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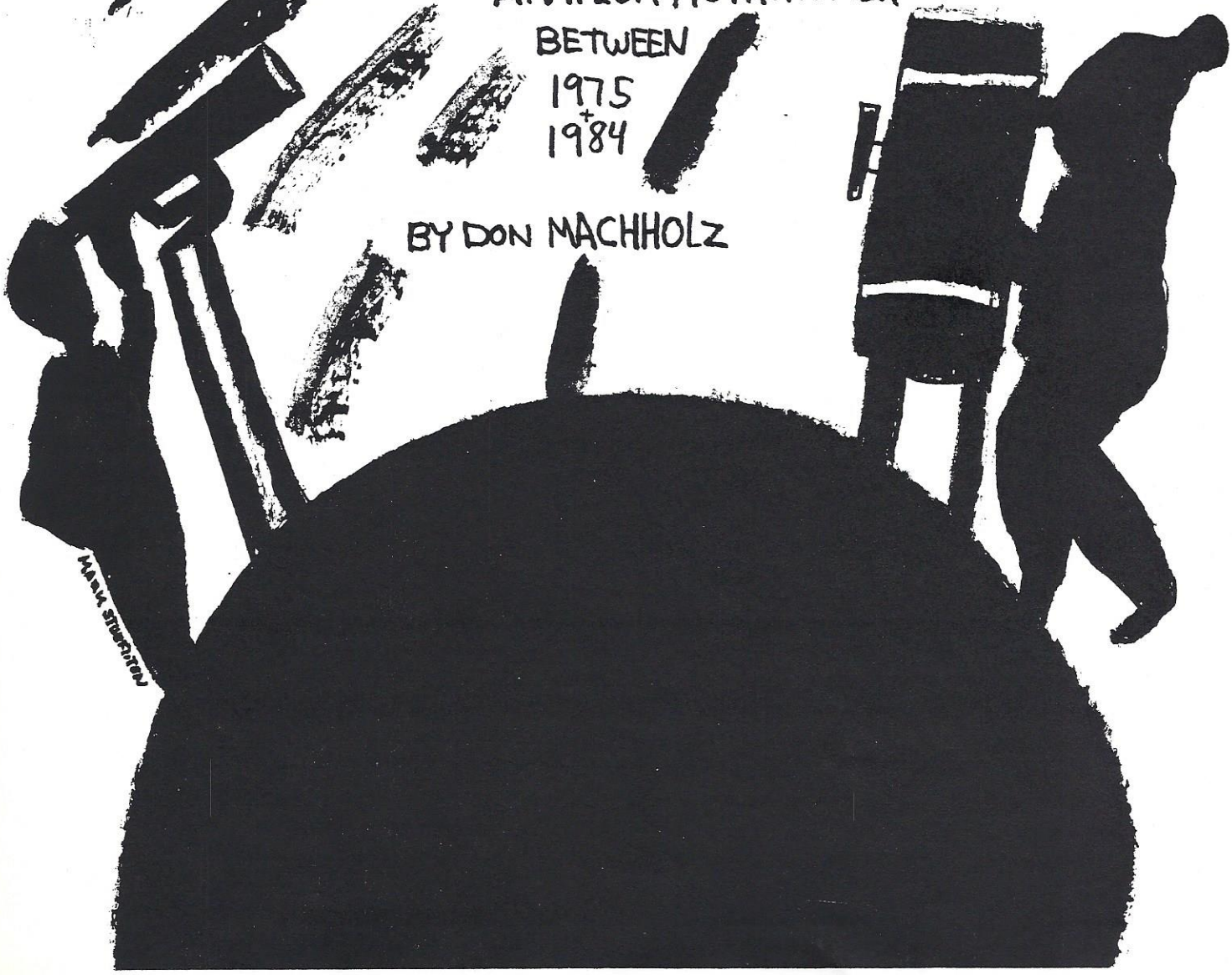
A STUDY OF 33 COMETS DISCOVERED BY AMATEUR ASTRONOMERS BETWEEN 1975 + 1984

BY DON MACHHOLZ



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THIRD EDITION

PRINTED 1995

ISBN 0-9646487-0-9

PART 2: THE INDIVIDUAL COMETS

INTRODUCTION

Following is a synopsis of each of the 33 comets found by amateur astronomers between January 1975 and December 1984. Specific areas for each discovery are explored, along with additional information, where possible. Here is a brief explanation of the data presented.

THE HEADINGS

Identifying Number: Each comet studied is given a number in order of discovery.

The provisional label: The year of discovery is included, then there is a lowercase letter giving the order of discovery or recovery during the year. This is issued by the International Astronomical Union.

The Roman Numeral designation: This gives the year of perihelion passage (when the comet is closest the Sun) followed by a Roman Numeral showing the order of this passage compared to other comets of that same year.

The name of the comet: "Periodic" is used if the comet's orbital period is under 200 years. The names used are those of the discoverers, including those of the Comet 1978n which was originally found in 1881.

THE DISCOVERY DATA

The discovery date, in Universal Time. This is usually taken from the International Astronomical Union's Circulars, and reported to three significant digits, where possible. In the cases of multiple discoveries, all the discovery times are listed.

The distance from the comet to the sun at the time of discovery, in astronomical units. One astronomical unit (AU) is 92.9 million miles.

The distance from the comet to the earth at the time of discovery, in astronomical units.

The discovery position in Right Ascension and Declination, using 1950.0 coordinates. Right Ascension (RA) is similar to longitude on the earth. It is presented in "Hours" and "Minutes". There are 24 hours around the sky and 60 minutes in each hour. Declination (Dec) is similar to latitude. It is measured in degrees (denoted in this study by a "d"), and minutes of arc, (denoted by a "'"). There are 90 degrees from the celestial equator to each pole, declinations south of the equator are "-". There are 60 minutes in each degree. Here the position reported by the discoverer is used. If more than one discoverer is involved, and the finds are within a short period of time, then the position given is the most accurate of the positions reported.

The eclipitic coordinates in longitude and latitude of the comet at the time of discovery. This is presented in degrees, first the longitude, then the latitude.

Sky: This indicates whether the comet was found in the morning or evening sky. "Morning sky" denotes the comet's Right Ascension was within the twelve hours (RA) preceeding (west of) the Sun's Right Ascension. "Evening sky" means the comet was in the area twelve hours following (east of) the sun.

Elongation: The sun-earth-comet angle, or the number of degrees the comet appeared to be from the Sun as seen from Earth at the time of discovery.

Motion: The speed and direction of motion of the comet at the time of discovery. This is found by determining the positions of the comet seven days before and after the discovery date and taking the daily and hourly average. The exceptions are with fast-moving comets. Comet 1983d needed only one days travel for this calculation, while Comet 1984i used three days of positions.

Magnitude: The discovery magnitude. This is the total integrated magnitude of the coma (head) of the comet, a large figure means the comet is faint, a small figure means it's brighter. Magnitude is not easy to determine, the discoverer will usually report it to the nearest whole number, we want it to the nearest tenth. Moreover, the discoverer is not always prepared to make an accurate estimate, in some cases two discoverers' estimates will differ by more than one magnitude. The magnitude used here is derived from early estimates, mathematical formulae, and the discoverer's comments.

Mag./day: This indicates the brightness change of the comet during the 14 days centered on the day of discovery. This assumes that it follows the magnitude formula, but, as we shall see, comets do not always behave. A negative value means the comet was brightening, a positive value means it was dimming.

Azimuth and Altitude: The location of the comet in the discoverer's local sky at the time of discovery is given. This has been calculated from the discoverer's geographical coordinates, the comet's R.A. and Dec., and the date and time. For azimuth: 0d = North, 90d = East, etc. For altitude: 0d is at the horizon and 90d is at the zenith. Atmospheric refraction is not taken into account. If there is more than one discoverer, then all their positions are given.

The difference in minutes between discovery time and Astronomical Twilight, which is defined as the moment when the Sun is 18 degrees below the discoverer's horizon. In the cases of multiple discovery, times are given for each observer.

The Moon phase at the time of discovery.

ORBITAL ELEMENTS

These are usually computed by Dr. Brian Marsden of the Central Bureau for Astronomical Telegrams at the Smithsonian Astrophysical Observatory.

Perihelion date: The Universal Time of the moment when the comet is closest the sun.

Perihelion distance: The distance (in Astronomical Units), of the comet from the sun when the comet is at perihelion.

Eccentricity: The shape of the orbit. A figure of "0" indicates a circular orbit, a "1" is a parabola. Greater than one is a hyperbola.

Orbital period in years, if known.

Argument of the Perihelion: The angle, in degrees, from the point where the comet passes upward through the earth's plane, to its perihelion point. This is measured in the same direction as the comet's motion.

Ascending Node: The point in the comet's orbit where it passes upward through the earth's plane.

Inclination, or "tilt", of the orbit. If the inclination is greater than 90 degrees, the comet is in a retrograde orbit.

"L" value: The longitude of the comet's perihelion in degrees, as seen from the sun.

"B" value: The latitude of the comet's perihelion in degrees, as seen from the sun.

OTHER DATA

Absolute magnitude: The brightness of the comet if it were one Astronomical Unit from both the earth and the sun. This, along with the "n" mentioned below, is usually calculated by such comet computers as Daniel Green, Charles Morris, John Bortle, and Joe Marcus, with minor corrections made to more nearly match the comet's brightness near discovery. This is done because many comets will change in absolute magnitude while under observation, we are concerned with the figures at the time of the comet's discovery.

"n" value: This is used to show the degree of change in the comet's brightness as it moves toward or away from the sun. A large figure indicates the comet's brightness varies greatly with its distance to the sun, a small number means there is little change. The "n" is assumed to be 4.0 unless extended observations show otherwise.

Discovery Probability #1: This percentage is derived from Table II of a study conducted by Dr. Edgar Everhart. It is entitled "Intrinsic Distributions of Cometary Perihelia and Magnitudes", and is printed in the ASTRONOMICAL JOURNAL, (Vol. 72, No. 8) Oct, 1967. This particular number is based only on the comet's absolute magnitude and perihelion distance. Dr. Everhart developed his table from determining discovery probabilities for 21,120 hypothetical comets.

Discovery Probability #2: This is the discovery probability of the comet in its actual orbit, then assuming the ascending node had shifted by 90, 180, and 270 degrees. Each of the four orbits is evaluated for the chance of discovery using

present-day standards in both the Northern and Southern Hemispheres. Moon position is ignored, and the comet is assumed to follow the normal brightness laws, using the known absolute magnitude and "n" values for that comet. The maximum chance for each orbit is 100%, each is divided by four and added together for the total probability.

Holetschek angle: This is the difference between the heliocentric angle of the earth and that of the comet when it is at perihelion. Holetschek, in 1891, determined that when this angle is more than 90 degrees, the chance of discovery is less than when the angle is less than 90 degrees.

THE DISCOVERER, THE DISCOVERY AND THE COMET

What follows is a number of paragraphs describing the circumstances concerning the discovery. This information comes from a wide variety of magazine articles, newspaper clippings, and personal correspondence. Here are some additional notes to keep in mind while reading these sections.

The day of the week is in local time, the date is in universal time.

The position of the comet in the sky as seen from various latitudes is also stated.

The question of: "could this comet have been found earlier?" is also explored. The possible reasons that the comet wasn't discovered sooner than it was are discussed.

One factor of the comet's orbit, the ascending node, is changed by 90d, 180d and 270d, and the possible discovery circumstances are explored.

Sources: Listed are some of the sources for the information presented. The International Astrophysical Observatory Circulars issued by the Central Bureau for Astronomical Telegrams are helpful for discovery details. Often this is augmented by my personal correspondence with the comet discoverer himself. Orbital data are usually found in the "Catalogue of Cometary Orbits" by Dr. Brian Marsden. Magnitude estimates often come from the IAU Circulars, THE INTERNATIONAL COMET QUARTERLY, and THE COMET NEWS SERVICE, all of which made this study possible. The magnitude parameters are often found in the sources listed above, or in the book "Comets", edited by Laurel Wilkening, in the section "Comet Head Photometry: Past, Present and Future" by David D. Meisel and Charles S. Morris. Often the magnitude formula, variable and debatable in itself, is for the complete observation period. I will often make a minor adjustment to fit the more narrow discovery period. Where formula is not available and the comet acted "normal", I will assume that "n" = 4 and match the absolute magnitude to the comet's discovery brightness.

#25) 1982g = 1982 VI

Comet Austin

Disc.: Jun. 18.667, 1982.
Dis. from Sun: 1.44 AU. Dis. from Earth: 1.49 AU.
RA: 04h 04.5m Dec: -40d05'. Ecl. Pos.: 43.9d; -59.0d.
Morning sky. 68d from Sun. Motion: 0.4 deg/day = 0.9'/hr. NE.
Mag.: 10.4. Mag/day = -0.08.
Azu: 128d Alt.: 17d. 126 min. before Ast. Twi.
Moon Phase: Four days after Last Quarter.
Peri.: Aug. 24.73, 1982 at 0.65 AU. E. = 0.999. A/P = 033.82d.
Orbital Period = 65,203.74 yrs.
A/N = 325.56d. Incl. = 84.49d. L = 329.2d. B = +33.6d.
A/M = 7.9. N = 4.0. Disc. Prob. #1 = 24%. #2 = 100%.
Holetschek angle = 2d.

Rodney Richard Darce Austin, born in Christchurch, New Zealand in 1945, found this comet 151 search hours and 13 years after he started seeking comets. He began by using 7x50 binoculars, by 1971 he had logged 19 hours. During the next five years he used a 60 mm rifle finderscope, notching up another 55 hours. He then built a 6" (15 cm) f/8 refractor, using a Jaegers lens and an eyepiece giving 18x. It's mounted on an altazimuth mount. His usual observing site is at 1300 feet elevation, near Mt. Egmont National Park, some ten miles south of New Plymouth.

At the time of discovery, Rodney worked as a process camera operator on the permanent night staff of Taranaki Newspapers Ltd. He would leave work at 2:30 AM and go out comet hunting. On this particular Saturday morning the sky was clear, but the wind was quite strong. After about 45 minutes the sky began to get hazy and by 3:45 he decided to take one more vertical scan up from the horizon through Horologium. "At 3:53," he writes, "near the top of the scan, I picked up the faintest smudge I had seen all morning." After checking his charts, then watching for motion, he reported the comet, but it was over three days before it was confirmed. It was about 2' in diameter and diffuse with some condensation. From the equator it was only four degrees above the horizon at astronomical twilight. From 40d north latitude it was 44 degrees below the horizon.

Could the comet have been found sooner? Prediscovery calculations show the comet was mag. 11.8 only three weeks before discovery. At that time the moon was beginning to interfere with the morning sky. By discovery date the comet had brightened and the moon had just left the sky, giving ideal conditions for discovery. So June 18 was probably the first available date for discovery.

If the ascending node had changed by 90d, the comet could have been found at mag. 10 some 35 degrees from the sun in the morning sky in early July. It then would have brightened to mag. 6. If the ascending node had changed by another 90d, the comet would have been found in the evening equatorial zone, also in July, at mag. 10 and 35 degrees from the sun. It would have brightened to mag. 7, neared the sun, then traveled back into the evening sky at mag. 8 and 40 degrees from the sun. With another shift of 90d, the comet would be discoverable at mag. 10, 70 degrees from the sun in the evening June sky. It

would have brightened to mag. 6 and stayed at least 35 degrees from the sun. So in all instances the comet would have been an easy object.

Sources: Discovery: IAU Cir. 3705 (Dr. Brian Marsden). Discovery data: "Tonight's Asteroids", Bulletin 70. Orbital Elements: IAU Cir. 3730 (Dr. Brain Marsden). Magnitude Formula: "N" = 4 assumed. A/M designed to fit early observations.

#26) 1983d = 1983 ??

Comet IRAS-Araki-Alcock

Disc.: 1) Apr. 25.855 2) May 3.611 3) May 3.916, 1983.
Dis. from Sun: 1.04 AU. Dis. from Earth: 0.22 AU. (May 3).
RA: 18h 56.0m Dec: +52d30'. Ecl. Pos.: 303.5d; +74.0d.
Morning sky. 92d from Sun. Motion: 1.5 deg/day = 3.6'/hr. NW.
Mag.: 6.4. Mag/day = -0.34.
Azu: ---/50d/50d. Alt.: ---/44d/38d (#2 is an est.)
----/206 min. after/16 min. before evening Ast. Twi. (#2 is an est.)
Moon Phase: One day before Last Quarter (on May 3).
Peri.: May 21.19, 1983 at 0.99 AU. E. = 1.000. A/P = 192.79d.
A/N = 48.40d. Incl. = 73.37d. L = 232.1d. B = -12.3d.
A/M = 9.5. N = 4.0. Disc. Prob. #1 = 05%. #2 = 65%.
Holetschek angle = 8d.

This fast-moving comet was first detected by an earth-orbiting satellite named IRAS. This satellite, launched Jan. 25, 1983, was to survey the sky in infrared light using a 22.5", f/9.6 telescope, with a 1.1 degrees field of view. This was IRAS' first comet discovery, it was later to find five more comets before its sensors died in late Nov. 1983. The telescope surveyed a ring that was 90 degrees from the sun.

Since the IRAS ground crew did not at first recognize it to be a comet, and then did not communicate it to the right people, co-discoveries followed. The comet was found by Genichi Araki of Yuzawa, Niigata, Japan on Tuesday evening, May 3. It was in the constellation Draco and moving rapidly. It appeared about 12' in diameter and diffuse with some condensation. Slightly more than seven hours later the comet was discovered by George Alcock, who himself had discovered four other comets, the last being in 1965. He has also discovered several novae. He was searching from indoors, using a pair of 11x80 binoculars. From all latitudes north of about -35 degrees the comet was above the horizon at morning astronomical twilight. From latitudes north of roughly 25 degrees north, the comet was also above the horizon at evening astronomical twilight, remaining up all night long.

Following discovery the comet approached the earth, becoming as close as 2.9 million miles, closer than any known comet since Periodic Comet Lexell (1770 I). On May 11 it appeared as large as 2.2 degrees in diameter and at mag. 2.3. It also seemed to surge in brightness by one magnitude on May 12. Following this it raced into the evening southern sky, dimming to mag. 10 by the end of May.

Could the comet have been found sooner? It should have been mag. 10.8 in

late March, 1983, near Vega. From here it brightened by more than 0.1 mag. per day until discovery. I swept the area on Apr. 7 with a 10", f/3.8 reflector, but I did not see the comet.

Perhaps it was missed because it was seen against the Milky Way background. Or possibly because comet hunters usually do not sweep 85 degrees from the sun in the morning sky. Additionally, during the week prior to discovery, many comet hunters were still sweeping the evening sky or observing the several periodic comets visible. But the possibility remains that the comet did brighten rapidly before discovery.

If the ascending node had changed by 90d, then the comet could have been found at mag. 10.8, in the morning May equatorial sky about 50 degrees from the sun. But it would have brightened to only mag. 10.1. With another shift of 90d the comet would not have been visible, being on the far side of the sun. With a final shift of 90d the comet would have emerged into the morning northern May sky at mag. 7 and would surely have been found. So the chance of discovery depends greatly upon the earth's and comet's positions in relation to the sun.

Sources: Discovery: IAU Cir. 3796 (Dr. Brian Marsden). Orbital Elements: IAU Cir. 3805 (Dr. Brain Marsden). Magnitude Formula: "N" = 4 assumed. A/M designed to fit early observations.

#27) 1983e = 1983 ??

Comet Sugano-Saigusa-Fujikawa

Disc.: 1) May 8.757 2) May 8.769 3) May 8.790, 1983.
Dis. from Sun: 0.51 AU. Dis. from Earth: 1.00 AU.
RA: 01h 34.0m Dec: +39d40'. Ecl. Pos.: 37.0d; +27.3d.
Morning sky. 28d from Sun. Motion: 0.5 deg/day = 1.3'/hr. WNW.
Mag.: 7.0. Mag/day = +0.04.
Azu: 47d/51d/54d. Alt.: 8d/13d/18d (#2 & 3 are ests.).
17/21 min. before/52 min. after Ast. Twi. (#2 & 3 are ests.)
Moon Phase: Four days after Last Quarter (on May 3).
Peri.: May 1.33, 1983 at 0.47 AU. E. = 1.000. A/P = 82.17d.
A/N = 82.34d. Incl. = 96.62d. L = 042.4d. B = +79.8d.
A/M = 11.5. N = 6.0. Disc. Prob. #1 = 00%. #2 = 80%.
Holetschek angle = 178d.

While the world was watching the previous comet, a new object was discovered in the morning sky. This comet was found by M. Sugano (his first named comet), Yoshikaza Saigusa (his second) and Shigehisa Fujikawa (his fifth). All three discoverers, searching from Japan, found the comets within 50 minutes of each other. Saigusa may have used the same 6" (15 cm) reflector (27x) as he did for Comet 1975k, and Fujikawa may have used 20x120 binoculars, but we're not sure of this.

The comet was close to the sun, and early reports indicated that the comet was roughly 2' in diameter. It was diffuse with condensation, and displayed a short tail.

PART 2: THE INDIVIDUAL COMETS (1983e)

At discovery, the moon was a 25%-lit cresent, rising about the same time as the comet. The comet was in the constellation Andromeda, about ten degrees north of M 33 and ten degrees east of M 31. The location was eight degrees east of the projected path for Comet Swift-Tuttle, the comet responsible for the Persaid meteor shower each August. This comet is believed to be overdue and some comet hunters, possibly these too, sweep this area looking for this comet. From the equator the comet was only two degrees above the horizon at morning astronomical twilight. From -40 degrees latitude the comet was 17 degrees below the horizon. Following discovery the comet passed only 6 million miles from the earth on June 12. At that time the comet appeared quite diffuse and mag. 6, but very difficult to see.

Could this comet have been found earlier? It approached the sun while brightening, but close proximity to the sun prevented discovery until early May. Its elongation was increasing and its magnitude holding steady when it was finally found. It probably could not have been found much sooner than it was. Daniel Green suggests, in ICQ for Apr. 1983, that the comet might have outburst near discovery, noting that it later seemed to be fainter than early observations would predict.

If the ascending node had changed by 90d, the comet would have been found in the evening sky in March, 1983. It would have brightened to mag. 7. With another shift of 90d, the comet would have been found in the morning sky, at an elongation of about 45 degrees and mag. 10 in April, 1983. Once again it would have brightened to mag. 7. With a final shift of 90d the comet would have been discoverable for only a short time in the evening sky in late May. So in most cases the comet would have been easily discoverable.

Sources: Discovery: IAU Cir. 3803 (Dr. Brian Marsden). Orbital Elements: IAU Cir. 3826 (Dr. Brain Marsden). Magnitude Formula: John Bortle.

#28) 1983l = 1983 ??

Comet Cernis

Disc.: Jul. 18.916, 1983.
Dis. from Sun: 3.32 AU. Dis. from Earth: 3.46 AU.
RA: 02h 43.0m Dec: +11d47'. Ecl. Pos.: 41.9d; -4.0d.
Morning sky. 73d from Sun. Motion: 0.2 deg/day = 0.5'/hr. S.
Mag.: 10.7. Mag/day = -0.01.
Azu: 95d. Alt: 24d. 25 min. before Ast. Twi.
Moon Phase: The day of First Quarter.
Peri.: Jul. 19.72, 1983 at 3.32 AU. E. = 1.000. A/P = 185.87d.
A/N = 208.88d. Incl. = 134.66d. L = 024.7d. B = -04.2.d
A/M = 2.8. N = 4.0. Disc. Prob. #1 = 56%. #2 = 60%.
Holetschek angle = 88d.

This comet was found by Kazimeras Cernis, a comet hunter from the Soviet Union. This is his second discovery, his first being nearly three years before. Between those times he spent 297 hours comet hunting, most of it with

20x110 binoculars, but 31 hours with a large reflector. It was with this 19-inch (48-cm) f/4.8 telescope, mounted equatorially, at 65x, that he discovered this comet. The discovery site was at Maidanak Mountain, in the Uzbek S.S.R. section of the USSR, this is located about 120 miles north of Afghanistan.

Some people may wonder why we call Cernis an amateur astronomer. First, he does use conventional, visual means for comet seeking. Secondly, although he uses a large instrument which he doesn't own, this has never been a requirement for amateur status (i.e. Meier). And third, he is finding comets which could be discovered by many amateurs.

The comet was in the constellation Aries when found. It was mag. 10.7 and appeared diffuse with some condensation and about 1.5' in diameter. The comet was moving slowly southward, it was a distant 3.3 AU from the sun. The moon was nearing the full phase. From the equator the comet was 55 degrees high at astronomical twilight, from -40d latitude the comet was 35 degrees high at that time.

In many ways this discovery was similar to the finding of Comet Machholz (1978 XIII). Both were found about 72 degrees from the sun in the morning sky, and at mag. 10.7. They were both found on Tuesday mornings, just prior to full moon. Both used large reflectors and both were in retrograde orbits heading south.

Could this comet have been found sooner? It seems as though it could have, if it behaved normally. It should have been mag. 11.2 in Dec. 1982, this would be seven months before discovery! It would have slowly drifted through the evening northern sky, undergoing conjunction on Apr. 30, 1983. It then entered the morning sky, becoming discoverable again in mid-June at mag. 11.1 and 40 degrees from the sun. For the next month it brightened slowly as it traveled another 5 degrees southward.

Why wasn't it seen sooner? It was quite faint for us to expect discovery. Its small size also made it hard to see. Then, too, the possibility exists that the comet brightened rapidly before discovery. I swept over the comet on July 6, 7, 14 and 20, each time with 27x130 binoculars, but I did not see the comet.

The comet was 90 degrees from the sun on Jan 26.6, 1983, and moving toward the sun at 1 degrees/day. The satellite IRAS was launched Jan. 25, beginning tests on the first orbit. Since it swept 90 degrees from the sun, it would have picked up the comet (at mag. 11.2) if it had begun collecting data as soon as it achieved orbit. As of yet the discovery image has not been reported.

If the ascending node had changed by 90d, the comet would have been discoverable in the morning sky at mag. 10.8 in Feb. 1983, 150 degrees from the sun. It would have brightened to mag. 10.5, but then it would have been behind the sun. With another shift of 90d the comet would be discoverable at mag. 10.8 in March, 1983, 100 degrees from the sun. It would have brightened to mag. 10.0 at opposition. With a final shift of 90d the comet would have been discoverable in the morning May sky, 80 degrees from the sun, at mag. 10.8. It would then brighten by one magnitude. So in all four cases it would be discoverable, but difficult.

Sources: Discovery: IAU Cir. 3840 (Dr. Brian Marsden). Disc. Data: Personal

communications. "Sky and Telescope" Apr. 1984, p. 386. Orbital Elements: IAU Cir. 3852 (Dr. Brain Marsden). Magnitude Formula: "N" assumed. A/M to match comet magnitude near discovery.

#29) 1984a = 1983 ??

Periodic Comet Bradfield

Disc.: Jan. 7.733, 1984.
Dis. from Sun: 1.37 AU. Dis. from Earth: 1.84 AU.
RA: 15h 51.6m Dec: -46d47'. Ecl. Pos.: 246.0d; -26.1d.
Morning sky. 46d from Sun. Motion: 1.0 deg/day = 2.5'/hr. SE.
Mag.: 10.7. Mag/day = 0.00.
Azu: 131d. Alt: 25d. 17 min. before Ast. Twi.
Moon Phase: Three days after New Moon.
Peri.: Dec. 27.80, 1983 at 1.36 AU. E. = 0.952. A/P = 219.17d.
Orbital Period = 152.38 yrs.
A/N = 356.16d. Incl. = 51.79d. L = 203.0d. B = -29.8d.
A/M = 8.0. N = 4.0. Disc. Prob. #1 = 9%. #2 = 60%.
Holetschek angle = 108d.

William Bradfield found this, his twelfth comet, 384 hours and three years after his previous find. This discovery, points out Daniel Green in the ICQ, tied him with Minoru Honda for the leader of living comet discoverers. Later in the year Antonin Mrkos co-discovered a comet to tie with Bradfield and Honda. All of Bradfield's discoveries carry his name alone. This comet is also periodic, with an orbital period of 152 years. This is Bradfield's first comet with a period of under 200 years.

For discovery, Bradfield used a 10-inch (25-cm), f/5.6 reflector, with a 32 mm eyepiece giving 44x and a 1.3 degree field of view. This telescope is mounted on a tri-axis mount, an altazimuth head driven around the polar axis. The comet was in the constellation Norma when found on Sunday morning, Jan. 8. Original magnitude formula would place the discovery magnitude at 12.7, Bradfield himself stated that it was mag. 11, that if it were mag. 12.7 or 13 it would not have been found. It appeared about 2' in diameter and diffuse. From the equator the comet was 20 degrees high at astronomical twilight. From 40d N. latitude it was 6 degrees below the horizon. Following discovery the comet continued south and dimmed.

Could the comet have been found sooner? Five weeks before discovery, as the moon was clearing from the morning sky, the comet was 38 degrees from the sun and mag. 11.0. From here if brightened by 0.1 mag./week for the next three weeks, while elongation increased steadly at 1.8 degrees/week as it moved southeastward. While it could have been discovered at that time, it wasn't due to it's faintness and small elongation.

If the ascending node had changed by 90d, the comet would not have been found, remaining fainter than mag. 11.8 when more than 33 degrees from the sun. With another shift of 90d, the comet would have been found in the evening sky, about 120 degrees from the sun, at mag. 10.7 in Oct. 1983. It would have brightened to mag. 10.1. With a final shift of 90d, the comet would have been

found at mag. 11 in the morning northern sky, 90 degrees from the Sun, in Oct. 1983. It would have brightened to mag. 8.7 by year's end. So in three of four cases it probably would have been found.

Sources: Discovery: IAU Cir. 3907 (Dr. Brian Marsden). Disc. Data: Personal communication. Orbital Elements: IAU Cir. 3955 (Daniel Green). Magnitude Formula: "N" assumed. A/M to match comet magnitude near discovery.

#30) 1984i = 1984 ??

Comet Austin

Disc.: Jul. 8.729, 1984.
Dis. from Sun: 0.96 AU. Dis. from Earth: 0.26 AU.
RA: 04h 51.5m Dec: -38d50'. Ecl. Pos.: 62.0d; -60.5d.
Morning sky. 69d from Sun. Motion: 6.5 deg/day = 16.3'/hr. E.
Mag.: 5.8. Mag/day = -0.14.
Azu: 113d. Alt: 37d. 36 min. before Ast. Twi.
Moon Phase: Two days after First Quarter.
Peri.: Aug. 12.14, 1984 at 0.29 AU. E. = 0.999. A/P = 353.13d.
Orbital Period = 77,564.01 yrs.
A/N = 170.88d. Incl. = 164.16d. L = 177.49d. B = -1.88d.
A/M = 8.8. N = 4.0. Disc. Prob. #1 = 9%. #2 = 85%.
Holetschek angle = 142d.

Rodney Austin of New Plymouth, New Zealand discovered this, his second comet, on Monday morning, July 9. The comet was quite close to the earth and moving rapidly when found. Austin again used his 6-inch (15-cm) f/8 refractor for this find. During the past two years, however, he had redesigned the mount to a "cross-four" configuration. This way, the eyepiece remains stationary while the telescope moves in altitude. He was sweeping in horizontal sweeps.

Austin reported the discovery magnitude at 8, then 6.5 on the next morning. The figure used here (5.8) fits the magnitude formula for early observations. Possibly the comet appeared fainter due to its large size and diffuseness. Or possibily it did rapidly brighten on the day of discovery.

The discovery location, in the constellation Caelum, was about ten degrees east of the location of his first find, two years earlier. The object appeared diffuse with condensation, and about 10' in diameter. From his location the comet was 37 degrees high in the sky. From the equator the comet was 12 degrees was high at morning astronomical twilight. From 40d north latitude the comet was still 35 degrees below. Following discovery the comet quickly passed between the earth and sun, entered the evening sky briefly, then re-emerged into the morning sky in late August. It appeared at mag. 6 and displayed two tails, one pointing toward the sun and one away.

Could this comet have been found earlier? Five weeks before discovery the comet was 84 degrees from the sun in the morning southern sky, at mag. 11.6. From here it brightened rapidly, at 0.1 mag/day, while elongation increased to 95 degrees, then decreased. Two weeks before discovery, as the moon was leaving the morning sky, the comet should have been mag. 8.8 and five degrees

NW of the galaxy NGC 253. On that morning I swept that area with a 10-inch (25-cm) telescope, I saw the galaxy, but not the comet. Both objects were just a few degrees above the horizon, the comet being slightly higher in altitude. Perhaps the comet remained faint until very shortly before discovery. Or perhaps poor weather prevented southern hemisphere observers from sweeping it up with the more favorable positional conditions.

If the ascending node had changed by 90d, the comet would have been discoverable in the July, morning, equatorial regions at mag. 10.4 at elongation 38 degrees. The comet's would then brighten to mag. 5. With another 90d shift in A/N the comet would be discoverable in the evening equatorial areas in late August, as it pulls away from the sun and dims. With a final shift of 90d, the comet would have slowly brightened in the June evening sky as elongation decreased, becoming discoverable at mag. 10.2 when 72 degrees from the sun. So in all cases the comet would have been discoverable for at least a short time.

Sources: Discovery: IAU Cir. 3957 (Dr. Brian Marsden). Orbital Elements: IAU Cir. 3990 (Dr. Brain Marsden). Magnitude Formula: From R. J. Bouma, Australia comet Section Bulletin 84-R-4.

#31) 1984j = 1984 ??

Comet Takamizawa

Disc.: Jul. 30.528, 1984.
Dis. from Sun: 1.73 AU. Dis. from Earth: 0.72 AU.
RA: 21h 12.0m Dec: -18d40'. Ecl. Pos.: 314.8d; -2.5d.
Morning sky. 171d from Sun. Motion: 0.2 deg/day = 0.6'/hr. SSW.
Mag.: 9.4. Mag/day = +0.01.
Azu: 137d. Alt: 22d. 62 min. after Evening Ast. Twi.
Moon Phase: Two days after New Moon.
Peri.: May 24.95, 1984 at 1.60 AU. E. = 0.575. A/P = 147.57d.
Orbital Period = 7.26 yrs.
A/N = 124.24d. Incl. = 9.49d. L = 272.2d. B = +05.1d.
A/M = 7.7. N = 4.0. Disc. Prob. #1 = 9%. #2 = 40%.
Holetschek angle = 28d.

This comet was discovered by Kesao Takamizawa of Saku-machi, Nagano Prefecture, Japan. This was his first named comet discovery. He was using a pair of 20x120 binoculars.

The comet was located in the constellation Capricornus, nearly opposite the sun and near the ecliptic. It appeared about 1.5' in diameter, diffuse with a fair amount of condensation. Several observers noted a short tail. It was later learned that this was a periodic comet, with a 7.26 year period. From nearly all latitudes the comet was above the horizon all night. In New Zealand, Rodney Austin swept to within ten degrees of it on July 31. Following discovery the comet faded about one magnitude per month, as predicted.

Could this comet have been discovered earlier? If it had behaved normally

it was mag. 11.0 in mid-March when 88 degrees from the sun in the morning sky, about 6 degrees south of M 14. From here it would have brightened to mag. 9.5 in mid-May while 113 degrees from the sun. By early July it would have been mag. 9.0 and 150 degrees from the sun. I swept over the comet on nine occasions during those months without finding it. So why wasn't it found sooner?

Word later arrived concerning prediscovery observations. The comet appeared photographic magnitude 16 by Paul Wild on July 6.0. It had brightened to mag. 13 on July 8.0. Next, T. Seki photographed it at mag. 6.5 on July 26.7, it appeared condensed with a short tail. He was comparing the comet to a star of mag. 6.2. So it seems the comet outburst beginning in early July, perhaps reaching maximum in the week before discovery.

Assuming the comet had stayed at its outburst absolute magnitude, if the ascending node had changed by 90d the comet would have probably remained undiscovered. It would have stayed fainter than mag. 11.5 and within 50 degrees of the sun in the morning sky. With another shift of 90d, the comet would be even more difficult, near the sun in the evening sky, fainter than mag. 11.6. With a final shift of 90d the comet would have slowly brightened to mag. 10.4, being discoverable in the evening northern sky at about 100 degrees elongation. So in two out of four cases it would not have been found, even at its discovery absolute magnitude. This is also some indication why it wasn't found in any of its other returns.

Sources: Discovery: IAU Cir. 3964 (Dr. Brian Marsden). Orbital Elements: IAU Cir. 3974 (Dr. Brain Marsden). Prediscovery information: IAU Cir. 3970, 3973. Magnitude Formula: "N" assumed. A/M to match comet magnitude near discovery.

#32) 1984o = 1984 ??

Comet Meier

Disc.: Sep. 18.035, 1984.
Dis. from Sun: 0.98 AU. Dis. from Earth: 1.18 AU.
RA: 15h 09.2m Dec: +11d19'. Ecl. Pos.: 221.1d; +27.7d.
Evening sky. 52d from Sun. Motion: 0.9 deg/day = 2.2'/hr. SSW.
Mag.: 11.7. Mag/day = +0.01.
Azu: 261d. Alt: 24d. 3 min. after Ast. Twi.
Moon Phase: The day of Last Quarter.
Peri.: Oct. 13.95, 1984 at 0.86 AU. E. = 1.000. A/P = 128.01d.
A/N = 11.01d. Incl. = 145.61d. L = 237.6d. B = +26.4d.
A/M = 11.4. N = 4.0. Disc. Prob. #1 = 0%. #2 = 45%.
Holetschek angle = 143d.

Rolf Meier found this, his fourth comet, on Monday night, Sept. 17. He was using the 16-inch (41-cm) f/5 reflector at 56x. It's located at the Indian River Observatory in Canada. Meier had searched for 86 hours over nearly four years to find it. The discovery date was two days short of being five years after Meier's second comet discovery.

When found, the comet was in the constellation Serpens Caput, diffuse with condensation, and about 1.5' in diameter. From the equator the comet was 32 degrees high at astronomical twilight, from -40d it was 13 degrees high. Following discovery the comet continued to decrease in elongation, moving into the solar glare within a month. It was visible for only a few weeks after it was found. I had swept the area on Sept. 14 with an 10-inch (25-cm) reflector but failed to see the comet. And, in the USSR, Kazimeras Cernis swept over it with a 19-inch (48-cm) reflector. This comet would have probably remained undiscovered if Meier had not found it.

Could this comet have been found earlier? Five weeks before discovery, as the moon was leaving the evening sky, the comet should have been mag. 11.9 and 109 degrees from the sun, about 10 degrees north of Deneb. Within a week it had brightened to mag. 11.5 about 10 degrees NNW of Vega. From here it continued to move SSW, dimming slightly until found. It would seem that its faintness, diffuseness, and the Milky Way background prevented earlier discovery.

If the ascending node had changed by 90d, the comet could have been found in the northern polar area in mid-Sept. 1984 at mag. 10.7. From here it would have brightened by one magnitude as it entered the evening sky. With another shift of 90d the comet would have been found in the morning, northern sky at mag. 10.5 and 50 degrees from the Sun in early Oct. It would have brightened to mag. 8. With a final shift of 90d the comet would have brightened to mag. 10.7, this being in the morning sky about 120 degrees from the sun in December. So in two cases discovery would have been rather easy, with two others it would be difficult.

Sources: Discovery: IAU Cir. 3991 (Dr. Brian Marsden). Orbital Elements: IAU Cir. 3999 (Dr. Brain Marsden). Magnitude Formula: "N" assumed. A/M to match comet magnitude near discovery.

#33) 1984t = 1984 ??

Comet Levy-Rudenko

Disc.: 1) Nov. 14.12 2) Nov. 15.05, 1984.
Dis. from Sun: 1.06 AU. Dis. from Earth: 1.14 AU.
RA: 18h 47.8m Dec: +09d39'. Ecl. Pos.: 284.0d; +32.6d.
Evening sky. 60d from Sun. Motion: 0.6 deg/day = 1.5'/hr. NNW.
Mag.: 9.4. Mag/day = -0.04.
Azu: 264d/270d. Alt: 27d/16d.
63/126 min. after Ast. Twi.
Moon Phase: Five days after Full Moon.
Peri.: Dec. 14.26, 1984 at 0.92 AU. E. = 0.999. A/P = 82.74d.
Orbital Period = 56,697.90 yrs.
A/N = 330.47d. Incl. = 65.71d. L = 043.8d. B = +64.6d.
A/M = 9.1. N = 4.0. Disc. Prob. #1 = 9%. #2 = 70%.
Holetschek angle = 39d.

The last comet we'll discuss was discovered by two American comet hunters, the first time in over six years that American amateurs have found a comet.

David Levy of Tucson, Arizona found it on Tuesday evening, Nov. 13, 59 years after Leslie Peltier found his first comet. Michael Rudenko of Amherst, Massachusetts found it the next night. For both men this was their first named comet discovery.

Levy, also a variable star observer, found the comet after 917 hr, 28 min. and 19 years of comet hunting. This took about 850 comet seeking sessions. He has used a variety of instruments, including an 8-inch (20-cm) f/7 reflector and a 6-inch (15-cm) f/5 reflector. This discovery was with a 16-inch (41-cm), f/5 reflector. He used a 32 mm Erfle eyepiece giving 64x and a field of view of about 0.75 degrees. The telescope is mounted on an altazimuth mount, he was sweeping in an up-and-down motion.

Nearly one year before, Levy independently found Comet Hartley-IRAS (1983v) at mag. about 11, when it was in the evening sky. The comet was first sighted by Malcolm Hartley on Nov. 4, then by the satellite IRAS six days later. Confirmation did not come until Nov. 23. But word took a few days to get out and David Levy found the comet on Nov. 30 with the 16-inch reflector. He reported it at roughly magnitude 11.5 the next night, John Bortle estimated it at 10.6 a few hours later. The name was not added to the comet.

Twenty three hours later Comet 1984t was discovered by Michael Rudenko. He was sweeping with a 6-inch (15-cm) f/8 refractor, a 40 mm wide angle eyepiece gave him 30x. He was also using a Lumicon Deep Sky filter. The scope is mounted on an altazimuth mounting. He had swept 247 hours for this find over three years time. The first 200 hours were done under the brighter skies near Boston, Mass. Eighteen months before he had missed discovering Comet 1983e by just a few degrees.

The comet was found in the constellation Aquila, very close to the open cluster NGC 6709. It appeared diffuse with some condensation and about 2' in diameter. From the equator the comet was 33 degrees high in the sky at evening astronomical twilight, from -40d latitude the comet was 1 degrees below the horizon. Following discovery the comet continued north, it entered the morning sky and brightened to mag. 8. This is about one magnitude brighter than predicted and is not believed to be related to its distance from the sun.

It was later learned that the comet was discovered on Nov. 13.4 by H. Mori, discoverer of two comets in 1975. He was using a 12-inch (31-cm) reflector at 45x and estimated the comet to be mag. 12. Mori also observed it the next night and recorded it at mag. 12 through thin clouds. He reported the comet too late to be credited for it though.

Could the comet have been found earlier? Two months before discovery it was mag. 11.5 and 135 degrees from the sun in the evening sky in northern Microscopium. A month later it should have brightened to mag. 10.6 while it was 90 degrees from the sun in southern Aquila. From here it brightened steadly as it moved northward.

If the comet had behaved this way, why wasn't if found sooner? First, it was diffuse and difficult to see, despite the bright magnitudes. Secondly, weather in the Northern Hemisphere wasn't good in October. Third, it was far from the sun in the evening sky, comet hunters do not always sweep such areas. And finally, it may have brightened rapidly before discovery. Clues to this are the 2.0 magnitude range in discovery estimates and the unexpected brightening after perihelion.

If the ascending node had changed by 90d the comet would have been found in the morning northern sky, about 90 degrees from the sun, in October. It would have then brightened to mag. 8.7. With another 90d shift in A/N the comet would probably be missed, attaining mag. 9.7 but at small elongations of 35 degrees or less in the morning December sky. With another 90d shift the comet would have emerged into the evening sky at mag. 9.7 and 35 degrees from the sun. From this time, in mid-December, the comet would continue pulling away from the sun as it dimmed. So in most cases the comet would have been found.

Sources: Discovery: IAU Cir. 4007 (Dr. Brian Marsden). Disc. Data: personal communications. IAU Cir. 3896, 4014. Orbital Elements: IAU Cir. 4013, 4032 (Dr. Brain Marsden). Magnitude Formula: "N" assumed. A/M to match comet magnitude near discovery.