A DECADE OF COMETS

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

BY DON MACHHOLZ

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PART 3: THE TIME OF DISCOVERY

FIGURE 1

TIME LINE FOR AMATEUR DISCOVERIES

Yr	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	TOT.
75	+a	+	+ d	+	+	+	h	+	+	j +k	+ p	+q	+ 7
76	+	+	a +d	+	+	+	+	+	+	+	+	+	2
77	+	+	+	+	+	+	+	+	+m	+	+	+	1
78	+	+c	+	+	f+	+	+	+	j l	n mo	+	+	+ 7
79	+	+	+	+	+	+	c+	+	+ i	+	+	l+	3
80	+	+	+	+	+	+	+	k	+	+	+q	+ tu+	4
81	+	+	+	+	+	+	+	+	+	+	+	+	0
82	+	+	+	+	+	+ g	+	+	+	+	+	+	1
83	+	+	+	+	+de	+	+ l	+	+	+	+	+	3
84	+a	+	+	+	+	+	+i	j	+ o	+	+ t	+	+ 4

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	TOT.
2	2	2	1	2	2	5	0	5	5	3	4	33

Figure 1: All 33 comets discoveries by amateur astronomers are displayed here. Each comet is represented by the letter designation in the year and at the time it was discovered.

Figure 1 shows that amateur astronomers do not find comets at regular intervals. If they did, one comet would be found every 111 days, or 3.6 months, meaning three or four finds a year. As it was, though, two comets, 1975j and 1975k, were found simultaneously on the morning of Oct. 5, 1975. This is the order of these two discoveries:

PART 3: THE TIME OF DISCOVERY

TABLE 2

COMET DISCOVERIES OF OCT. 5, 1975

COMET	DISCOVERER	UNIV. TIME
1975j	Mori	17:50
1975j	Sato	18:10
1975k	Suzuki	18:40
1975k	Saigusa	19:00
1975k	Mori	19:00
1975j	Fujikawa	19:00
1975k	Okazaki	19:02
1975k	Furuyama	19:10

Another close pair of discoveries came in October 1978, Periodic Comet Denning-Fujikawa and Comet Bradfield were found 23h 40m apart.

Two nearly equally-lengthed comet droughts lasted 18 months each, one between March 1976 and September 1977. The other stretched between December 1980 and June 1982.

Two other points become apparent from Figure 1. First, some years show more discoveries than others. Secondly, some months show more discoveries than others. Let's first look at the yearly variations.

From Table 3 we see that the total number of discoveries for each year varies from 3 to 13. For amateurs alone the range is 0 through 7, for professionals alone it is 2 through 9. There seems to be little correlation between the number of amateur and professional discoveries. This would imply that the yearly variation in amateur comet finds is not due to poor world-wide weather, because the professionals still find comets even when the amateurs don't, and vice versa.

PART 3: THE TIME OF DISCOVERY

TABLE 3

AMATEUR AND PROFESSIONAL COMET DISCOVERIES FOR EACH YEAR

YEAR	AMAT.	PRO.	TOTAL	AMAT/PRO
1975	7	6	13	1.2
1976	2	3	5	0.7
1977	1	7	8	0.1
1978	7	4	11	1.8
1979	3	4	7	0.8
1980	4	6	10	0.7
1981	0	5	5	0.0
1982	1	2	3	0.5
1983	3	9	12	0.3
1984	5	8	13	0.6
TOTAL	33	54	87	0.61

We cannot gauge amateur comet hunting activity from these data alone, but a variation in the number, or efficiently, of comet hunters could be an explanation. Perhaps the most plausible reason is that some years simply display more bright comets than do other years. Exactly why this happens is not known for sure.

Now let's look at the unequal number of comets found each month.

TABLE 4

MONTHLY TOTALS OF AMATEUR COMET DISCOVERIES: 1975-1984

Jan.: 2.	Apr.: 1.	Jul.: 5.	Oct.: 5.
Feb.: 2.	May : 2.	Aug.: 0.	Nov.: 3.
Mar.: 2.	Jun.: 2.	Sep.: 5.	Dec.: 4.

Perhaps this disparity is due to better weather in one hemisphere than another, or perhaps the longer nights favor one part of the year over another. Let's take a more detailed look at this. Table 5 shows those comets found in the morning and evening skies, plus whether the comet was found north or south of the celestial equator, and whether the discoverer lived north or south of the equator. Following that is a column showing the number of comets that came to perihelion each month.

PART 3: THE TIME OF DISCOVERY

TABLE 5

COMET DISCOVERY TOTALS FOR EACH MONTH

(Comet N + S = Equatorial Position)

	MORN. DISC.					EVEN. DISC.					TOTALS				
MON.	COMET		OBSVR		PERI	COMET		OBSVR		PERI	COMET		OBSVR		PERI
	N	S	N	S	DATE	N	S	N	S	DATE	N	S	N	S	DATE
Jan.	0	1	0	1	1	0	1	1	0	2	0	2	1	1	3
Feb.	0	1	0	1	1	0	1	0	1	1	0	2	0	2	2
Mar.	0	1	0	1	1	0	1	0	1	0	0	2	0	2	1
Apr.	0	0	0	0	0	1	0	1	0	1	1	0	1	0	1
May	2	0	5	0	3	0	0	0	0	0	2	0	5	0	3
Jun.	0	1	0	1	0	0	1	0	1	1	0	2	0	2	1
Jul.	1	3	5	1	1	1	0	2	0	1	2	3	7	1	2
Aug.	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3
Sep.	0	1	1	0	3	3	1	4	1	0	3	2	5	1	3
Oct.	3	2	7	2	2	0	0	0	0	3	3	2	7	2	5
Nov.	0	1	0	1	0	2	0	3	0	2	2	1	3	1	2
Dec.	1	2	1	2	5	1	0	1	0	2	2	2	2	2	7
TOT.	7	13	19	10	20	8	5	12	4	13	15	18	31	14	33

Several tendencies become apparent from Table 5. Of the 20 comets found in the morning sky and the 13 found in the evening sky, here's what we find:

Morning Sky Discoveries

Nearly twice as many comets are found south of the equator than north of the equator. Those found in the north are all discovered in May, July, October or December. Nine of the 13 in the southern hemisphere are found in the last six months of the year.

As for the location of the discoverers, 18 of 19 of those in the northern hemisphere found their comets during the six months of May-October. Eight of the ten Southern Hemisphere discoverers found their comets in the six months extending from October through March.

Perihelion dates: Thirteen of the 20 comets listed here reach perihelion during five months: August through December.

Evening Sky Discoveries

Northern Hemisphere discoveries are again grouped toward the end of the year, while comets found south of the equator were found in the beginning of the year.

Discoverers living in the Northern Hemisphere found three-fourths of their comets between July and November. For Southern Hemisphere discoverers, the finds are spaced between February and September.

Perihelion dates are grouped mainly between October and Feburary.

Totals and Summary

Note that while the month of August contained no discoveries, there were two finds on the last day of July and two more within the first four days of September.

Northern Hemisphere comet hunters find most of their comets when the weather is good, between May and October, generally. Southern Hemisphere comet hunters find comets over a large portion of the year, with the months September through March showing greater numbers. These are times when the weather is generally better in the Southern Hemisphere.

We should not assume, however, that more comets are found during certain clear weather months simply because there are more available nights for comet hunting. Indeed, some of the poor-weather months have longer nights, allowing more time per night for comet seeking. While we do not expect a sample of only 33 comets to answer these questions, let's take a look at one more parameter-the location of the comet when discovered.

We found from Table 5 that, for the morning sky, nearly twice as many comets are found south of the equator than north of the equator. In the evening sky the reverse is true. The ecliptic, the path of the sun through the year, is north of the equator in the Autumn morning and Spring evening skies, and south of the equator in the Autumn evening and Spring morning skies. If we rewrite Table 5, exchanging the comet location, N and S of the equator with N and S of the ecliptic, we may see if comets are found equally north and south of the ecliptic. This is shown in Table 6.

The changes in the discovery positions are shown with an *. They indicate Periodic Comet Boethin (1975a) found in Jan. 1975, Comet Mori-Sato-Fujikawa (1975j) found in Oct. 1975 and Periodic Comet Denning-Fujikawa (1978n), re-discovered in Oct. 1978. The first and last listed here are periodic comets, found within 5 degrees of the ecliptic. Table 6 shows that the N/S ecliptical distribution of morning and evening finds is nearly the same as the N/S equatorial distribution.

PART 3: THE TIME OF DISCOVERY

TABLE 6

COMET DISCOVERY TOTALS FOR EACH MONTH

(Comet N + S = Ecliptical Position)

	MORN. DISC.					EVEN. DISC.					TOTALS				
MON.	COMET N	COMET S	OBSVR N	OBSVR S	PERI DATE	COMET N	COMET S	OBSVR N	OBSVR S	PERI DATE	COMET N	COMET S	OBSVR N	OBSVR S	PERI DATE
Jan.	0	1	0	1	1	1*	0	1	0	2	1	1	1	1	3
Feb.	0	1	0	1	1	0	1	0	1	1	0	2	0	2	2
Mar.	0	1	0	1	1	0	1	0	1	0	0	2	0	2	1
Apr.	0	0	0	0	0	1	0	1	0	1	1	0	1	0	1
May	2	0	5	0	3	0	0	0	0	0	2	0	5	0	3
Jun.	0	1	0	1	0	0	1	0	1	1	0	2	0	2	1
Jul.	1	3	5	1	1	1	0	2	0	1	2	3	7	1	2
Aug.	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3
Sep.	0	1	1	0	3	3	1	4	1	0	3	2	5	1	3
Oct.	1	4*	7	2	2	0	0	0	0	3	1	4	7	2	5
Nov.	0	1	0	1	0	2	0	3	0	2	2	1	3	1	2
Dec.	1	2	1	2	5	1	0	1	0	2	2	2	2	2	7
TOT.	5	15	19	10	20	9	4	12	4	13	14	19	31	14	33

One final point is that 25 of the 33 comets reached perihelion during seven months-from August through February. Whether this is due to a non-random distribution of comets or a non-random distribution of comet hunting activity we can not answer from these data alone.

MOON PHASE

Here we look at moon phases during both the morning and evening comet discoveries. Figures 2 and 3 contain data for the first amateur discovery of each comet. For multiple finds the second and third find times are not used. "Morning" or "evening" denotes the sky in which the comet was found.

FIGURE 2

MOON PHASES FOR MORNING DISCOVERIES

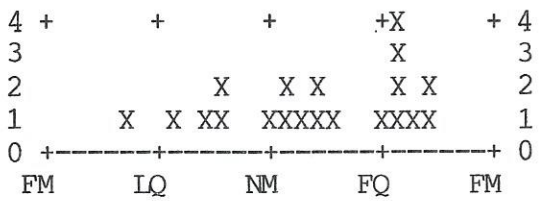
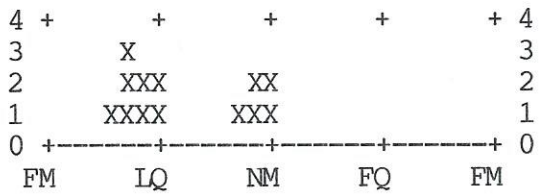


FIGURE 3

MOON PHASES FOR EVENING DISCOVERIES



As we can see from Figures 2 and 3, comets are generally found when the moon is not in the sky. The morning sky shows six discoveries in the nine days prior to New Moon, this is when the moon is clearing out of the sky. Discoveries also take place in the ten days after New Moon, ending just as the nearly-Full Moon is entering the morning sky.

For evening discoveries the comets are found just as the post-Full Moon is leaving the evening sky. A second series of finds takes place near New Moon.

This would be expected because: 1) comet hunters do not generally sweep when the moon is up, and 2) comet hunters generally sweep an area just as the moon leaves that part of the sky, then cover it again before the moon re-enters it.

DAYS OF THE WEEK

An examination is made of the day of the week in which the discovery is made. Two morning sky finds were made when the discoverers' mean solar time still showed evening. These are shown as being found in the evening in the following table. Also, the co-discovery by the satellite IRAS does not include the day of the week for IRAS's find.

TABLE 7

DAYS OF THE WEEK

DAY	MORNING	EVENING	TOTAL
SUN.	2	1	3
MON.	12	2	14
TUE.	4	3	7
WED.	2	5	7
THU.	3	4	7
FRI.	0	2	2
SAT.	3	2	5
TOT.	26	19	45

Nine of the Monday morning finds were of three comets found by three Japanese observers each. Three of Rolf Meier's four finds were made on Wednesday evenings. Apparently, Fridays and Sundays are days off for comet hunters, with the middle of the work week being a busy time. Comet hunters are not out only on weekends!

DISCOVERY TIMES BEFORE AND AFTER ASTRONOMICAL TWILIGHT

A look here is made of the discovery times and how they compare to the time of the discoverers' astronomical twilights. Astronomical twilight refers to the time when the sun is 18 degrees below the horizon. In three cases comets in the morning sky were found soon after the discoverers' evening twilight, these are reflected in the evening table.

From these figures (next page) we see that most discoveries are made within one hour of astronomical twilight. There are probably two basic reasons for this. First, most comets are found near the sun, and they are highest in a dark sky at astronomical twilight. Secondly, most comet hunters confine their searching to these times.

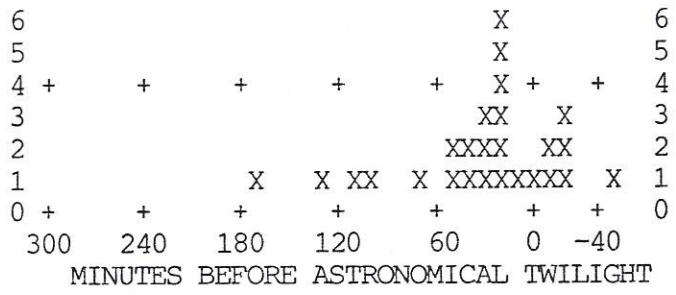
Two comets, IRAS-Araki-Alcock (1983d) and Takamizawa (1984j), were morning sky comets found closer to evening than morning astronomical twilight. But for the most part, comet hunters look in the western part of the sky in the evening and in the eastern part of the sky in the morning.

PART 3: THE TIME OF DISCOVERY

FIGURE 4

DISCOVERY TIME VS. ASTRONOMICAL TWILIGHT

MORNING SKY DISCOVERIES



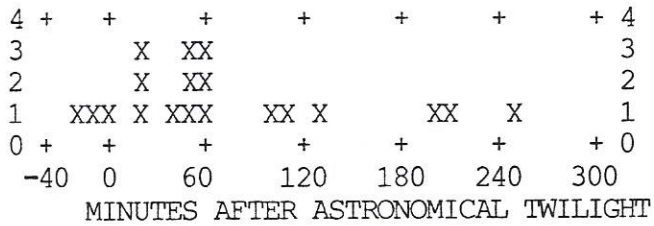
The average time from discovery to astronomical twilight for morning finds is:

30.73 minutes.

FIGURE 5

DISCOVERY TIME VS. ASTRONOMICAL TWILIGHT

EVENING SKY DISCOVERIES



The average time from astronomical twilight to discovery for evening finds is:

75.47 minutes.

DISCOVERY DATE VS. PERIHELION DATE

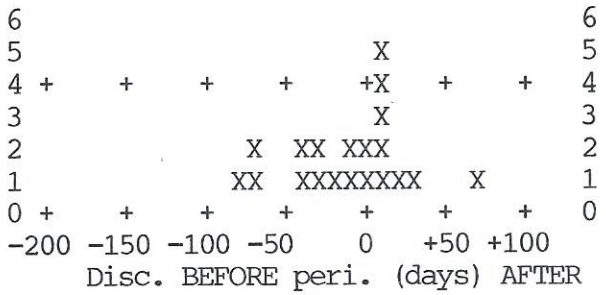
We now take a look at the number of days after the comet discovery that the comet reaches its perihelion-the time when it is closest the sun. In most cases the comet is found before perihelion, this is demonstrated by a negative plot in the figures.

PART 3: THE TIME OF DISCOVERY

FIGURE 6

DISCOVERY DATE VS. PERIHELION DATE

MORNING DISCOVERIES

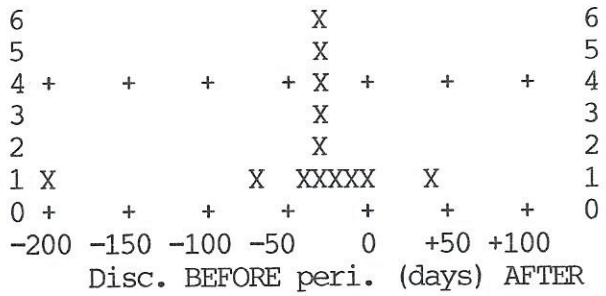


The average number of days following discovery that morning-found comets came to perihelion is:
11.8 days.

FIGURE 7

DISCOVERY DATE VS. PERIHELION DATE

EVENING DISCOVERIES



The average number of days following discovery that evening-found comets came to perihelion is:
36.2 days.

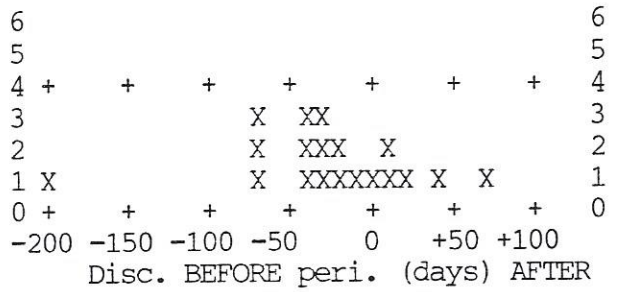
From Figures 6 and 7 we see that comets found in the morning sky are more likely to be post-perihelion than those comets found in the evening sky. One reason for this is that morning sky comets have usually been in the sun's glare prior to discovery, they then move westward (in reference to the sun) into darker skies where they are found. Evening sky comets, usually moving westward also, are found as they slowly brighten until they reach discoverable magnitudes. In other words, often the morning sky comets brighten and reach perihelion while in the sun's glare, while evening sky comets brighten while still in dark sky.

PART 3: THE TIME OF DISCOVERY

FIGURE 8

DISCOVERY DATE VS. PERIHELION DATE

DIRECT ORBIT COMETS

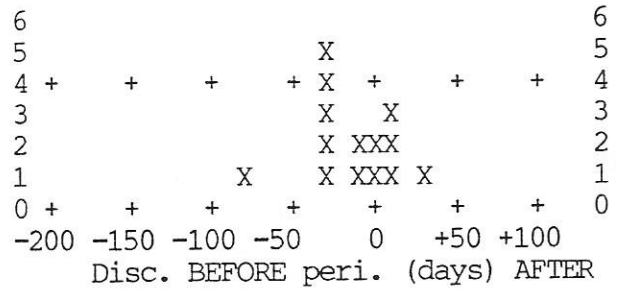


The average number of days following discovery that direct orbit comets came to perihelion is:
26.8 days.

FIGURE 9

DISCOVERY DATE VS. PERIHELION DATE

RETROGRADE ORBIT COMETS



The average number of days following discovery that retrograde comets came to perihelion is:
14.1 days.

Looking at the same parameter for direct and retrograde orbits, we find that retrograde orbit comets have a slightly better chance of being found after perihelion than direct orbit comets. This may be because retrograde comets generally travel faster through our skies and can go undetected longer than direct orbit comets.