

A DECADE OF COMETS

A STUDY OF 33 COMETS DISCOVERED BY
AMATEUR ASTRONOMERS

BETWEEN

1975

1984

BY DON MACHHOLZ



MARK STURTEVANT

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PART 4: MAGNITUDES AND POSITIONS

MAGNITUDES

Let's now look at the magnitude, or brightness, of the comets at discovery. These numbers represent the total integrated magnitude, the higher the number the fainter the comet.

FIGURE 10

DISCOVERY MAGNITUDES, MORNING SKY

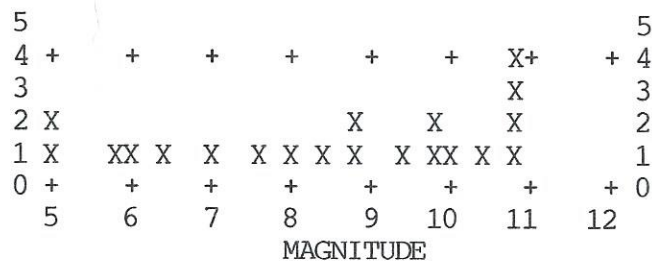
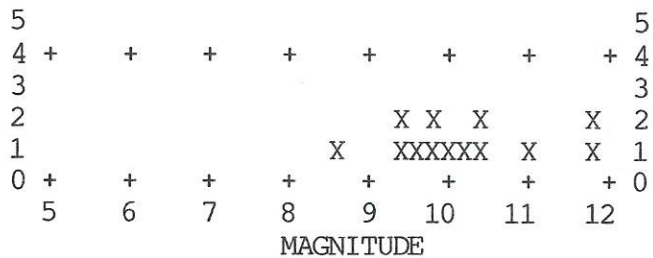


FIGURE 11

DISCOVERY MAGNITUDES, EVENING SKY



The average discovery magnitude for all comets is:
9.13 +/- 1.8.

For morning finds the average is:
8.45 +/- 2.0.

For evening finds the average is:
10.19 +/- 0.8.

As we can see, comets found in the morning sky are brighter at discovery than those found in the evening. Several reasons could explain this. First, comets found in the morning sky are generally brightening more rapidly because the earth's motion is decreasing the distance between comet and earth. Secondly, it is believed that the evening sky is more thoroughly covered than the morning sky, therefore comets have more time to brighten in the morning sky.

It would at first appear that any small telescope would be able to discover most of these comets. But we must remember that these are total intergrated magnitudes, meaning that the comet is as bright as a similarly bright star seen out of focus. This differs from the limiting stellar magnitude of a given instrument by about 1 to 1.5 magnitudes. Added to this must be the factor of sweeping for an object in an unknown location, which adds another magnitude. This means that a 6-inch (15 cm) telescope, which under good conditions can see stars to magnitude 13.0, will generally sweep right over and miss comets fainter than magnitude 10.5.

BRIGHTNESS VARIATIONS IN COMETS

In most cases a comet is slowly brightening as it is discovered. The two figures below show changes in brightness of comets found in the morning and evening sky. The comet's estimated brightness variation for ten days centered on the discovery date is shown in each graph. These plots are determined by the magnitude formula and may not reflect the actual performance of the comet.

FIGURE 12

BRIGHTNESS VARIATIONS OF COMETS FOUND IN MORNING SKY

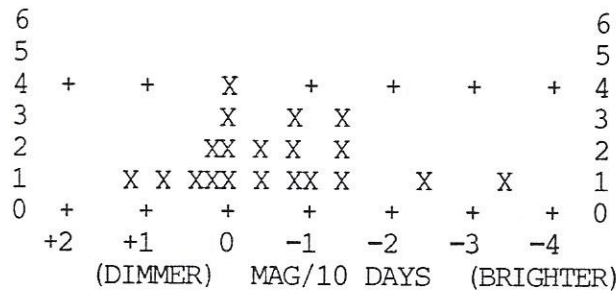
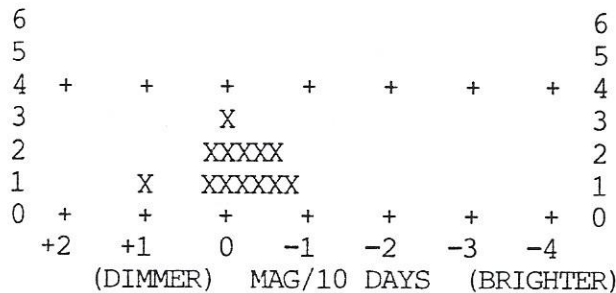


FIGURE 13

BRIGHTNESS VARIATIONS OF COMETS FOUND IN EVENING SKY



PART 4: MAGNITUDES AND POSITIONS

The brightness change of the comets in the morning sky are spread out over a larger range than are those found in the evening sky.

The average for all comets is a brightening of:
0.45 magnitude/10 days.

The average for morning finds is a brightening of:
0.62 magnitude/10 days.

The average for evening finds is a brightening of:
0.21 magnitude/10 days.

We can see that the average comet found in the morning sky is brightening three times faster than the average comet found in the evening sky. The average comet was brightening at a rate of 1.2 magnitude each month.

We have learned, however, that some comets seem to brighten rapidly before discovery. Evidence of this variation is difficult to acquire, since often the first observation of a comet is at the discovery time. However, for some comets predisccovery images were later found which strongly imply a flare. For others there is heavy circumstantial evidence that they brightened rapidly before discovery. Here are those comets listed in decreasing probability of flaring.

Periodic Comet Takamizawa (1984j): Strong evidence. Predisccovery photos show it flared one to four weeks before discovery. Other evidence is that it was missed by comet hunters for several months before discovery, and that, with an orbital period of 7.3 years, this is the first time we've observed it.

Periodic Comet Haneda-Campos (1978j): This comet could have been found a week earlier but it wasn't. The behavior of the comet after discovery proves instability, as do the facts of no previous discoveries of the 6-year periodic comet and no recovery through 1984.

Comet Panther (1980u): Strong photographic evidence shows at least a mild outburst in the weeks before discovery. Another clue is that it was missed for several months in the evening sky.

Periodic Comet Denning-Fujikawa (1978n): This comet was missed for eleven revolutions between 1881 and 1978. Finally, six weeks before discovery it should have been visible in the evening southern sky, but it was missed by comet hunters.

Comet Bradfield (19791): This comet should have been visible as it traversed the evening sky at magnitude 9-11 in October and November, 1979. It was missed by all Northern Hemisphere observers.

PART 4: MAGNITUDES AND POSITIONS

For some comets we have no direct evidence of flaring or rapid brightening, but the fact that they should have been discoverable for long periods of time and remained undiscovered implies unusual behavior. These are listed in order of discovery.

Comet Kobayashi-Berger-Milon (1975h): No predisccovery photographs, but if it behaved normally it should have been picked up a full month before at magnitude 10, far removed from the sun.

Comet Kohler (1977m): This comet should have been brighter than mag. 11 in the evening sky for more than a month before discovery but it wasn't found.

Comet Bradfield (1978c): This comet, if it behaved normally, should have been discoverable for about five weeks before it actually was.

Comet Seargent (1978m): This comet should have been picked up in the evening northern sky about two months before it was finally found in the morning southern sky.

Comet Meier (1980q): Another comet that should have been bright enough to be found for the month before discovery.

Comet IRAS-Araki-Alcock (1983d): At large elongation this object might have been found one month before it was.

Comet Levy-Rudenko (1984t): There are some good reasons why it wasn't found sooner, but for a full month before discovery it was bright enough to be found. It also brightened unexpectedly after perihelion.

We've listed 12 of the 33 comets in our study as probable or possible "rapid brighteners". We could conceivably list the remaining 21 comets too since we cannot prove what their magnitudes were before discovery. But if someone wishes to investigate this further, and it does need more study, the above-listed comets would be a good place to begin.

SPEED AND DIRECTION OF COMET AT DISCOVERY

It is said that a comet's motion can be detected within a half-hour's time if a map is drawn showing its position in relation to the stars. How fast do these comets move at discovery?

The two figures below show the comet's motion in arcminutes per hour of time. This is calculated from the comet's ephemeris for one week before discovery and one week after. In the cases of two fast-moving comets (1983d and 1984i) a shorter time interval is used. This is translated into arcminutes per hour of time and is plotted here. One figure is for morning finds and the other for evening finds.

FIGURE 14

APPARENT SPEEDS OF COMETS AT DISCOVERY

MORNING SKY

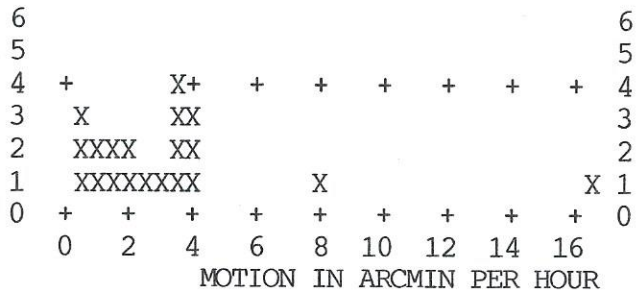
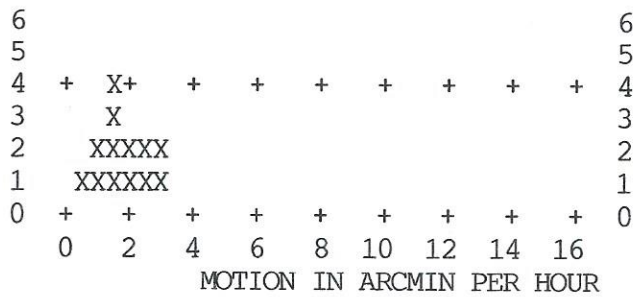


FIGURE 15

APPARENT SPEEDS OF COMETS AT DISCOVERY

EVENING SKY



The average speed for all comets is:
2.71 arcmin per hour.

The average for morning finds is:
3.29 arcmin per hour.

The average for evening finds is:
1.82 arcmin per hour.

It is also found that retrograde comets tend to travel about 1.3 times faster than direct orbit comets.

For morning finds the speed ratio of retrograde to direct comets is:
 $3.65/2.84 = 1.28$.

For evening finds that speed ratio is:
 $2.30/1.68 = 1.44$.

In which direction, in reference to the stars, are comets traveling at the time of discovery? This is shown in the following two graphs.

FIGURE 16

DIRECTION OF TRAVEL OF COMETS AT DISCOVERY

MORNING FINDS

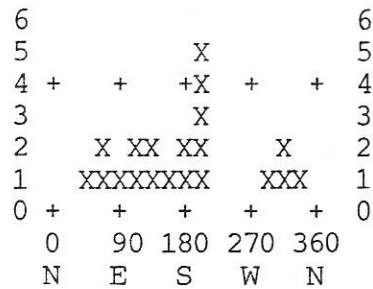
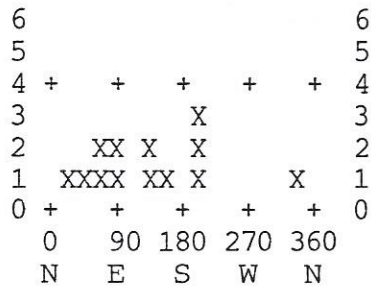


FIGURE 17

DIRECTION OF TRAVEL OF COMETS AT DISCOVERY

EVENING FINDS



It appears that most comets are moving eastward or southward at discovery. This is their direction in reference to the stars. When compared to the sun, which is itself moving eastward at 2.5' per hour, many comets would appear to be standing still!

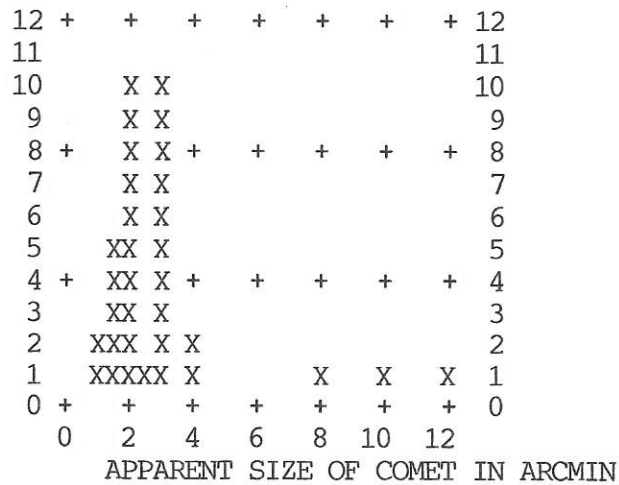
APPARENT SIZE AND APPEARANCE OF THE COMETS

Related in some ways to the brightness of the comet is the size and appearance. A small comet, even with a high surface brightness, would be difficult to discover with very low power. And a diffuse object of a given magnitude is usually more difficult to detect than a condensed object of the same brightness. Following is a tabulation of the sizes of our 33 comets.

PART 4: MAGNITUDES AND POSITIONS

FIGURE 18

APPARENT SIZE OF COMETS AT DISCOVERY



The average comet's size is:
3.03 arc minutes.

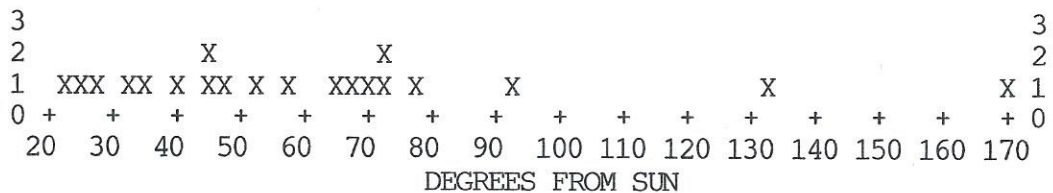
Most comets were reported as either "diffuse" or "diffuse with some condensation" upon discovery. Of the 33 comets, only five (15%) displayed tails at discovery.

ELONGATIONS

Here we examine the elongation, or number of degrees from the sun, that the comets are at the time of discovery. This is displayed for both the morning and evening skies.

FIGURE 19

DISCOVERY ELONGATIONS, MORNING SKY

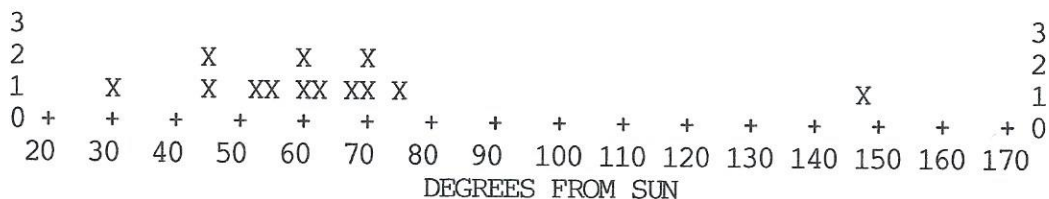


PART 4: MAGNITUDES AND POSITIONS

MAGNITUDES

FIGURE 20

DISCOVERY ELONGATIONS, EVENING SKY



The average elongation for all comets is:
63.2 +/- 33.1 degrees.

The average elongation for morning finds is:
62.6 +/- 36.8 degrees.

The average elongation for evenings finds is:
64.4 +/- 27.9 degrees.

Comets found in the morning sky generally span wider elongations than do those in the evening sky. Once again this is probably due to faster-moving comets in the morning sky and the fact that it is not swept as thoroughly.

COMPARING MAGNITUDE AND ELONGATION

Generally, the further the comet is from the sun, the fainter it is at discovery. This is true because often a comet is brighter when close to the sun than when far from it. In the morning sky the brighter comets increase in elongation as they dim, they are caught as they enter the darker sky away from the sun. In the evening sky the comets usually brighten as elongation decreases, they are found when they become bright enough to be seen.

Our study shows that brighter comets are found close to the sun, dimmer comets further away. Exceptions in the morning sky include one comet which flared shortly before discovery (1984j) and two comets which were close to the earth when found (1983d and 1984i).

Graphed here is discovery magnitudes and elongations. The magnitude is listed along the left side and the elongation is listed along the bottom.

PART 4: MAGNITUDES AND POSITIONS

FIGURE 21

MAGNITUDE VS. ELONGATION: MORNING SKY

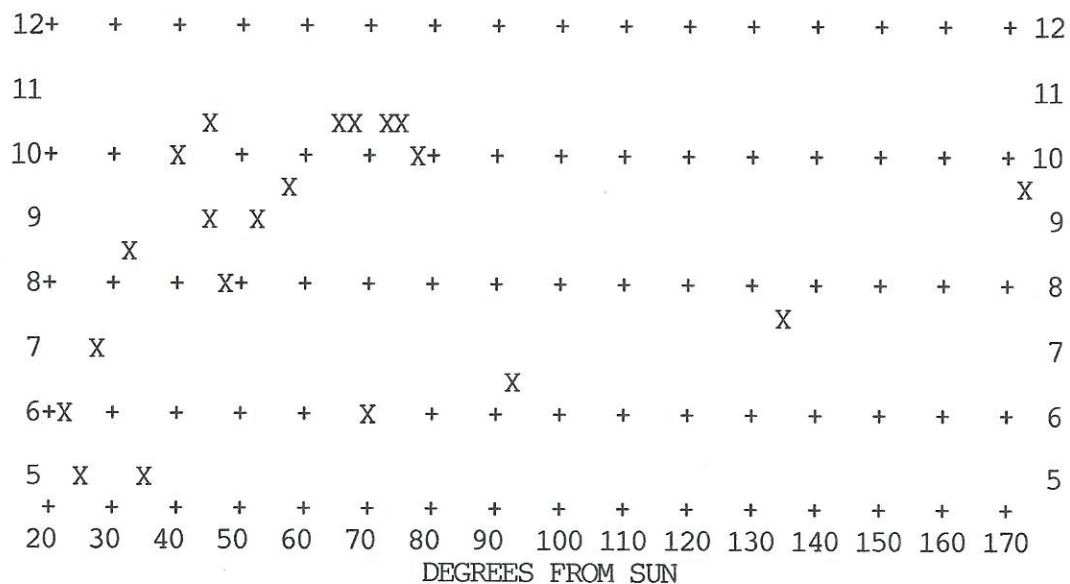
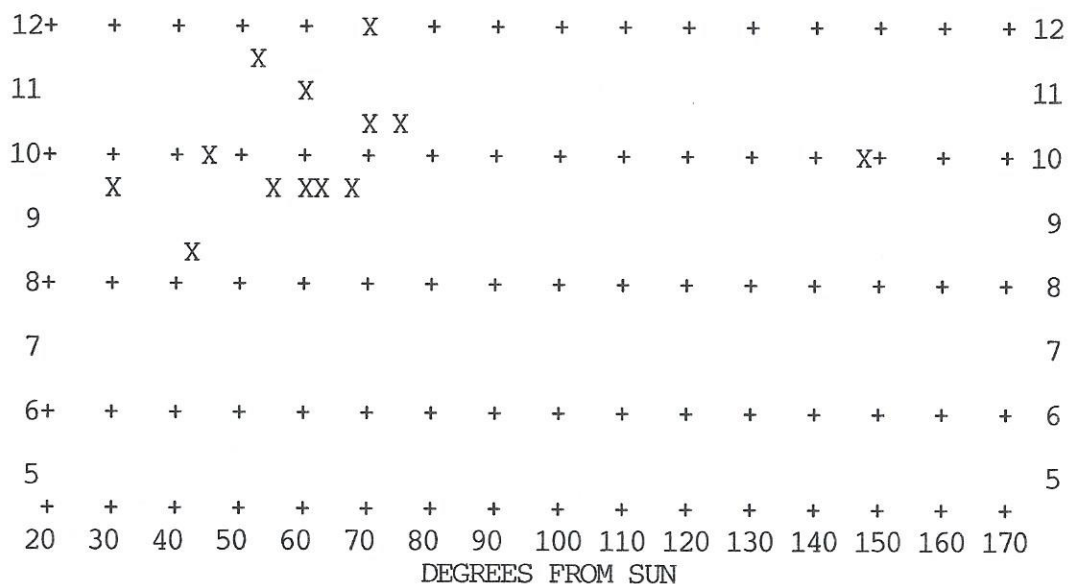


FIGURE 22

MAGNITUDE VS. ELONGATION: EVENING SKY

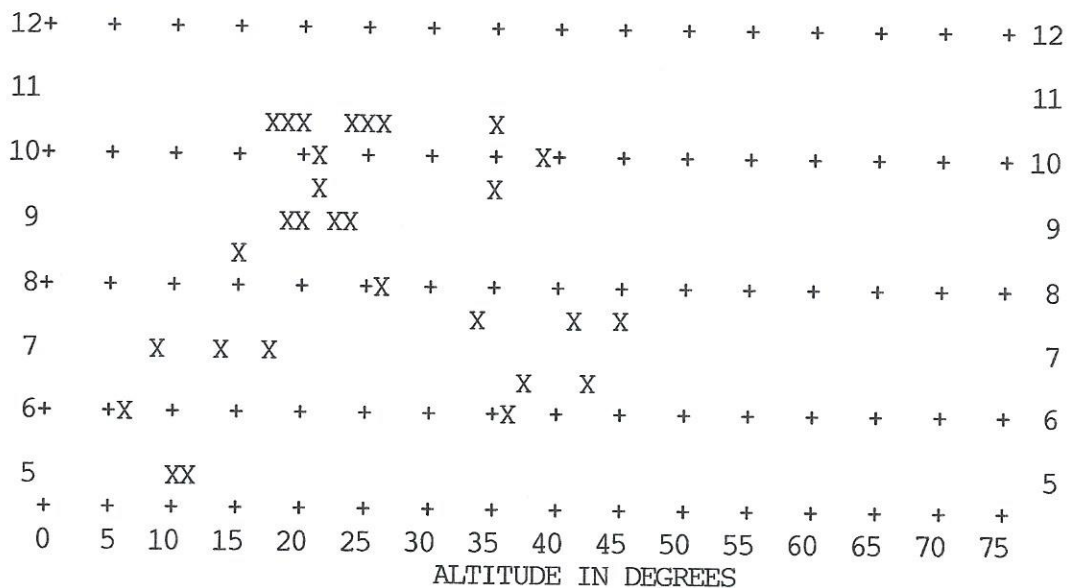


THE HEIGHT OF THE COMETS IN THE DISCOVERER'S SKY

We often imagine that a comet is barely above the discoverer's horizon when it is found. Comet hunters are usually told to sweep from an area where the horizons are low, with no obstructions. Here we take a look at the altitude of the comets in the discoverers' skies when found. Listed along the left is the magnitude of the comet, along the bottom of the graph is the altitude in degrees,

FIGURE 23

MAGNITUDE VS. ALTITUDE: MORNING SKY



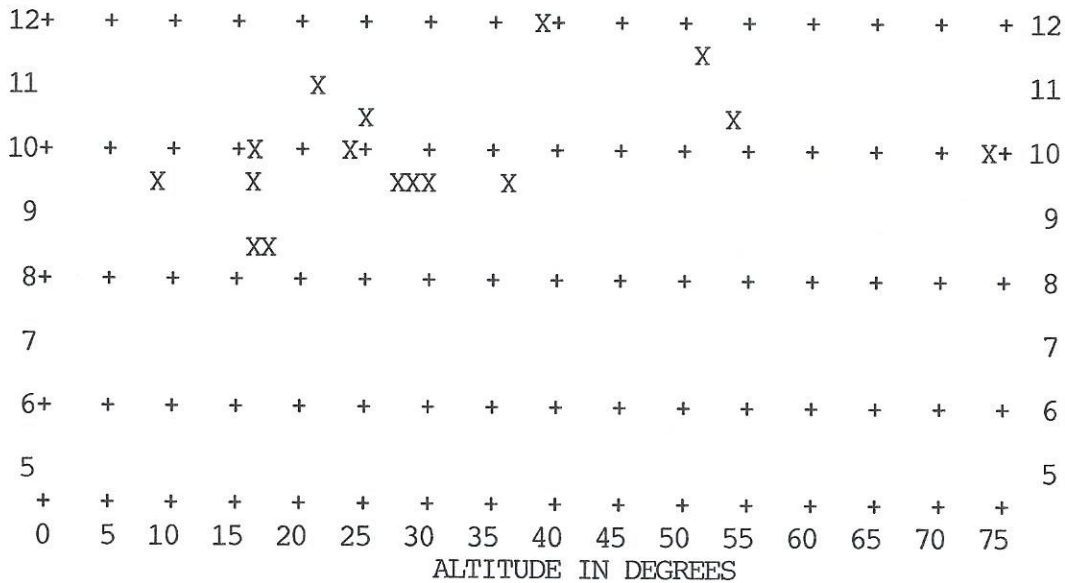
For the morning sky the average is:
24.6 degrees altitude.

For the evening sky the average is:
28.3 degrees altitude.

Figures 23 and 24 (following page) show us that comets are usually rather high in the observer's sky, away from most obstructions and out of the low level haze. This also means that the comets are generally above the horizon and in dark skies for a few hours. We also see that brighter comets are usually found close to the horizon while fainter comets are found higher up.

FIGURE 24

MAGNITUDE VS. ALTITUDE: EVENING SKY



"POINTING POSITIONS" OF COMETS AT DISCOVERY

When the comet hunter is searching his sky, should he search north, south, east or west? In which part of the sky is the comet usually found? Here we take a look at that. Plotted on the following four graphs are discovery positions in altitude (listed along the left side of each graph) and azimuth (listed along the bottom). Comet locations are shown by a digit, either a "1" (for one comet) or a "2" (for two comets). Graphs are shown for comets found by discoverers living both north and south of the equator, and for both the morning and evening skies.

Figures 25-28, on the next two pages show that comets found in the morning sky from the Northern Hemisphere are in a wide variety of positions, but there is an absence between azimuths of 60 degrees and 90 degrees. Those found in the morning sky from the Southern Hemisphere are all found south of the due east point. The reason why is not clear, perhaps Southern Hemisphere comet hunters concentrate on the areas not accessible to Northern Hemisphere hunters.

The evening sky shows a similar imbalance, but the Northern Hemisphere discoverers do favor sweeping north of the equator more than south of it.

FIGURE 25

DISCOVERY POSITIONS FROM THE NORTHERN HEMISPHERE

MORNING SKY

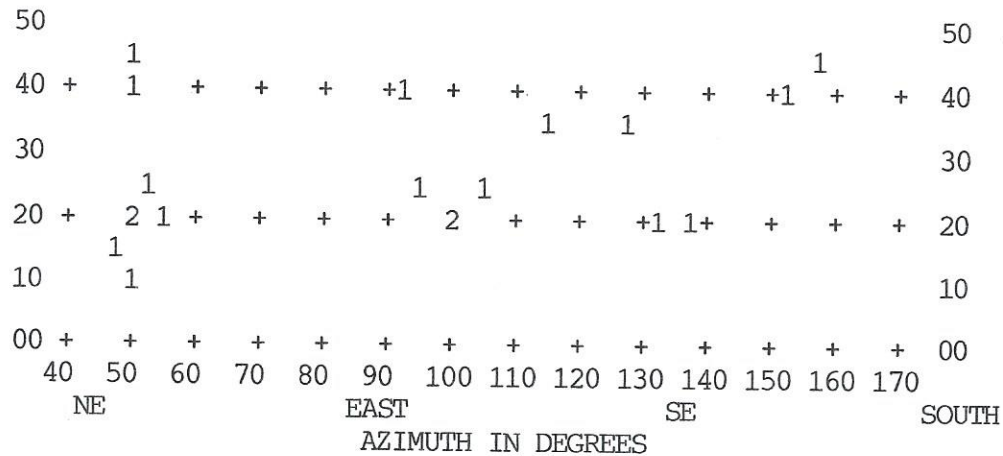
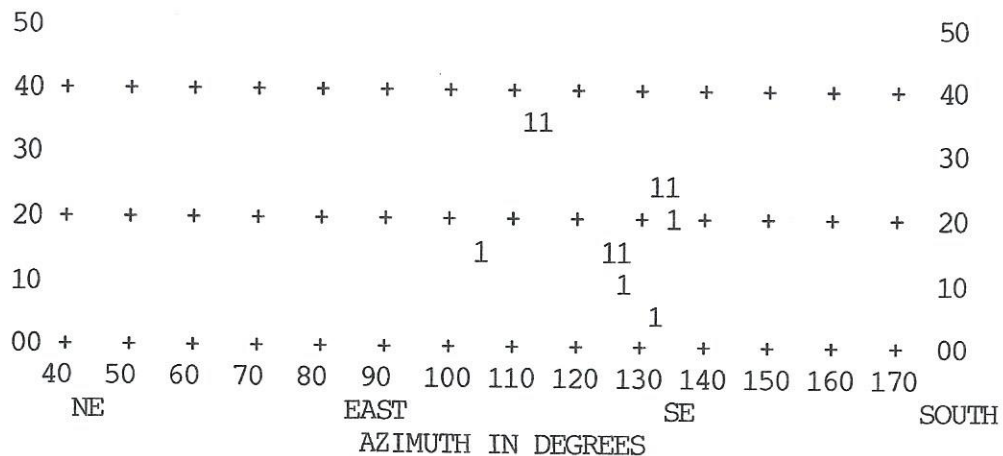


FIGURE 26

DISCOVERY POSITIONS FROM THE SOUTHERN HEMISPHERE

MORNING SKY



PART 4: MAGNITUDES AND POSITIONS

FIGURE 27

DISCOVERY POSITIONS FROM THE NORTHERN HEMISPHERE

EVENING SKY

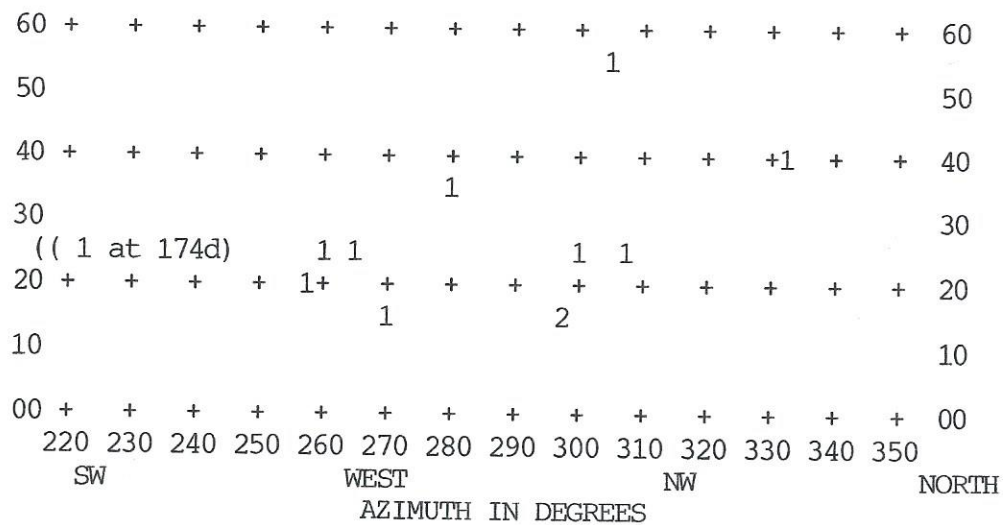
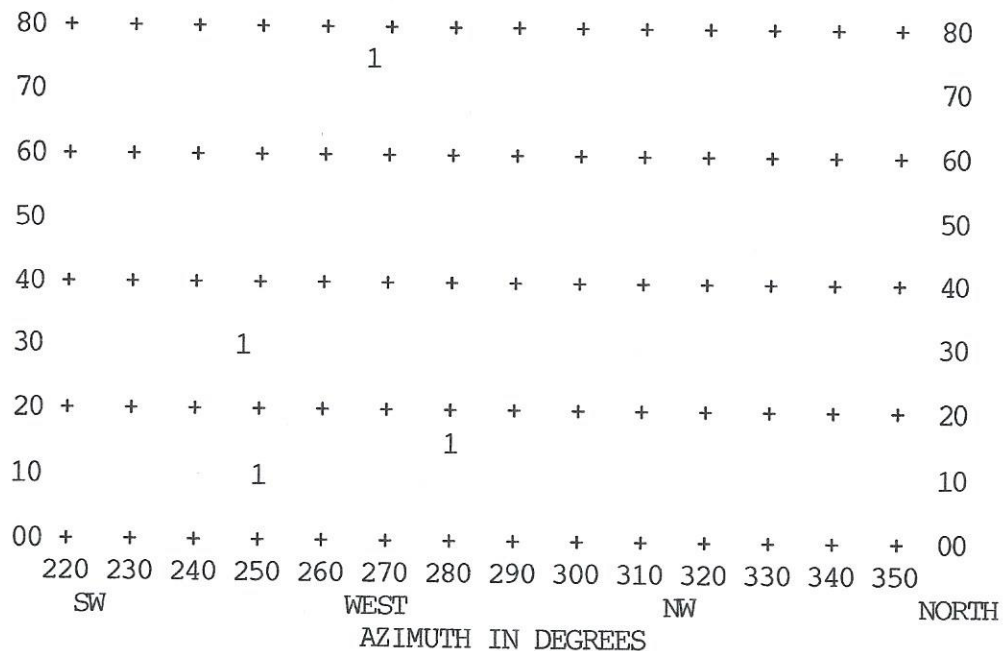


FIGURE 28

DISCOVERY POSITIONS FROM THE SOUTHERN HEMISPHERE

EVENING SKY



COMET ALTAZIMUTH POSITIONS AT THE TIME OF DISCOVERY

AND AT ASTRONOMICAL TWILIGHT AT VARIOUS LATITUDES:

At the time of discovery, is a comet visible to most of the world's comet hunters, or only to those living at certain latitudes? Here we examine each of the 33 comets in our study. Where the altazimuth position is given, the first figure refers to the azimuth location of the comet in the sky, North = 0 degrees, East = 90 degrees, etc. The second figure refers to the altitude in the observer's sky, 0 degrees is on the horizon and 90 degrees is at the zenith.

In the figures below, listed first is the comet's designation, then its alt-azimuth position to the discoverer at the time of discovery, along with its magnitude. Following this is the comet's alt-azimuth position at astronomical twilight on the morning or evening of discovery. When there is more than one discoverer, comet's positions for both observers are given. When the comet is above the horizon most of the night, both morning and evening positions are presented. Positions shown in "()" are approximate since the accurate location of the discoverer is unknown.

TABLE 8

MORNING DISCOVERIES

COMET	DISC. POS.	MAG.	+40d LAT.	EQUAT.	-40d LAT.
1975h	158d +44d	7.6	169d +42d	252d +65d	302d +42d
# 2	128d +34d				
# 3	152d +41d				
1975j	101d +20d	10.7	121d +35d	86d +47d	62d +25d
# 2	106d +26d				
# 3	(114d +34d)				
1975k	(50d +20d)	8.8	55d +28d	46d +3d	56d -30d
# 2	(52d +23d)				
# 3	51d +22d				
1975p	115d +36d	9.7	151d +5d	136d +32d	113d +35d
1975q	93d +38d	9.8	122d +58d	62d +44d	65d -1d
1976d	136d +18d	8.8	131d -26d	137d +2d	133d +23d
1978c	134d +26d	8.0	146d -13d	142d +15d	132d +30d
1978l	133d +19d	10.7	132d +16d	118d +48d	71d +49d
1978m	126d +12d	5.0	114d -32d	127d -8d	130d +11d
1978n	(99d +21d)	10.0	99d +18d	84d +20d	81d +3d

PART 4: MAGNITUDES AND POSITIONS

TABLE 8 (con't.)

MORNING DISCOVERIES

COMET	DISC. POS.	MAG.	+40d LAT.	EQUAT.	-40d LAT.
1978o	104d +14d	8.4	112d -4d	110d +11d	105d +12d
1979i	126d +11d	5.0	131d -8d	126d +6d	133d +5d
1980t	130d +7d	6.0	128d -12d	126d 0d	137d +2d
1982g	128d +17d	10.4	111d -44d	130d +4d	114d +38d
1983d	(50d +44d)	6.4	37d +19d	28d -26d	51d -63d
# 3	50d +38d				
(morn)	-----	-----	36d +73d	355d +37d	351d -3d
1983e	47d +8d	7.0	47d +11d	50d +2d	52d -17d
# 2	(51d +13d)				
# 3	(54d +18d)				
1983l	95d +24d	10.7	101d +31d	67d +58d	21d +36d
1984a	131d +25d	10.7	151d -6d	141d +20d	130d +27d
1984i	113d +37d	5.8	114d -35d	130d +12d	109d +44d
1984j	(137d +22d)	9.4	129d +13d	109d +11d	104d +12d
(morn)	-----	-----	218d +22d	249d +26d	266d +25d
AVERAGES:	+25d		+8d	+22d	+18d

PART 4: MAGNITUDES AND POSITIONS

TABLE 9

EVENING DISCOVERIES

COMET	DISC.	POS.	MAG.	+40d LAT.	EQUAT.	-40d LAT.
1975a	257d	+21d	11.0	223d +35d	263d +40d	271d +9d
1975d	250d	+9d	9.3	251d -12d	248d +5d	251d +12d
1976a	248d	+29d	9.4	219d +4d	231d +30d	253d +35d
1977m	281d	+36d	9.5	274d +46d	312d +41d	325d +11d
1978f	304d	+53d	10.4	310d +53d	339d +30d	345d -6d
1978j	174d	+23d	10.0	153d +15d	129d +38d	89d +51d
# 2	267d	+76d				
(morn)	-----	-----	-----	244d -15d	240d -8d	241d +12d
1979c	280d	+16d	10.2	280d -14d	269d +17d	291d +25d
1979i	333d	+38d	11.8	332d +38d	338d +3d	333d -35d
(morn)	-----	-----	-----	14d +22d	16d -15d	24d -55d
1980k	298d	+17d	8.5	294d +21d	305d +23d	318d +3d
# 2	298d	+17d				
1980q	307d	+24d	10.3	290d +53d	317d +23d	309d -20d
1980u	300d	+27d	9.7	300d +26d	310d -10d	283d -56d
(morn)	-----	-----	-----	52d +16d	48d -21d	84d -68d
1984o	261d	+24d	11.7	262d +27d	283d +32d	298d +13d
1984t	264d	+27d	9.4	246d +39d	282d +33d	282d -1d
# 2	270d	+16d				
AVERAGES:	+28d			+25d	+23d	+3d

As shown here, about half of the comets are visible (above the horizon between astronomical twilights) to all comet hunters when discovered. In many cases, though, they are not far above the horizon.

CELESTIAL COORDINATES

The celestial sphere is divided into coordinates. The Right Ascension, similar to longitude on the earth, runs north and south, the declination, similar to latitude, runs east-west. The 33 comets we are studying were found in these positions:

PART 4: MAGNITUDES AND POSITIONS

For Right Ascension:

00 hours to 06 hours: 6 discoveries.

06 hours to 12 hours: 10 discoveries.

12 hours to 18 hours: 7 discoveries.

18 hours to 24 hours: 10 discoveries.

For Declination:

15 comets were found north of the equator. All were found by Northern Hemisphere observers. The most northerly was found at +68 degrees.

18 comets were found south of the equator. Fourteen of these comets were found only by Southern Hemisphere observers. One of them was co-discovered by a Northern Hemisphere observer. And four were found only by those living north of the equator.

The average declination of all comets is:
-1.9 +/- 34.8 degrees.

The average declination of morning discoveries is:
-12.9 +/- 32.4 degrees.

The average declination for evening discoveries is:
+15.0 +/- 32.4 degrees.

Therefore, comets found in the morning sky tend to be in the Southern Hemisphere, while those found in the evening sky are generally in the Northern Hemisphere. This difference is also reflected in Figures 25-28. It may be a product of comet sweeping habits, but the full reasons for morning discoveries to favor the southern sky and evening finds to favor the northern sky are not yet understood.

The two discoveries closest each other are William Bradfield finds, Comets 1979l and 1980t. Their positions are 1.2 degrees apart, one being found 51 weeks after the other, in southern Scorpius.

Comets do not seem to avoid the Milky Way background. A proportional number are found against the star-rich sky of the Milky Way, where there's little contrast between the comet and sky.

Some galaxies look like comets, therefore many comet hunters avoid sweeping parts of the sky where large concentrations of galaxies are located. Of our 33 comets, one (1975q) was found near M 85, not far from the Realm of Galaxies in the constellation Coma Berenices. Two other comets (1975k and 1980q) were found in the southern part of Ursa Major, also a location of many galaxies. And another two comets (1978n and 1982g) were found in such areas too. Apparently some comet hunters do sweep these portions of the sky.

CONSTELLATIONS

The stars of the heavens are drawn into 88 groups, or constellations. The boundaries were set in 1930 by the International Astronomical Union. The table below lists the constellations with two comet discoveries, and those with one find.

TABLE 10

CONSTELLATIONS WHERE COMETS WERE FOUND

TWO COMETS EACH

Aquarius	Draco	Hydra
Scorpius	Ursa Major	

ONE COMET EACH

Andromeda	Antila	Aquila
Aries	Caelum	Capricornus
Canis Major	Centaurus	Cetus
Coma Berenices	Corona Borealis	Crater
Fornax	Grus	Hercules
Horologium	Lynx	Lyra
Microscopium	Norma	Serpens Caput
Sextans	Telescopium	