NATIONAL NEWSLETTER

June 1976

Comet West as it appeared on March 12th, 1976, at 04.40 E.S.T. Photograph by Robert Dick of the Ottawa Centre. Taken at North Mountain Observatory, Ottawa, with 400 mm. telephoto lens, at f/18, 5 minute exposure on Tri-X film. Mr. Dick calculated the position of Comet West as R.A. $21^h\ 21^m.3$; Dec. + 9° 22′.5.

NATIONAL NEWSLETTER
June 1976

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Public Interest in Astronomy is High, Winnipeg Planetarium Finds

By Frank Shinn

Editor's Note: This article is the second of a series describing the activities of Canadian planetaria. Its author, Mr. Frank Shinn, is Director of the Manitoba Museum of Man and Nature Planetarium and a long-standing member of the Winnipeg Centre of the Society. Mr. Shinn received the Society's Service Award in 1972.

Several times throughout 1975 the staff of Winnipeg's Planetarium announced that telescopes would be set up in various parks about the city for people who don't own their own instruments to have a look at some of the things that interest astronomers, whether they are professional or amateur.

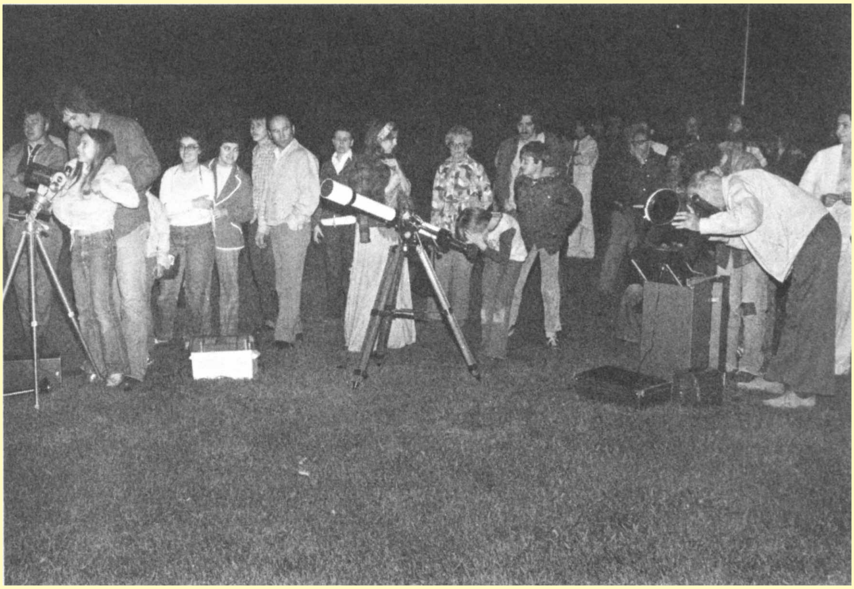
"I was prepared to let you go ahead, but I didn't think you would get many people out," said Dave Hemphill, Director of the Museum, when I reported to him that we had over 500 people waiting in line for a brief glimpse of things the first time we tried it. That was for the last May 24–25, when we had a total eclipse of the moon. The night was fine, the sky was clear, and the moon well placed from our viewing site.

Encouraged by this result, we announced about two weeks later that we would set up telescopes for people to view Saturn and Venus. This we announced for a Friday, and as our former site could not see into the western sky, we announced a site northeast of the city where a man-made hill gave us a chance to see to the horizon. In Manitoba if you want a hill it has to be man-made, and the one in question is the result of construction of the Winnipeg floodway, a ditch diverting excess Red River water around the city in the springtime. It involved people driving out highway 59 until they found the floodway bridge, then turning off on a short sideroad known as Oasis Road. The hill is now known as Springhill.

The evening was about 80% clouded. I had doubts, but feeling that not-to-show if there were any public there would be poor P.R., I loaded up my telescope and started out.

On arriving at the turnoff point I found 150 people waiting for something to happen, and more arriving every minute, cars lined bumper-to-bumper along the muddy edge of the road (not to class it as a shoulder), – and a Hot Dog Vendor!

I set up the telescope, and we had a few brief glimpses before the clouds closed over the holes there had been. I told folk that I'd come back the next night if it was clear. It was, and I went out on the Saturday. There were about 200 people there. Roger Woloshyn of my staff turned up with our Questar, and Roy Belfield and Phyllis arrived with their 8-inch Celestron. Things were not ideal, but we had no complaints. The Hot Dog Vendor did not reappear.



Winnipegers look through telescopes provided by the Manitoba Museum of Man and Nature Planetarium. Photo by Jim Walker, courtesy of the *Winnipeg Tribune*.

Came the fall, and I was deep in a reworking of the annual *Star of Bethlehem* presentation for the Planetarium. As I worked at it I came to realize that the three protagonists in the most widely used account of the event – Jupiter, Saturn and Mars – were all in our evening skies. So I announced we would set up telescopes in Bonnycastle Park to see these three planets. Members of the Winnipeg Centre kindly offered to cooperate and set up telescopes at another site west of the city so as to provide convenient sites for those curious enough to turn out. We announced it for a Sunday night. It was 100% socked in.

I decided to drive down anyway in case anyone turned out. On the way I tuned in the car radio just in time to hear the enthusiastic voice of the announcer urging people to turn out and see the Star of Bethlehem through the Planetarium's telescope, right through the clouds! I dashed into the office and phoned the station, announcing that we'd postponed the viewing to Tuesday evening. It had to be Tuesday as we had a Staff and Media Show scheduled for the Monday.

Tuesday was cloudy also. I postponed to Thursday.

Thursday was clear – and minus 31° Celsius. I set up my Maksutov, and Bill Webster, who by then had become our Assistant Planetarium Director arrived with a Tasco 3-inch which a local camera shop presented to us. Bill has worked with professional instruments in observatories, such as the 48-inch at London, Ontario, but the mysteries of small portable instruments were new to him. After a few minutes he asked me if I could find Jupiter for him, as he couldn't see anything through the telescope. So he minded the Maksutov while I tried to find out how far out of line the finder of the three-inch was after the usual transportation jolting. I couldn't find it either. I couldn't find anything else – until I took the cover off the front objective!

Roger turned up with the Questar. We had lines of people twenty-five or thirty deep at each instrument. Images were shivering, and I was shivering more. Still the people came.

We began the evening at 7:30 p.m. It took Saturn until about 9:15 to become high enough to be seen. At 10:00 p.m. Roger and Bill ganged up on me and packed me back in my car and headed me for home. Roy and Phyllis had come straight from work about 9:00 with their instruments. Other members of the Winnipeg Centre had set up instruments at Woodhaven Park, and they reported perhaps 150 people at that site, despite the cold. The *Winnipeg Free Press* summed it up in a four-column headline:

Chilly Night Gives Fine Planet Sight

About the only disappointment expressed was that some people were sure the Planetarium was staging a re-enactment of a conjunction that occurred some 1900 years ago, and that possibly another miracle was anticipated, or at least might occur.

Come to think of it, there was one: I only froze the tips of three fingers. I guess the exercise of shivering kept the rest of me thawed out.

Anyway, people are interested in looking through telescopes. We've proved that in Winnipeg, and we're planning to do more of it. I've just sent off a Press Release for viewing of Saturn and the Moon this Thursday. It'll be cloudy!

The Many Merits of Modest Magnification

By Dr Roy L. Bishop

"How much does it magnify?" This ubiquitous question not only reveals the limited knowledge of the speaker, but also serves to demonstrate the extent to which mass advertising has misled the public. I wonder how many more children would be turned on to astronomy if their first looks were through a modest, large aperture, low power telescope, instead of through one of the standard, small aperture, high power, wobbly, $99 wonders from the local department store.

The range of useful magnification for an astronomical telescope extends from about 0.2× to 2× per millimeter of objective diameter (or 5× to 50× per inch of objective for those who also still think in Fahrenheit). As an example, for a 60 mm telescope the useful magnification extends from about 12× to 120× (and not to 450× as the mail order catalogues would have us believe). Beyond 2X/mm, all that is revealed is the fuzziness inherent in the wave nature of light.

The reciprocals of 0.2×/mm and 2×/mm give the range of diameter (5 mm to 0.5 mm) of the exit pupil, the small, round bundle of light located at the observer's eye. "Modest magnification" might be defined as from about 0.2×/mm to 0.5×/mm (exit pupil diameter 5 mm to 2 mm). The first figure is approximately where richest field telescopes (RFT's) operate.

I first came across the RFT concept back in 1960 while browsing through a large paperback entitled *Amateur Astronomy Handbook*, A Fawcett How-To Book, #454. It contained fascinating statements such as: "It can visually define the galactic reaches of space more brilliantly than any other small instrument. In fact, it outperforms the giant telescopes in the definition of the richness of star fields." These thoughts struck deep and helped to fire an interest in the wonders of optics.

According to volume 2 of the classic *Amateur Telescope Making* books (Scientific American), the RFT concept was first emphasized by S. L. Walkden of London, England around 1916. On page 638 Walkden himself states:

> It has long appeared to me that amateur astronomy is too much obsessed with the idea that a telescope is to be valued as a powerful magnifying instrument, with light-grasp as a secondary necessity. But for the chief pleasures in the contemplation of the sidereal heavens, the telescope needs considering primarily as a light-gathering instrument, with magnifying power as the secondary necessity only so far as without some, the light grasp cannot be made available. If we knew a way of increasing light-grasp without any magnification at all, we should obtain most magnificent impressions of the night sky — such as possibly the owls tend to have — but, unfortunately, present optics can tell of no way of having that. Photography, with its cumulative

> effect, is some solution to the problem, but, except in its wealth of detail, a photograph is a poor substitute for the life and sparkle of the visual impression. (The RFT) is the next best thing. (An RFT will show objects such as the Andromeda galaxy and the America Nebula) not dead, though, but come to life, so that, indeed, the solemn thinking and realizing observer can sometimes almost want to be left alone with what he sees.

Walkden's comments serve to illuminate an interesting fact: namely, nearly all of the Universe is best seen at low magnifications. It is only in our immediate backyard, for the Moon and the planets, that high magnifications are really desirable (with modest apologies to double star and planetary nebulae fans). Low powers (near 0.2×/mm) with their large, eye-filling exit pupils (about 5 mm), yield optimum illuminance of the retinal images of extended (non-star like) objects. With such powers the delicate, gossamer nebulosity of gas clouds and galaxies can best be seen. (The brilliance of stars is independent of magnification, except below 0.2×/mm where all the light is unable to enter the eye since the exit pupil is larger than the eye pupil, and above 2×/mm where diffraction noticeably broadens their images.)

I suspect that some readers probably think that the lower limit of 0.2×/mm is not quite right. Would not a better figure be 0.14×/mm corresponding to a 7 mm exit pupil? After all, what about 7×50 binoculars? Let me make four comments on this. Firstly, 0.2×/mm is only an approximation. It is not a fixed, magic number. Secondly, as one grows older the eye pupil cannot open quite as wide as it used to. Thirdly, aberrations associated with the peripheral portions of the cornea and lens of the eye tend to offset the advantage of a 7 mm exit pupil. And finally, a 5 mm exit pupil lowers the background skylight a bit to produce views that are, to me at least, aesthetically more pleasing.

In addition to giving the best views of gas clouds and galaxies, modest magnifications have many other merits (and here we have one of those rare instances where several good features are not mutually exclusive!). For completeness I shall begin the list with the merit that lies behind the RFT concept:

1. The *brightness (luminance) of extended objects* is near its optimum value. Reflection nebulae, gas clouds, and galaxies are thus best seen near 0.2×/mm.
2. *Field of view*. For a given telescope, the lowest magnifications (~0.2×/mm) yield the largest field of view, particularly if the low power eyepiece is of the "Erfle" type. A wide field has several advantages:
   (a) A bigger segment of the Universe is in view at any one instant.
   (b) The location of celestial objects is easier.
   (c) The need for a motor drive is minimized. In fact, an equatorial mount is not even essential. The neglected altazimuth mount can be very serviceable and convenient for a visual RFT.
   (d) There is a greater chance of seeing meteors and other unexpected sights (small star clusters, comets, RCMP, ...)
3. *Atmospheric turbulence* is seldom a problem at low magnifications. On dark, sparkly nights when higher magnifications are often useless, the RFT is ideal.
4. *Steadiness of the mount* is less critical. This is especially appreciated when touching the telescope to focus or aim it. Other sources of vibration such as wind and "friends" are less annoying also.
5. *Focusing* is less critical with a low power eyepiece.
6. *Eye relief* (the distance between the eyepiece and the eye) is greater and thus more comfortable.
7. *Imperfections* in the optics, including diffraction effects, are less noticeable at low magnifications.
8. *Motes* (small, strange spots and hair-like things) in the observer's eye are often bothersome at high magnifications; however, with an exit pupil as wide as 5 mm, the retinal shadows of this flotsam in the vitreous humor of the eye are much less noticeable.

By using binoculars, one can add to all of these merits both the light gain and the sense of depth and reality that attends the simultaneous use of both eyes. Some of the most heavenly views I have experienced have tumbled through the limpid lenses of 15×60 binoculars.

Reprinted from the Halifax Centre's newsletter *Nova Notes*

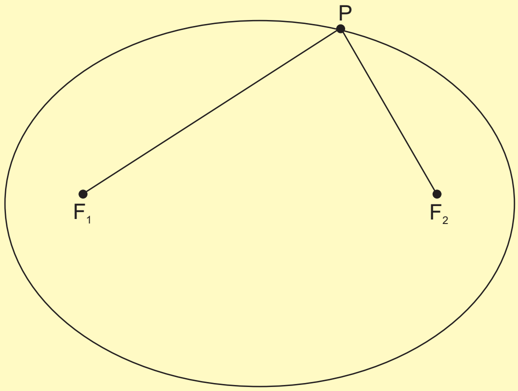
Is an Ellipse a Conic Section?

By Dr J. B. Tatum

In the *NATIONAL NEWSLETTER* of December 1975, W. Weller introduced us to several of the important properties of the conic sections. In my student days I was made to do all sorts of complicated calculations on ellipses, but one thing puzzled me for years: is an ellipse a conic section?

What do I mean by that? Well, I was told I could draw an ellipse by looping a loop of string around two pins stuck in the paper and pulling it taut with a pencil. The curve traced out would be an ellipse. This property gives us the following formal definition of an ellipse:

"An ellipse is the locus of a point P such that the sum of its distances from two fixed points F_1 and F_2, known as the foci of the ellipse, is constant." See figure 1.



(Other definitions are possible, but this one is related directly to an easy method of drawing an ellipse.)

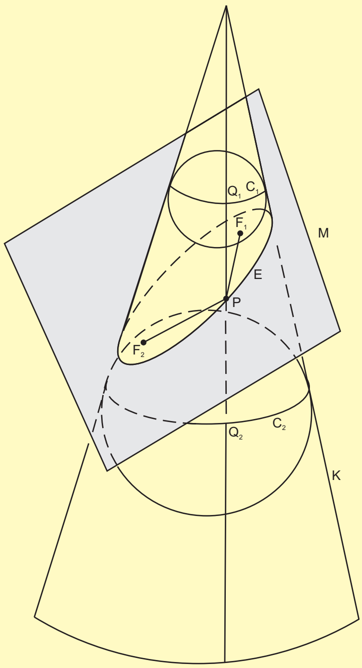
Now every elementary book also told me that a closed plane section of a cone was also an ellipse. But how was I to know that the two curves made by such quite different methods were one and the same?

Several years later someone showed me a most elegant proof. Remember in the old, old days when you had to do little problems in Euclidean geometry? Remember the style? – GIVEN. REQUIRED. CONSTRUCTION. PROOF. Q.E.D. (My teacher used to insist that Q.E.D. stood for Quod Erat Demonstrandum, but I'm sure every schoolchild knows that it really means Quite Easily Done.) Modern mathematics teachers frown on such "dull" stuff, but actually it was quite fun. Often the proof depended on some beautiful construction, and the following is an especially creative example. So here goes.

GIVEN: A cone K intersected by a plane M in a closed curve E. See figure 2.

REQUIRED: To prove E is an ellipse.

CONSTRUCTION: Construct two spheres, one above the plane M, the other below it, such that one touches the cone internally on a circle C_1 and the plane at a point F_1, and the other touches the cone internally on a circle C_2 and the plane at a point F_2.



PROOF: Let P be a point on E, and Q_1 and Q_2 be points on C_1 and C_2 such that Q_1PQ_2 is a generator of the cone.

$PF_1 = PQ_1$ (Tangents to a sphere)

$PF_2 = PQ_2$ (Tangents to a sphere)

$PF_1 + PF_2 = PQ_1 + PQ_2 = Q_1Q_2 =$ constant

E is an ellipse, and F_1 and F_2 are its foci.

Q.E.D.

This very imaginative construction and elegant proof was thought of by a nineteenth century Belgian engineer Germinal Dandelin and it does not seem to be as well known as it deserves to be. Readers might like to try adapting the proof to the parabolic and hyperbolic conic sections, and also to show that a plane section of a cylinder is an ellipse. Also, the planes containing the circles C_1 and C_2 intersect the plane M in two straight lines, and it is easy to show that these lines are the directrices of the ellipse.

Victoria Centre

Information Packet

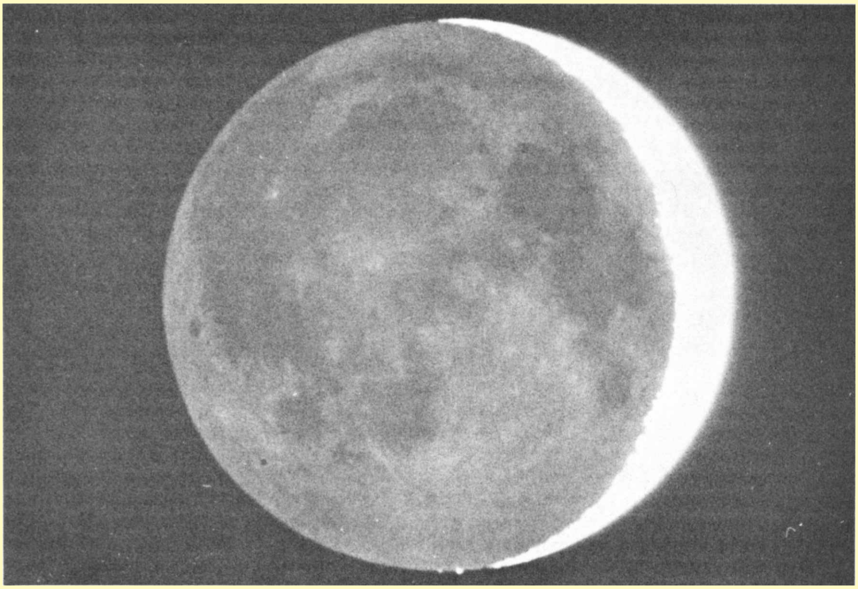
A packet of materials designed to help local astronomy clubs and planetaria publicize astronomical events is available from the Astronomical League's Middle East Region.

The 1976 News Service Packet, expanded from last year, contains 11 pattern news releases, a suggested year-long publicity calendar, astronomy fact fillers for newspapers and publications and helpful ideas to increase the flow of accurate, timely astronomy information to the public.

Send a self-addressed mailing label and $1.00 to: R. Young, c/o MERAL News Service, 329 S. Front St., Harrisburg, Pa. 17104.

Astrophotos by Damien Lemay

The editors of this *NEWSLETTER* are pleased to publish this fine series of photographs, submitted by M. Damien Lemay of Rimouski, P.Q. We feel that it is important to present as many photographs as possible in these pages, since they cannot be reproduced in most centre newsletters. We welcome any pictures submitted for our consideration. (WTP)



Lune, lumière cendré (clair de terre)
13 mai 1975. Dynamax – 8, f/10 Plus – X, 1/15 sec.

Vesta et Pallas dans le Verseau
Cette photo peut être comparée à celle parue dans *S & T*, janvier 1976, p. 60. Les déplacements relatifs supposent environ 20 heures de difference entre ces deux photos.
13 mai 1975. Dynamax – 8, f/10 Plus – X, $^{1}/_{15}$ sec.

M 11 et environ, i.e. nuage d'étoiles dans I'ECU
La Nova ECU 1975 est contenu dans cette photo. Ref: *Sky & Telescope*, août 1975, p.94
11 juin 1975, 200 mm, f/3.5 Tri-X, 15 min.

Comet West
La météo a été très frustrante pour l'observation de cette comète. Mes efforts furent finalement récompensés le 8 mars au matin alors que je pouvais prendre ce photo. La transparence du ciel n'était pas excellente, mais l'éclat de la Comête West était plus que suffisant pour m'impressionner, de même que la pellicule de ma caméra. A la jumelle, c'était vraiment quelque chose à voir.
8 mars 1976 ~ 4.30 HNE 200 mm, f/3.5 Tri-X, 5 min.

Hydrogen Hypersensitization for Films

By Rick Salmon

After having received so many issues of *Astronotes* and reading about my friends back home, I figured it was time to contribute a bit for once. I thought you might be interested in a relatively new, fairly promising method of hypersensitizing photographic emulsions that might be fairly easy for amateurs to carry out, since it involves equipment any high-school science lab would have.

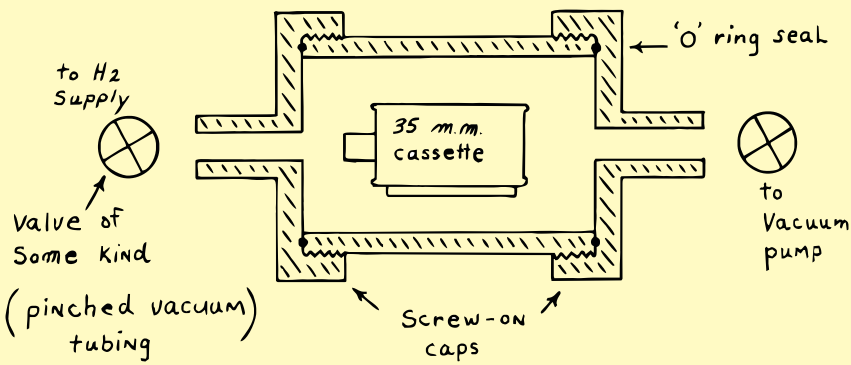
The process is called H_2 (hydrogen) hypersensitization and is a straightforward, 3-step process:

1) The emulsion is evacuated at room temperature for several hours.

2) Then the film is exposed to hydrogen gas at room temperature and room pressure for from two to eight hours.

3) The hydrogen is pumped out and replaced with some photographically-inert atmosphere for storage, or just flushed out with dry air if the film is to be used in the near future (within less than a day).

Sound complicated? It isn't! The whole process can be carried out on 35-mm film while it is still in its cassette, in a small chamber such as the one below:



The *first step* in the process is used to get water vapor and oxygen out of the emulsion. It seems that oxygen in the presence of water vapor causes reciprocity failure (loss of speed for faint sources), and that water vapor also promotes fogging of the emulsion in the H_2 atmosphere.

A Welch vacuum pump similar to those in most high school science labs should be more than adequate – let it pump for about 4 hours.

(If a pump is not available, baking the film, cassette and all, for an hour or two at 50° to 65°C should do the trick – or skipping this step altogether might even work.)

Step two is the real hypersensitization process. Hypering times are a matter of trial-and-error for various types of film. Why it does what it does is not completely understood, but it is closely related to "reduction sensitization" of the film, which is a standard process in the production of most emulsions.

Step three is just a means of stopping the hypering process, since film fog levels will start to increase if left too long. Only inert gas, N_2, CO_2, or other relatively non-reactive gas that is O_2 and H_2O free should do for flushing (*dry* air is probably sufficiently O_2 free for a starter).

H_2 deserves respect: treat it with caution, and you should have no problem. No flames, no sparks, no heating coils, and please – no smoking!

The process is fairly new – it works like gang-busters on some types of films and doesn't do a bit of good on others, especially IR-sensitive emulsions. It could work very well on color film.

If H_2 sounds too complicated, here's another one for black-and-white films. Preflash the film by exposing it (at some convenient shutter speed) to a faint, uniform field of illumination, and then, without changing frame, expose it again through the telescope.

(This only works if your exposures are not generally very dark due to general skylight illumination.) Preflash exposures *must* be “visible” on the film as a light (D = 0.15) to dark (D = 0.4) grey. If you preflash, and develop right away, and cannot see the preflash exposure, it is not going to gain you anything when you re-expose it at the telescope.

Reprinted from *Astronotes*, Ottawa Centre

Binoculars for Celestial Viewing

By Larry Coldwell

There is no monocular telescope which can reveal the same magnitude of beauty of a clear, star-filled night like a good pair of binoculars. They are an excellent tool for learning your way around the sky, as well as for more serious observing such as hunting comets and studying variable stars. Binoculars are very portable and offer the unsurpassed advantage of allowing the user to see spectacular fields of view with both eyes. Whether you are a beginner or an advanced amateur, many hours of pleasurable stargazing can be derived with virtually carefree maintenance and preparation.

Binoculars are basically a matched set of reduced-size refractor telescopes connected in precise alignment, enabling both eyes to see the same object at the same time. Both objective and ocular lenses are achromatic and between each optical path are matched prisms that serve a two-fold purpose. First, they erect the otherwise upside-down image produced by an astronomical telescope. Second, instead of just giving an upright view like the right angle star diagonal prisms supplied on small refractor telescopes, binocular prisms flip the mirrorlike image of a scene so that ‘right’ and ‘left’ in the binocular eyepiece corresponds to right and left in the scene you are viewing.

True prismatic binoculars should be distinguished from less costly and often optically inferior opera or field glasses. These consist of two simple telescopes mounted side by side and are often referred to as imitation binoculars. While both types give erect images for terrestrial use, opera glasses use negative eyepiece lenses to magnify the image produced by the objectives and give a very restricted field of view. Usually you can buy high quality prismatic binoculars for less than the cost of the smallest refractor telescope, making them an ideal first sky-watching instrument for the raw, beginning astronomy enthusiast. Their value does not stop there, however, because they are an indispensable accessory for the seasoned observer as well as maintaining their observational value even after the beginner graduates to his first telescope.

Specifications for binoculars are written as a sequence of numbers like 7×35. The first number and ‘×’ is magnification, while the second number gives the clear aperture in millimeters of the objective lens. Specifications of 6×30, 7×35, 7×50 and 10×50 are generally useful for stargazing; however most serious observers find 7×50s and 10×50s a good compromise between size, power and field of view. The larger aperture works best for low levels encountered in sky observing.

Virtually every celestial object can be enjoyably viewed with binoculars. Lunar surface features provide fine sights with higher power models, while eclipses of both sun and moon are best observed with such instruments. At 7 or 10 power, you can see the thin crescent of Venus and watch the satellites of Jupiter (though here, higher magnification is recommended). Also, you can track from night to night, against the sky background, the slow movement of all the planets (except Pluto) and the brighter asteroids. Frequent and beautiful twilight conjunctions of the moon and bright planets are often superb binocular sights. Rounding out the solar system are comets, some of which have been discovered with 10 × 50 binoculars.

When it comes to the realm of the stars, an almost limitless number of objects lie within the realm of binoculars, including bright variables and highly-coloured variables and highly-coloured stars, wide double and multiple stars, open and globular clusters, bright and dark nebulae, and even galaxies. Perhaps the grandest sight of all is the Milky Way: an incredible profusion of suns, seen in binoculars as in no other type of optical instrument. All of this and more awaits the binocular user!

Even though all celestial objects are technically at “infinity” and therefore too distant to show depth perspective, one of the surprises and delights of binocular viewing you will encounter is the breath-taking view of the moon seemingly suspended three dimensionally against the starry background. Although only illusionary, the effect is, nevertheless, real and dramatic.

Reprinted from *Nova Notes*, Halifax Centre

Astronomy Update

By Dr. D. P. Hube

There are now five known X-ray binaries in which the optical counterpart has been detected and in which regular pulses have been observed in the X-radiation. Each can be observed as the analogue of a double-lined spectroscopic binary and, hence, a lower limit to the mass of each component can be derived. Orbital motion produces a periodic Doppler displacement in the spectral lines of the optical component, and produces a periodic variation in the arrival times of the X-ray pulses. In the case of Vela X-l, eclipses of the X-ray source are observed as well as light variations in the optical component. These latter facts allow one to place limits on the orbital inclination and, thereby, permit an even more precise mass estimate. For Vela X-1, the X-ray and optical components have masses of 1.6 and 21.2 solar masses, respectively. The two objects are probably a neutron star and a normal supergiant. [Nature **259**, 547, 1976]

A rare but interesting feature of pulsars is the observation of "glitches" in the pulse train. These are thought to be due possibly to starquakes occurring in the underlying rotating neutron stars. It is now suggested that during a starquake matter may be ejected from the surface of the neutron star, and a scheme has been postulated whereby the ejection process leads to the formation of heavy elements. [Nature **259**, 643, 1976]

The star HD193964 = 71 Draconis was found to be a spectroscopic binary almost sixty years ago, although the first orbital solution was only found three years ago by the undersigned (J.R.A.S.C. **67**, 161, 1973). This star has recently been found to be an eclipsing binary. With an apparent magnitude of 5.6, it is just visible to the naked eye. The amplitude of about 0.2 magnitude means that the light variation should be detectable visually through a telescope, and because it is circumpolar the star can be observed at all seasons. A suitable comparison star is 68 Draconis whose brightness is almost identical to that of 71 Draconis outside of eclipse. These two stars can be found on Map 2 in Norton's Star Atlas at R.A. = $20^h\ 20^m$, Dec. = 62° just west of Eta Cephei. The period is 5.2981 days and an eclipse was observed on January 28, 1976 at 1500 MST [IBVS no. 1071 and private communication]

An increasingly complex picture of the centre of our Galaxy is developing as a result of observations made over a wide range of the electromagnetic spectrum. The exact physical nature of the galactic centre remains unknown, although there appear to be several very small, highly energetic and variable sources there. For example, during the period February 8–14, eleven X-ray bursts were observed from at least two sources near the centre which are separated from one-another by about thirty minutes of arc.

[IAU Circular No. 2918]

Reprinted from *Stardust*, Edmonton Centre

Accurate Time

By John Howell

The need for exact time, especially for occultation observations, has always posed a problem due to difficulties sometimes experienced in receiving the shortwave radio signals of WWV or CHU.

The quartz digital watches are advertised as being very accurate and after carefully checking an LCD (liquid crystal display) type for more than two weeks, the watch was found to be less than a second out over this period. LCD watches will be a very reliable addition to radios for future expeditions, so positive results should be achieved on many more occasions in the future.

The LCD timepiece shows a continuous readout, whereas the LED (light emitting diode) type only shows a readout if the button is operated. The timekeeping accuracy is probably equivalent, but the LCD type would appear to be the best choice.

Reprinted from *The Star Seeker*, Calgary Centre