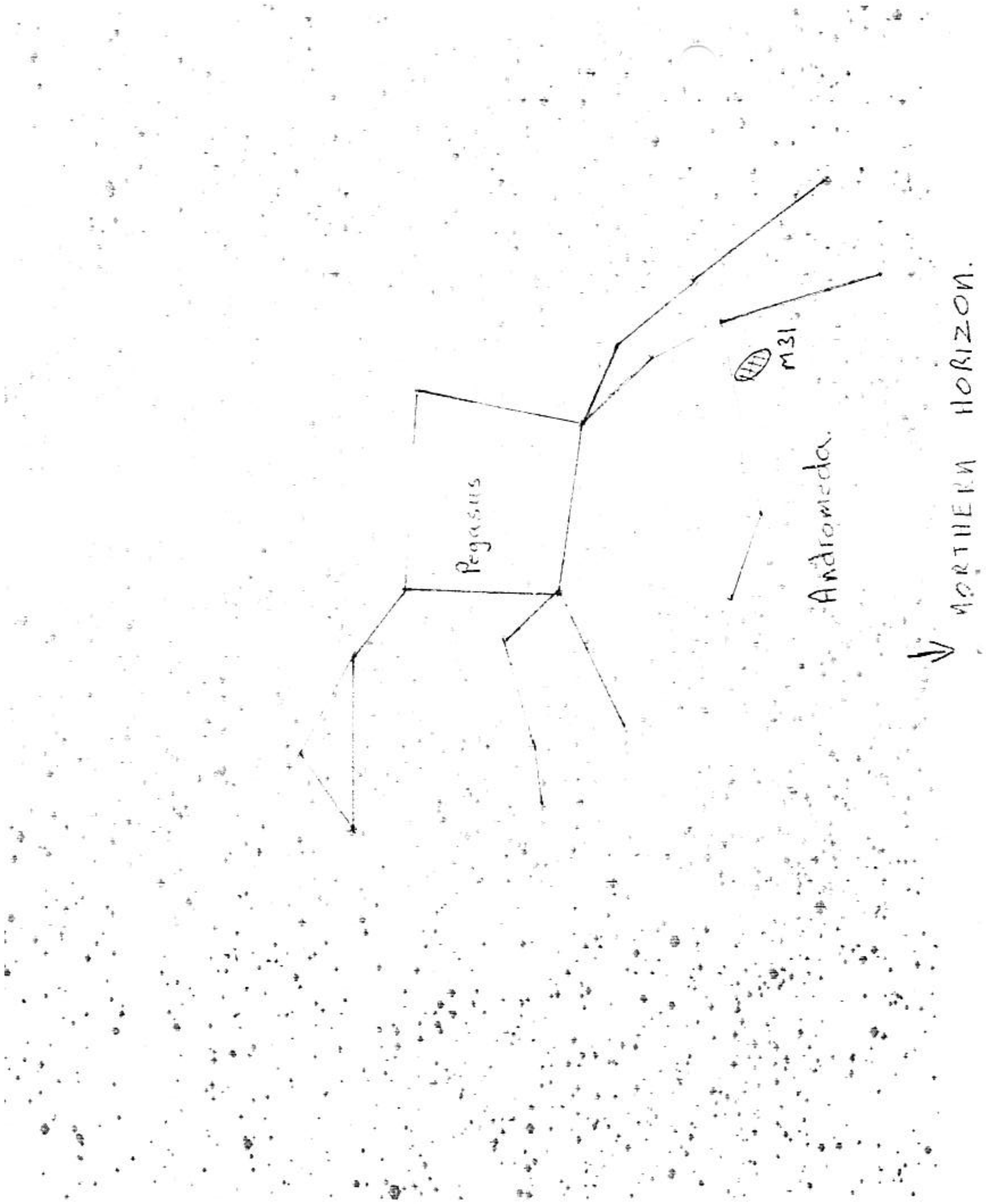


October 1990

Urania

Astronomical Society of Southern Africa
Pretoria Centre

angular measure Cross staff

WHATS UP DOC?

It seems by the vast number of reports I have received that nobody - (a) read last months edition of What's up Doc; or (b) tried to observe any of the planetary nebulae.

Sculptor is available after about 8pm SAST and contains two of the brightest galaxies available in the southern hemisphere.

NGC 55

This galaxy, located at RA 00:12.5 Dec -39:30 is listed as Mag 7.8 and is a long spindle of light some 25' by 3'. (If you don't know what the ' means see the section entitled Angles in the sky).

Remember that galaxies are all faint and you must dark adapt properly if you want any chance of success. As with all galaxies the sight is not very impressive.

While looking at that faint smudge of light consider that the light entering your eye was emitted collectively by several billion stars and has been travelling through space for millions of years before reaching this little rock on which we live. If your perspective is right this little planet of ours will seem insignificant and not the smudge in your eyepiece.

NGC 253

Another of the many galaxies in Sculptor located at RA 00:45.1 Dec -25:34 and listed as Mag 8.9 covering some 25' by 4.5'.

As already mentioned these two galaxies are among the brightest seen from the southern hemisphere. Both are spiral types seen at an angle and therefore they appear elongated and not circular.

M31

The easiest spiral galaxy is of course the Andromeda Spiral, M31 otherwise known as NGC 224. Located at RA 00:40.0 Dec +41.00 it is listed at Mag 4.8 and covers 160' by 35'. It is most easily observed in binoculars since it is too big to fit in even wide field eyepieces. Two companion galaxies are located near the andromeda spiral and should easily be visible in telescopes of 3 inches and up. This is a nearby galaxy and the light has only had

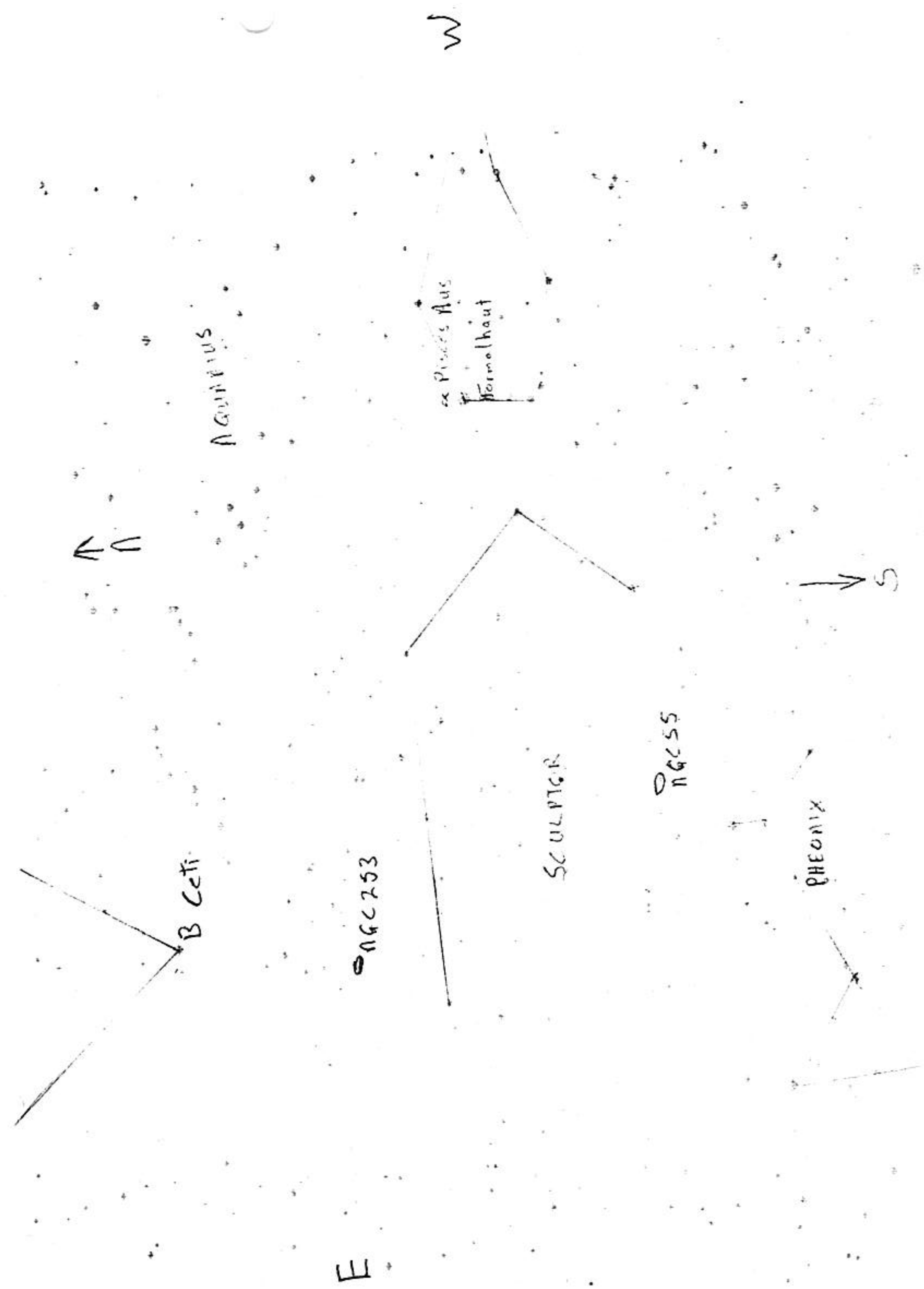
Next month lets look at some double stars, nice and easy through to severe tests of resolution of your telescopes.

6 inch f/8 primary mirror in cell for any type of 3 to 4.5 inch telescope with 1 to 1.5 metre focal length. I need a guidescope for photography so the quality does not have to be exceptional.
J W Swart tel 705557

Angles in the sky.

Neville Young did a good job of explaining the Right Ascension and Declination coordinate system at last months meeting. Those of you who attended will know that Declination is measured in degrees north or south of the equator. Degrees of course can be broken up into minutes and the minutes into seconds. Each degree consists of 60 minutes and each minute consists of 60 seconds. In any circle of 360 degrees we therefore have 360*60*60 = 1296000 seconds of arc and you will appreciate that this is therefore quite a small angle. It is precise enough at the current level of our astronomy to serve as the smallest angular measurement for most purposes.
Remember that RA is measured in hours, minutes and seconds. These minutes and seconds differ from the angular minutes and seconds and care must be taken not to confuse them. There are 24 hours * 60 minutes * 60 seconds = 86400 RA seconds in 360 degrees and you can see that there is a significant difference between the two. Unless indicated otherwise it may safely be assumed that any reference to minutes and seconds is a reference to an angular measurement. Where a writer specifically refers to RA minutes and seconds he will always take care to indicate this.

Often coordinates for objects are given without using the symbols -i.e. 0432.5-3423.75 Right Ascension is always listed first and the declination then always has a + or - sign preceding it. Note also that in the above example the seconds are in fact indicated as fractions of minutes. The example above would therefore translate to RA 04:32:30 Dec -34:23:45.
The symbols for degrees, minutes and seconds are as follows:
10 degrees = 10°, 25 minutes = 25' 35 seconds = 35"
The angular distance between two stars might therefore be $3^{\circ}15'23''$ (three degrees, 15 minutes and 23 seconds). Such angular measurements are often used to indicate the distance between objects (i.e. components of a double star) or to indicate the size of objects such as the galaxies listed in What's up Doc. Get used to angular measurements, they form an integral part of astronomy and we would be lost without them.



Looking at the two cases we will see that:-

CASE	APERTURE	FOCAL RATIO	BRIGHTNESS
one	100	10	1676
two	200	5	6699

Notice that we have only doubled the aperture but the brightness has increased by a factor of more than two. The brightness has in fact increased according to the inverse of the focal ratio squared. To prove this :-

$\frac{1}{(10*10)}*1676 = 0.017$

in the case of the first telescope and

$\frac{1}{(5*5)}*6699 = 0.017$

in the case of the second telescope.

From this we can infer that for two telescopes to show the same brightness of image photographically:

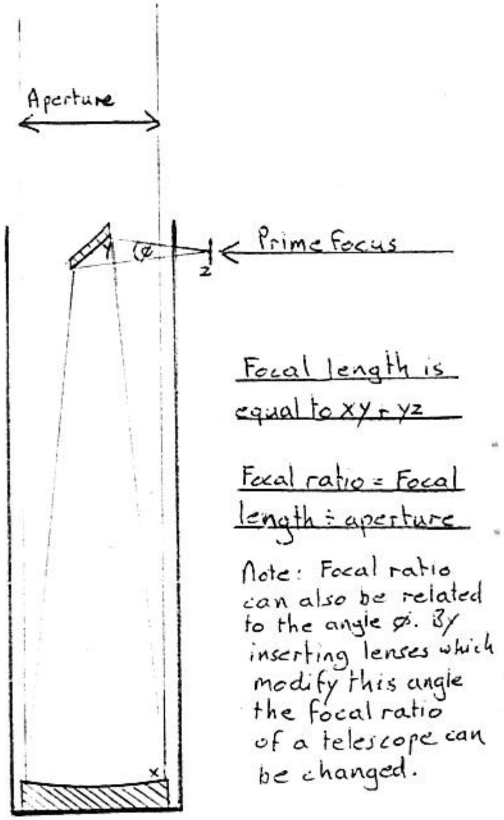
$E/F^2 = e/f^2$

where E and e are the exposures and F and f are the focal ratios.
Thus to duplicate an image made with a 30 second exposure through an f/2 lens with an f/4 lens the exposure would be:

$e/(4*4) = 30/(2*2)$

$e = 120$ seconds.

The focal ratio/image brightness relationship leads to the interesting result that the 50mm lens on your camera at f/4 can photograph exactly the same nebulosity as the biggest f/4 telescope in the world. The image on your film would, however, be very small compared to that of the telescope due to the difference in focal lengths and the resolution on the telescopes photo would be greater due to its greater aperture.
Remember that the image of a point source such as a star is not affected in this manner as it does not give an extended image on the film. Its size is related solely to the aperture as the focal length does not influence the size of the stars final image at the film plane.



If you are serious about astrophotography make some effort to understand the implications of these three factors and you will end up saving yourself much frustration and money. I initially obtained very few good images per roll of film but have suceeded in at least doubling the number of good images since studying the manner in which these factors relate to photography.
Good luck with those photos.

A WONDER ON Y[illegible]R FINGER

Do you know that atomic fusion such as happens in stars can only produce substances up to iron. Iron and any elements heavier than iron can only be fused to still heavier elements by using large amounts of energy. Such reactions therefore do not produce energy, they consume it. Heavier elements such as uranium release that energy when they are broken down and we in fact power our nuclear power stations by the fission (breaking up) of heavier elements such as uranium and plutonium. The interesting thing about all this is that a normal star cannot produce elements heavier than iron. As soon as it would try to do so, the energy preventing the star from collapsing would be used in the reaction and the star would be destroyed. The only time and place where conditions are right for the creation of the elements heavier than iron is during a supernova when elements in the vacinity of iron as well as the necessary energy is in good supply. If you are married you are probably wearing a gold ring. Consider that those atoms of gold were produced in one of the most awesome explosions that nature can produce. Like me, you will probably now have a new respect for the noble metal. You can also truly say that your marriage, or at least the part of it on your finger, started with a great bang.

EDITORIAL

At the last comittee meeting it was pointed out that every good editor should have an editorial and I dont want to disappoint you so here it is.

What to write about though?
After much consideration the subject of contributions comes to mind. So far I have written every single word that has appeared in Urania which makes my title of editor somewhat suspect. This is not meant to be a one man job or a technical journal. Anybody can contribute anything at any level. What we would like to see is an article by a beginner about his experiences and his problems. I want to stress this point - contributions at ANY LEVEL ABOUT ANYTHING ASTRONOMICAL are welcome.
How to submit contributions? The ideal would be in the form of an ascii text file on disc but even a vaguely readable scrawl on the back of a cardboard box would be welcome. Apart from contibutions, letters to the editor would be welcome. Letters about what you ask? Letters complaining about this or that or commenting on some interesting thing you have noticed. Anything! That's the beauty of letters, you can say exactly what you want although I can't guarantee that everything will eventually be printable.

Come on, lets start a Urania contribution fad and make this an internationally famous amatuar astronomers magazine (i.e. Lets put Sky and Telescope out of business).

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EFFECT OF APERTURE, FOCAL LENGTH AND FOCAL RATIO

These factors all have important effects on photography and if you understand these effects you will have a better understanding of the results you can expect.

Lets start off by defining these terms.

APERTURE: The unobstructed diameter of the primary lens or mirror.
FOCAL LENGTH: The distance from the mirror or lens at which the primary image is focussed.
FOCAL RATIO: The focal length divided by the aperture. The focal ratio is always expressed as f/x where x is the focal ratio as such. For a 200mm telescope with a 1000mm focal length the focal ratio is f/5.

EFFECT OF APERTURE

Aperture is probably the aspect of a lens or telescope which is the most important from an astronomers point of view. The first reason for this is that the greater the aperture the greater the area which is collecting light. Since we observe objects which are in general pretty dim, the more light collected the better. Secondly the greater the aperture the greater the resolution. The telescopic image is not a pure one that can be infinitely magnified. Due to diffraction effects the image can be regarded as being made up of thousands of little dots and the size of these dots is proportional to the aperture alone. The formula for determining the resolution of a telescope is:

where K = a constant and A = aperture. When measuring A in inches the constant is 4.56 and when measuring A in millimeters the constant is 115.

With my 200 mm aperture telescope the resolution limit is therefore 115/200 = 0.57. The answer is in seconds of arc and I can therefore at best resolve two stars that are about 0.6 arc seconds apart. Stars closer together than this will always appear as one image and nothing that I could do to the telescope could show them as two distinct stars.

With a larger aperture the telescope is concentrating more light from the star into the final image and consequently the larger the aperture the greater the limiting magnitude that a telescope will reach both visually and photographically. With a 100mm telescope a given exposure will result in stars of magnitude 10 being recorded. A 200mm telescope will record the same stars in much less time. Unfortunately there are so many factors affecting the photographic limiting magnitude that nobody has yet come up with an accurate formula to calculate it.

I have tables and formulae in three books that indicate widely differing limiting magnitudes for the same exposure with the same film speed and the same size telescope. Broadly it can, however, be said that the limiting magnitude is proportional to the square of the aperture X the exposure time X the film speed. As a rough guide I have found that the following formula gives somewhat conservative estimates of the limting magnitudes on photographs.

$$a^2 \times s \times e = 10^{0.4(m-13)}$$

where a = aperture in mm
s = film speed in ISO units
e = exposure in seconds and
m = limiting magnitude

In practice I have reached between 1 to 1.5 magnitudes fainter than that indicated by the formula.

EFFECT OF FOCAL LENGTH

Focal length determines the size of the primary image. I have in a previous article given the formula for determining the prime focus size of any specific object but I will repeat it here for completeness.

h = af/k

where h = size of image at prime focus in mm;
a = angular size of object in seconds of arc;
f = focal length of telescope in mm; and
k = constant = 208000

Lets take a nebula that is 30 minutes of arc (1800 seconds of arc) in diameter and determine the size of the prime focus image in two telescopes with focal lengths of 1000mm and 2000mm. (The prime focus is the area where the main mirror or lens produces its image).

CASE A: Focal length 1000mm
h = 1800*1000/208000 = 8.65 mm

CASE B: Focal length 2000mm.
h = 1800*2000/208000 = 17.31mm

By <u>doubling</u> the <u>focal length</u> we have therefore <u>doubled the size of the image</u> at prime focus.

EFFECT OF FOCAL RATIO

The focal ratio is only of importance photographically and not really visually. Photographically however, it is very significant since it determines the brightness of extended images such as nubulae and galaxies. Remember that the focal ratio is the ratio between focal length and aperture. Lets examine the results at the prime foci of two telescopes both with a focal length of 1000mm but with apertures of 100mm and 200mm respectively. We will once again examine a round nebula which is 30 minutes of arc in diameter.

Case one : focal length 1000mm, aperture 100mm, focal ratio f/10

The diameter of the image at prime focus is 8.65mm and the area of the image is thus 18.75 square millimeters. The light being concentrated into this image is proportional to the area of the mirror. The area of the mirror is 31430 square millimeters and thus we are focussing the equivalent of 31430 units of light into the image. We thus have 1676 units of light per square millimeter.

Case two focal length 1000mm, aperture 200mm, focal ratio f/5

The diameter of the image at prime focus is again 8.65mm and the area of the image is thus also 18.75 square millimeters. The area of the mirror is 125600 square millimeters and thus we are focussing the equivalent of 125600 units of light into the image. We thus have ***6698.67* units of light per square millimeter. We will call this figure the brightness of the image.**