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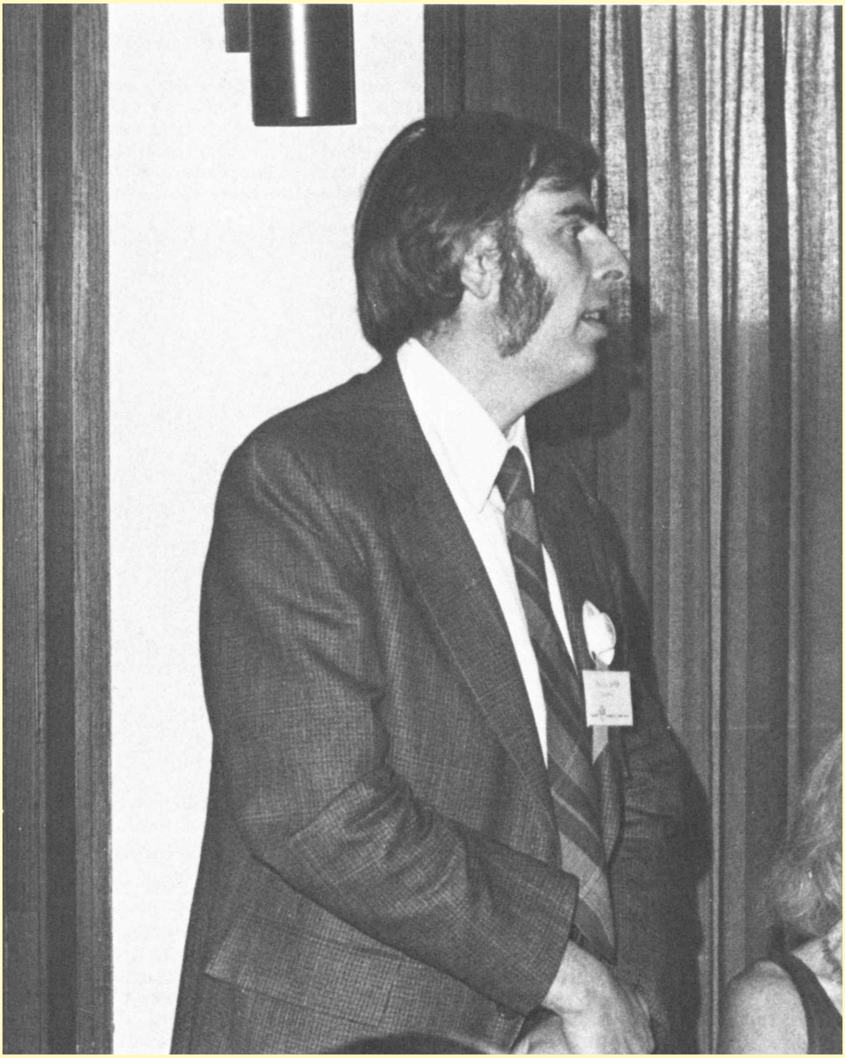
NATIONAL NEWSLETTER

August 1976



RASC President Dr. Allen Batten addresses guests at the Provincial Banquet during the recent General Assembly in Calgary. Photo by Glen Reed.

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Editor: HARLAN CREIGHTON
Assistant Editors: MARIE FIDLER / NORMAN GREEN / J.F. HEARD / WILLIAM PETERS / CELESTE PETERS
Western Regional Editor: PAUL DEANS, Edmonton

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c/o William T. Peters
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Retiring RASC president Dr. Don Fernie entertains guests at the Wainwright Hotel in Calgary's Heritage Park with a fascinating talk about Quasars. Photo by Glen Reed.

Editorial

It is with pleasure that we welcome Mr. Paul Deans as our Western Regional Editor. Mr. Deans is editor of the excellent newsletter, *Stardust*, and a member of the staff of the Queen Elizabeth Planetarium in Edmonton.

Among other things, Mr. Deans will be working to increase the interest and participation of western members in your *NATIONAL NEWSLETTER*. Members from Winnipeg and west may submit articles, new items and photographs to Mr. Deans, c/o the Queen Elizabeth Planetarium, Edmonton Parks and Recreation, 10th Floor CN Tower, Edmonton, Alberta T2P 2M5

Calgary General Assembly Successful

by Robert Pike

Friday, May 21 was the first of three days of good weather for the 1976 General Assembly in Calgary, marred only by a brief bout of rain on Sunday morning. The Friday afternoon was spent in registration at Kananaskis Hall on the spacious and modern University of Calgary campus. The delegates all received a useful tourism and information package and a nameplate which was adorned with a small plastic cowboy hat. The delegates from out of town stayed in the residences on the upper floors of the hall.

After registration, delegates relaxed in their rooms or walked around the beautiful campus if they were not required to attend the National Council meeting at 15:00 in the Blue Room of the dining complex.

For dinner, buses took us to Heritage Park, a replica of a frontier town, where we visited the Wainwright Hotel for a session at the bar followed by a beefalo meal. Beefalo is a cross between Buffalo and cattle, and is higher in protein than regular beef. After the meal, Dr. Fernie, our retiring President, gave an address on "Quasars – the Continuing Enigma", which was not only interesting but also understandable by the non-astronomers present. By this time it was getting dark, and some members went outside to observe through the telescopes set up (in a frontier town!), while some stayed inside for the "Old Tyme" entertainment. The buses returned us to the campus about 23:00. Back at Kananaskis Hall, members settled into small groups on the various occupied floors for some get-together sessions.

Saturday morning was the second perfect day for the assembly, and, as always, the most important, with the paper sessions and the Annual Meeting. Some delegates remarked that the paper sessions were the best in a long time, and, indeed, there were a number of excellent presentations. A list of titles and the abstracts will be found elsewhere in this issue. But, alas, all good things must end. A meal in the cafeteria was followed by a luxurious and relaxingly long break before the Annual Meeting. A full discussion of the proceedings of the Annual Meeting will be published in the *JOURNAL*.

After the Annual Meeting, the delegates retired to prepare for the Province-hosted banquet, held on campus. Before the banquet, though, we had to have a re-take of the group photo, as the first one had not turned out due to equipment failure, something any observer is all too familiar with! Then the delegates filtered into the banquet hall for a chicken dinner. Over coffee, the presentation of awards began with Ken Chilton of the Hamilton Centre receiving a Service Award. Service Awards were also presented to Roy and Phyllis Belfield of Winnipeg and Franklin Loehde of Edmonton. Following this, the prizes for the observing competition were awarded. The entrants' exhibits had been on display in Kananaskis Hall since Friday night, and the judges often had difficulty choosing an outright winner in some categories.

After a brief break, delegates assembled in a lecture room for two multi-media presentations. The first was by Ian McLennan of the Toronto Centre, who gave a tongue-in-cheek slide-show invitation to the General Assembly in Toronto next year. Mr. McLennan's little show was one of the highlights of the meeting, and was talked about until the planes left on Monday morning!

It was a hard act to follow, but Dr. Fernie rose to introduce the guest speaker for the night, Dr. J.L. Locke, Past National President, who presented the Ruth Northcott Memorial Lecture on the Canada-France-Hawaii telescope. Currently, plans are for an official opening in 1979.

French astronomers first approached the Canadians to share the work, expense and time to build and use a major research instrument. Because Canadian astronomers rarely get observing time on large instruments, they were eager to undertake the project. The site chosen is about 4300 meters above sea level, on the top of Mauna Kea in Hawaii, and is almost always above the clouds. For the installation of the road and provision of the land and utilities, the University of Hawaii will receive 15% usage of the 'scope, and the French and Canadians will evenly share the remainder of the observing time.

Currently, the pier has been poured, the peripheral building is ready, and the rotating structure (dome) is prefabricated and at the site. The building will be essentially

Oh that Beefalo! At the Wainwright Hotel guests enjoyed real old time hospitality and for dinner a main dish that was a cross between beef and buffalo. Marie Litchinsky shares the excitement of the occasion with, to her right, Celeste Peters, Bill Peters, Dave Rodger and Dave Hurd. To her left is a guest from the Chicago area. Photo by Glen Reed.

complete sometime this summer. The telescope itself is a 3.66-meter aperture, prime-focus/Cassegrain/Coude instrument mounted on a Porter split-ring, and is very similar to the Hale 200″, but with a few of its shortcomings removed. The structure is being built in France, and the optics are being prepared at the Dominion Astrophysical Observatory in Victoria. The primary mirror is within one-half wavelength, and the back surface is also accurate. This is necessary because the large size of the mirror would cause serious irregularities in the surface to form at various temperatures if the thickness were not uniform across the mirror.

After Dr. Locke's lecture, the delegates returned to Kananaskis Hall for another stint of socializing, and even a party or two.

Sunday is traditionally the day of tourism at a General Assembly, and 1976 was no exception. After breakfast, the delegates boarded two buses bound for Banff, almost due west of Calgary and in the Rockies. Everyone was on the buses soon after 9:00, but they did not leave until 9:30 as Marie Litchinsky did not think I was on board!

The clouds overhead turned to rain as we headed west. We ate lunch at the Banff Centre of Fine Art as the rain slowly abated. After lunch, the delegates socialized outside in the mist.

From the Centre of Fine Art, the buses journeyed through downtown (!) Banff and on to the Gondola lift. Delegates lined up for a ride up the side of the mountain to an observation area. It was still quite hazy, so the view was limited. On the other end of a ridge leading from the top of the gondola ride was a scientific station for monitoring the influx of cosmic radiation. Some of the younger delegates tried their hands at mountain climbing on the rocky ridges and talus slopes leading to the station.

As soon as most delegates had used up all their film, the clouds cleared and revealed the beautiful view of the mountains, and of Banff hidden in the valley below. After

Calgary Centre President Ulrich Haasdyk presents Damien Lemay (left) of Rimouski, Quebec with the Grand Prize in the Observing Competition.

absorbing our fill of the sunshine, we boarded the gondola cars to a more acceptable elevation and the buses which were preparing to take us to dinner.

We stopped at a park outside Banff where a pavilion had been set up and the food was being prepared. After a hefty roast beef meal, the delegates spread out on their first real chance to explore mountainous terrain unattended. Later the London Centre contingent initiated a plot to construct the largest human pyramid ever undertaken at a General Assembly. Many photographers were there to give visual confirmation of this mind-boggling achievement.

Back in Calgary we were presented with B.F. Shinn's fascinating film of the construction of Jack Newton's twelve-inch telescope.

After this, the exhausted delegates trailed off to bed in order to be up in time for their plane flights home early the following morning, or for the trip to the Rothney Astrophysical Observatory just outside Calgary.

All round, it was an exciting assembly and we look forward to seeing you in Toronto next year.

(Special to the *NATIONAL NEWSLETTER*)

Abstracts of Papers Presented at Calgary General Assembly

A Planetary and Lunar Astrophotography Exposure Guide
by G. N. Patterson, Saskatoon Centre

A simple circular slide-rule (copyright G.N. Patterson 1975), which simplifies exposure calculations, has been devised based on the formula

$$\text{Time (sec)} = \frac{(\text{f / no. of system})^2}{\text{Film ASA} \times \text{Brightness}}$$

Explanation sheets with the Guide show the amateur how to determine the f/number of his system. Incorporated on one of the three plates of the Guide is the correlation between planetary magnitude, age of moon and "brightness", so it is only necessary to determine one of these parameters from the *OBSERVER'S HANDBOOK*.

In use, the f/number of the telecamera system is set to one arrow, the film speed to a second cursor arrow and a moveable plastic cursor is set to the brightness, or the age of the moon, or the planetary magnitude. The exposure time is then read off directly in seconds or decimals of a second. For exposure times less than one second, camera shutter speeds are also listed; for exposures greater than one second, the exposure time corrected for reciprocity failure is also shown.

The Guide also includes a table showing extinction factor for objects lower than 45° and also the brightness values for lunar eclipses, i.e. umbra, penumbra and earthshine.

Burnham's Binaries: Some Historical Comments
by P. Teece, Victoria Centre

Biographical notes connected with S.W. Burnham's *General Catalogue of Double Stars* (1906), and remarks about how the catalogue can be of use to the amateur observer, are presented.

Magnitudes, Photons and the Eye
by R. L. Bishop, Halifax Centre

The limiting magnitude that an observer can detect with a specific telescope is a pertinent quantity to the astronomer; however, most descriptions of this limit seldom go beyond a magnitude-aperture relation. The quantum nature of light and the operation of the most important optical device, the human eye, are central to this topic. The connection between limiting magnitude and the interaction of light with the eye-brain system will be examined.

The Sky Brightness Programme and the Growth of Light Pollution
by R. Pike, Toronto Centre

In the summer of 1974, an observational programme was initiated by the Toronto Centre Observational Activities Committee to monitor the brightness of the night sky over southern Ontario. For about a year, observations were collected and correlated to allow the development of a mathematical model of sky brightness in terms of known properties of the atmosphere and the distribution of human population. This model was then extended by making assumptions about the growth of population to enable predictions to be made about the future situation in the area. A brief discussion of the goals and methods of the Sky Brightness Programme is presented, followed by the results of the observations. Computer-generated maps of the area produced by the model showing the present and predicted situations are shown. The paper concludes with some discussion about the validity and usefulness of the predictions.

Diagonal Mirrors
by William T. Peters and Robert Pike

Books on telescope making often give conflicting or inadequate advice on selecting the right size elliptical diagonal mirror for a Newtonian telescope. By carefully considering the rate at which illumination falls off across the telescope's focal plane it is often possible to select a diagonal mirror that is much smaller than recommended in the conventional texts. The smaller diagonal is not only less expensive, but it has less effect on the telescope's diffraction pattern.

The Use of a "Flat Star Globe" or Cylindrical Astrolabe
by L. D. Bogan, Halifax Centre

A star map and transparent plastic overlay have been designed to provide all the features of a star globe, but with the convenience of a flat geometry that is useful in the observatory, office or classroom. The same principles as the astrolabe or star-finder are used but with the emphasis on the equatorial regions of the sky rather than the celestial pole. The projection of the celestial sphere that is used has the advantage of little distortion of the sky near the equator, where there is the most astronomical interest. Overlays have been calculated and drawn for several observer latitudes to work with the Sky Publishing Corporation's SC1 Constellation Chart. With these it is easy to determine times of sunset, sunrise, transits, sidereal time, star-rise, twilight end, etc.; and to determine altitude and azimuth of any celestial object for any time of the day on any date. The construction and use of the "flat star globe" will be demonstrated.

Application of the Photoelectric Photometer in Amateur Astronomy
by D. Somers, Ottawa Centre

With today's new level of technology, it has become possible for individuals to build or purchase equipment which a few years ago was within reach of only the large scientific institutions or the independently wealthy. Advances in miniaturization and other techniques in electronics have brought photometers within the easy reach of any amateur. This allows them to supply a great deal of useful information, aiding present scientific knowledge, and relieving large observatories for more major undertakings which better befit their costly equipment.

Members of the Ottawa Centre Observers' Group have used photometers for several different projects, including eclipses, asteroid rotation periods and moonlight scatter, to name a few, and have obtained very satisfactory results.

Using Compass and Protractor to Locate Planets
by J. D. Jones, Victoria Centre

The procedure for finding the right ascension and declination of a planet, by constructing an approximate scale drawing of the orbits of the planet and the earth, is demonstrated. The error resulting from this construction can be kept to about one degree.

The Film "Communing with the Heavens"
by Mary W. Grey, Ottawa Centre

A film, which was produced about 1919 by the Canadian Government Motion Picture Bureau (the predecessor of the National Film Board) and which shows research activities at the Dominion Observatory, will be presented. This film, restored under the direction of Dr. D. M. Baird of the National Museum of Science and Technology, is currently used in the public education program of the Astronomy Division of that Museum. Much of the research into the history of this film, surely one of the earliest films on astronomical research in Canada, has been done by M. M. Thomson.

The Total Solar Eclipse of 1979 February 26
by J. E. Kennedy, Saskatoon Centre

With the assistance of Dr. V. Gaizauskas of the Herzberg Institute of Astrophysics, the path of the 1979 total solar eclipse has been plotted for that portion crossing the south-eastern corner of Saskatchewan and continuing across the more central part of the province of Manitoba. The cities of Winnipeg and Brandon will be ideal locations for observing this eclipse.

Mr. J. L. Bergsteinsson of the Physics Division, Saskatchewan Research Council, has prepared an estimate of the probability of favourable viewing conditions on this date in 1979.

As this will be the last total solar eclipse in the present century observable in Canada, members of the R.A.S.C. will be urged to travel to western Canada for viewing the eclipse.

Photoelectric Photometry with a Small Telescope
by C. D. Scarfe, Victoria Centre

Since 1969, photometric observations of eclipsing binaries have been made using a photoelectric photometer attached to the University of Victoria's twelve-inch Cassegrain reflector. This paper includes a description of the photometer and the observing technique, and presents some results from the observing programme.

1977 RASC Observing Display Competition at Toronto

At the General Assembly in Toronto next July (1977), there will be an observing display competition, inspired by the highly successful one in Calgary this year. The categories and rules are outlined below, and there will be prizes, so start observing and we'll see you in Toronto.

CATEGORIES

1. Best Centre observing display.
2. Best photographic star atlas of a selected region (at least 1500 square degrees). The choice of the region is up to the entrant.
3. Best photometric project. This may be done visually, photographically or electronically, but must be an observing project (see category 4 below for instruments.)
4. Best special-purpose instrument; best observing or reducing technique.

   The following categories involve the best single observation of a particular type of object. Awards will be given for two observations in each category – one for visual observations and one for photographic ones.
5. Any solar system object – sun, moon, planets, comets, etc.
6. Any deep sky object – galaxy, nebula, etc.
7. Any astronomical atmospheric phenomenon such as meteors, aurora, etc.

RULES

1. The contest is open to all R.A.S.C. members in good standing.
2. All work presented must have been done during the two years preceding July 1, 1977.
3. All work presented must be original, and have not been entered in the Calgary competition.
4. Exhibits may be entered in one category only.
5. Group projects are allowed (besides, of course, the centre exhibits), and will have the prizes given on an exhibit basis (i.e. any prize awarded will be shared among the contributors).
6. An entrant may enter in a maximum of three categories, and may enter only one exhibit in each category.
7. Exhibits must be brought to the 1977 General Assembly, not necessarily by the entrant, for display and judging. The prizes will be awarded there.
8. All entrants must have submitted an entry form by mail before the start of the assembly. Entry forms are available from W. T. Peters, c/o McLaughlin Planetarium, 100 Queen's Park, Toronto, Ont. M5S 2C6.

   Completed entry forms must be received before June 1, 1977 at the same address.
9. Prizes will be considered for each category, but if no work in a category is considered outstanding, no prizes will be awarded in that category. Displays must be of top quality to receive a first prize.
10. Judging will be done by members of the various centres. Centres participating in the competition are requested to send a judge to the assembly. A judge may enter the competition, but may not judge the category he is entered in.
11. In the judging, all relevant factors will be taken into consideration, including observing equipment and conditions and the experience of the observer(s) involved. Clarity and originality of presentation will be considered very important.

Oculars (Eyepieces)

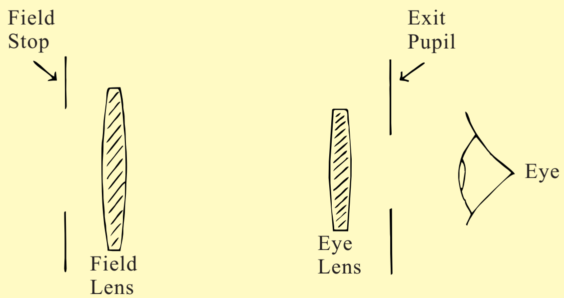
by G. N. Patterson

Many amateurs are frequently confronted with the problem of determining which ocular or oculars to buy for their telescope, particularly if costs are a problem. Obviously, you get what you pay for, so the more you can afford, the better the quality of the ocular. But the question is – which is the best ocular for the money one can afford?

When I started digging into this problem I found there were well over one hundred different types of oculars. Each was designed for a specific purpose, with distinct advantages for the designed purpose but with decided draw-backs if used for some other purpose. Fortunately, for the amateur astronomer it is possible to reduce this menagerie of oculars down to about six different types usable on a telescope. These are:

a) Huygens
b) Ramsden
c) Kellner
d) Erfle
e) Orthoscopic, and
f) Concave Lens.

Before discussing these various types of oculars, it would be advisable to review a few simple lens concepts and formulae. The lens nearest the telescope objective is



known as the field lens; that nearest the eye, the eye lens. Lenses between these two, if any, are intermediate lenses. A field stop is placed at the focal plane, usually ahead of the field lens at the point where the light rays from the objective are brought to a focus; i.e., the primary image. This stop prevents stray light from entering the ocular. The clear opening of the eye lens is the exit-pupil, and should be at least of equal size to the entrance pupil of the eye – about 7 to 8 millimeters when dark adjusted, but considerably less in daylight (about 2 to 3 mm). For this reason, an ocular intended for use in daylight, such as a microscope ocular, is not good for night work since the exit pupil is too small, resulting in a loss of light to the eye.

The effective focal length of a two-lens combination spaced apart is given by the formula:

$$\text{E.F.L.} = \frac{F_f \times F_e}{F_f + F_e - D}$$

where F_f = focal length of field lens
F_e = focal length of eye lens
D = distance between principal points of the two lenses.

The focus, F, is considered positive (+) if the lens is convex, and negative (–) if the lens is concave.

The ocular is used to collect the light rays focused by the telescope objective, and present these rays to the eye in a parallel beam. The effective length of a telescope focused at infinity is the sum of the EFL of the telescope objective and the EFL of the ocular.

Effective Length = $EFL_{objective} + EFL_{ocular}$

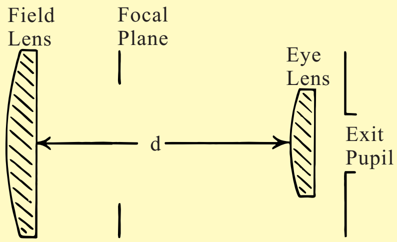
The power (X) of a telescope is the ratio of the two EFLs;

$$\text{Power (X)} = \frac{EFL_{objective}}{EFL_{ocular}}$$

Hence, by reducing the EFL of the ocular, it is possible to increase the power of-the telescope. Maximum *usable* power of any telescope is limited by the clear aperture of the objective lens or mirror, and is usually listed as 60X per inch of objective diameter, so that a telescope with a clear aperture of 3 inches has a usable power of 3 × 60 or l80X. Any increase over this power is offset by a loss of brilliance and image definition, and is only of value for something very bright such as the Moon.

A. The Huygens Ocular

This ocular was designed by Huygens in 1700 in an attempt to minimize the aberrations of a single simple lens in common usage at that time. When two simple lenses are separated by one-half the sum of their focal lengths, certain aberrations are minimized. This is now known as the Huygens' Principle.



In the Huygens ocular, the focal length of the field lens is twice that of the eye lens, both lenses are simple plano-convex, and are mounted so the convex side is toward the telescope objective. Using the lens formula with:

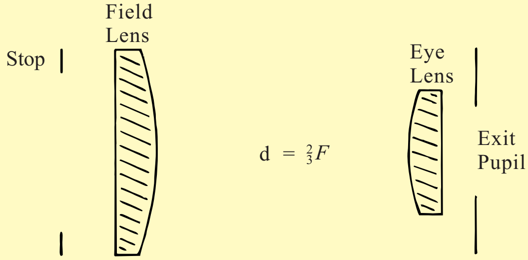
$$F_f = 2F_e \text{ and } D = \tfrac{1}{2}(F_f + F_e) = \tfrac{1}{2}(2F_e + F_e) = 3/2F_e$$

$$\text{E.F.L.} = \frac{2F_e \times F_e}{2F_e + F_e - 3/2F_e} = \tfrac{4}{3} \cdot F_e \quad \text{or} \quad \tfrac{2}{3} \cdot F_f$$

In this ocular the image is formed between the two lenses, so if a cross hair or reticule is used, it is mounted between the lenses and protected from damage. This ocular has a field-of-view varying from 25° to 40° and has relatively good color correction. The color correction can be improved even further if achromatic lenses are used in place of the simple piano-convex lenses but of course the cost of the ocular increases. It is a good ocular for telescopes but is primarily designed for microscopes, and is not suitable for wide angle, low power usage.

B. The Ramsden Ocular

The Ramsden ocular was designed in 1780 using the Huygens Principle of spacing the two simple plano-convex lenses apart a distance equal to one-half the sum of the individual lens' focal lengths. However, it differs in that the two lenses are of equal focal length, and the two convex sides face each other.

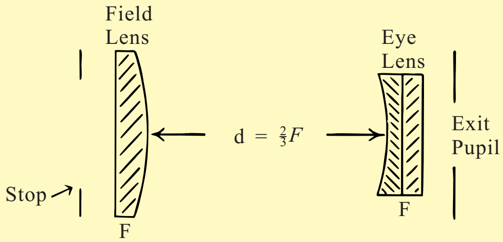


$$\text{EFL} = \frac{F^2}{2F - F} = F$$

In this ocular the image is formed on the plano-surface of the field lens, making it possible to etch measuring lines on this surface. While this is an advantage in certain usages, it is also a disadvantage in that any marks or dust on this surface is also in focus necessitating frequent cleaning. To overcome this difficulty, it is customary to reduce the separation between the two lenses to 2/3 F so that the focal plane (field stop) then lies outside (in front) of the field lens. The chromatic correction is not as good with such reduced separation, but this disadvantage is outweighed by the advantage of having an external focal plane. Field of view ranges between 35° and 45°. This is an economical ocular and is good for use with a reticule or cross-hairs.

C. The Kellner Ocular

The Kellner ocular is simply an adaptation of the Ramsden, designed in 1850, using an achromatic eye lens; hence is an achromatized Ramsden. Lens spacing is usually two-thirds that of the unmodified Ramsden ocular.

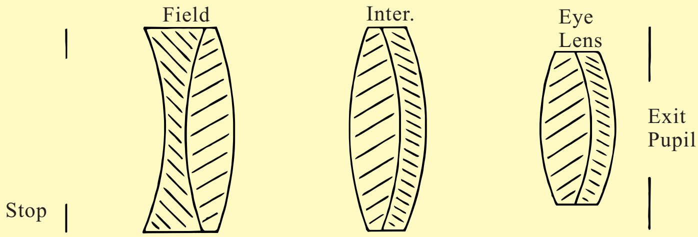


$$EFL = \frac{F^2}{2F - 2/3F} = \frac{3}{4}F$$

The Kellner ocular gives a wider field of view than that of the Ramsden, varying between 40° to 55°. The ocular has low achromatic aberration. This makes it a very good low-cost telescope ocular, and it is widely used for this purpose. Like all the preceding oculars, the Kellner does suffer from some spherical aberration near the outer edges of the field of view, so these oculars are not ideal for use for projection astrophotography.

D. The Erfle Ocular

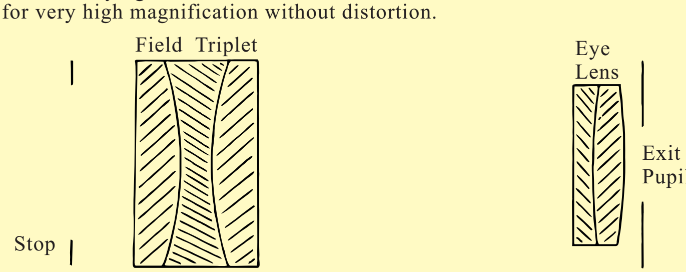
The Erfle ocular, developed about 1925, was designed specifically to give an extra-wide field of view between 65° and 70°, with good correction for all aberrations. It is usually a triple lens system with all lenses being achromatic. Lens spacing depends upon a variety of circumstances, so no attempt will be made to indicate a lens formula for this type of ocular.



This type of ocular is ideal for low-power instruments, particularly Rich Field telescopes, and is used in wide field binoculars. While this ocular can be used for projection photography, its projection field is not completely flat, making the stars at the outer edges of the film out of focus unless the film plane is curved.

E. The Orthoscopic Ocular

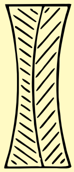
The word, "Orthoscopic" means flat field, and this type of ocular is the preferred one for most telescope work. In its basic form, it uses a triplet field lens (three lenses cemented together) and a convex achromat for the eye lens. The field of view is relatively wide, varying from 35° to 50° and this ocular has excellent color correction, allowing for very high magnification without distortion.

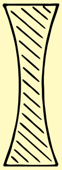


As the field is essentially flat, this type of ocular is probably the best to use for projection astrophotography, but the major drawback is its cost. However, if this can be handled, the orthoscopic ocular is the best all-round ocular for the amateur astronomer.

F. The Concave Ocular

Many amateur astronomers fail to realize that the concave lens can be used as an ocular, yet this was probably one of the first types of eyepiece used by Galileo. When used as a concave (negative) achromat, it gives excellent color correction, and is an excellent lens for photography.





Most amateurs are aware of the Barlow lens used to increase the power of a telescope. This lens is usually a negative achromat. The Barlow has been badly maligned by many amateurs, but it is probably one of the most useful oculars available. However, to be fully effective the lens should be securely mounted in its tube at one fixed position, providing a fixed power increase; i.e. 2.4X or similar. The Barlow can increase telescope power without loss of eye relief that is usual in the case of increasing power by using a shorter, positive efl ocular having a smaller exit pupil.

The Barlow operates on the principal of increasing the effective focal length of the telescope objective without increasing the effective telescope length more than a few inches. Variable-power Barlows should be avoided as it is not possible to ensure precise axial fitting with a lens that can be freely moved. It is this latter type of Barlow that has given this type of lens such a bad reputation.

Parafocal Oculars

One of the many problems all amateur astronomers encounter is the need to change magnifying power by changing from one ocular to another, with a consequent re-focusing required.

This problem can be almost completely overcome by using parafocalized oculars: all oculars in the set are designed to have their focal point at the same position in the focusing tube used to hold the ocular. Unfortunately, a set of parafocalized oculars is expensive and may be outside the price range of most amateurs. A cheap (?) substitute is a Zoom type ocular, adjustable from about 8 mm to 21 mm. Personally I do not consider such an ocular as good as separate, fixed focal length oculars.

Care of Oculars

The quality of the image seen depends largely upon the ocular. If this is dirty or scratched, the resulting image is seriously deteriorated, so it is essential that oculars be kept clean.

Oculars used in amateur work are frequently changed, often in cold weather. An ocular not in use should be capped at both ends to prevent dust, etc., from entering. In addition, if the ocular is taken inside after use in cold temperatures, condensation will form on and between the lenses unless the ocular is tightly wrapped in plastic while still outside to prevent the warm, moist inside air from causing condensation on the cold surfaces of the ocular.

Normally, any film or dust is only on the outer surface of the lenses so it should not be necessary to dismantle the ocular to clean these surfaces. All dust should be removed before attempting to wipe a lens — this can be done with a soft camel's hair brush and compressed air. If this is not done, wiping the lens' surface with dust on it will cause scratches that cannot be removed. If the lens' surface needs washing, use a solution of mild detergent and a soft brush, rinsing after in clear water. Do not use alcohol as this will dissolve the bonding between a cemented lens.

An ocular should never be taken apart unless the person doing so thoroughly understands what he is doing. Proper tools and extreme care is needed to avoid damage and possible mis-spacing between lens elements.

A good choice of oculars is 40 mm, 32 mm, 24 mm, 16 mm and 8 mm with a 2.4X Barlow. Do not buy an ocular that will exceed the maximum usable power of your telescope of 60X per inch of objective diameter. Good viewing.

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