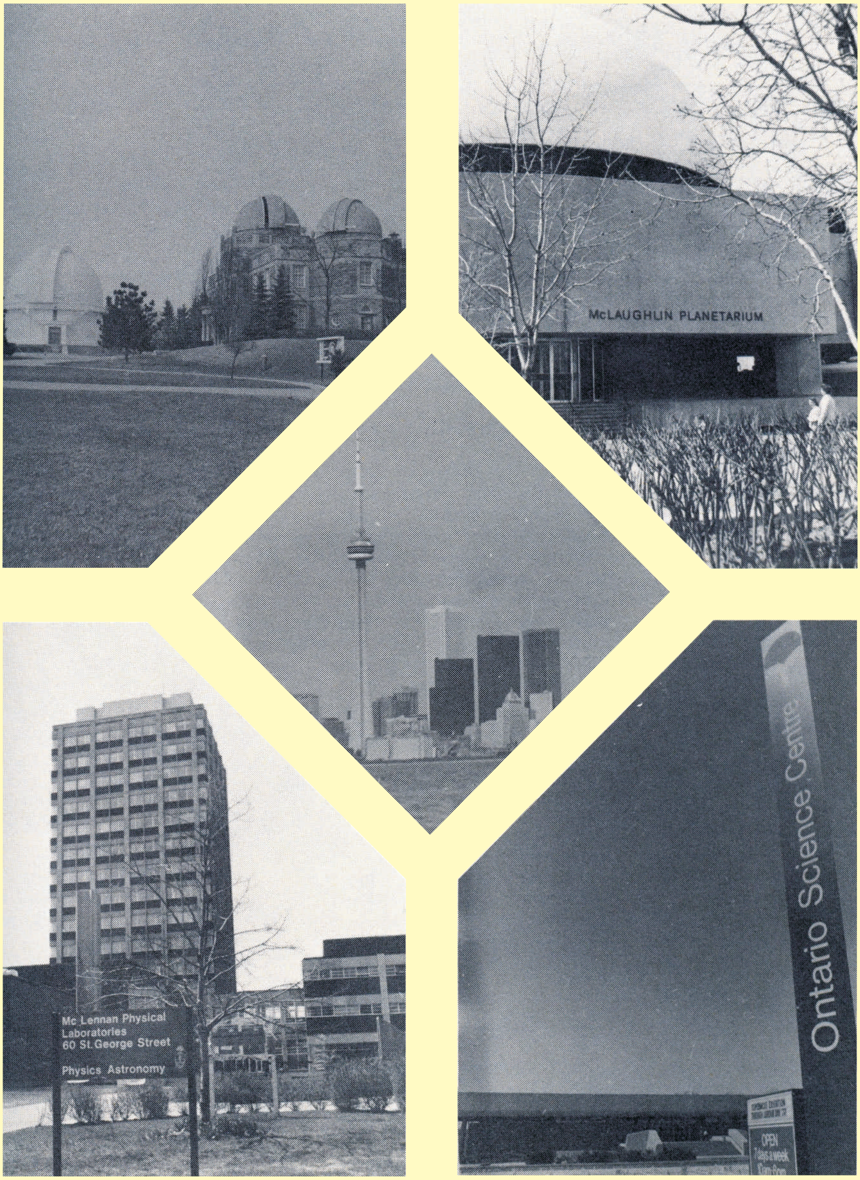
NATIONAL NEWSLETTER

June, 1977



Toronto and some of the sites of the 1977 General Assembly of the RASC. Clockwise from top left: David Dunlap Observatory; McLaughlin Planetarium; McLennan Physics Laboratories, University of Toronto; Ontario Science Centre.

NATIONAL NEWSLETTER

June, 1977

Editor: HARLAN CREIGHTON
Assistant Editors: RALPH CHOU, J. D. FERNIE, NICK FRASER, NORMAN GREEN
Western Regional Editor: PAUL DEANS, 10707 UNIVERSITY AVE., EDMONTON, ALBERTA T6E 4P8
Art Director: BILL IRELAND *Photographic editor*: RICHARD MCDONALD

Please submit all material and communications to:
THE NATIONAL NEWSLETTER
c/o Norman Green
McLaughlin Planetarium
100 Queen's Park
Toronto, Ontario
M5S 2C6

Deadline is two months prior to the month of issue.

Headlines and Deadlines

Recently, we've had some complaints about the lateness of your publications. Now it's time for us to sound off too!

The *NATIONAL NEWSLETTER* depends upon you to supply the material for our pages and we are grateful for your contributions. One of our problems, however, is to maintain a certain standard for the Queen's English, and it is sometimes no easy task to weed through an interesting, though fractured article. It's for this reason that we ask you to submit your articles at least two months ahead of time. Any major revision has to go back to the author for approval, then it has to be checked over again before going to layout. It takes about two weeks to get the proofs back from the printers, and by the time those things are checked, and the press run is approved and made, we're late! (We won't mention what can go wrong in the mail.) Photographs and diagrams also take a lot of time to prepare.

Please bear with us. We want to provide you with the very best that we can – but we need time!

Address Change

The Kingston Centre has requested that in future all correspondence should be sent to the following address, rather than to the Secretary-Treasurer:

Royal Astronomical Society of Canada
Kingston Centre
c/o Queen's Astronomy Club
AMS Office, University Centre
Queen's University
Kingston, Ontario
K7L 3N6

A Reminder

There's still a little time left to register for this year's General Assembly! For further information, write to the General Assembly Planning Committee:

c/o Mrs. Ann Scott
63 Donlea Dr.
Toronto, Ontario
M4G 2M3

Astronomical League

The Astronomical League has available two publications to help local astronomical societies and planetaria publicize activities and astronomical events.

The 1977 NEWS SERVICE PACKET is an expansion of two previous annual packets produced by the League's Middle East Region. It contains fifteen "pattern" news releases about astronomical events and amateur activities during 1977. A special section has been included with guidelines, releases and other material to enable groups to sponsor local telescope building and astrophotography contests either in conjunction with the League's 1977 national competition or as separate events. Also included is a suggested year-long publicity calendar, a bulletin with ideas used by local groups and fact fillers for newspapers and other publications.

Order the packet by sending a self-addressed mailing label and $1 to: R. Young, 329 S. Front St., Harrisburg, Pa. 17104.

A PUBLIC RELATIONS CHAIRMAN'S KIT is also available and includes a publicity handbook, a handbook suggesting how to get and use broadcast time effectively, ideas for the club publicity committee and instructions and samples of public service radio and TV commercials to promote groups or planetaria. Order the CHAIRMAN'S KIT and 1977 NEWS SERVICE PACKET together for $3 ($2 for League Members).

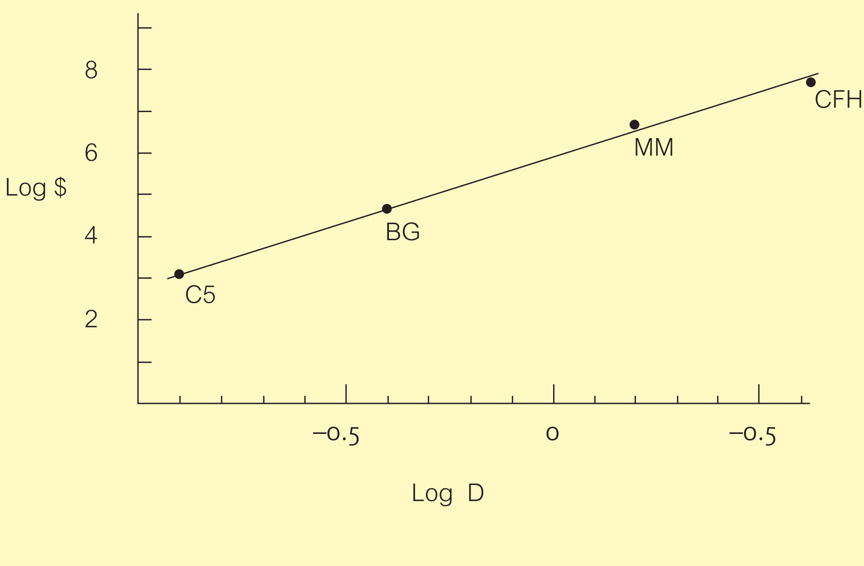
What Price Infinity?

Roy L. Bishop
Maktomkus Observatory

On the large scale the basic units of the Universe are the galaxies. Ourselves, the planet beneath us, and all the stars in the sky compose only our local corner of the Milky Way Galaxy; but, aside from this, it is curious that for the unaided eyes there is only one, distinctly visible, full-size galaxy. This is M31, a typical large spiral system and a familiar sight to amateur astronomers.

With the least optical aid other galaxies are accessible. Through the modest telescopes used by amateurs, hundreds of galaxies emerge out of the blackness, like dim snowflakes frozen in the eternal night. Most of these are the largest galaxies, spirals or large elliptical systems. Since these are of roughly the same absolute magnitude, the illuminance provided by the dim light each sends to Earth depends only on their distance (R), and this dependence is the familiar inverse square law (R^2). The portion of this light intercepted by a telescope varies directly as the area or square of the telescope's aperture (D^2). Thus the distance R at which one of these large galaxies can be detected is directly proportional to the aperture D. Hence, the volume of space accessible ($\frac{4}{3}\pi R^3$) is proportional to the cube of the aperture (D^3).

The graph below is a log-log plot of the cost of various astronomical facilities against



aperture. (C5 = Celestron 5 telescope with accessories, BG = Burke-Gaffney Observatory, Halifax, MM = the proposed Mont Mégantic Observatory, CFH = the Canada-France-Hawaii Observatory). The relation is nearly linear which suggests that:

$$\log \$ = \log K + n \log D$$

or

$$\$ = KD^n$$

The constant K is numerically equal to \$ when D is 1 meter. This gives $K = 6 \times 10^5$. The exponent n is the slope of the line, which is 3. That is, the cost of an astronomical facility varies as the cube of the aperture (D^3). (For the unaided dark-adapted human eye: $\$ = (6 \times 10^5)\ (7 \times 10^{-3})^3 = 21¢$, a rather modest figure.)

Since both the volume of space accessible to a telescope and the cost of a telescope depend in the same way on its aperture (both vary as D^3), the cost of observing the Universe is constant per unit of volume.

To arrive at a number, consider the Andromeda galaxy M31 ($R \sim 2.1 \times 10^6$ l.y.) as being roughly at the limit of the unaided eye ($D \sim 7 \times 10^{-3}$ m):

$$\frac{\$}{\text{Volume}} = \frac{KD^3}{\frac{4}{3}\pi R^3} = \frac{(6 \times 10^5)(7 \times 10^{-3})^3}{\frac{4}{3}\pi(2.1 \times 10^6)^3}$$

$$= 5.3 \times 10^{-21}\ \$/(\text{l.y.})^3$$

$$= 18¢ \text{ per } (\text{Mpc})^3$$

which is a bargain by anyone's standards! An even better price is available if, instead of vision, photographic or electronic detection is used. This approximately doubles R with little additional expense, and the cost of a cubic megaparsec drops to about 2¢.

from *Nova Notes*, Halifax Centre

Lunar Occultations

by David Brown

Occultation phenomena are by no means limited to those events involving moon and stars; however, it is from the timing of these lunar occultations that we are gaining a better understanding of the relative motions of the earth and moon. The usual procedure is simply to time, with the aid of a stopwatch, the star's disappearance behind, or emersion from the dark limb of the moon. Owing to the high relative brightness of the illuminated portion of the moon, bright limb occultations are seldom observed. The moon's relative stellar motion is eastward and therefore dark limb occultations occurring before full moon are disappearances, and those events of the waning phase are emersions. A shortwave radio receiving WWV or CHU time signals is used as a reference, and the timing itself is recorded to 0.1 second precision. Since the angular diameter of a star is very small, the occultation is virtually instantaneous. Invariably, the observer's reaction time to the event will be several tenths of a second. As such, his "personal equation" should be estimated and recorded with the timing so that the appropriate correction can be made.

Infrequently a star's disappearance may not seem instantaneous. This will most probably occur because the star is a binary. Other unusual phenomena include apparent blinks and flashes, especially if the direction of the star's relative motion is tangent to the lunar limb. Any unusual aspect of an observation should be noted carefully in your report.

Disappearances are of course easier to observe than reappearances, since the star may be followed to the point of ingress. In general, one will find that rigidity of mount and smoothness of tracking are more crucial for a sure timing than extra-large telescope aperture.

Reappearances are somewhat more exciting, as the point of egress must be estimated beforehand. An accurate timing of egress is considered slightly more valuable than the timing of an easier and more widely observed ingress. Similarly observations of phenomena occurring near full and new moon have increased value.

Occultation observations are sent to the Royal Greenwich Observatory for computer reduction. This process eliminates parameters such as the observer's position on the earth's surface, and small time changes due to varying location. A "residual" in seconds of arc is determined, which represents the difference between the moon's apparent position, and its theoretical position which is determined from the centre of the earth at the time of the occultation. The individual observations can now be compared directly with all others in a meaningful way.

Occultation data have uncovered several types of periodic changes in the earth's rotational period. One new theory has gone so far as to propose a slowly changing value of the gravitational constant G to explain certain long-period variations in the earth-moon motion, as determined from occultation timings.

The amateur astronomer's reward for his effort in making a careful timing is to see firsthand the interesting irregulanties in earth-moon motion by comparing his reduced observations with those of others. As can be appreciated, the more observations made, the more reliable is the interpretation of the results. In short, we need observers.

A small telescope, or perhaps even a good set of binoculars will suffice until the observer develops the technique warranting a larger instrument. The *OBSERVER'S HANDBOOK* lists occultations of stars down to magnitude 7.5, and a 2.4-inch refractor will catch most of these. Increasing aperture will bring a twenty-fold increase to the number of predicted occultations observable. An 8-inch or larger telescope will catch events involving stars as faint as magnitude 10, as in the USNO extended predictions. A timing should be recorded to 0.1 second precision, for in that small interval the earth has rotated slightly more than 0.1 second of arc (about 100 feet) about its axis. Therefore the observer's longitude and latitude should be known to within 1 second of arc. (This data is readily available from maps.) A stopwatch and shortwave radio are also necessities. The only indispensible item is your enthusiasm.

Ed. Note: For further information, contact David Brown at 2289 Hingston Ave., Montreal, P.Q. H4A 2J3.

Reprinted from
Skyward, Montreal Centre

Catadioptric Telescope Systems III

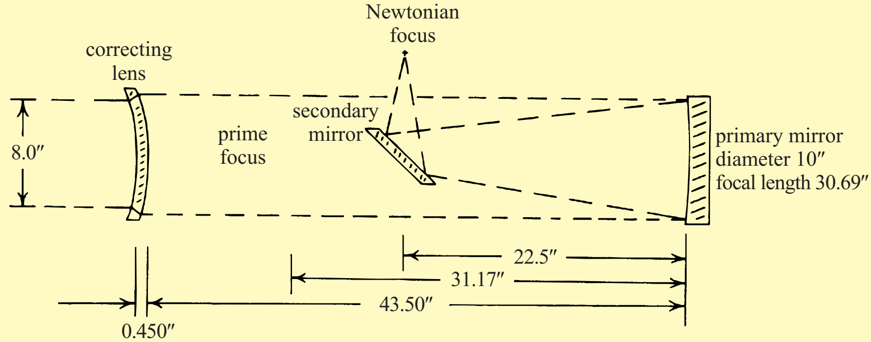
by Jack Winzer
Edmonton Centre

(3) The Maksutov:

The catadioptric telescope system now known as the Maksutov was first suggested by Bouwers about 1940 in Holland. Unfortunately, at the time Bouwers made his discovery, Holland was under Nazi occupation, and consequently the Bouwers design was not published until 1946 (in his book *Achievements in Optics*). In the meantime, Maksutov, in Russia, had designed a similar system, patented in Moscow in 1941 and described in the May 1944 issue of the *Journal of the Optical Society of America* (Volume **24**, page 270).

The telescope proposed by Maksutov (and Bouwers) uses a very deep, spherical correcting lens of almost zero power in conjunction with a spherical primary mirror. The correcting lens is almost full aperture (slightly less than full aperture if vignetting is to be minimized) and is placed at a distance from the primary mirror approximately equal to the focal length. Although all curves are nominally spherical, if strictly spherical curves are used, there are residual high-order aberrations present. It is usually necessary to aspherize the primary mirror to minimize these. There is also a small, transverse colour error which is negligible in most cases, and is far less than in conventional refracting systems in any respect.

With the exception of specialized Maksutov-type designs for spectrograph cameras or super-fast meteor cameras, the Maksutov has not found favour with professional astronomers. There are three reasons for this, all a result of the nature of the correcting lens. First, because of the deep curves on the correcting lens, the thickness of the blank from which the lens is to be made is almost 1/3 of the diameter of the blank. Glass costs become prohibitive very rapidly as larger telescopes are considered. Second, the weight of the correcting lens is large, and it must be mounted in a heavy cell, both adding considerably to the weight of the telescope and requiring a more rigid mechanical design. Finally, the absorption of light (particularly in the ultraviolet) due to the thick lens is very objectionable. By contrast, the Maksutov has seen wide popularity by amateur telescope makers, largely due to a design published by Gregory in the March 1957 issue of *Sky and Telescope*. The design has subsequently become known as the Gregory-Maksutov telescope. A similar instrument is produced commercially by Questar.



scale 10 inches

SPECIFICATIONS

primary mirror
  focal length = 30.69 inches
  diameter = 10.0 inches

inches

secondary mirror
  distance from primary = 22.5 inches
  semi-major axis = 4.5 inches

correcting lens
  clear front aperture = 8.0 inches
  clear back aperture = 9.0 inches
  distance from primary =43.50

  front radius = 9.87 inches
  back radius = 10.03 inches
  center thickness = 0.450 inches
  glass 517645 (BSC Crown)

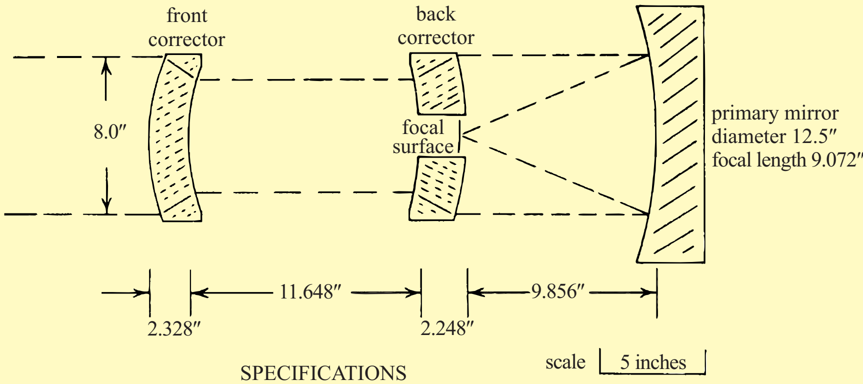
Figure 5. The design of an 8-inch (nominal clear aperture) F/4 Maksutov-Newtonian.

3(a) The Maksutov Camera:

The design originally proposed by Maksutov was intended as a camera, roughly equivalent to the Schmidt, but eliminating the problems of the length of the Schmidt (twice the focal length), the large loss in aperture necessary to minimize vignetting, and the necessity of making an aspheric plate. Unfortunately, the simple Maksutov camera falls far short of the Schmidt camera in image quality and usable field size at fast F/ratios. At medium speeds, however, (say F/4) the simple Maksutov camera does provide suitable images at moderate field sizes. At such focal ratios, the Maksutov can be used in a Newtonian configuration.

A design for an 8-inch, F/4 Maksutov camera/Newtonian is shown in Figure 5. Nominally, all surfaces are spheres; however, in practice the primary will have to be aspherized to minimize residual aberrations for optimum performance. This step requires autocollimation testing of the complete system. The radii are critical as is the thickness of the corrector. Also important, and difficult to achieve, is that the two surfaces of the corrector be concentric. Note that the corrector is smaller than the primary mirror (corrector: 8-inch clear aperture, primary mirror: 10-inch diameter) to minimize vignetting as in the Schmidt. The production of the optics for such an instrument is probably more difficult than for an equivalent Schmidt, yet the overall image quality is somewhat inferior. Hence there is little to recommend this particular design over an equivalent Schmidt-type system.

If a more complex corrector system is employed, however, the Maksutov can be made superior in performance to the Schmidt. The Baker-Nunn satellite cameras, originally built for the United States Air Force and subsequently finding wide use in meteor tracking, employ such a corrector system. The basic design of this type of system is due to Wynne (1947 *Monthly Notices of the Royal Astronomical Society*, Volume **107**, page 536). In this reference, Wynne discusses a number of variants of this design, and one of these, scaled to an 8-inch, F/1.0 camera, is shown in Figure 6. Other designs are not particularly suitable for amateur construction. In particular, the corrector lens in the 8-inch shown in Figure 6 would require two glass blanks about 9 inches in diameter and 5 inches thick, costing about $800 each!



SPECIFICATIONS

primary mirror
focal length = 9.072 inches
diameter = 12.5 inches

front corrector
front radius = 7.763 inches
back radius = 6.256 inches
centre thickness = 2.328 inches
diameter = 8.0 inches
distance from back corrector = 11.648 inches
glass 613593

back corrector
front radius = 6.256 inches
back radius = 7.763 inches
centre thickness = 2.248 inches
diameter = 8.0 inches
distance from primary mirror = 8.0 inches
glass 613593

Figure 6. F/1.0 Maksutov camera similar in design to the Baker-Nunn satellite cameras. The design presented here has a nominal clear aperture of 8.0 inches.

Reprinted from *Stardust*, Edmonton Centre.

Les Asteroides

par Damien Lemay

Le premier astéroide fut découvert le premierjanvier 1801, par l'astronome italien Piazzi. Il lui donna le nom de Cérès, d'après le dieu Grec de la Sicile.

Après s'être approché du soleil, on le perdit de vue et l'on craint qu'il fut alors perdu à jamais. Un scientifique allemand du nom de Gauss vint à la rescousse, et à partir des positions déterminées par Piazzi, prédit l'endroit ou se trouverait Cérès son opposition par rapport au soleil. C'est avec une très grande satisfaction que l'objet était retrouvé avant la fin de la même année, à l'endroit prévu.

Ces mêmes calculs indiquaient aussi que l'orbite de Cérès coincidait avec la position inoccupée de la loi de Bode. Cette dernière est une formule mathématique empirique prévoyant la position des planètes dans le système solaire. On cru alors qu'il s'agissait bel et bien de la planète manquante, mais bientôt la découverte d'autres astéroides vint ébranler cette hypothèse.

Dans l'ordre, étaient découverts Pallas (1802), Juno (1804), et Vesta (1807). Bientôt leur nombre fut tel que pour faciliter leur identification, on décida de les numéroter dan l'ordre suivant laquel leur orbite est déterminée.

En 1950, plus de 1500 astéroides étaient ainsi catalogués et aujourd'hui il y en a environ 2000. Une estimé statistique base surplusieurs photos prises avec les plus grands telescopes, indique qu'il devrait être possible d'identifier quelques 100,000 objets du genre avec les moyens actuels.

Une grande part des astéroides ont leur orbite située entre Mars et Jupiter. Ces orbites sont généralement circulaires et approximativement dans le plan de l'écliptique comme les autres planètes, avec des périodes entre 4 et 7 ans.

Certains astéroides ont cependant des orbites inusuelles, tels que: Hermes, Eros, Icare, etc. ... On croit que l'orbite de certains d'entre eux aurait été modifiée par leur passage a proximité de Jupiter.

L'effet de Jupiter ne fait aucun doute sur les groupes d'astéroides appelés Trojans. Ceux-ci sont des concentrations d'astéroides situés à 60° en avant et après Jupiter. Aussi, certaines périodes d'orbites sont inexistantes (Kirkwood gaps) et s'explique par l'attraction de Jupiter qui modifie le trajet des astéroides qui occuperaient ces orbites.

Certains astéroides s'amènent parfois près de la terre (ex: Hermes 800,000 KM ou environ 2 fois la distance terre-lune).

La plupart des astéroides ont moins de 200 KM de diamètre, le plus gros étant Cérès avec 770 KM. Les calculs indiquent que la masse de tous les astéroides dont on estime l'existence dans le système solaire, ferait seulement 10^{-3} la masse de la terre. Ceci est alors insuffisant pour s'expliquer par l'hypothèse de l'explosion d'une planète existante autrefois entre Mars et Jupiter.

A cause de leur petitesse, il a été impossible à date de distinguer avec certitude des détails a leur surface, cependant que leur forme irrégulière a pu être observée pour quelques uns d'entre eux.

Cette forme irrégulière de ces objets se traduit par une variation de leur luminosité au cours de leur rotation. Par exemple, les photomètres électroniques, très sensibles, permettent de mesurer des variations très faibles. Ceci a permis d'établir que les périodes de rotation des astéroides se situent entre 2 et 10 heures. (Ex: voir multiple exposition de *Eros* dans *Sky & Telescope*, Mars 1975, p. 162).

Cette irrégularité s'explique par la faible masse de ces corps dont la force d'attraction est inférieure à la résistance des matérieux qui les composent. Les calculs montrent que pour de la roche de résistance moyenne, au delà de 150 KM de diamètre, ces objets seront sphériques, ce qui est confirmé par les plus gros astéroides dont la magnitude varie très peu au cours de leur rotation.

Pour ceux qui désireraient approfondir le sujet, je vous recommande les articles suivants parus dans *Sky & Telescope* au cours des trois dernières années.

The Minor Planets: Sizes and Mineralogy	Février '74
Toro: the imprisoned bull	Juin '74
Two Minor Planets Approach Opposition	Août '74
A Bright Apparition of Nausikaa	Octobre '74
Bulletin for Eros Observers	Janvier '75
The Eros Flyby	Mars '75
Amateurs Observe Rotation of Eros	Mai '75
Minor Planet 9 Metis in Taurus	Décembre '75
New Finding about Eros	Décembre '75
The Coming Flyby of Asteroid Betulia	Avril '76
Path of 6 Hebe	Septembre '76

Enfin, je souhaite que quelques amateurs suivent l'évolution d'astéroides en 1977. Consultez vos annuaires astronomiques pour des cartes appropriés concernant les plus lumineux.

Bonne observation.

de Bulletin du Centre de Quebec