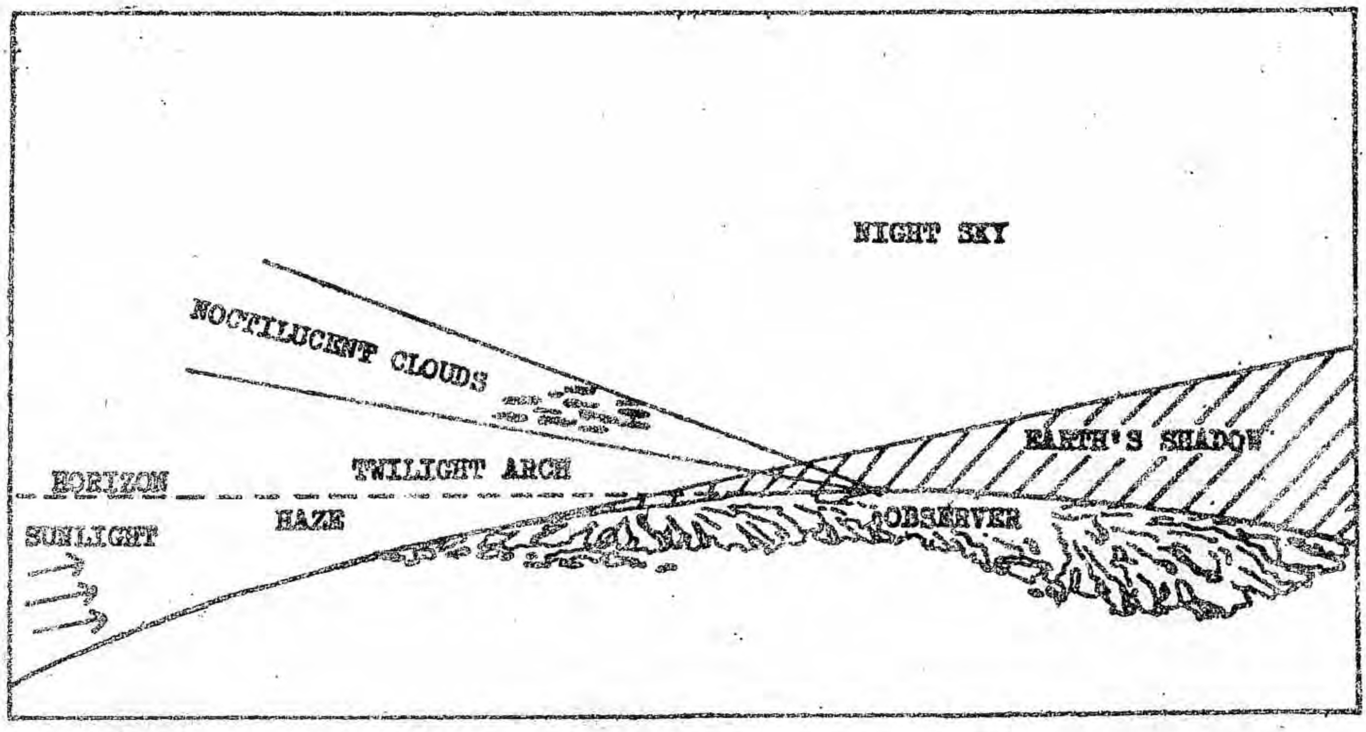
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

SASKATOON CENTRE

President: Halyna Kornuta
Editor: Greg Towstego
Published by the Saskatoon Centre, R.A.S.C.

P.O. Box 317, Sub 6
Saskatoon, Saskatchewan
S7N - 0W0
March, 1976
Vol. 6,- Copy 3

NEWSLETTER



TWILIGHT CONDITIONS ASSOCIATED WITH OBSERVATION OF NOCTILUCENT CLOUDS

NOCTILUCENT CLOUDS

Dr. B.W. Currie

Introduction. A paper of mine, entitled The Need for Canadian Observations of Noctilucent Clouds and published in the R.A.S.C. Journal for August, 1962, noted the remarkable lack of reported observations of the clouds in North America compared with Europe. The first reported observation in Canada had been one by E.H. Vestine at Meanook during July 1933. Two observations at Edmonton on June 26-27, 1956, by J.J. Kinisky had been reported, as had one by K.D. Baker and B.W. Currie at Saskatoon on July 24, 1961. In contrast, there had been numerous reported observations of the clouds over Europe (particularly Scandinavia and the U.S.S.R.) starting back in the nineteenth century. The number of observations had varied annually from about ten to over thirty.

Currie suggested several reasons for this notable difference. One was that the clouds had been observed occasionally, but the observers had not recognized that they were different from the ordinary type of clouds, - possibly assuming that they were some type of auroral luminosity. Another was that a remarkable difference existed between North America and Europe in physical processes at the 80-kilometre level that lead to the formation of the clouds. He then suggested that there was a need for regular observations throughout Canada to see if the occurrences were indeed rare in this region. He further suggested that this was an interesting task which could be undertaken by amateur astronomers (particularly those in the R.A.S.C. Branches). To assist them, he outlined the circumstances favourable to their observation. Members of the Saskatoon Branch organized a regular watch for the clouds during the summer twilight hours. This was continued for several years. They were rewarded by seeing a number of interesting displays, - some getting good photographs in colour.

Others also became concerned about the occurrence of the clouds and the atmospheric conditions which lead to their formation. Weather stations making hourly weather observations, and pilots on aircraft making regular flights across Canada were asked to look for the clouds and to note their occurrence. The network of stations making observations for noctilucent clouds in Alaska and Northern Europe and Asia was increased. Rockets with packages on board were fired into the clouds over Sweden in attempt to collect particles (probably meteoric dust) on which the cloud particles formed. As a result, an extensive literature now exists on their frequency of occurrence for the Northern Hemisphere. The rocket flights were not particularly successful, and the source of the water vapour forming the clouds and the circumstances through which the cloud particles are still unresolved.

The number of occurrences over Canada have decreased notably during recent years. However, Baker on a visit to Western Canada in 1975 observed and photographed an exceptionally extensive display at Regina. This was on the last day of June.

The display lasted for several days, Baker observing it during successive nights from Saskatoon and places in Northern Saskatchewan. If past experience can be taken as a guide, we may be in a period of several years during which there will be frequent displays. There follows excerpts from my 1962 paper that will assist members of our Branch in making observations.

Form and Colour. The clouds are visible only by sunlight reflected or scattered by them to an observer located in the twilight zone. Because of their diffuseness they cannot be detected by a dimming of the stars behind them. If the background of the sky is too bright, insufficient contrast exists between the illuminated clouds and the sky for them to be seen. Observers in the U.S.S.R. have classified the clouds into four basic types: veils or sheets, bands, crests and whirls. The veil is very tenuous and lacks structure. Like all noctilucent clouds, it shines faintly with bluish tints. Sometimes golden shades close to the horizon are mentioned. Bands are long streaks with diffuse edges, more or less straight, and parallel to each other. Crests look something like ripples on a water surface, and are often located among or on the bands in a cross direction to them. Whirls are twists or turns in the two previous types that suggest the presence of much turbulence. To a person acquainted with ordinary clouds and their descriptions, the first type resembles cirrostratus nebulosus, the second and third types, cirrostratus undulatus. Apart from the veil, their structural appearance is quite different from that of aurora. Aurora, appears generally in concentrated arcs, bands and rays. The greenish shades characteristic of aurora are never mentioned by observers of noctilucent clouds.

Geometrical Conditions for Viewing. The geometrical conditions for viewing are somewhat critical, and help to distinguish the noctilucent clouds from ordinary twilight clouds and aurora. The heights of the clouds over Europe have been measured on several occasions by taking photographs of them simultaneously from the ends of long base-lines. The heights determined in this way range from 78 to 90 km., and average about 82 km. This limits the range of depressions of the sun below the observer's horizon and of the azimuths at which the clouds can be seen readily. The best conditions for their visibility occur when the sun is 6 to 12° below the horizon. Against the weakly-illuminated background of the sky, during this period, they are seen at altitudes from 4 to 15° and in azimuths toward the sun. Close to the horizon, their brightness is reduced through atmospheric absorption; at greater altitudes through insufficient illumination by the sun. The ranges of altitudes and azimuths at which the clouds can be observed may be extended somewhat by using binoculars or a telescope with a large field of view.

The clouds should presumably be seen at all times of the year and over all latitudes. The probability of them being seen increases substantially for the higher latitudes during the summer seasons because of the long twilight periods. For the northern hemisphere, they have never been reported earlier than April, or later than September, the maximum number of appearances occurring in July. They have not been reported from latitudes lower than 45°N., and only rarely from latitudes below 50°N. Reports from the southern hemisphere suggest approximately the same seasonal and latitudinal occurrences.

Table I lists approximate times for selected dates between May 9 and September 16 inclusive and for latitudes 50, 55 and 60° when the sun is 6° and 12° respectively below the horizon. To obtain the standard time at any location, the times must be increased, or decreased by 4 minutes for every degree of longitude that the station is west, or east, of the standard meridian. The table should serve as a guide to the best times when attempts should be made to see the clouds, and for checking doubtful appearances of the clouds. Actually, the possibility exists of the clouds being seen throughout twilight. The twilight periods can be found readily from an ephemeris listing times for sunset and sunrise, and the ending and beginning of astronomical twilight (sun 18° below horizon).*

TABLE I

Approximate times between May 9 and September 16 when the sun is 6° and 12° below the horizon for latitudes 50, 55 and 60° N. To get the standard time, the times must be increased, or decreased, by four minutes for every degree that the location is west, or east, of the standard meridian.

Date		50° N. Morn.		50° N. Even.		55° N. Morn.		55° N. Even.		60° N. Morn.		60° N. Even.	
		h	m	h	m	h	m	h	m	h	m	h	m
Solar Depression −6°													
May	9	3	44	20	07	3	16	20	34	2	43	21	14
	19	3	27	20	24	2	54	20	56	2	03	21	46
	29	3	16	20	37	2	37	21	16	1	34	22	18
June	8	3	08	20	49	2	30	21	30	1	08	22	55
	18	3	05	20	56	2	21	21	40	0	50	23	12
	28	3	10	20	57	2	26	21	40	0	59	23	08
July	8	3	21	20	53	2	38	21	38	1	25	22	48
	18	3	30	20	44	2	54	21	19	1	57	22	18
	28	3	46	20	28	3	15	20	58	2	30	21	46
Aug.	7	4	02	20	11	3	41	20	32	3	00	21	15
	17	4	17	19	52	3	57	20	13	3	30	20	41
	27	4	34	19	31	4	18	19	40	3	50	20	07
Sept.	6	4	49	19	06	4	39	19	18	4	24	19	35
	16	5	08	18	46	4	59	18	53	4	50	19	03
Solar Depression −12°													
May	9	3	00	2	14	0	47	21	00	21	42	23	16
	19	2	33	1	38	—	—	21	19	22	20	—	—
	29	2	17	1	08	—	—	21	41	22	54	—	—
June	8	2	08	0	25	—	—	21	57	23	39	—	—
	18	1	57	—	—	—	—	22	03	—	—	—	—
	28	1	58	—	—	—	—	22	02	—	—	—	—
July	8	2	14	0	47	—	—	21	54	23	20	—	—
	18	2	32	1	26	—	—	21	38	22	42	—	—
	28	2	51	2	02	—	—	21	21	22	09	—	—
Aug.	7	3	11	2	23	1	22	20	58	21	36	22	44
	17	3	31	3	02	2	15	20	35	21	04	21	50
	27	3	50	3	27	2	52	20	11	20	28	21	06
Sept.	6	4	09	3	51	3	27	19	48	20	02	20	27
	16	4	29	4	17	3	59	19	26	19	38	19	54

* See the Observer's Handbook, p.19.

Suggested Origins. A brief summary of the various hypotheses concerning the origin of the clouds should emphasize the need for establishing if the difference in number of appearances between Canada and Europe is a real one. The paper by Vestine (1934), and a recent one by Ludlam (1957) are recommended for readers who want to go into the nature of the clouds in some detail.

Water vapour as a source for the cloud particles was originally considered unlikely for several reasons. The water vapour would have to originate from the earth's surface, and processes for its transfer upward to the 80-km. level in sufficient quantity to produce the clouds did not appear to exist. Even if sufficient water vapour could reach this level, the temperature appeared to be too high for condensation or sublimation particles to persist at the existing atmospheric pressures. Condensation or sublimation nuclei on which the water molecules could collect would also have to be present. As a result, ash from volcanic eruptions, condensed materials evaporated from meteors as they penetrate into the atmosphere and interplanetary dust swept up by the earth were considered as more likely sources.

Vast quantities of ash are propelled into the lower stratosphere by volcanic eruptions. The frequency and brightness of the clouds in the years 1885 to 1894 has often been attributed to the eruptions of Krakatoa in August 1883. Apart from this particular occasion, attempts to associate appearances of the clouds with volcanic eruptions have been most unconvincing. The reddish-brown corona (Bishop's ring) that is observed sometimes around the sun following a violent volcanic eruption gives an average radius for the volcanic particles of about 18 x 10^{-5}cm. This is an order of magnitude greater than the 10^{-5}- to 10^{-6}-cm. radii, deduced for the cloud particles from polarization measurements on the light from the clouds. Twilight colours also give a means of deducing the maximum height of the dust cloud from a volcanic eruption. For Krakatoa, this was about 35 km. The temperature in the ozonosphere rises to a maximum of about 0°C. at the 50-km level, producing a stable layer through which the volcanic dust would find difficulty in passing. Estimates of the size and number of particles in the trails from large meteors suggest that they are comparable to the corresponding values for the particles in noctilucent clouds. For ordinary meteorites the size of the meteoric particles is probably too small and the amount of material insufficient for the noctilucent clouds. If meteors are responsible, there should be a convincing association between known meteor showers and the appearances of the clouds. In particular, the association should explain the maximum in the number of appearances following the summer solstice. Fairly reliable information is now available on daylight showers during the summer months. This information together with that on night-time showers does not disclose a significant relationship between the appearance of noctilucent clouds and the arrival of meteor showers. The visible paths of most meteors lie between the heights of about 100 and 50 km., so that their condensation products are distributed over a layer extending somewhat above and below the level of noctilucent clouds. The meteoric material may contribute the cloud particles. Studies of the zodiacal light suggest that micrometeoric particles in numbers substantially greater than indicated by the number of visible meteors enter the atmosphere. These constitute in part the interplanetary dust swept up by the earth. Satellite observations on micrometeoric particles (Alexander, at al. 1961) show that sporadic streams of such particles occur in the space close to the earth. These must penetrate on occasion into the atmosphere and, presumably, could form the clouds. Information on such streams is far too limited to attempt an association between them and appearances of the clouds. The concentration of such particles close to the 80-km. level is difficult to explain. It is equally difficult to explain the observed spatial and temporal distributions of noctilucent clouds, if they originate in this way.

Observations in recent years on the upper atmosphere by balloons and rockets have concentrated attention once again on water vapour as the source of the clouds. Observations by balloons on the moisture content up to the 100,000-ft. level (Mastenbrook and Dinger 1961) show higher and more uniform water vapour contents at the upper levels than had been anticipated. Temperatures in the atmosphere decrease to a minimum at the tropopause, then rise to a maximum at about the 50-km. level, and finally decrease to a pronounced minimum at about the 80-km. level before starting to increase rapidly for still higher levels. Rocket observations on temperatures over Churchill show that the temperature for the minimum at the 80-km. level may be as much as 75°C. lower in summer than in winter. Temperatures for this minimum may be as low as -100°C., a temperature favourable to the formation of ice particles. Suitable sublimation nuclei are needed, but these are probably provided by meteorites and interplanetary dusts. The low temperatures during the polar summer may explain the maximum in the appearance of the clouds at high latitudes at this time of the year. The sporadic nature of the appearances may also find an explanation in the irregular occurrence of conditions which favour transfer to water vapour upward in sufficient quantities to the 80-km. level for the clouds to form.

If the clouds do have a meteorological origin as suggested in the previous paragraph, and if the difference in the number of appearances for Canada and Europe is real, one must assume significant atmospheric differences at upper levels over the two regions. A fairly systematic schedule of observations in search of the clouds over Canada is needed to decide this point.

Observing Techniques. The west, north and east parts of the horizon must be visible to the observer, since the clouds are seen generally at low altitudes. The clouds are often so faint that the observer is unlikely to see them until his eyes are accommodated to the darkness. If clouds suspected of being noctilucent ones are observed, the time should be noted so that it can be checked with the times in the table. In addition, the upper and lower altitudes and the extreme azimuths should be noted. If means are not available for measuring these at the time, significant features on the landscape should be used as reference points. These can be used later to get the altitudes and azimuths. With these data, one can decide whether or not the time and location were ones favourable to the observing of noctilucent clouds. The colours of the clouds should be noted - particularly the changes in the colours as the sun rises. Notes should also be made on the form and motion of the clouds.

The clouds are not difficult to photograph. For the brighter clouds, an exposure of about one to three sec. at f/5.6 on panchromatic film is sufficient; for the fainter clouds, exposures up to about 100 sec. may be needed. If photographs are taken, the photographer should place himself so objects will appear in the foreground that can be used later for altitude and azimuth determinations. Somewhat longer exposures will be needed for colour film. Excellent photographs have been obtained at 1/30 sec. on fast ektachrome film at f/2.0. Generally, exposures from 10 to 30 sec. will be required at f/2.0.

B.W. Currie.

THE ROYAL ASTRONOMICAL SOCIETY 1968
SASKATOON CENTRE

MEETING NOTICE

Place Rm B110, Health Sciences Bldg, U of S

Date Tuesday, 16 March 1976

Time 8:00 p.m.

Purpose March General Meeting

Talk on Astrophotography by

Mr Dyer, Edmonton Centre

After the approval of the January minutes, our President, Halyna Kornuta, communicated to members that a letter from the Edmonton Centre had been recieved and that plans are made for a guest speaker from Edmonton to speak at the March General Meeting and that in return, Mr. G.N. Patterson from our Centre will be going to Edmonton to speak at a meeting of that Centre. When the business portion of the meeting was ended, our guest speaker, Dr. B.W. Currie was introduced. He then proceeded to give an interesting talk on "Solar-Terrestrial Relationships and Climate", illustrated with transparencies. The talk concerned itself with the effects the sun and the motions of the Earth have on our weather. I was very surprised to find out just how much effect solar activity has on our surface weather conditions. The talk then wound up with a question period. All those who did not attend missed a good talk delivered by an authority on these subjects.

We then went over to the Observatory for coffee and hot chocolate and found that further renovations are proceeding quite well. Some members spotted Saturn, the Orion Nebula and Sirius in the 7" refractor telescope, however, that was about all we saw because most of the sky was covered by cloud. The meeting was relatively well attended but it would be nice to see a lot more faces there. Mark March 16 on your calendar and let's assure an excellent turnout for our guest speaker from Edmonton.

GENERAL ASSEMBLY PROJECTS

All members who are planning to enter a project(s) in the General Assembly at Calgary are reminded that there is not very much time left, as the deadline for entries is 30 April, 1976. It is being held on the Victoria Day long weekend in May and you don't have to attend to enter a project. It would be to our Centre's best advantage if as many categories as possible were entered, because this would not only give us better odds for winning individual awards, but would bring us closer to winning the award for the best overall Centre exhibit. Let's get cracking now and assure a good representation from Saskatoon.

LUNAR OBSERVATIONS - Greg Towstego

For those members who are interested (let's hope that's almost all of you) a page containing information on the March thin lunar crescents is contained in this "Newsletter". This month you can observe this phenomena on Monday 29 March and Wednesday 31 March. Monday will be the sunrise waning phase and Wednesday evening will be the sunset waxing phase. (waning - diminishing in size as it approaches new moon, waxing - increasing in size as it moves away from new moon phase) If you have a camera (preferably on a tripod) I suggest you take colour slides of it. Good luck.

MOON LESS THAN 48 HOURS OLD FOR NEW MOON, 30 MARCH, 17:08 CST., 1976

WANING PHASE 29 March 1976

Sunrise 06:48 CST 12:48 UT

Sun at Sunrise R.A. = $00^h\ 32^m\ 54^s.86$; Dec. = $+03^\circ\ 33'\ 02''.70$
Moon at Sunrise R.A. = $23^h\ 39^m\ 45^s.68$; Dec. = $+01^\circ\ 56'\ 02''.63$

Difference R.A. = $00^h\ 53^m\ 09^s.12$; Dec. = $01^\circ\ 37'\ 00''.07$
Angle between Sun and Moon = $13^\circ.39$
Siderbal Time at Sunrise = $18^h\ 07^m\ 54^s$

Moonrise 05:47 CST 11:47 UT

Sun at Moonrise R.A. = $00^h\ 32^m\ 45^s.54$; Dec. = $+03^\circ\ 32'\ 03''.35$
Moon at Moonrise R.A. = $23^h\ 37^m\ 51^s.91$; Dec. = $+01^\circ\ 45'\ 41''.81$

Difference R.A. = $00^h\ 54^m\ 43^s.63$; Dec. = $001^\circ\ 46'\ 16''.54$
Angle between Sun and Moon = $13^\circ.80$
Sidereal Time at Moonrise = $17^h\ 06^m\ 54^s$

dT = Sunrise − Moonrise = 06:48 − 05:47 = $1^h\ 01^m$
Age of Moon at Sunrise = $34^h\ 20^m$
Age of Moon at Moonrise = $35^h\ 21^m$

Altitude of Moon at Sunrise approx. = 11°

. . . .

WAXING PHASE - 31 March 1976

Sunset 19:39 CST 01:39 UT

Sun at Sunset R.A. = $00^h\ 41^m\ 59^s.99$; Dec. = $+04^\circ\ 31'\ 03''.75$
Moon at Sunset R.A. = $01^h\ 34^m\ 37^s.25$; Dec. = $+11^\circ\ 28'\ 17''.63$

Difference R.A. = $00^h\ 52^m\ 37^s.26$; Dec. = $06^\circ\ 57'\ 13''.88$
Angle between Sun and Moon = $14^\circ.88$
Sidereal Time at Sunset = $07^h\ 06^m\ 07^s$

Moonset 20:01 CST 02.01 UT

Sun at Moonset R.A. = $00^h\ 42^m\ 01^s.26$; Dec. = $+04^\circ\ 31'\ 11''.85$
Moon at Moonset R.A. = $01^h\ 35^m\ 17^s.80$; Dec. = $+11^\circ\ 31'\ 12''.99$

Difference R.A. = $00^h\ 53^m\ 16^s.54$; Dec. = $07^\circ\ 00'\ 01''.14$
Angle between Sun and Moon = $15^\circ.05$
Sidereal Time at Moonset = $07^h\ 28^m\ 07^s$

dT = Moonset − Sunset = 20:01 − 19:39 = $0^h\ 22^m$
Age of Moon at Sunset = $26^h\ 31^m$
Age of Moon at Moonset = $26^h\ 53^m$

Altitude of Moon at Sunset approx. = 2°

. . . .

A TRULY BEAUTIFUL SIGHT - Comet West

G. N. Patterson

The title of this article cannot truly convey the spectacular view of the Comet West (1975n) as seen visually on the morning of this past Friday, March 4th, 1976, by Greg Towstego and myself. Outside temperature was $-32^\circ C$ with a south-east wind blowing at 20 mph, a chill factor of about 2300. Even these weather conditions failed to dampen our enthusiasm although it did limit our viewing time.

The Comet rose in the eastern skies (almost due East) about 6:00 am. Living on the eastern side of the city meant that all the city air pollution, heat from houses and furnaces, ice fog, etc, were all blown away leaving a very clear eastern horizon so that the comet was clearly naked-eye visible when about 3 to 4° above the horizon. The coma (head) was large and very bright, estimated at about -2.0 magnitude, and the vertical fan-shaped tail stretched longer than the field-of-view of my zoom binoculars at 14X which is 4.8°, so I estimate the tail length (naked-eye visible) to be at least 5°. There appeared to be a fair amount of color in the head and tail of the comet but this could have been largely due to its low altitude above the horizon. Rise time of the comet was about $1^{hr}45^{m}$ ahead of the Sun so the dark blue sky background set this magnificent spectacle off beautifully. This comet is visually about 2 magnitudes brighter than Comet Kohoutek was at its brightest.

As this comet is past perihelion (25 February 1976) it has now reached its peak brilliance and will rapidly lower in brightness. This will be off-set to some extent by its increasingly earlier rise time ahead of the Sun. A list of approximate rise times compared to Sunrise are given below:

DATE	COMET RISE	SUNRISE	DATE	COMET RISE	SUNRISE
March 6	5:50 am		March 15	4:49 am	7:22 am
7	5:42 am	7:39 am	16	4:45 am	
8	5:34 am		17	4:41 am	7:16 am
9	5:26 am	7:35 am	18	4:37 am	
10	5:18 am		19	4:33 am	7:12 am
11	5:10 am	7:30 am	20	4:29 am	
12	5:02 am		21	4:25 am	7:07 am
13	4:57 am	7:25 am	22	4:21 am	
14	4:53 am		23	4:17 am	7:02 am

Everyone should make an attempt to see this magnificent sight.

MINUTES OF A GENERAL MEETING, SASKATOON CENTRE, RASC,

HELD IN ROOM B-110, HEALTH SCIENCES BUILDING, U of S, 8:00 pm., 17 FEB., 1976

Present:

Halyna Kornuta......... President
Mr Jim Young............ Vice President
Mr Gordon Patterson.... Centre Rep.
Mr Alan Blackwell...... Treasurer
Lillia Wilcox...... Secretary
Mr Hugh Hunter..... Librarian
Greg Towstego...... Editor

Absent:

Mr Merlyn Melby........ Activities
Doug Beck.......... Sub-Councillor

Minute	Subject	Action
57.	Meeting called to order at 8:00 pm.	H. Kornuta
58.	Moved that January minutes be adopted as published	J. Young, G.N. Patterson
59.	(a.) Correspondence with Edmonton Centre in regards to the speaker exchange has been completed. Mr Alan Dyer will speak on "Astrophotography" at our March General Meeting. (b.) In return, Mr Gordon Patterson will speak to the Edmonton Centre at their regular meeting in March. The Centre will pay air fare.	H. Kornuta J. Young
60.	The "Graphic Timetable of the Heavens" charts have been ordered but have not arrived as yet.	H. Kornuta
61.	Dr B.W. Currie gave a talk on "Solar-Terrestrial Relationships and Climate." He used transparencies to illustrate.	
62.	Meeting adjourned to Observatory - 9:15 pm.	Michael Wesolowski Robert McAllister

Minutes prepared by Lillia Wilcox
(Lillia Wilcox, Secretary)

MINUTES OF AN EXECUTIVE MEETING, SASKATOON CENTRE, RASC,

HELD IN ROOM B-110, HEALTH SCIENCES BUILDING, U of S, 9:15 pm, 17 FEB., 1976

Present:

Halyna Kornuta........ President
Mr Jim Young............ Vice President
Mr Gordon Patterson.... Centre Rep.
Mr Alan Blackwell...... Treasurer
Lillia Wilcox...... Secretary
Mr Hugh Hunter..... Librarian
Greg Towstego...... Editor

Absent:

Mr Merlyn Melby......... Activities
Doug Beck.......... Sub-Councillor

minutes continued .....

Minute	Subject	Action
63.	Meeting called to order at 9:15 pm.	H. Kornuta
64.	Bindings of the Journals received from Prof. Kennedy was mentioned and they are to be bound as soon as possible.	H. Kornuta
65.	The April General Meeting was discussed and it may have to be cancelled due to exam writing at the University along with the possibility of the dome replacement being done at the same time as the meeting. (be watching the April Newsletter for further details on the meeting.)	G.N. Patterson
66.	The Kamsack Astronomy Club trip to Saskatoon was discussed. There are no accomodations available for their tour on the May 28 weekend.	Alan Blackwell
67.	Meeting adjourned to Observatory - 9:30 pm.	J. Young

Minutes prepared by Lillia Wilcox
(Lillia Wilcox, Secretary)

PHYSICS FOR FUN

Time: 8:15 pm

Place: Room 107, Physics Building, U of S, Saskatoon

Admission: Open to the public and free of charge

Lecture: Wednesday, 10 March, 1976

"Applications of Nuclear Physics in Agriculture" by Dr. J.W.B. Stewart, associate professor in the Dept. of Soil Science, U of S, Saskatoon.

This lecture will discuss some of the applications of isotopes to measurements of soil moisture, root systems, organic matter, and plant nutrition.

Film Show: Wednesday, 24 March, 1976

Space in the Age of Aquarius

Hurricane Below

Tornado Below

. . . .