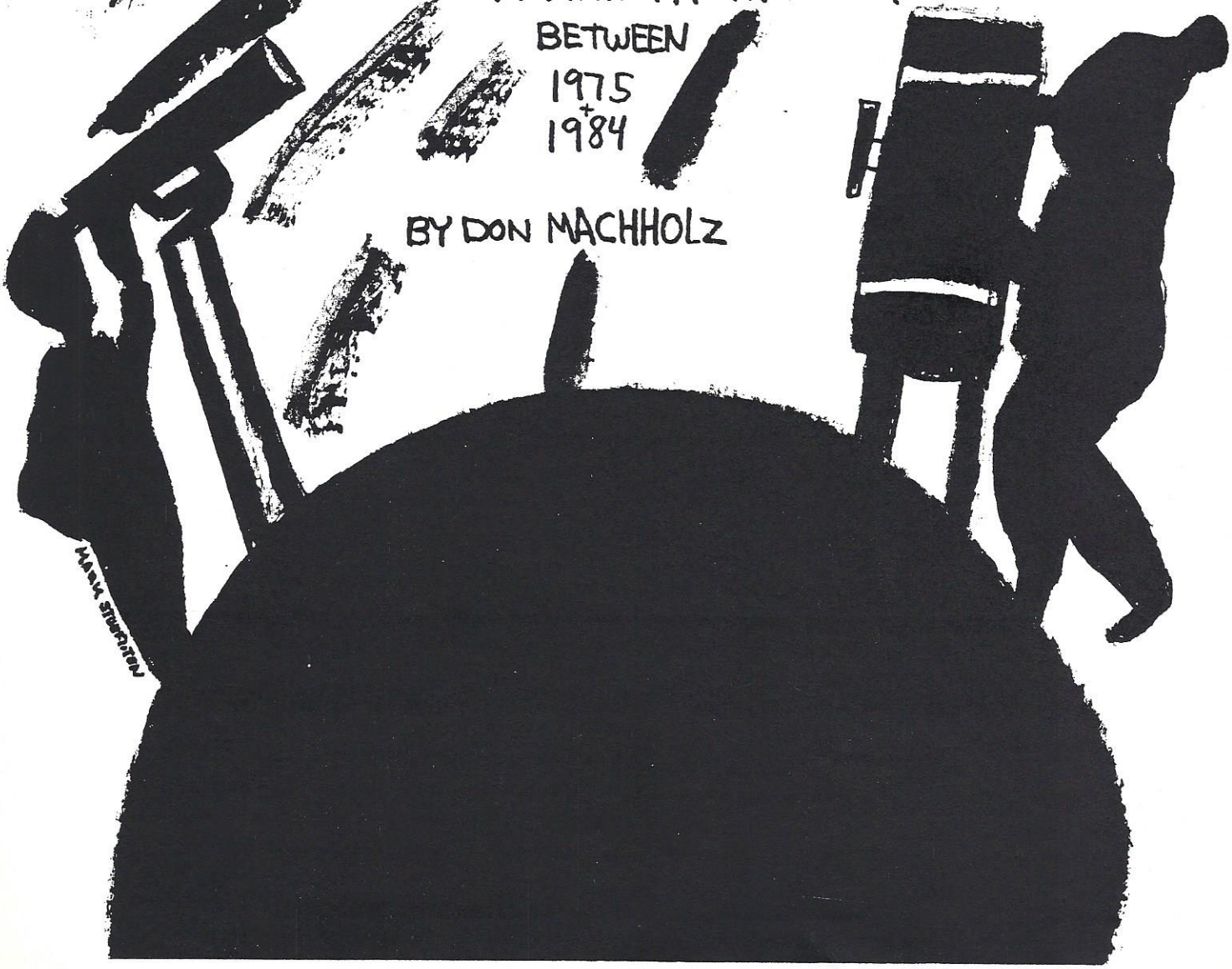
A DECADE OF COMETS

A STUDY OF 33 COMETS DISCOVERED BY AMATEUR ASTRONOMERS BETWEEN 1975 + 1984

BY DON MACHHOLZ



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A STUDY OF THE 33 COMETS

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INTRODUCTION

Is it correct to assume that a cross-section sample of comets is discovered? Or do comet hunters find mostly those coming from certain directions and, even then, only the brightest members? In this section we will examine the orbits and magnitude properties of the 33 comets found by amateurs between 1975 and 1984.

First, let's look at the data for the comets. Tables 16 and 17 list each comet with perihelion distance in astronomical units. Following this is the argument of the perihelion, ascending node, inclination, L and B values, given in degrees. Finally we find listed the absolute magnitude and "N" factor indicating the change in brightness as the comet nears the sun. Further explanation of these columns will be given below as each is examined separately and in detail.

TABLE 16

ORBITAL DATA

MORNING DISCOVERIES

COMET DESG.	PERI. DIS.	ARG. PER.	ASC. NODE	INCL. ANG.	ECC. VAL.	L VAL	B VAL	ABSOL. MAG.	"N" #
1975h	0.43	117.0	295.7	80.8	1.0001	98.2	+61.6	7.3	3.8
1975j	1.60	246.2	278.0	91.6	0.9975	94.3	-66.2	6.7	3.3
1975k	0.84	152.0	216.1	118.2	0.9857	50.2	+24.4	9.6	4.0
1975p	0.22	358.1	270.6	70.6	1.0000	270.0	-01.8	8.9	2.9
1975q	0.86	215.5	280.8	94.0	1.0012	98.0	-35&4	11.0	4.0
1976d	0.68	221.8	69.5	147.8	1.0000	212.4	-20.8	11.3	4.0
1978c	0.44	48.7	259.8	51.1	1.0000	295.4	+35.8	7.1	2.9
1978l	1.77	224.8	290.0	130.6	1.0004	77.1	-32.3	6.8	4.0
1978m	0.37	207.8	41.1	67.8	0.9983	232.3	-25.5	7.5	4.0
1978n	0.78	334.0	41.0	8.7	0.8202	15.3	-3.8	13.7	4.0
1978o	0.43	240.5	357.7	138.3	1.0000	124.9	-35.4	11.6	4.0
1979l	0.55	257.6	102.5	148.6	0.9877	207.0	-30.6	8.0	5.3
1980t	0.26	358.3	114.6	138.6	0.9997	115.9	-1.1	8.0	3.0

PART 6: ORBITAL PARAMETERS

TABLE 16 (con't.)

MORNING DISCOVERIES

COMET DESG.	PERI. DIS.	ARG. PER.	ASC. NODE	INCL. ANG.	ECC. VAL.	L VAL	B VAL	ABSOL. MAG.	"N" #
1982g	0.65	33.8	325.6	84.5	0.9996	329.2	+33.6	7.9	4.0
1983d	0.99	192.8	48.4	73.4	1.0000	232.1	-12.3	9.5	4.0
1983e	0.47	82.2	82.3	96.6	1.0000	42.4	+79.8	11.5	6.0
1983l	3.32	185.9	208.9	134.7	1.0000	24.7	-4.2	2.8	4.0
1984a	1.36	219.2	356.2	51.8	0.9524	203.0	-29.8	8.0	4.0
1984i	0.29	353.1	170.9	164.2	0.9998	177.5	-1.9	8.8	4.0
1984j	1.60	147.6	124.2	9.5	0.5745	272.2	+5.1	7.7	4.0

TABLE 17

ORBITAL DATA

EVENING DISCOVERIES

COMET DESG.	PERI. DIS.	ARG. PER.	ASC. NODE	INCL. ANG.	ECC. VAL.	L VAL	B VAL	ABSOL. MAG.	"N" #
1975a	1.09	11.1	27.0	5.9	0.7795	38.0	+1.1	10.3	4.0
1975d	1.22	264.1	157.2	55.3	1.0014	57.0	-54.8	6.7	4.0
1976a	0.85	313.0	160.1	46.8	0.9938	123.8	-32.2	10.8	5.3
1977m	0.99	163.5	181.8	48.7	0.9996	350.8	+12.3	6.7	4.3
1978f	1.14	231.4	348.6	43.8	1.0008	210.8	-32.7	0.0	6.6
1978j	1.10	240.4	131.6	6.0	0.6652	11.9	-5.2	12.3	4.0
1979c	0.41	47.7	163.5	136.2	1.0001	125.1	+30.7	10.8	4.5
1979i	1.43	112.6	296.9	67.1	0.9732	73.8	+58.3	9.2	4.0
1980k	0.52	337.8	159.9	49.1	1.0000	145.0	-16.6	7.7	4.0
1980q	1.52	88.0	24.7	101.0	0.9947	305.3	+78.8	7.4	4.0
1980u	1.66	105.6	331.3	82.6	0.9990	126.7	+72.8	5.9	4.0
1984o	0.86	128.0	11.0	145.6	1.0000	237.6	+26.4	11.4	4.0
1984t	0.92	82.7	330.5	65.7	0.9994	43.8	+64.6	9.1	4.0

PART 6: ORBITAL PARAMETERS
PERIHELION DISTANCE

Each comet orbits the sun. On every passage it approaches to within a certain distance of the sun, then travels back into the outer solar system again. This closest distance is called it's perihelion distance, or "q", as astronomers refer to it. It is usually measured in astronomical units (A.U.), or the distance from the earth to the sun, 92.9 million miles. Below we examine this parameter in two tables, one showing perihelion distances of one A.U. or less, the other showing values out to 4.0 A.U.

FIGURE 29

PERIHELION DISTANCES

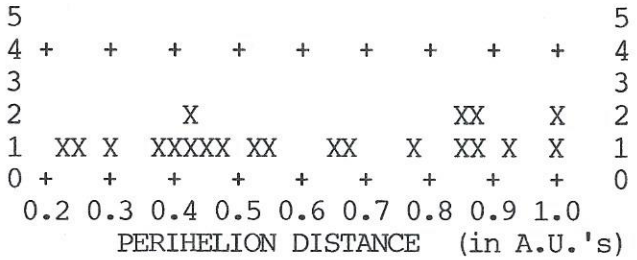
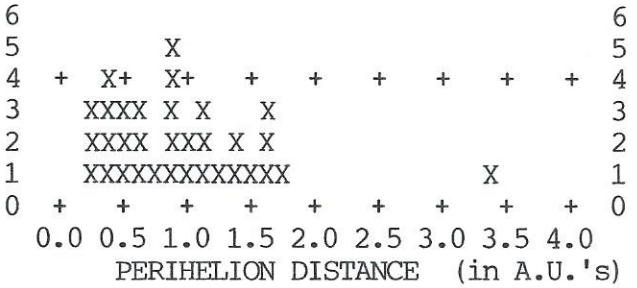


FIGURE 30

PERIHELION DISTANCE



These figures show us that 21 of the 33 comets were closer to the sun than the earth. The most distant comet was Comet Cernis (1983L), which came no closer than 3.32 A.U. of the sun. The closest comet was Comet Bradfield (1975p) which came as close as 0.22 A.U. of the sun.

The average perihelion distance for all comets is:
0.958 +/- 0.617 A.U.

The average for morning finds is:
0.895 +/- 0.741 A.U.

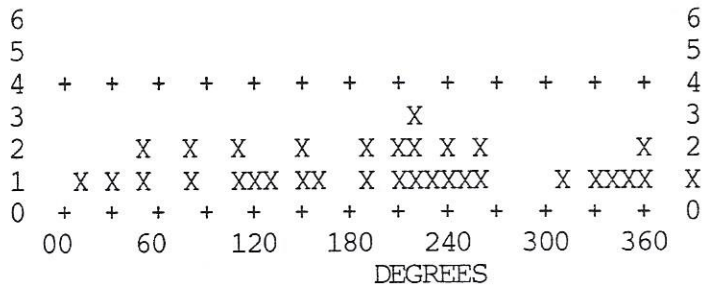
The average for evening finds is:
1.054 +/- 0.360 A.U.

THE ARGUMENT OF PERIHELION

The argument of the perihelion is the angle, in degrees, from the ascending node (where the comet passes upward through the earth's plane) to the perihelion point. It's measured in the same direction as the comet's motion. This figure in itself may not mean much, for one also needs the comet's ascending node and inclination to determine the direction from which the comet came. But we'll examine here the argument of perihelion for the 33 comets.

FIGURE 31

ARGUMENT OF PERIHELION



The graph shows certain groupings, especially near 220 degrees. While we cannot draw any firm conclusions from such a small sampling, the following figures do show some difference between morning and evening finds.

The average for all comets is:
191.60 +/- 100.20 degrees.

The average for morning finds is:
209.83 +/- 95.96 degrees.

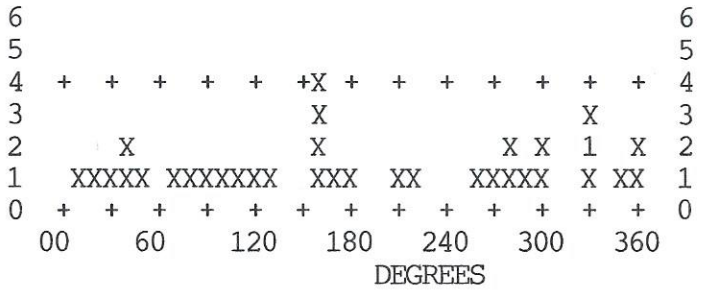
The average for evening finds is:
163.55 +/- 103.85 degrees.

THE ASCENDING NODE

The ascending node is the difference in degrees, measured eastward, from the Vernal Equinox to the point where the comet crosses the ecliptic moving northward. Here we will examine the ascending nodes for the 33 comets in this study.

FIGURE 32

ASCENDING NODE



Here we see that the ascending nodes seem more evenly distributed, with a one peak at 160 degrees. There isn't much diffference between the morning and evening finds.

The average for all comets is:
189.63 +/- 112.0 degrees.

The average for morning finds is:
196.69 +/- 110.3 degrees.

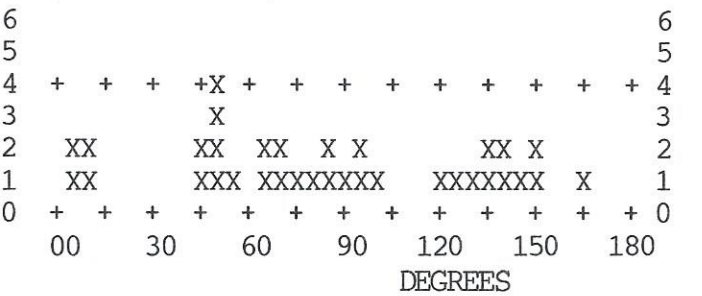
The average for evening finds is:
178.78 +/- 118.2 degrees.

INCLINATION ANGLES

The inclination is the tilt of the comet's orbit to the plane of the ecliptic. An inclination of less than 90 degrees means that the comet is in a direct orbit, traveling around the sun in the same general direction as the planets. An inclination of greater than 90 degrees means a reverse, or "retrograde", orbit. Most short period comets have low inclinations. Here we plot the values for all 33 comets.

FIGURE 33

INCLINATIONS



The average for all comets is:
83.48 +/- 45.6 degrees.

The average for morning finds is:
95.06 +/- 44.9 degrees.

The average for evening finds is:
65.67 +/- 42.4 degrees.

There is a grouping of comets near an inclination of 50 degrees. We also find a difference between morning sky and evening sky inclinations.

Of all 33 comets, 19 comets, or 58% of them, had a direct orbit. Only 14 had a retrograde orbit.

Of the 20 comets found in the morning sky, nine comets, or 45% of them, had a direct orbit. Eleven had a retrograde orbit.

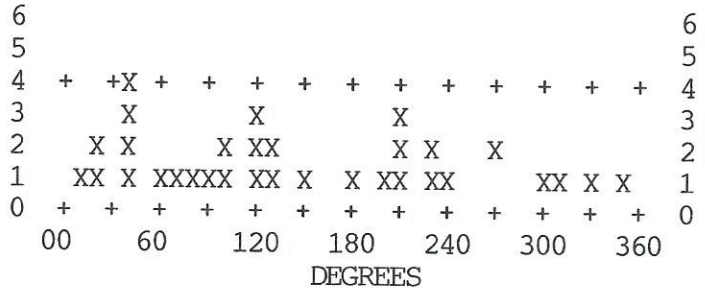
Of the 13 comets found in the evening sky, ten comets, or 77% of them, had a direct orbit. Only three had a retrograde orbit.

THE "L" VALUE

The L value is calculated from the ascending node, argument of perihelion and the inclination. It gives the longitude of the comet's perihelion in degrees, as seen from the sun. If several comets belong to a family, their L's and B's should be similar. Let's now look at the "L" values.

FIGURE 34

"L" VALUES



The average for all comets is:
152.17 +/- 98.8 degrees.

The average for morning finds is:
158.61 +/- 96.3 degrees.

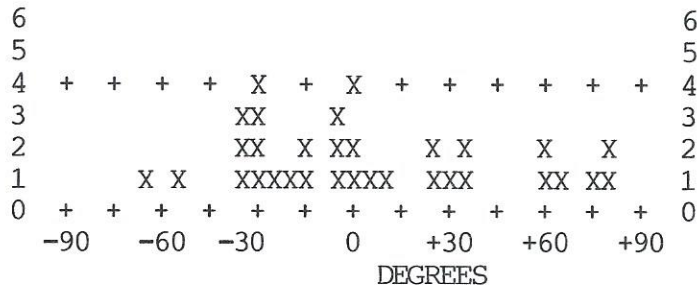
The average for evening finds is:
142.28 +/- 105.8 degrees.

THE "B" VALUES

The "B" value is the latitude of the comet's perihelion, in degrees, as seen from the sun. A (-) value means it is below the ecliptic plane at perihelion, but probably above that plane for most of the rest of its journey. For a (+) value the opposite is true. Let's look at the "B" values for 33 comets.

FIGURE 35

"B" VALUES



The average for all comets is:
+4.32 +/- 39.5 degrees.

The average for morning finds is:
-3.04 +/- 35.6 degrees.

The average for evening finds is:
+15.65 +/- 43.9 degrees.

COMPARING "B" VALUES AND DISCOVERY DECLINATIONS

Nineteen comets had a "B" value of less than 0.

The average declination of these comets is:
-11.73 +/- 32.6 degrees.

The average declination for the 14 comets in this group that were found in the morning sky is:
-16.04 +/- 30.0 degrees.

The average declination for the 5 comets in this group that were found in the evening sky is:
+0.33 +/- 40.1 degrees.

PART 6: ORBITAL PARAMETERS

Fourteen comets had a "B" value of greater than 0.

The average declination of these comets is:
+11.51 +/- 34.2 degrees.

The average declination for the 6 comets in this group that were found in the morning sky is:
-5.46 +/- 39.5 degrees.

The average declination for the 8 comets in this group that were found in the evening sky is:
+24.23 +/- 25.1 degrees.

From this small sample of 33 comets it seems as though comets with a perihelion position that is below the ecliptic are usually found south of the earth's equator, especially when found in the morning sky ...and...

Comets with a perihelion position north of the ecliptic are generally found north of the equator, especially when found in the evening sky ...and...

Comets found in the morning sky are more likely to have a -B than a +B value ...and...

Comets found in the evening sky are more likely to have a +B than a -B value.

"L" and "B" VALUES

Plotted on the following page is the location of each comet on the "L" vs. "B" graph. This shows the two dimensional map of comet perihelia as seen from the sun. The "B" is listed along the left side of the graph, it represents the latitude of the comet's perihelion as seen from the sun. The "L" value, similar to longitude, is listed along the bottom.

From first appearance it would seem that some comets share orbits. But a further look (Table 18) shows that even though "L"'s and "B"'s may be similar, the orbital elements are not.

PART 6: ORBITAL PARAMETERS

FIGURE 36

"L" AND "B" VALUES

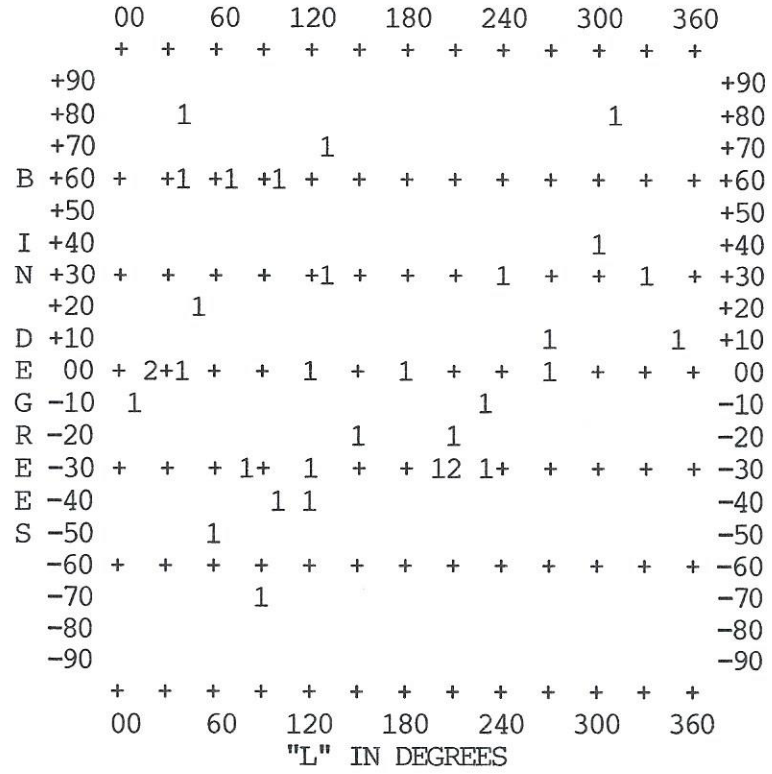


TABLE 18

COMETS WITH SIMILAR "L"'S AND "B"'S

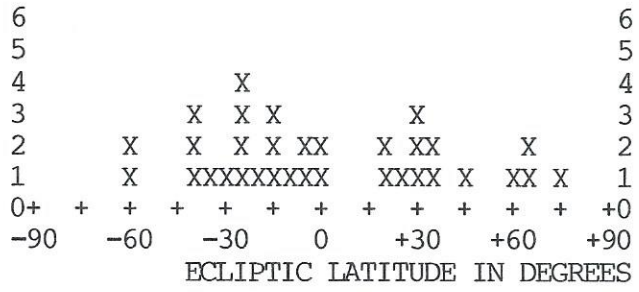
COMET DESG.	PERI. DIS.	ARG. PER.	ASC. NODE	INCL. ANG.	ECC. VAL.	L VAL	B VAL	ABSOL MAG.	"N" #
1976d	0.68	221.8	69.5	147.8	1.0000	212.4	-20.8	11.3	4.0
1984a	1.36	219.2	356.2	51.8	0.9524	203.0	-29.8	8.0	4.0
1979l	0.55	257.6	102.5	148.6	0.9877	207.0	-30.6	8.0	5.3
1978f	1.14	231.4	348.6	43.8	1.0008	210.8	-32.7	0.0	6.6
1978n	0.78	334.0	41.0	8.7	0.8202	15.3	-3.8	13.7	4.0
1983l	3.32	185.9	208.9	134.7	1.0000	24.7	-4.2	2.8	4.0
1978o	0.43	240.5	357.7	138.3	1.0000	124.9	-35.4	11.6	4.0
1976a	0.85	313.0	160.1	46.8	0.9938	123.8	-32.2	10.8	5.3

ECLIPTICAL LATITUDES AT DISCOVERY

Are comets found close to the ecliptic? The ecliptic is the path that the sun takes through the sky. Logic would suggest that low inclination comets, which would possibly be periodic, will be found close to the ecliptic. Here we graph the ecliptical values (along the bottom of the graphs) with the number of comets in each sector.

FIGURE 37

ECLIPTICAL LATITUDES AT DISCOVERY



More comets are found south of the ecliptic than north of it. The most northernly was +74 degrees, Comet IRAS-ARAKI-Alcock (1983e). The most southernly comet was at -60.5 degrees: Comet Austin (1984i).

The average ecliptic latitude for all comets is:
+1.19 degrees.

The average for morning finds is:
-11.06 degrees.

The average for evening finds is:
+20.04 degrees.

We find that comets found in the morning sky are usually found south of the ecliptic. The evening sky discoveries are generally found north of the ecliptic. We found this same type of relationship when we compared discovery positions with declination.

The five comets which have orbital periods of less than 200 years are shown below with their ecliptic latitudes at discovery. We see that periodic comets are generally found near the ecliptic.

PART 6: ORBITAL PARAMETERS

TABLE 19

PERIODIC COMETS AND THEIR ECLIPTIC

LATITUDES AT DISCOVERY

COMET	COMET NAME	PERIOD (YRS)	ECL. LAT.
1978j	Haneda-Campos	5.96	-11.5d
1984i	Takamizawa	7.26	-2.5d
1978n	Denning-Fujikawa	9.02	-4.4d
1975a	Boethin	11.05	+0.9d
1984a	Bradfield	152.38	-26.1d

ECCENTRICITY

The eccentricity of an orbit relates to it's shape. An eccentricity of 0.0 means the orbit is circular. A figure of greater than zero but less than one is an elliptical orbit, the comet will return in a given time. A 1.0 means it is a parabola. A parabolic orbit closes in on itself only at an infinite distance from the sun. Finally, a figure of greater than 1.0 is a hyperbolic orbit, the comet will never return to the inner solar system. For many comets, a figure of 1.00 is assumed, and this closely fits the orbits of a wide variery of eccentricities when the comet is close to the sun.

On the following page is listed the periodic comets in our study. It shows the comet's name, orbital period in years, inclination and eccentricity of its orbit, and perihelion distance in astronomical units.

PART 6: ORBITAL PARAMETERS

TABLE 20

PERIODIC COMETS

COMET	COMET NAME	PER.(YRS)	INCL.	ECCEN.	PER. DIS.
1978j	Haneda-Campos	5.96	11.9d	0.6652	1.101
1984i	Takamizawa	7.26	7.3d	0.5745	1.596
1978n	Denning-Fujikawa	9.02	8.7d	0.8202	0.779
1975a	Boethin	11.05	5.9d	0.7795	1.094
1984a	Bradfield	152.38	51.8d	0.9524	1.358
1979L	Bradfield	293.15	148.6d	0.9877	0.545
1979i	Meier	390.58	67.1d	0.9732	1.432
1975k	Suz.-Sai.-Mori	446.26	118.2d	0.9857	0.838

Most of these comets have low inclinations, this is typical of periodic comets. Two of the three shortest period comets have irregular light curves, this is possibly why they were not discovered until this decade.

Several of our comets have hyperbolic orbits.

TABLE 21

HYPERBOLIC COMETS

COMET	COMET NAME	ECCEN.	INCL.	PER. DIS.
1975d	Bradfield	1.00141	55.3d	1.217
1975q	Sato	1.00121	94.0d	0.864
1978f	Meier	1.00084	43.8d	1.137
1978l	Machholz	1.00042	130.6d	1.772
1975h	Kob.-Berger-Milon	1.00009	80.8d	0.426
1979c	Bradfield	1.00006	136.2d	0.413

These comets tend to travel in a direct orbit, as do most of our comets. They are evenly split with perhelion distance, half being less than 1 A.U. and half being more, while 64% of all our 33 comets come closer than 1 A.U. to the sun.

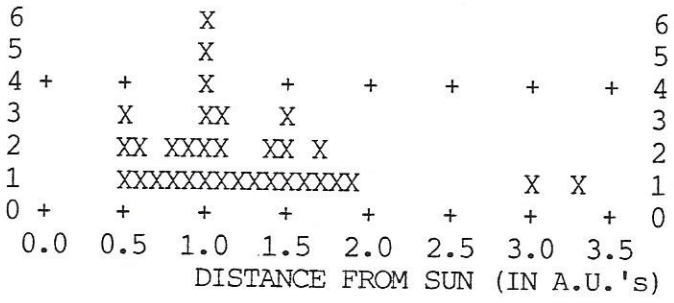
PART 6: ORBITAL PARAMETERS

COMET DISTANCE FROM EARTH AND SUN AT DISCOVERY

It is often said that comets become visible to amateur astronomers when they get within about 1.5 A.U. of the sun. In the first two graphs below we see the number of comets (listed along the left) plotted against the distance of each comet to the sun (listed along the bottom) and then the comet's distance to the earth is plotted.

FIGURE 38

COMET'S DISTANCE FROM SUN AT DISCOVERY



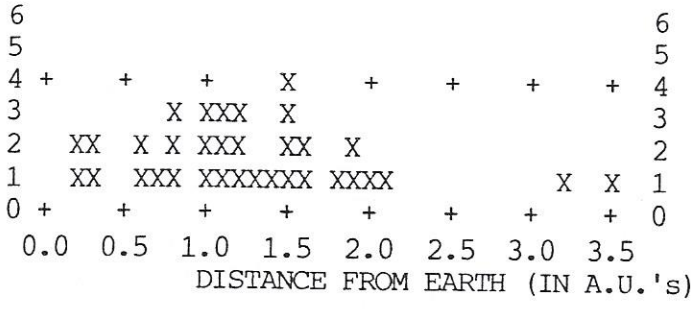
The average distance from the sun for all comets is:
1.24 A.U.

The average for morning finds is:
1.16 A.U.

The average for evening finds is:
1.35 A.U.

FIGURE 39

COMET'S DISTANCE FROM EARTH AT DISCOVERY



PART 6: ORBITAL PARAMETERS

The average distance from the earth for all comets is:
1.26 A.U.

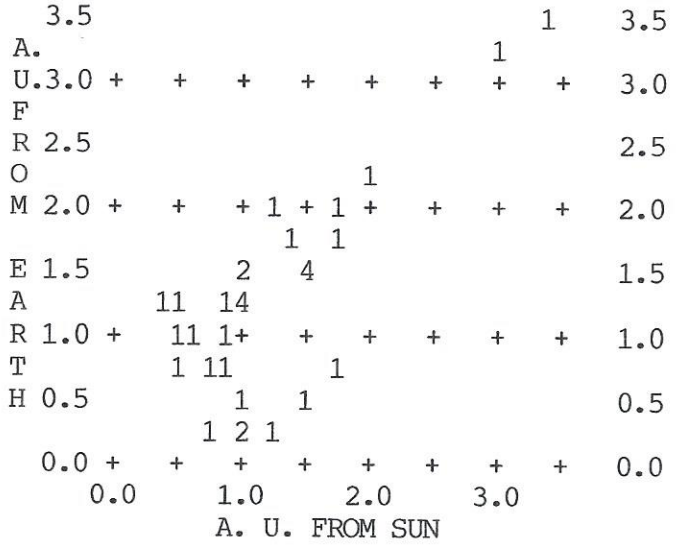
The average for morning finds is:
1.14 A.U.

The average for evening finds is:
1.45 A.U.

Now we look at the comet's distance to the earth and sun plotted on one graph. The distance of each comet to the earth is listed along the left side and distance to the sun is listed along the bottom.

FIGURE 40

DISTANCE FROM EARTH AND SUN

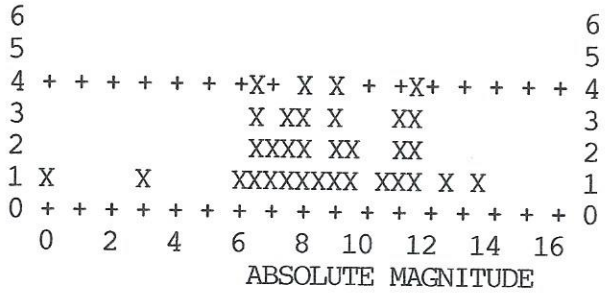


ABSOLUTE MAGNITUDE

The absolute magnitude of a comet is its magnitude, or brightness, at 1.0 A.U. from both the earth and sun. This value is calculated from various magnitude estimates made mostly by amateur astronomers.

PART 6: ORBITAL PARAMETERS

FIGURE 41
ABSOLUTE MAGNITUDE



The average absolute magnitude for all comets is:
8.54 +/- 2.7.

The average for morning finds is:
8.69 +/- 2.37.

The average for evening finds is:
8.33 +/- 3.22.

THE "N" FACTOR

Included in the formula for comet magnitudes is a factor referred to as "n". This is related to the comet's distance to the sun and fits into the formula:

Magnitude = Absol. Mag. + (5 log D) + [2.5 n * (log R)].

...where D = the comet's distance to the earth and R = the comet's distance to the sun.

A large number for "N" means that the comet brightens rapidly as it approaches the sun, a small number means it brightens very slowly.

The "N" factor is often assumed to be 4.0. With further studies of the comet it is often changed. A graph of the "N" figures is shown in FIGURE 42. All of the "N" values assumed to be 4.0 are removed.

Of the 33 comets in our study, 22 were given an "N" of 4.0.

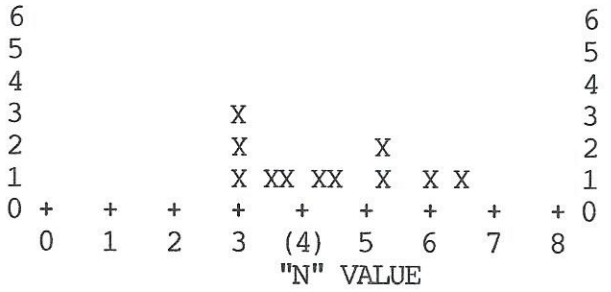
Of the remaining 11 comets, the average is:
4.35.

PART 6: ORBITAL PARAMETERS

FIGURE 42

THE "N" VALUES

(NOT INCLUDING THOSE ASSUMED TO BE 4.0)

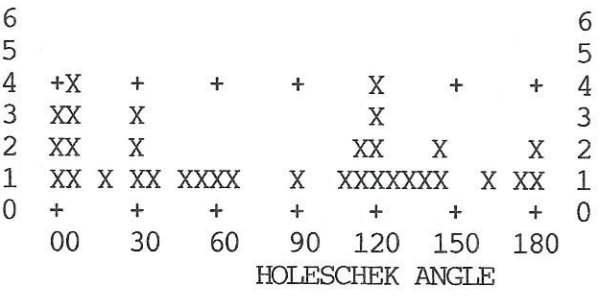


THE HOLETSCHEK EFFECT AND DISCOVERY PROBABILITIES

In the late 1800's, J. Holetschek discovered that when a comet comes to perihelion when the earth is on the opposite side of the sun, it is less likely to be discovered. The value has been calculated for each comet, it is the difference between the longitudes of the earth and comet as seen from the sun. When this angle is near 180 degrees, the comet is opposite the earth and should not be as likely to be discovered. When this angle is near 0 degrees, the comet would likely be an easy discovery. This Holetschek angle is graphed in Figure 43 and stated in Tables 22 and 23.

FIGURE 43

THE HOLETSCHEK ANGLE



We find that 17 of the 33 comets have a Holetschek angle of less than 90 degrees.

PART 6: ORBITAL PARAMETERS

The average Holeschek angle for all comets is:
81.27 degrees.

The average for morning finds is:
77.87 degrees.

The average for evening finds is:
86.50 degrees.

Now we will examine the discovery probabilities of each comet. Two figures were calculated for this. The first is based on a study conducted in 1967 by Dr. Everhart and printed in the ASTRONOMICAL JOURNAL for August, 1967. In this paper, entitled "Intrinsic Distributions of Cometary Perihelia and Magnitudes", Dr. Everhart determines the discovery probability for comets of certain perihelion distances and absolute magnitudes. He bases this on a mathematical model of 21,120 hypothetical comets. This probability figure is an average for all possible comet orbits with that same perihelion distance and absolute magnitude.

The second probability figure (labeled as # 2), was calculated by this author, and is based on the four ascending nodes studied for each particular comet. Each of the four cases carries a 25% maximum chance of discovery.

As shown in Tables 22 and 23, Probability # 2 is never lower than Probability # 1. Usually # 2 is much higher than #1. Why is this?

First, the # 1 set of probabilities was calculated using an "N" of 4.0. Probability # 2 used the actual "N" for each comet, this affects the chance of discovery. Secondly, Prob. # 1 is based on 160 orbits of the same perihelion distance and absolute magnitude. Prob. # 2 uses only four samples, the comet being discovered in one and the other three being at fixed intervals to the first. The argument of perihelion, inclination, and perihelion date are all constant in the # 2 probabilities, unlike the Everhart study. Thirdly, Dr. Everhart confined his discovery probability to observers from 40 degrees N. latitude, this was needed for the particular purpose of the study. I determined discovery probability for an observer from any latitude on earth. A final point is that discovery criteria for the comets were not identical. Dr. Everhart's study assumed a comet could be found as faint as magnitude 12 when far from the sun. In my study a comet would still be considered undiscoverable at mag. 12, since most comets were found only after brightening to mag. 10 or 11. This one difference would tend to lower, and not raise the Prob. # 2 figures.

Tables 22 and 23 also contain figures representing the number of days the comet was within 1 AU, and then within 2 AU, of the sun. This is regardless of its position in relation to the earth, but we do see that many comets spent over 200 days within 2 AU's of the sun. Note, however, that discovery probabilities are seldom related to the amount of time the comet is within a certain radius of the sun.

PART 6: ORBITAL PARAMETERS

TABLE 22

ORBITAL DATA

MORNING DISCOVERIES

COMET DESG.	PERI. DIS.	ARG. PER.	ASC. NODE	INCL. ANG.	HOL. ANG.	PROB. # 1	PROB. # 2	WITHIN 1 AU	WITHIN 2 AU	ABSOL. MAG.	"N" #
1975h	0.43	117.0	295.7	80.8	116d	32%	100%	77	196	7.3	3.8
1975j	1.60	246.2	278.0	91.6	1d	22%	80%	0	180	6.7	3.3
1975k	0.84	152.0	216.1	118.2	29d	6%	70%	59	219	9.6	4.0
1975p	0.22	358.1	270.6	70.6	179d	9%	85%	70	178	8.9	2.9
1975q	0.86	215.5	280.8	94.0	5d	1%	30%	56	218	11.0	4.0
1976d	0.68	221.8	69.5	147.8	57d	1%	50%	73	212	11.3	4.0
1978c	0.44	48.7	259.8	51.1	119d	33%	90%	77	197	7.1	2.9
1978l	1.77	224.8	290.0	130.6	117d	17%	60%	0	146	6.8	4.0
1978m	0.37	207.8	41.1	67.8	119d	24%	80%	76	192	7.5	4.0
1978n	0.78	334.0	41.0	8.7	7d	00%	20%	73	247	13.7	4.0
1978o	0.43	240.5	357.7	138.3	120d	00%	60%	77	196	11.6	4.0
1979l	0.55	257.6	102.5	148.6	118d	23%	85%	78	207	8.0	5.3
1980t	0.26	358.3	114.6	138.6	18d	4%	100%	72	182	8.0	3.0
1982g	0.65	33.8	325.6	84.5	2d	24%	100%	75	210	7.9	4.0
1983d	0.99	192.8	48.4	73.4	8d	5%	65%	16	219	9.5	4.0
1983e	0.47	82.2	82.3	96.6	178d	00%	80%	77	199	11.5	6.0
1983l	3.32	185.9	208.9	134.7	88d	56%	60%	0	0	2.8	4.0
1984a	1.36	219.2	356.2	51.8	108d	9%	60%	0	213	8.0	4.0
1984i	0.29	353.1	170.9	164.2	142d	9%	85%	73	185	8.8	4.0
1984j	1.60	147.6	124.2	9.5	29d	9%	40%	0	242	7.7	4.0

PART 6: ORBITAL PARAMETERS

TABLE 23

ORBITAL DATA

EVENING DISCOVERIES

COMET DESG.	PERI. DIS.	ARG. PER.	ASC. NODE	INCL. ANG.	HOL. ANG.	PROB. # 1	PROB. # 2	WITHIN 1 AU	WITHIN 2 AU	ABSOL. MAG.	"N" #
1975a	1.09	11.1	27.0	5.9	67d	1%	40%	0	254	10.3	4.0
1975d	1.22	264.1	157.2	55.3	137d	36%	60%	0	215	6.7	4.0
1976a	0.85	313.0	160.1	46.8	31d	1%	25%	57	218	10.8	5.3
1977m	0.99	163.5	181.8	48.7	57d	40%	80%	16	219	6.7	4.3
1978f	1.14	231.4	348.6	43.8	162d	100%	100%	0	218	0.0	6.6
1978j	1.10	240.4	131.6	6.0	4d	00%	15%	0	280	12.3	4.0
1979c	0.41	47.7	163.5	136.2	175d	2%	60%	77	195	10.8	4.5
1979i	1.43	112.6	296.9	67.1	50d	1%	10%	0	204	9.2	4.0
1980k	0.52	337.8	159.9	49.1	126d	25%	75%	77	203	7.7	4.0
1980q	1.52	88.0	24.7	101.0	133d	12%	50%	0	192	7.4	4.0
1980u	1.66	105.6	331.3	82.6	1d	33%	60%	0	170	5.9	4.0
1984o	0.86	128.0	11.0	145.6	143d	0%	45%	56	218	11.4	4.0
1984t	0.92	82.7	330.5	65.7	39d	9%	70%	44	219	9.1	4.0

Each of these 33 comets was discovered no matter what the probabilities or orbital elements would predict. This is one of the wonders of amateur comet discoveries-some of the most difficult finds are found. For as long as there is even one comet in the sky, there will be amateur astronomers looking for it.

The past decade has seen 33 new comets enter our midst, all found and officially named by amateurs. These intrepid enthusiasts, armed with extensive knowledge of the night-time sky, and warmed by the spirit of discovery, searched and searched and learned to love to search. And somewhere along that long or short road to a comet, the lucky ones realized that there is more to comet discovery than comets, for discovery goes on with every new field full of stars. Who knows what discoveries await us between now and the next comet?

NOTES