NOVA NOTES

Halifax Centre

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Notice of Meetings

NOVA EAST '88

FUNDY NATIONAL PARK

AUGUST 12th - 15th

see inside this issue for more details!!

Date:	Friday, September **16th**, 1988: **7:00 P.M.**
Place:	Nova Scotia Museum. Access from the parking lot and side entrance. Meeting to be held in the lower theatre.
Topic:	**FIRST MEETING OF THE NEW YEAR!** The **7:00** video presentation has not been finalized, nor has the speaker. Stay tuned for the next issue of **NOVA NOTES.**

Note: The above list is tentative and subject to change.

About the cover: The cover this issue is a rendition of the space station built by Tom Swift, Jr, from the series of books: *The New Tom Swift Jr. Adventures.* Notice that it is constructed in segments with each being made from the hull of a previously launced rocket. Not bad for 1956!

Editor's Report

Patrick Kelly

My how time flies! It always seems that after I finish writing this column for each issue, I'll never be able to come up with enough interesting tidbits for the next issue. Fortunately, lots of interesting things happen in the meantime. For example.... those of you who didn't get your issue of **NOVA NOTES** in time for the announcement about the May Beginner's Meeting can blame Murphy's Law. You may recall that I mentioned last issue that I hoped no one at Canada Post every weighed **NOVA NOTES**? Well, someone did. I found out about it when I went up one day to check our mailbox and found about 150 issues of our newsletter nicely bundled up and marked "Insufficient Postage". It seems that the weight limit is 30 grams and that issue was 35. Because of that, I will be limiting **NOVA NOTES** to six sheets of paper in the future. However, with the new 10 point size of writing there should be the same amount of information as before.

The annual banquet went very well with over 40 people attending. The food was excellent and there was enough to please even those with large appetites. This was accomplished by a tendency for the plates to drift towards Doug's section of the table. We had a very interesting talk on early astronomical instruments by **Randall Brooks**.In addition, for the first time in quite a few years we actually presented the **Burke-Gaffney Award**. It was awarded to **Dan Falk** for a paper that he wrote on spectroscopy (or as Darrin calls it, the "S" word!!) dan gave a short slide show on what he had done. His essay appears elsewhere in this issue.

Also on the topics of awards, I am pleased to be able to tell you that at the General Assembly this year, our own **Roy Bishop** will be awarded the Society's **Service Award.** He will only be the third member of our center to receive this award; the other two being **Father Burke-Gaffney** and **Randall Brooks**. We ran into a bit of a problem, because each center is only allowed to nominate a person every three years, but as Randall had just been awarded it officially we could not nominate Roy. The solution was to nominate him *jointly* with the National Office. However, a further complication arose because Roy chairs the Awards Committee. At one of the recent National Council meetings, a conveniently placed phone call drew him away in time for his service award to be approved and then announced to him on his return! I have reproduced below the text of the citation that was send to National Office to nominate Roy.

The executive and members of the Halifax Centre of the Royal Astronomical Society of Canada wish to nominate our outstanding member,Dr. Roy Bishop, for the Service Award.

Throughout the R.A.S.C. in Canada, and particularly for us of the Halifax Centre, Roy is synonymous with "The Observer's Handbook" which he has edited since 1982. As a result of extensive lecturing and media exposure in the Maritimes many people have discovered Roy and astronomy. He has consistently encouraged the advancement of Astronomy through his very many contributions both to the membership of the R.A.S.C. and the general public. His love of astronomy has inspired many Nova Scotians to learn more and to participate actively in the Society.

Roy has filled many positions on the National Executive over the past dozen years, from that of the high profile Presidency for 1984 to 1986 to the many "behind the scenes" National Committees that he is currently on:

1) *Chair of the Awards Committee*
2) *Member of Constitution Committee*
3) *Member of Editing Committee*
4) *Chair of the Historical Committee*
5) *Member of the Honorary Members Committee*
6) *Member of the Nominating Committee*
7) *Member of the Executive Committee.*

He is currently Editor of the Education Notes in the Journal.

Within the Halifax Centre Roy has continually made contributions. He has been active since the reestablishment of our Halifax Centre in 1969, providing a willing hand at almost all centre events. He has held the executive offices of President and National Representative and was on the organizing committee for both the 1975 General Assembly (which was the first held in Atlantic Canada) and the 1980 General Assembly (the only joint meeting of CASCA and the R.A.S.C. which was held in Halifax).

Roy has often hosted our Centre at Maktomkus Observatory (built and located at his home) for meteor and other observing parties. At such times he displayed his talents as an acute observer and as a telescope designer and builder.

Roy has done historical research on the 18th century work of DesBarres in Nova Scotia and on the 19th century Kings College Observatory in Windsor, Nova Scotia. He has written several papers of an historical nature including a surprising revelation that "Newton's Second (and best known) Telescope" was not made by Newton.

He has spoken at many of the Centre's monthly meetings over the years and is often called upon at special events to be the keynote speaker.

Respectfully submitted on behalf of the entire membership of the Halifax Centre,

Kathy Oakley,
President, 1987.

Congratulations Roy!! We are proud to have you as a member of our center and hope that you will accept this award as a "thank you" from all of us.

Also of interest is the Astronomy Weekend that we held for the Hebron Astronomy Club. This group is made up mostly of Grade VII students from the **Maple Grove Education Centre.** They came up for several lectures, a planetarium show and an observing session and a tour of the Burke-Gaffney Observatory. They all had a great time and some of them plan to come to **NOVA EAST**.

Lastly, I came across the following poem on a bulleting board at the Dalhousie Physics Department. I hope you all find it as amusing as I did.

In the beginning there was Aristotle
And objects at rest tended to remain at rest
And objects in motion tended to come to rest
And soon everything was at rest
And God saw that it was boring

And then God created Newton
And objects at rest tended to remain at rest
And objects in motion tended to remain in motion
And energy was conserved
And momentum was conserved
And God saw that it was conservative

And then God created Einstein
And everything was relative
And fast things became short
And straight things became curved
And the universe was filled with inertial frames
And God saw that it was relatively general
But some of it was especially relative

Then God created Bohr
And there was the principle
And the principle was quantum
And all things were quantified
But some things were still relative
And God saw that it was confusing

And then God was going to create Ferguson
And Ferguson would have unified
And he would have fielded a theory
And all would have been one
But it was the seventh day
And God rested
And objects at rest tend to remain at rest.

Until next issue, I hope you all have a pleasant summer and hope to see many of you at **NOVA EAST**. Ω

New Brunswick - Québec Fireball of April 17, 1988

Bob Hawkes

At approximately 23:10 ADT on 17 April 1988 observers throughout New Brunswick and parts of the Gaspé peninsula of Québec observed an incredibly bright fireball. While bright meteors are not uncommon, this was clearly an event of exceptional luminosity. Almost without exception each observer claimed the brightness was significantly greater than the brightness of the full moon. I would expect that an area the size of New Brunswick would witness one event of this luminosity perhaps every 10 years or so.

The key interest in such events is the possibility of a recoverable meteorite, which is an even more rare phenomenon. Even very bright fireballs often drop no meteorite fragments, particularly if the meteoroid enters the atmosphere at a steep angle and with a high speed. On the official list of Canadian meteorite falls only 45 (or possibly 46) events are recorded (the number of meteorite fragments is considerably larger since a single event often produces 6 or more separate fragments). Only one meteorite has been recorded in the Atlantic provinces, the Benton meteorite which fell in New Brunswick west of Woodstock on January 16, 1949. This fall resulted in two recovered fragments, one of 1.5 kg and the other 1.3 kg. Even in all of North America the average rate of recovery of fresh meteorites is less than one per year.

Hence when I was contacted by the RCMP detachment in Plaster Rock with the first reports the morning after the fireball, I knew that the odds of finding the meteorite were slim. Nevertheless the scientific importance of fresh meteorites in yielding clues about the formation and evolution of our solar system means that every possible event should be investigated.

It appears that there are no photographic observations of the fireball, and hence a synthesis of eyewitness accounts into some sort of consistent picture of the event was required. The first few days I contacted numerous air traffic control towers, weather offices, armed forces bases and police departments. Twelve reports scattered around much of New Brunswick were obtained in this fashion. Several days later I decided to go to the press, and requested the general public to forward their reports. Soon the number of independent reports had grown to almost 40, representing about 100 individuals altogether. I now have reports from the Gaspé region in the north to Grand Manan Island in the south, and Fort Fairfield , Maine in the west to Moncton in the east. While visual reports of such a fleeting phenomenon are always subject to error, a fairly consistent picture of the event can be pieced together from many such reports. It appears that the object started over the south eastern part of New Brunswick and traveled in a mainly north path, with possibly some very slight westerly component. The inclination of the entry, an important criterion for determining meteorite survival during atmospheric flight, is more difficult to estimate. It would appear to be somewhere around 45 degrees. The speed is impossible to estimate with any degree of confidence, but several of the 40 observers were very familiar with faint meteors and placed the speed of the fireball as comparable to the slowest meteors which they had ever seen. Hence the entry speed was probably somewhere between 11 and 20 km/s. The height when significant luminosity began was probably 80 km or so, and the bright part of the visual trail may have ended somewhere around 30 km.

The accounts of the appearance of the fireball are remarkably consistent. Almost all reports described the main luminosity as a predominant white ball with a slight orange hue. Estimates of brightness are difficult, but almost all observers felt that it was significantly brighter than the full moon. One observer in Fredericton was an experienced photographer who was able to provide a fairly accurate color temperature for the fireball, and a brightness estimate in terms of highway lights. From his observation I estimate the peak brightness at -17 magnitude apparent brightness, although -13 or -14 might be a more realistic value. Most observers reported a tail stretching a short distance behind the main body with an extension of two or three times the width of the brightest part. Many observers reported a continuous display of "sparks" behind the object - in actual fact these would be fragments separated from the main object during flight which are then differentially decelerated and ablate separately. Some reported a darker region in the center of the fireball. Observers with a low view to the horizon reported an intense flare at the end of the trail (many felt that this was associated with the object hitting the ground, but almost certainly it was still a considerable distance above the ground when it fragmented into many small pieces).

While this terminal flare means that a single large (more easily recovered) meteorite is unlikely, it does give a single consistent point on the trail which can be used when trying to pinpoint the fall position by combining reports from observers at different locations. Hence from early in my investigation I placed most emphasis on obtaining a precise bearing to this terminal flare from each observer. For example the large number of observers from around Moncton report that the flare was almost due north of them, while observers in the Saint John area reported a bearing slightly east of north, and an almost north easterly bearing was found by those observing the report from north western New Brunswick. Combining may such reports I now believe that the meteorite would have fallen (if indeed it survived to reach the ground) somewhere on the eastern tip of the Gaspé peninsula in Québec. It is now clear that it did not fall in New Brunswick, as an observer in New Carlisle, Québec reports the fireball ending to the north of her. I am still hoping to obtain more Québec reports in order to narrow the potential fall site. Unfortunately the region is relatively unpopulated and tree covered, and I realistically feel that the chance of recovering a meteorite is quite low. Nor does the uncertainty in the fall site preclude a fall into the ocean.

It is almost impossible to provide a meaningful estimate of the mass of the fragments, if any, on the ground. It might be helpful to make comparisons with other recent fireballs. The Grande Prairie fireball of 1984 (see R.A.S.C. Journal, 1985, 79, 197) had a peak absolute (i.e. at a distance of 100 km) magnitude of -15. This object (which had an initial speed of 26 km/s) is calculated to have had an initial mass of over 500 kg, but at most 12 kg at the end of a terminal flare. No meteorite fragments have been recovered. The Innisfree meteorite which fell in Alberta in 1977 had an initial speed of 15 km/s and reached a maximum luminosity of about -12 magnitude. Six stones totalling 3.8 kg have been recovered. Some readers may recall the Newfoundland fireball of Jan. 19, 1986 which was widely reported in the regional and national press. This object was probably comparable in brightness to the Grande Prairie fireball, and an air search was conducted but no meteorite was recovered.

The National Research Council Associate Committee on Meteorites provides a national network of professionals interested in meteorites who can investigate local reports. The current maritime representatives on this committee are:

Roy Bishop	Bob Hawkes
Physics Department	Physics Department
Acadia University	Mount Allison University
Wolfville, N.S.	Sackville, N.B.
B0P 1X0	E0A 3C0

We would ask that reports of very bright fireballs and possible meteorite finds be directed to us for investigation. In particular I would appreciate receiving any additional observations of the April 17 fireball. Ω

Astro Ads

NOVA EAST '88

Patrick Kelly

Once again, the Halifax Centre of the R.A.S.C. and the Saint John Astronomy Club will be jointly hosting NOVA EAST. You will find a map of how to get there and a rough map of the park following this article. More detailed maps of the park are available at the information centre which is just over the bridge from the town of Alma.

There are two kinds of accommodations available. For those who prefer camping, we have a large site in the Micmac Group Campground. There will be enough room to accommodate all who wish to come. For those who prefer to be a bit more civilized, there are two inns in the park. One is **Fundy Park Chalets** which has 29 housekeeping units. It features a licensed dining room and lounge, coffee shop, shower, B&W TV and heated pool. Rates are from $30 - $45 per night (1987 prices) Phone: (506) 887-2808 or (506) 433-2084. The other is **Caledonia Highlands Inn and Chalets** which has 44 units,showers and color TV. Rates are $45 - $47.50 (1987 prices). Phone: (506) 887-2930.

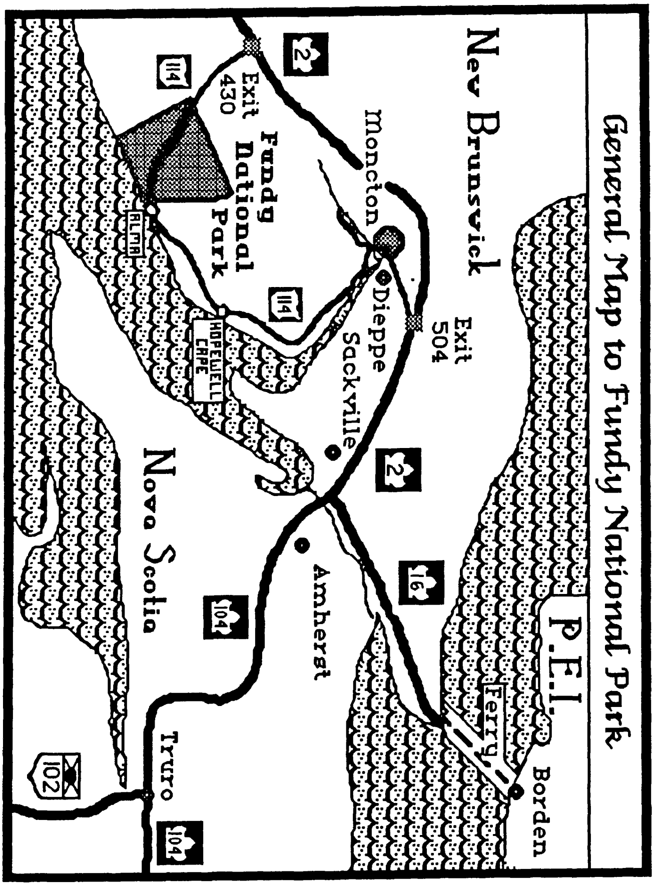
We have had quite a bit of publicity this year (you may have seen this event listed in both **Sky & Telescope** and **Astronomy** magazines), so we are expecting a good turnout. In addition, the park will be publicizing the public star shows and talks this year, so we hope to have even more people showing up for all of the events.

Tentative Schedule of Events

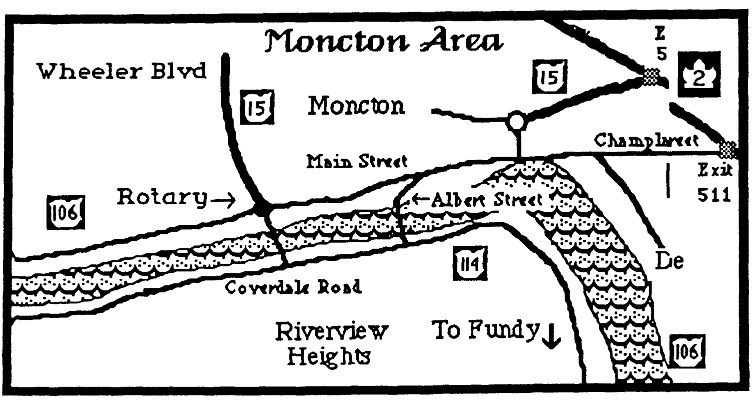
Date	Time	Event	Place
Friday August 12	All day	Arrival and setup	Various places
	23:00-24:00	Public viewing	Swimming pool parking lot
Saturday August 13	16:00-17:00	Astronomy seminar (no public)	Assembly hall stage
	18:30-20:30	Public presentations	Assembly hall
	22:00-24:00	Public viewing	Swimming poll parking lot
Sunday August 14	16:00-17:00	Astronomy seminar (no public)	Assembly hall stage
	18:30-20:30	Public presentations	Assembly hall
	22:00-24:00	Public viewing	Swimming poll parking lot
Monday August 15	All day	Farewells and departures	

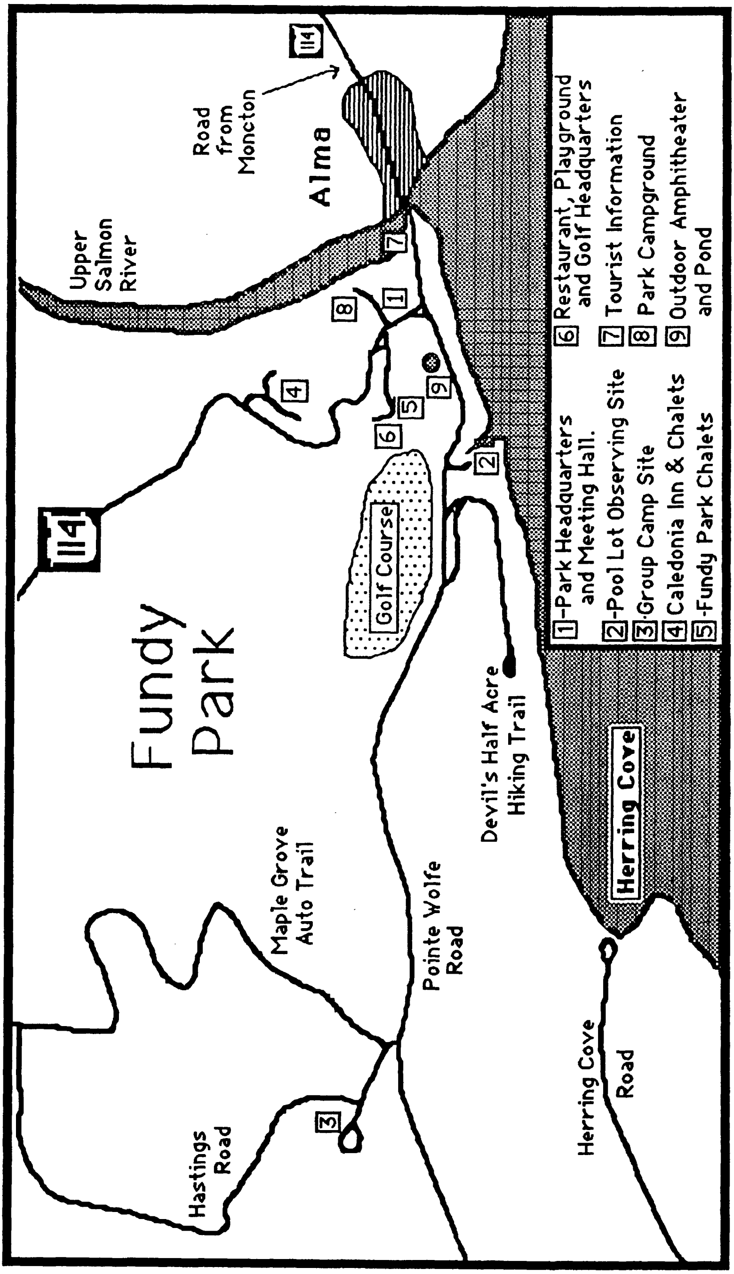
A finalized schedule will be available at the park. We look forward to seeing you there!!Ω

Maps of Fundy Park



This is not a map!




Fundy Park
Road from Moncton
114
Alma
Upper Salmon River
Golf Course
114
Maple Grove Auto Trail
Pointe Wolfe Road
Devil's Half Acre Hiking Trail
Hastings Road
Herring Cove
Herring Cove Road
1-Park Headquarters and Meeting Hall.
2-Pool Lot Observing Site
3·Group Camp Site
4 Caledonia Inn & Chalets
5-Fundy Park Chalets
6 Restaurant, Playground and Golf Headquarters
7 Tourist Information
8 Park Campground
9 Outdoor Amphitheater and Pond

The Pioneer Plaque

Pat Kelly

As I promised in the last issue, here is an explanation of the Pioneer plaque which appeared on the cover of that issue. When it was realized that the Pioneer 10 and 11 spacecraft would escape from the solar system, it was decided to put a message on these probes in the event that it was found by an alien civilization. Hopefully they should have no trouble deciphering the message contained on the plaque. Why not try deciphering it for yourself before reading on. After all, if a human has problems, image an alien trying to decipher it!

In the upper left hand corner is a diagram of a hydrogen atom. Note the little dots on the end of the "proton" and "electron". The left atom has them pointing in opposite directions, while the right atom has them aligned. This is the spin transition that neutral hydrogen undergoes which produces the famous 21 cm line. The "1" below the line connecting the atoms shows that the units used on the plaque are based on this transition.

Across the bottom is a schematic diagram of our solar system showing the path of Pioneer leaving Earth, passing Jupiter and continuing on into deep space. The numbers under each of the planets give its relative distance from the Sun with the Earth-Sun distance given as 100. This may indicate that we use base 10.

On the right we have a sketch of two humans. Their sizes can be inferred from the outline of Pioneer in the background and from the number to the right giving the height of the female, in this case 168 cm. (1000 in binary = 8 and 8*21 cm = 168 cm). The facial features are a combination representing most of the races of humans. The man's arm is raised in what is hoped will be a gesture of peace and friendship. It also shows our finger and thumb arrangement. It was decided not to show the woman in the same position so that the aliens would not think that all humans have their right arm locked in that position!

The star burst on the left is a galactic map radiating from the center of our galaxy. The position of the sun is shown by the tick at the end of the line passing behind the human forms. The other lines indicate the directions to different pulsars as viewed from the north galactic pole, with the tick marks indicating their distance from the galactic core. The numbers give the periods of the pulsars. Since the periods of pulsars slow down at easily determined rate. This map can be used to not only determine where the Sun is, but the time at which Pioneer was launched.

Now that you know the story behind the plaque, it should all be simple in retrospect. An interesting intellectual exercise is trying to invent your own plaque! What would you put on it to tell potential aliens about the human race? Ω

Spectroscopy with a Wire Diffraction Grating

Dan Falk

INTRODUCTION

Last year I took a course in experimental physics at Dalhousie University, as required for my degree program. In the second term the professor, Dr. R.A. Dunlap, allowed us to devise our own experiments. Being interested in astronomy, I decided to try a physics experiment that had astronomical applications. I remembered a talk at an R.A.S.C. meeting several years ago in which it was suggested that stellar spectra could be observed by placing a "home-made" diffraction grating over the objective of the telescope. As far as I could tell, though, no one in this area had successfully carried out the project, so I decided to give it a try. Here I am presenting the details of the experiment, still essentially in the format of a lab report.

In this experiment, the spectra of some remote light sources were observed using the Physics Department's 3-inch Questar telescope and an objective-mounted diffraction grating. The grating was made from a series of closely spaced, thin parallel wires. The purpose of this experiment, in addition to providing an introduction to spectroscopic techniques (and an opportunity to spend some long, cold nights on the roof of the Dunn Building), was to determine if this method was suitable for the observation of stellar spectra.

THEORY

The basic geometry of the diffraction grating is shown in Fig. 1. If plane waves of light (i.e. light from a distant source) are incident normally on the grating, the diffraction maxima will occur at angles θ given by

$$n\lambda = d \sin(\theta) \qquad (1)$$

where n is the order of the diffraction, λ is the wavelength of the light and d is the distance between the wires in the grating. A derivation of equation (1) can be found in any elementary text, eg. Tipler [1].

If the wires are too far apart (d too large), spectra will spread out so little that no detail will be visible. On the other hand, if d is too small, spectra will be spread out so much that it will be impossible to observe a light source and its first order spectrum at the same time within the telescope's field of view. (The telescope has a field of view of about one degree, or 1/2 degree using the built-in Barlow lens, which doubles the magnification.) In practice, this second condition is not a problem, as it would be very difficult to place the wires so close together. A desirable compromise is to have the wires as close together as is possible to easily construct, giving $d \approx 1/2$ mm.

The resolving power of the grating, which relates the wavelength of light to the smallest resolvable wavelength difference, is given by:

$$\frac{\lambda}{|\Delta\lambda|} = n\,N \qquad (2)$$

where N is the total number of wires that cross the light-collecting area (i.e. that cross the aperture of the telescope)

EXPERIMENTAL METHODS

1. Making the Grating

To create an array of closely spaced, parallel wires, a special frame had to be constructed. This consisted of two parallel, treaded brass rods, each 15 cm long, held in place by two aluminum bars and secured as shown in Fig. 2

The array of wires was made by tightly wrapping a fine copper wire around the threads in the rod and soldering it in place. As an added precaution against the wire becoming loose, epoxy (resin and hardener) was applied along the top and bottom edges of the rods (see Fig. 2). After the epoxy was completely dry, half of the wires were cut away, leaving a single plane of parallel wires.

The rods were threaded with a density of 48 per inch, giving d= 1/48 inch = 0.053 cm, which fits in well with the preceding discussion. The first order diffraction angle for violet light (λ = 4000Å) would be (using the small angle approximation)

$$\begin{aligned}\theta \approx \sin(\theta) = n\lambda/d &= (1)\,(4\times 10^{-5}\text{ cm}) / (0.053\text{ cm})\\ &= 7.4\times10^{-4}\text{ rad}\\ &= 0.043^\circ\ (=2.5\text{ min. of arc})\end{aligned}$$

which is very easily resolved with the telescope. (the telescope itself can resolve angles as small as 1 sec. of arc) For second order red light (λ=7000Å) we have

$$\begin{aligned}\theta \approx &= (2)\,(7\times 10^{-5}\text{ cm}) / (0.053\text{ cm})\\ &= 2.6\times10^{-3}\text{ rad}\\ &= 0.015^\circ\ (=8.7\text{ min. of arc})\end{aligned}$$

which shows that, with the light source at the center of the field, two complete orders of spectra will fit in the filed of view on either side (when using the Barlow lens). At a lower magnification, of course, more orderswould fit in. If, for some application, one wanted to observe, say, the tenth order spectrum of a light source, this could be accomplished by pointing the telescope in the appropriate direction (providing the source is bright enough), but the 0th order image of the object could not be observed at the same time.

Clearly, larger values of θ (i.e. a smaller value of d) would be desirable, but with much more than 48 per inch, the grooves would be hard to see, let alone wrap the wires around.

The wire that was used had a diameter of 0.017 cm, as measured with a micrometer. Thus the distance, a , from the edge of one wire to the near edge of the next wire is

$$a = 0.053 \text{ cm} - 0.017 \text{ cm} = 0.036 \text{ cm}.$$

It is not immediately obvious what the optimum relationship between a and d is. It was shown by Vaughan [2] that $a/d \approx 0.45$ was best for his unblazed Mylar polyester amplitude gratings for use over the objective of a Schmidt telescope. However, with wires it is easier to ensure that each one is secure in the center of each groove if a is somewhat smaller relative to d (hence the diameter of the wire used). For the values of a and d used here, we have

$$a/d = 0.036 \text{ cm} / 0.053 \text{ cm} = 0.70.$$

The ratio a/d is also, by definition, the average transmittance of the grating.

Although care was taken to ensure that the wires were as straight and parallel as possible, the grating could not be made perfectly uniform. The distortions that result from an imperfect grating are discussed in detail by Kneubuhl [3]; it is shown that the resolving power of a grating will generally not be greatly reduced even if grooves (wires in this case) are shifted from their proper positions by as much as d/4n, although ghost images may be a problem.

2. Mounting the grating

A cardboard housing was made to hold the grating over the objective of the telescope, as shown in Fig. 3.

It should be noted that the grating was positioned with the wires running horizontally for a reason. In this orientation, with the telescope equatorially mounted for astrophotography, any spectra will be spread out in the north-south direction. Thus any dark lines in the spectra will run east-west, which is the direction of the motion of the stars (as the Earth turns on its axis). When a time exposure of the spectra is made, then, any dark lines can be "stretched out" (making them more visible) by simply turning off the telescope's clock drive. If the grating was oriented the other way (i.e. with the wires running north-south), this could not be done. (Note: such photographs were made, but are not included here. Instead, sketches from observations thought the telescope are presented.)

3. Observing distant light sources

The first sources observed were gas discharge lamps (Leybold Co.), controlled by an adjustable power supply. To observe the spectrum of one of the lamps, it is placed at one end of the hallway (~50 m long) in the Dunn Building. A slit (width ~ 1/4 mm) was placed immediately in front of the lamp. At the opposite end of the hall, the telescope (with the grating) was set up to view the lamp. The observations were carried out at night with most of the lights in the area turned off, but absolute darkness was not essential. In addition to the discharge lamps, an incandescent tungsten bulb was also observed.

4. Observing stellar spectra

To observe the spectra of stars, the telescope was mounted equatorially on its tripod on the roof of the Dunn building. The stars observed were selected so as to cover a variety of different spectral classes. A discussion of the theory of stellar spectra can be found in astronomy texts such as Kaufmann [4] or Norton [5]. Pasachoff [6] lists the brightest stars of each spectral class and Bishop [7] gives the exact spectral type of several hundred other bright stars. A good star atlas such as Norton's can be useful in locating particular stars.

RESULTS AND DISCUSSION

1. Sodium (Na)

Fig. 4 shows the observed spectrum, a single, bright yellow-orange line, repeated out to several orders on either side of the central 0th order image.The higher order lines were progressing dimmer, as expected. The line corresponds to the extremely close pair (5890Å and 5896Å) listed in the literature, eg. Brode [8].

2. Cadmium (Cd)

As shown in Fig. 5, a pair of close blue lines, a bright green line and a fairly bright red line were visible. Again, the literature values of the wavelengths that these lines correspond with are given in the figure.

The blue lines are a good test of the resolution of the grating (recall equation (2)). Since the aperture of the telescope is 3.5 inches, N is simply 3.5 times the number of wires per inch:

$$N = 3.5 \times 48 = 168.$$

For the first order lines (n=1) the resolving power of the grating is simply 168.

Now for the blue lines in cadmium, the wavelengths are 4678Å and 4800Å, so

$$\frac{\lambda}{|\Delta\lambda|} = 4700\text{Å} / (4800\text{Å} - 4678\text{Å}) = 39.$$

Since this is less than 168, we expect the two lines to be resolved, as indeed they were. (The 4700Å is an average value of λ over the range.)

3. Mercury (Hg)

Fig. 6 shows the observed spectrum: bright orange and green lines and a somewhat fainter deep blue (almost violet) line. The literature [8] shows that the orange line is actually three lines very close together, at 5769.6Å, 5789.7Å and 5790.6Å.

Using equation (2) for the yellow lines, we have:

$$\frac{\lambda}{|\Delta\lambda|} = 5780\text{Å} / (5791\text{Å} - 5770\text{Å}) = 275,$$

which is greater than 168, and so we expect the three lines to appear as one, as they did. A similar calculation for sodium shows that a resolving power of almost 1000 would be needed to resolve its close yellow-orange lines.

4. Potassium (K)

As shown in Fig. 7, a blue-green line and an orange-red line were visible. These did not seem to correspond to any of the major lines listed in [8]; they may be two of the fainter lines listed by west [9] (a more complete list), with the wavelengths indicated in the figure. Another possibility is that impurities may have been present in the potassium.

5. Incandescent Lamp

As expected, the tungsten lamp displayed a continuous spectrum, as shown in Fig. 8

Equation (1) can be applied to estimate the wavelength of, for example, the bright line in sodium (although one can tell from its color that it is close to 5900Å. Rearranging (1), and using n=1 for the first order spectrum, we have

$$\lambda = d \sin(\theta). \qquad (3)$$

Now sin(θ) is also equal to the apparent displacement of the line divided by the distance between the lamp and the telescope. Here, the measured values give

$$\sin(\theta) = 5.9 \text{ cm} / 5290 \text{ cm} = 1.1 \times 10^{-3}$$

and so (using (3)),

$$\lambda = (0.053 \text{ cm}) \times (1.1 \times 10^{-3}) = 5.9 \times 10^{-5} \text{ cm} = 5900\text{Å}$$

This agrees well with the literature [8] value of 5893Å (taking an average of the two components of the pair.

6. Stars

Unfortunately, all of the stars observed showed only a continuous spectrum — no dark lines were visible. Fig. 9 shows the observed spectrum of Sirius, a bright type A star which one would expect to show prominent hydrogen (Balmer series) absorption lines. In fact, these lines show up quite well in a photo in reference [2] and also in one by Sinnott [10] (although the latter used an objective prism, not a diffraction grating).

CONCLUSION

The objective-mounted diffraction grating worked quite well for observing the bright-line spectra of distant sources such as discharge lamps. It does not seem well suited, though, to the observation of continuous spectra with dark lines, such as those of stars. This is presumably a result of the limited resolution; it is also generally more difficult to observe dark lines against a light background than vice-versa.It may be possible to improve the results in the following ways:

1. A larger telescope (with a larger grating) could be used.
2. The grating could be made more uniform.
3. The grating could be replaced by an objective prism – although a prism big enough to cover the aperture of a large telescope is not readily available in most labs, and would be very expensive to buy.

Although I would not say the experiment was an overwhelming success, it was certainly not a failure. The experience of constructing and using one's own diffraction grating is unique. Perhaps the next person to try it will resolve stellar absorption lines!

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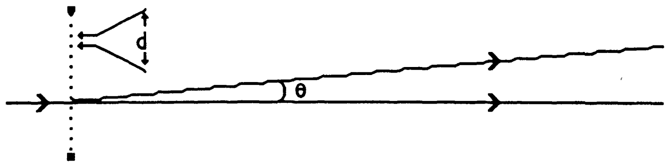

Fig 1) Diffraction from a grating

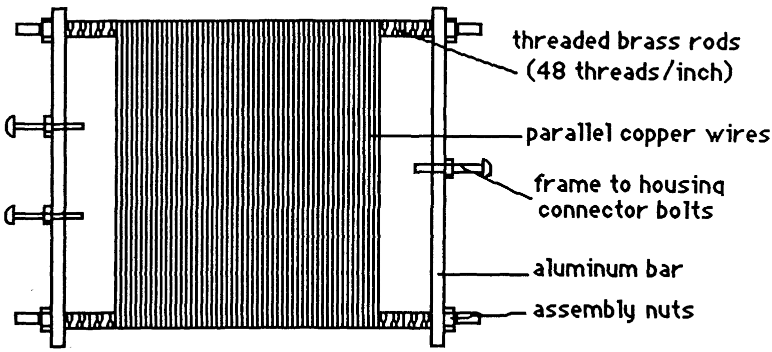

Fig.2) The grating and supporting frame

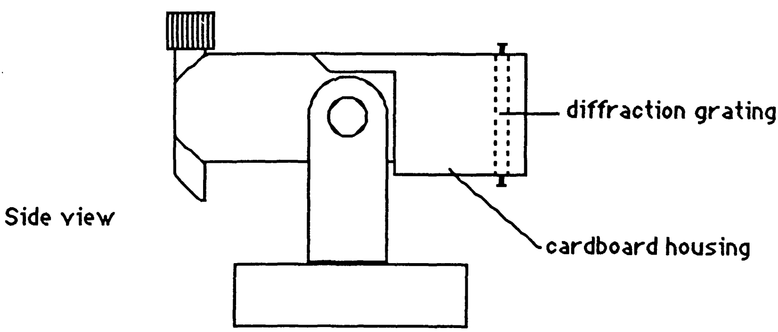

Fig. 3) The grating in its cardboard housing, mounted on the Dal. Physics Department's Questar telescope.

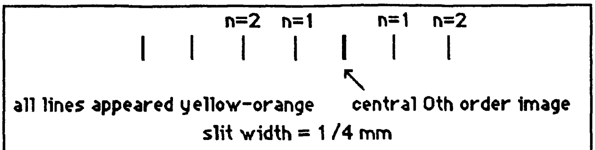

Fig. 4 Sodium

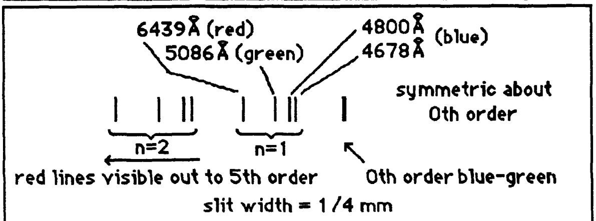

Fig. 5 Cadmium

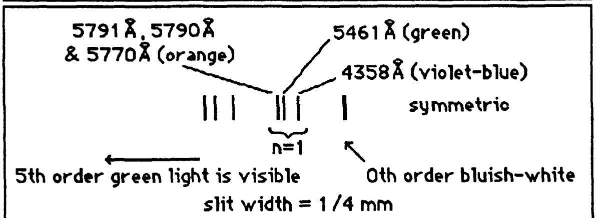

Fig. 6 Mercury

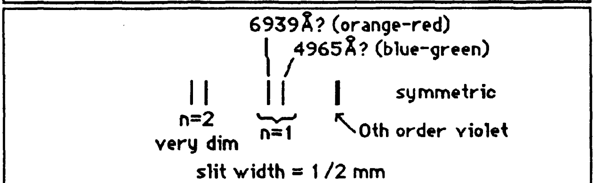

Fig. 7 Potassium

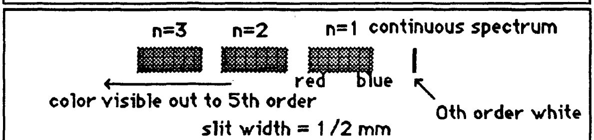

Fig. 8 Incandescent Lamp

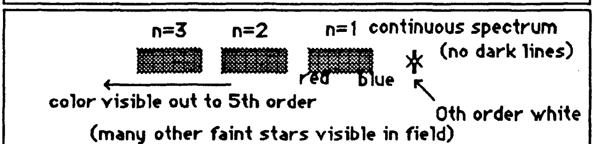

Fig. 9 Sirius

NOVA NOTES INDEX

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HALIFAX CENTRE - R. A. S. C.
1988 CALENDAR OF EVENTS

July 1988

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
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24	25	26	27	**28**	29	30
31						

August 1988

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

September 1988

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
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18	19	20	21	**22**	23	24
25	26	27	28	29	30	

October 1988

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Key to calendar:

Regular Meetings: shadowed and outlined
Beginner's Meetings: double underlined
Special days: **bold**
Possible observing sessions: underlined

Special Days:

July 19 - Venus at maximum brightness in morning (-4.5)
July 28 - South δ Aquarid meteors
August 11- Perseid Meteors
August 12-15 - NOVA EAST 88
September 11 - Another Solar Eclipse we won't see !!!!
September 22 - Autumnal Equinox
October 21 - Orionid Meteors

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