GEMINI

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Exploring the Coma-Virgo Cloud

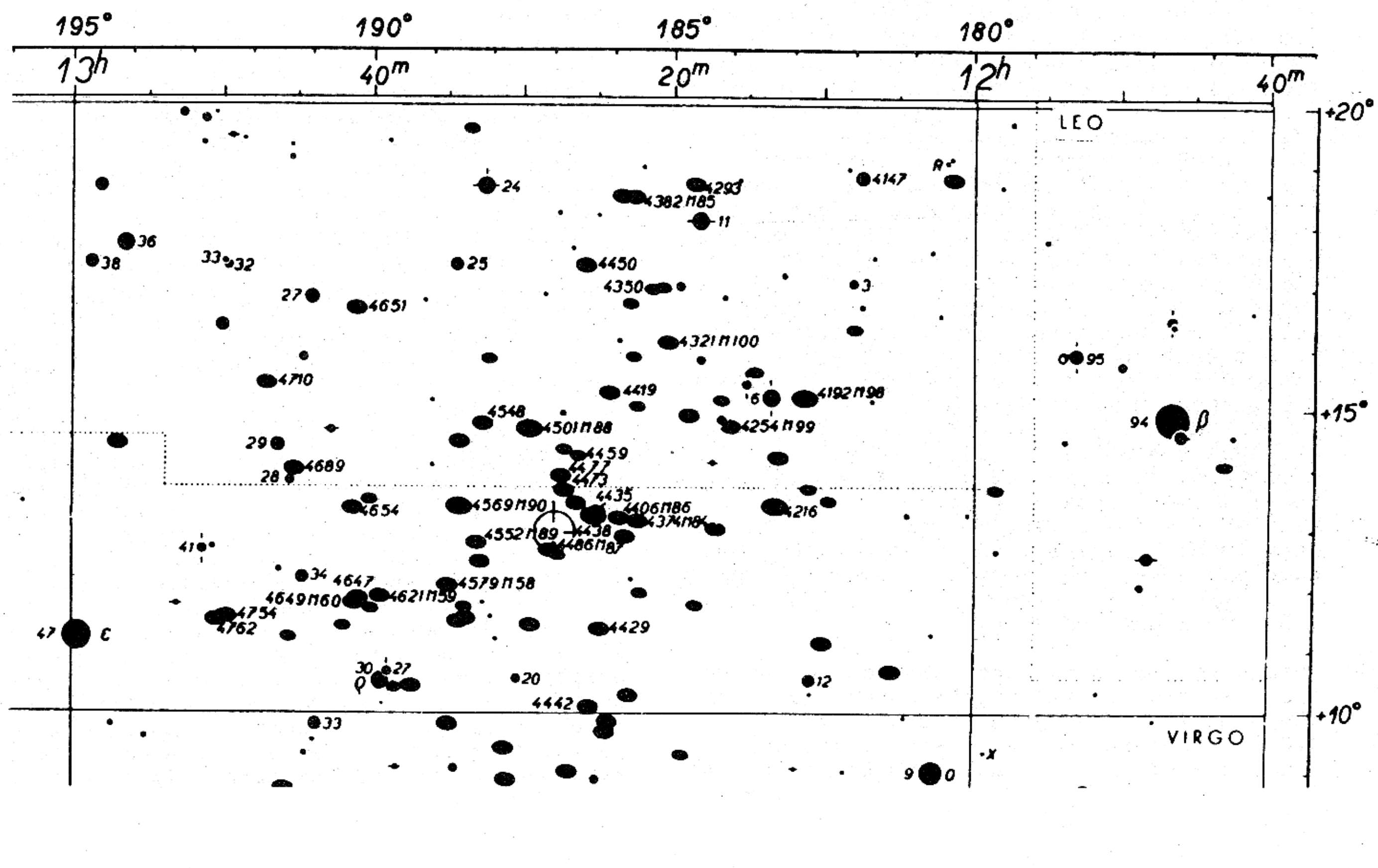
Spring is the season for observing galaxies. Stretching in a band from southern Virgo northward some ninety degrees into Ursa Major, the galaxies of the Virgo-Coma Cloud number in the thousands. While the most common problem experienced by observers is locating the faint objects often at the threshold of visibility, and therefore one of perception, the multitude of galaxies in the Virgo-Coma Cloud present a different problem, that of certain identification.

For the observer with relatively small instruments, the problem is somewhat simplified because the number of galaxies bright enough to be detected and consequently confused is fewer. For instruments as small as a six inch however, where the limiting magnitude approaches thirteen, the potential for confused identity is serious and for larger apertures the likelihood for misidentification grows geometrically.

The problems of identification are perhaps greatest in the heart of the Coma-Virgo Cloud. The greatest concentration of galaxies of less than thirteenth magnitude lies in the region bounded by β Leonis (Denebola) on the preceding side, ε Virginis (Vindimiatrix) on the following side, 30 and 20 Virginis on the south and 11 and 24 Comae Berenices on the north. A casual sweep of the area with even a three inch instrument will yield several of the brighter members of the group.

A few months back an article was brought to my attention entitled "Adventuring in the Virgo Cloud."[1] The subject was the same as will be taken up here, and the author's approach was not at all dissimilar, however, with a few exceptions I will omit the fanciful names for guide stars and routings. The intent here will be to provide a beginning guide to this rich central region of the Coma-Virgo Cloud particularly suited to the users of six inch and larger aperture instruments. Following is a segment of the Skelnate Pleso Atlas of the Heavens. The possibilities for misidentification are easily noted; not only are some members of the densest portion unlabelled, but virtually no guide stars are plotted in the region.

The most direct approach to the Cloud is to begin at β Leonis (Denebola) and sweep directly eastward twenty seven minutes to fifth magnitude 6 Comae Berenices. The westward pointing



"arrowhead" formed by this star and two seventh magnitude stars north and following and one south and following is the sonly prominent guide on the near west side of the galaxy cloud. Just preceding 6 Comae Berenices is M 98 (NGC 4192). While this galaxy may not be a true member of the Virgo Cloud, being situated in the foreground,[2] it is a nice introduction to the galaxies of the region. A six inch will show an elongated image, tapering on the ends and bulging and brightening slightly in the cneter, suggestive of a galaxy whose plane is little inclined to our line of sight.

Halfway up the north side of the "arrowhead" is NGC 4237, a small 13th magnitude spiral, rather diminished in size, but typical of many in the area.

Further up the north side of the "arrowhead" is M100 (NGC 4321). In contrast to nearly edge-on M99, this galaxy is situated nearly face-on. It is rather easily seen in even a three inch. The conspicuous nucleus is surrounded by a very large and tenuous envelope. In actuality only the nucleus and its immediately surrounding area are seen in six and eight inch instruments. The surrounding arms are much fainter. As with many larger members of the Cloud, superimposed stellar images will be noted.

Almost due north of M100 and just following a seventh magnitude star is the pair NGC 4350-4340. This rather conspicuous duo is composed of an elongated elliptical (E7) and a barred spiral respectively. The barred spiral is the following member of the pair and while somewhat brighter, appeared the smaller of the two. Just a half degree following and south of this pair is NGC 4383, a very small and faint peculiar elliptical, which I have not seen in less than a ten inch instrument. North and following the pair NGC 4350-4340 about a degree, and just south and preceding another seventh magnitude star, is NGC 4450. It is rather good size but has relatively low surface brightness. It appears considerably more elongated than would be indicated from its nearly symmetrical catalog dimensions.

The final members to be considered in the northern tier of the core of the Coma-Virgo Cloud are most easily found by locating 11 Comae Berenices. Slightly less than a degree north is NGC 4293. It is catalogued as a peculiar galaxy and its plane is evidentally much inclined to our line of sight. It is rather large and at first presents a round bright central concentration with tapering portions to either side. A diffuse patch seems to stand out to one side when studied with averted vision, suggesting a bright outlying arm as if the galaxy is situated much like M31. NGC 4394 and M85 (NGC 4382) are located a degree following NGC 4293. Both are at nearly the same declination and can be fit within a half degree field. The Messier object is 1.2 magnitudes brighter than its companion, but both are nearly equivalent in size. Both appear generallt round with a tight nucleus and a well defined envelope.

Return to the "arrowhead" and locate the seventh magnitude star on the south side. In the same field and just preceding is M99 (NGC 4254). This rather large spiral is poorly concentrated in the center and brightens only very gradually from its tenuous extremities inward. Six and eight inch apertures will reveal glimpses of large spiral arm structure. It is visible as a fuzzy patch in a three inch at 15x. North a half degree is NGC 4262, by comparison, a very small and more poorly defined object. East and slightly north of M99 about a half degree is NGC 4302. It is a rather large and much elongated ellipse. It is catalogued as an Sc galaxy, but is apparently seen nearly edge-on and the nucleus is not much in evidence. NGC 4298 is a companion galaxy only .2 minutes of right ascension preceding.

Continuing on a line from M99 through NGC 4302 and an equal distance beyond are NGC 4377 and NGC 4419. Both can be fit within a one degree field. NGC 4419 is the smaller and more elongated. NGV 4377 is very near an 8th magnitude star and is must slightly brighter overall, but perhaps less well defined on the extremities.

Approximately a degre further to the east and to the south and just following a seventh magnitude star is M88 (NGC 4501). As can be seen on the <u>Skelnate Pleso</u>, M88 marks the northern end of what might be considered the dense "central chain" of galaxies brighter than magnitude thirteen. M88 itself is a very large and conspicuous object even in a pair of 50mm binoculars. Larger apertures reveal a rough 2:1 ellipse with several superimposed stars. A noteable pair of stars appears on the south-following edge. It is quite well defined and the extremities appear somewhat mottled or streaked with magnification and study. Before beginning the sweep down the "central chain" it is perhaps easiest to pick up the two galaxies which lie to the east of M88, NGC 4548 and NGC 4571. NGC 4548 is at least a full magnitude brighter than its companion. Jones points to some evidence that NGC 4571 is M91, one of the "missing" Messier objects.[2]

Less than a degree preceding and south of M88 is the pair NGC 4459 and NGC 4474. Both galaxies can be fit in the same field with M88 at low powers, however the first time I observed this group with a six inch I failed to recognize NGC 4474. NGC 4459 is very compact looking like a nucleus minus an envelope. Sweeping along the arching chain of galaxies extending southwest from M88 one passes over NGC4477, 4473, 4461, 4435, 4438 M86 (NGC 4406) and M84 (NGC 4374). Several fainter interlopers may also be detected with larger instruments. NGC 4477 is nearly round and otherwise not outstanding among the other members of the chain. NGC 4473 is well situated for comparison with NGC 4461. Where the latter might be considered a compact wisp, NGC 4473 has a more expansive and tenuous envelope barely brightening toward the center. NGC 4473 is situated on the Coma-Virgo border. The pair NGC 4435-38 might at first appear to be a single galaxy when observed with low powers. The pair can be split with a little study, revealing NGC 4435 to be one of the smallest galaxies at its relative brightness I have ever observed. M84 and M86 can be situated in a wide field along with NGC 4388. M84 is only slightly brighter than M86. M84 however is distinctly oblong in comparison to the other two galaxies which appear nearly round. Holmberg has reported that M86 and NGC 4388 are actually situated between us and the main body of the Virgo

Cloud.[2] These galaxies are therefore not true members. NGC 4388 appeared at least comparable in size to the other two galaxies but was much fainter overall.

West of M 84 about at degree is NGC 4267, a rather well defined ellipse situated generally north-south. The center is round in contrast to the overall elongated shape. Study with averted vision in larger apertures suggests that the overall shape really is round. Further to the west is NGC 4216, a conspicuous tenth magnitude edge-on spiral. It exhibits a characteristiccentral bulge with tapering extremities on either side even in a three inch at 40x. Nearby to the west are two fainter companions, the northernmost of which is the brightest. The most westerly of the group is large with a star superimposed on the following side of its envelope. The third member of the group is fainter and was seen only in glimpses in an eight inch at moderate magnifications.

The remaining galaxies in the area can be located by returning to M84 (if you are at NGC 4216 simply put that galaxy on the northern edge of the field and shut off the clock drive for nine minutes) or a fresh approach may be taken beginning at ϵ Virginis (Vindimiatrix). Using this latter "back door" approach has the benefit of brighter guide stars.

West of ϵ Virginis about two degrees is the pair NGC 4762-4754. They offer an interesting comparison of shapes. NGC 4762, the most easterly, is clearly and edge-on spiral, whereas the companion is an elliptical. Their respective visual magnitudes are 11.0 and 10.5. Being separated by exactly half a magnitude, and being of similar size makes them useful for comparison to other galaxies.

West and north slightly two degrees further is a knot of four galaxies including M 60 (NGC4649), M 59 (NGC 4621), NGC 4647 and NGC 4638. The last mentioned is the faintest of the group. NGC 4647 is comparatively large and well concentrated toward the center. I found it surprising that early observers noted M59 and M60 but failed to detect this galaxy. M60 is the brightest of the galaxies in this field and while M59 was well concentrated and even a little grainy in texture, M60 is riddled with breaks and intrusions in its envelope.

Two degrees further west is a string of seventh magnitude stars situated roughly north-south. M58 (NGC 4579) is just following the most northerly of the string and three other galaxies are less than a degree to the south. The southerly group of three is comprised of NGC 4564, NGC 4567 and NGC 4568. All are relatively dim at 12th magnitude. M58, a brilliant nineth magnitude by comparison, has a near stellar nucleus situated just slightly off center giveing a general sense of assymetry to the whole.

Half a degree preceding and north of M58 is NGC 4550, which along with M89 (NGC 4552) just twenty minutes of arc to the north, straddle a seventh magnitude star charted on the <u>Skelnate Pleso.</u> NGC 4550 is very small compared to its Messier companion. It is definately elongated, perhaps 3:1 and while quite well defined in an eight inch at moderate powers, it showed no central brightening or internal detail. Nearby M89 is slightly smaller and dimmer than M58 described above. Much like M58 however, it reveals a very dense and bright, almost stellar, nucleus with a large surrounding envelope, a very remarkable feature considering it is catalogued as an early elliptical.

Due west of this last mentioned pair is the final pair of bright galaxies to be located before one arives back at the southern end of the "central chain" described earlier. The final pair is M87 (NGC 4486) and NGC 4478. M87, the subject of considerable study due to a unique jet of matter expelled from its nucleus, appears perfectly round and devoid of structure in a six inch at moderate powers. There is a gradual brightening toward the center. The companion galaxy, while much smaller, is quite bright. It also is generally round and featureless, but is less well defined on the extremities. It is no surprise that this is an elliptical system. A degree west of M87 and NGC 4478 are M84 and M86 at the southern end of the "central chain."

A few additional galaxies not far removed from the major concentration of the Cloud also bear some mention here. A degree north of M89 and just slightly following is M90 (NGC 4569). It is a rather interesting object, presenting a very long spindle. At first it might be supposed to be another edge-on spiral, but even in moderate apertures, the absense of a central bulge or concentration belies its true character, an E8 elliptical.

Just preceding Q Virginis is the pair NGC 4608 and NGC 4596. Both galaxies fit well in a half degree field, and although I missed this pair the first time I sought it, return attempts have never failed.with a three inch. Larger apertures show the smaller and more southerly of the two to be considerably elongated, perhaps 3:1 in contrast to a catalogue description that is symmetrical.

In conclusion it should be noted that by no means have all the galaxies of the Coma-Virgo Cloud within the limits of amateur instruments been commented on here. None of the galaxies mentioned are fainter than magnitude 13.5, and even an eight inch will reveal galaxies as faint as magnitude 14.0. A more complete description of any of the galaxies mentioned here and many others in the region is available from the author upon request.

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[2]Jones, Kenneth, Glynn Messier's Nebulae and Star Clusters, London, 1968.

[1]Copeland, Leland S., "Adventuring in the Virgo Cloud," Sky and Telescope, Feb. 1955.

Event of the Month

by Bill Larson

Eta Aquarid Meteor Shower on May 5

The only major meteor shower to occur near new moon this year is the Eta Aquarids. Therefore this is probably the best shower of the year. The Eta Aquarids are one of the fastest meteor showers at 64 Km/sec; only the Leonids at 72 Km/sec are faster. The meteors often produce long paths and glowing trails; the brighter meteors are often yellow. The average rate is 30 meteors per hour. The radiant rises about 2 a.m. The moon doesn't rise till about 4 a.m.

This stream has as its source Halley's Comet. The earth intersects the stream as it is going out toward aphelion. The Orionids of October are the same stream but going in.

The peak of this stream is very broad and some sources quote it as early as May 3; so it would be wise to observe for 2 or 3 nights to get the best view. Remember if you want to catch a meteor shower this year your best bet is either the Eta Aquarids or waiting till after midnight when the moon sets for the Perseids in August.

Profiles

By Hub Brueckner

Some Notes on Astrophotography and Photographic Image Effects

It is interesting to note that early photographers had no way of "fixing" their photographs. The picture would soon become dark. There was no way to dissolve away the unaltered silver chloride. Fox Talbot introduced the use of a concentrated solution of common table salt which achieved a partial fixation. It was not until 1839 that the celebrated astronomer, Sir John Herschel, the son of the great William, suggested the use of hypo-thiosulfate. This is in use to this day for the permanent fixing of photographs.

William Cranch Bond, the first director of the Harvard College Observatory, together with his son, George, pioneered in celestial photography in this country. From 1847 to 1856 they used the daguerreotype process. They made the first photograph of a star, Vega. In 1857 George Bond began to use the wet collodion process. The Bonds are generally considered the founders of celestial photography.

It soon became apparent, to astronomers, that photography held the key to future research work. Stellar spectra could be recorded and long exposures revealed objects which the eye could not see.

In 1912, George Eastman hired the brilliant British photo-chemist, C. E. Kenneth Mees. He was brought to America in August, 1912, and commissioned with the task of creating the Kodak Research Laboratory in Rochester, New York. While Dr. Mees was still in England, George Ellery Hale sent his assistant, F. H. Seares, to explain the importance astronomers attached to photography and the need for special emulsions. Dr. Mees promised to help. After the laboratory was established in Rochester he began to prepare emulsions which were the forerunners of today's "Kodak Plates and Films for Scientific Photography". Not only did he cater to the needs of Hale at Mount Wilson Observatory but he also worked with Harlow Shapley at Harvard, E. C. Slipher at the Lowel Observatory, Edwin B. Frost at Yerkes, and Aitken, Moore, and Wright at Lick. Mees himself had developed an interest in astronomy and this made him an eager and willing participant in astronomical research through photography.

When an image is recorded on a photographic emulsion the quality of that image is dependent upon many factors. We shall examine some of these.

Reciprocity Failure

A general law was proposed, in 1862, by Bunsen and Roscoe which stated that the density of a photographic image is dependent upon the energy to which the emulsion is exposed. The energy of the exposure is equal to the product of the intensity of the illumination and the time of the exposure. This is a reciprocal relationship. However, most photographic materials show some loss of sensitivity when exposed to very low or very high levels of illumination even though the total energy of the exposure is controlled by the exposure time. This loss of sensitivity under these extreme conditions is referred to as a failure of the reciprocity law.

The Intermittency Effect

It has been found that a continuous exposure may not produce the same density as an intermittent exposure in which the same total energy has been used. This is of importance to the astronomer since it is sometimes necessary to make an exposure over a period of several nights, a few hours each night.

The Clayden Effect

An exposure of very high intensity but very short duration followed by a second exposure of moderate intensity will not result in a density which simple addition of the two applied energies might indicate. The first very high intensity exposure will desensitize the emulsion to the second exposure. If only part of the emulsion was effected by the first exposure and the second exposure covers the entire area of the emulsion the image made by the first exposure often appears reversed after development.

The Villard Effect

This effect results from conditions similar to those responsible for the Clayden Effect, a high intensity first exposure followed by a moderate intensity second exposure. This similarity has been responsible for creating some confusion between these two effects. The term Villard effect describes a laten-image reversal in which there is a loss of developability, not merely a desensitization as with the Clayden effect. The result is the formation of a positive image accompanied by a decrease in developed density.

Solarization

When an emulsion has been exposed and reached its maximum density further exposure will not effect the density. However, if the exposure is greatly increased beyond the point at which maximum density was reached some photographic emulsions show a decrese in density. This effect is known as solarization and is a partial reversal of the image.

Herschel Effect

When an emulsion which is not sensitive to red or infrared light is exposed, normally with blue or white light the conventional latent image will be formed. When some emulsions are subsequently exposed to red or infrared light before development some of the effect of the original exposure will be erased.

Sabattier Effect

When an emulsion is exposed during the developing procedure an image reversal will take place. This reversal may be partial or complete depending upon the intensity of the exposure.

Eberhard Effect

When two small areas of unequal size are given equal exposure and development, the density of the smaller area will, in general, be higher.

Kostinsky Effect

When two small images, such as those formed by double stars or double emission lines, lie close together, a form of development inhibition may take place. In the region between the two images the developer is exhausted while elsewhere the development proceeds normally. The result of this asymmetrical inhibition is an exaggeration of the separation of the two images.

Shadow of the Moon

By Jim Fox

It has been two years since the column headings for occultations have been explained. Since several club members have asked about them, they are repeated here. I would still like to hear from any members who observe these events. Next issue I will begin discussing how occultation timings may be reduced.

The TIME column is the date and UT of the predicted event: day/hours:minutes:seconds (CST = UT - 6 hrs). The STAR column is the USNO number assigned to the star. An * indicates Zodiacal Catalog number. The PO column is the Phenomenon and Observability. Phenomena are: D = disappearance; R = reappearance; G = graze. Refer to the October '77 issue for a discussion of observability. MAG is the star's magnitude. PA is the position angle of the event, measured counter-clockwise around the lunar limb from the northernmost point in the field.

For example, the first entry specifies: on April 2, at 10:07:10 UT (4:07:10 am CST) star

ZC-2995 will reappear from behind the moon. Observability 9 indicates that almost any size telescope will show the event. The star's magnitude is 6.2 and the event will occur at position angle 267°.

TIME	STAR	PO	MAG	PA
April				
2/10:07:10	*2995	R9	6.2	267
11/02:33:37	*0592	D7	7.7	143
11/16:34:53	*0692	D9	1.1	115
11/17:27:43	*0692	R9	1.1	220
12/01:50:02	*0729	D8	7.2	66
12/03:41:34	03972	D8	7.1	104
13/02:11:58	*0858	D7	7.7	140
13/05:13:22	*0878	D8	5.5	54
14/01:50:32	06078	D7	7.7	114
14/02:23:44	06094	D7	8.1	44
14/04:29:32	06188	D7	7.8	123
16/02:03:26	*1234	D8	6.1	111
18/08:05:49	*1465	D7	6.3	71
May				
10/02:15:23	*0806	D9	5.1	162
11/01:54:38	*0944	D9	5.7	40
12/03:13:38	06895	D7	8.0	140
12/04:06:53	06958	D7	7.6	59
13/02:18:35	07937	D7	8.1	92
14/05:40:11	*1320	D7	6.8	148
16/04:47:28	*1518	D8	6.3	111
28/08:38:19	*3205	R7	6.8	242
28/09:01:19	*3208	R7	6.5	286
June				
10/02:10:49	*1271	D7	5.9	60
11/03:03:58	*1381	D9	6.3	51
12/03:07:37	*1478	D8	7.2	139
26/06:13:41	*3431	R7	6.6	288
27/09:20:16	00209	R7	7.4	210
28/07:49:12	*0155	R8	6.8	331

Note: events dated April 11 for star ZC-0692 should be visible even though they occur in the daytime! The occulted star is alpha Tauri, Aldeberan.

Flashes

by Carl Harstad

Meteor observing during this quarter is the pits.

Perhaps I should stop there, but someone will undoubtedly request an explanation. I cannot explain myself, but will endeavor to explain why meteor observing this quarter is the pits.

To begin with, the Lyrid shower this month peaks one day before full moon, so should you go to the site, you stand a better chance of being destroyed by a werewolf than seeing a Lyrid meteor. The Eta Aquarid shower initially looks good on paper, but there's good news and bad news about this shower.

The good news is the shower has a peak May 5, one day before new moon. Furthermore, it's near maximum for a full week, about May 3-10.

And now the bad news. This shower is best seen in the southern hemisphere. Rates of 15/hour can be seen in Florida, but in Minnesota far fewer can be seen, if any. Due to a very low radiant, one must wait until after 3 a.m. to see Eta Aquarids. In Minnesota, only one and one-half months before the summer solstice, twilight is fast approaching at that hour. Furthermore, these meteors are swift, although many are long due to the low radiant.

Frankly, unless something exceptional happens, you're better off watching the "Creature from the Black Lagoon" on the tele. That might keep you up late and, like the Eta Aquarids, disappoint you completely, but you probably won't catch a chill doing it.

The next really good shower will be the Perseids in August, which occur at first quarter moon. Thus, those observers with fortitude can stay up after moonset and should see a splendid shower from midnight to dawn.

Until then, take up deep-sky observing.

MINUTES

Minutes of the regular meeting of Tuesday, April 4, 1978:

The regular monthly meeting of the Twin City Astronomy Club was held in the Physics Building of the University of Minnesota Tuesday, April 4, 1978, at 7:30 p.m. The program for the evening was a lecture by Dr. Edward Ney, chairman of the Department of Astronomy at the University of Minnesota since 1974. His topic was "Stardust."

Dr. Ney's theory is that heavy atoms are produced in supergiants and driven into space by the solar wind. Nova and supernova are too rare to account for the abundance of heavy atoms, he said. His theory has been supported by infrared work up to 20 microns. Dr. Ney reports peaks in radiation at 10 and 20 microns due to the silicon/oxygen bond.

Dr. Ney discussed infra-red observations of several objects, including supergiants, comets and stars surrounded by dense dust.

For example, he discussed observations of a 19th magnitude object at 500°K., too cold to be a star. He believes this object is a carbon star surrounded by dust that absorbs visual light and reradiates it at 6 microns.

In 1969/1970, Dr. Ney discovered the 10 micron silicate signature in the radiation profile of Comet Bennett. He believes the 10 micron peak is due to iron/magnesium silicates in the coma.

Dr. Ney said the radiation signature of oxygen stars is due to silicates, while the peak from carbon stars is due to carbon dust. He estimated the size of this dust at 10^{-4} cm.

Dr. Ney said the "snot ball, rat tail" type of comet has no silicon signature, while comets like Comet West have a distinct silicon signature in the dust tail.

He also discussed formation of dust by nova. Nova Cygni, he said, was below 20th magnitude on the Palomar Sky Survey. It rose to 2nd magnitude. The plasma electrons and protons of Nova Cygni were in high temperature equilibrium after four days, he said. Nova Cygni was a single explosion; it expanded for 30 days before becoming a shell. To date, there is no condensed dust yet from Nova Cygni.

Another nova is Nova Vulpecula. Dust formed at 1000^{o}K. caused a severe drop in visual magnitude after 65 days.

Dr. Ney also discussed how he discovered the most polarized light source in the sky using a 12" telescope and a Polaroid filter in a backyard in Robbinsdale. The object, in Cygnus, is a star surrounded by a "dust doughnut" that lets light escape only through the holes in that doughnut. The spectrum is that of an F type supergiant. He estimates it size at 100,000 AU. The two components are separated by about 7" of arc.

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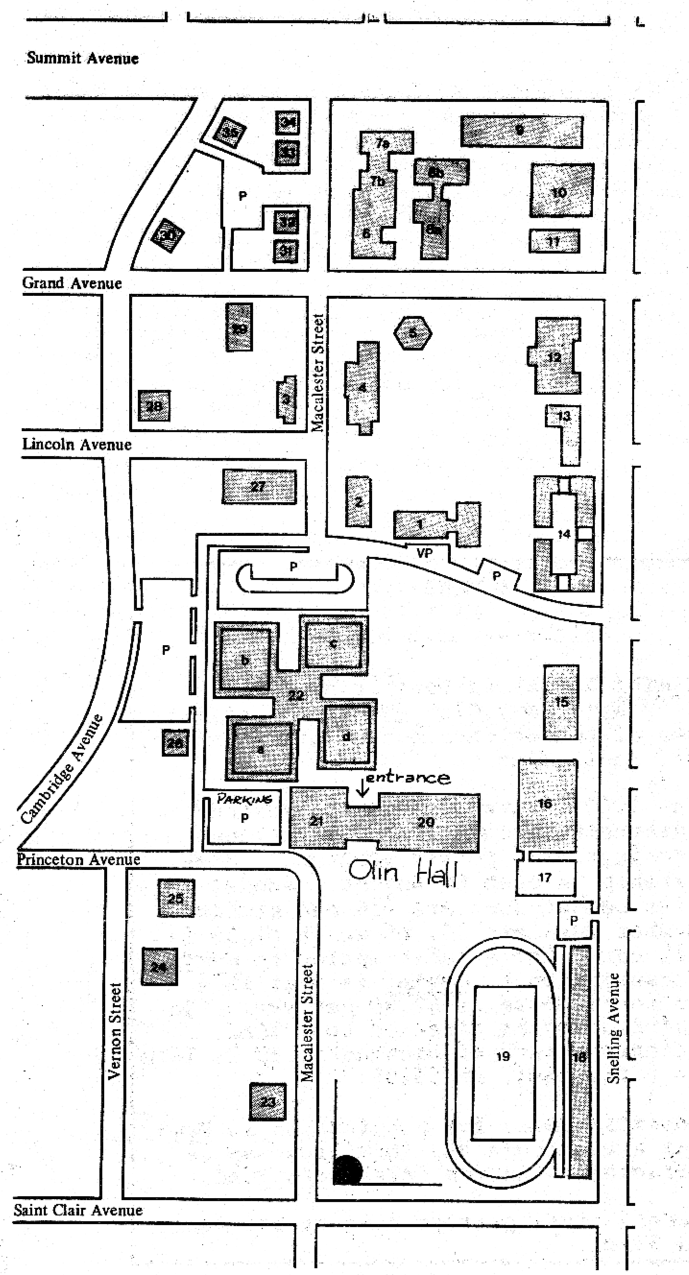
A short business session followed the evening's lecture. Bill Larson announced the election of officers this month and introduced the candidates. All members should have received a mail ballot listing the candidates.

Lauren Nelson announced the next meeting of the TCAC will be at Olin Hall, Macalester, 7:30 p.m. Tuesday May 2. The topic for the evening will be "Photometric Measurement at Macalester."

Please send all letters and articles to John Mlinar, 1131 55th Street North, Lake Elmo, 55042. The deadline will be the 20th of each month.

John Cooner would like to remind those members who receive their Sky & Telescope through the club to bring the address sticker to the next meeting and give it to him if you have not already done so.

The May 2 meeting will be a joint meeting of the Twin City Astronomy Club and the 3M Club Astronomical Society. The program to be held at Olin Hall on the campus of Macalester College will be given by Rick Binzel and Dr. Sherman Schultz on Photometric Measurement at Macalester College. Following this, Dr. Schultz will give a demonstration of 360 degree photography in the planetarium.



GEMINI

Editor----John Mlinar

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