Urania

Astronomical Society of Southern Africa
Pretoria Centre

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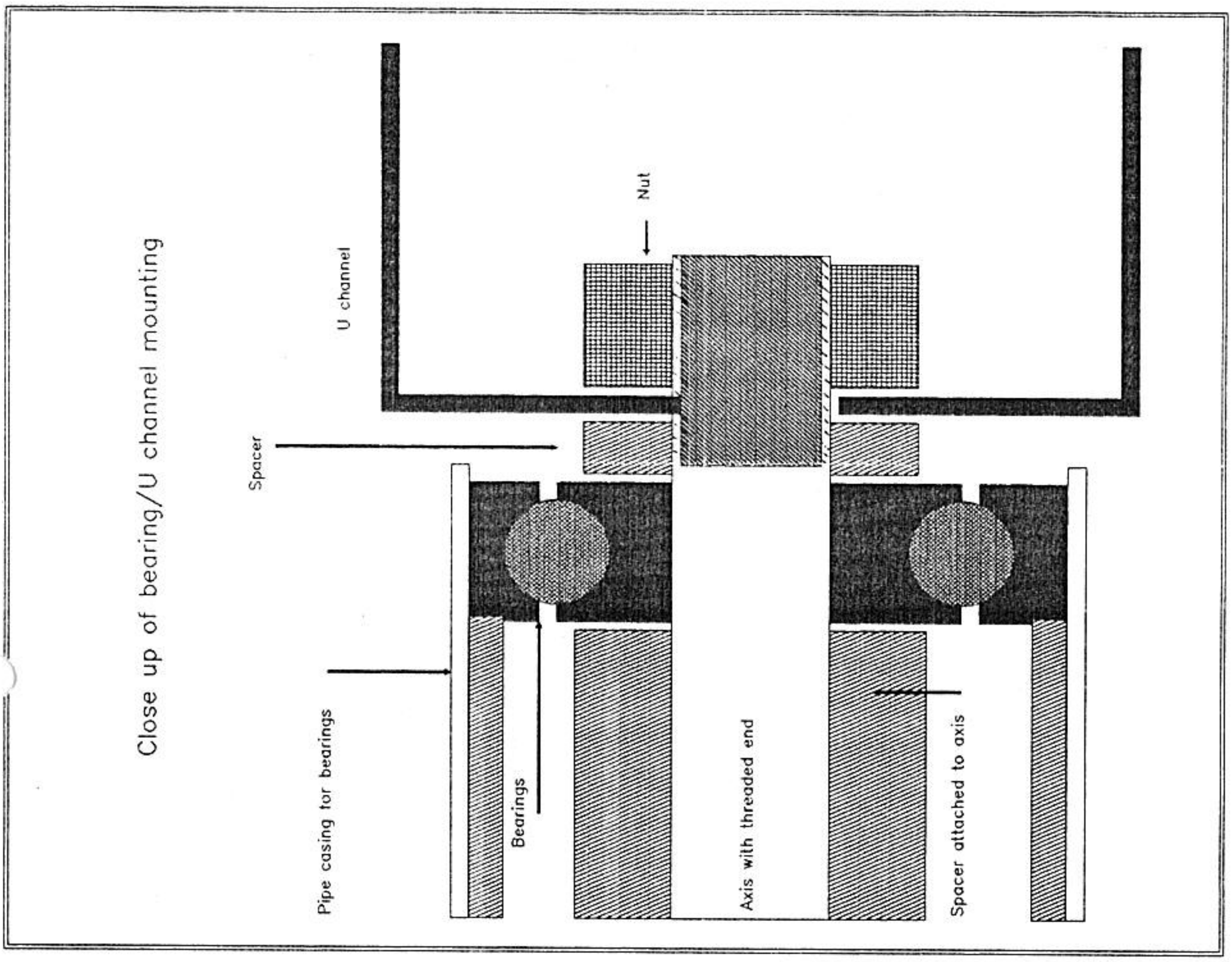
Polar alignment

Haley Mahon has requested advice on a common problem which all of you with equatorial mounts have at some stage come across and which is quite troublesome. How do you achieve polar alignment?

There are about half a dozen ways in which this can be done that I have come across over the years. Only two ways are really satisfactory in my opinion.

The first entails getting to know the dim stars in the polar region and aligning on them. This method is not particularly accurate but can be used for visual observations. Unfortunately we do not have any bright stars near the southern pole and this method is therefore difficult especially from a light polluted Pretoria.

The first step is to set the angle of the polar axis to the latitude at which we will be using the telescope. If we are *25.5* degrees south of the equator the pole will be *25.5* degrees above the horizon. This can usually be done accurately enough by drawing the angle on a piece of stiff card and cutting it out. This card is then placed on top of the polar axis and a spirit level is held on top of the card. If the angle of the polar axis is then adjusted until the spirit level is horizontal, the axis will be at the correct angle. Now align the mounting approximately toward the south pole using the visible bright stars or a compass. Point the telescope as nearly as possible parallel to the polar axis. By rotating the polar axis through at least 90 degrees any stars visible in a low power eyepiece (or the finder) should appear to circle a specific point in the sky. Adjust the declination axis until that center point lies as close as possible to the center of the field of view. (If you cannot bring the center of rotation to the approximate center of the eyepiece your equatorial mounting is badly built in that the telescope is not at 90 degrees to the declination axis or the Dec axis is not at 90 degrees to the RA axis.) Once this has been achieved, the telescope is pointing accurately parallel to the polar axis. Lock both the RA and Dec axis tightly to prevent the telescope from moving. Now examine the stars in the finder scope (or very low power eyepiece) and try to locate the pole by rotating the head of the mounting. The position of the pole is indicated in diagram 1. The stars in the region are quite dim and this may be quite difficult. It is worth while getting to know this region if you want to be able to quickly align your scope. Once the position of the pole is at the center of your


Close up of bearing/U channel mounting

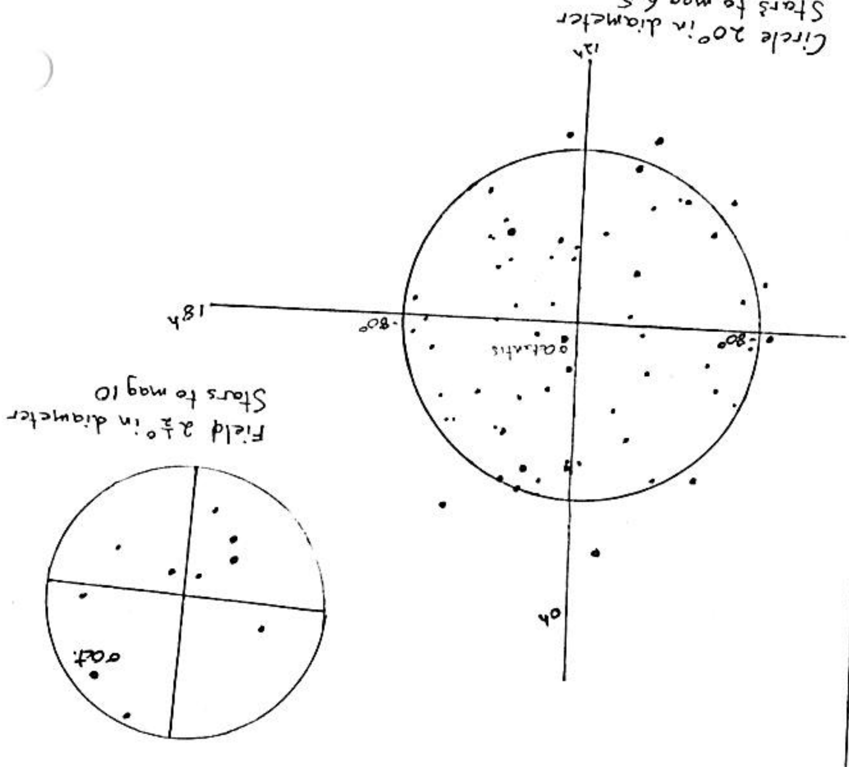


Diagram 1

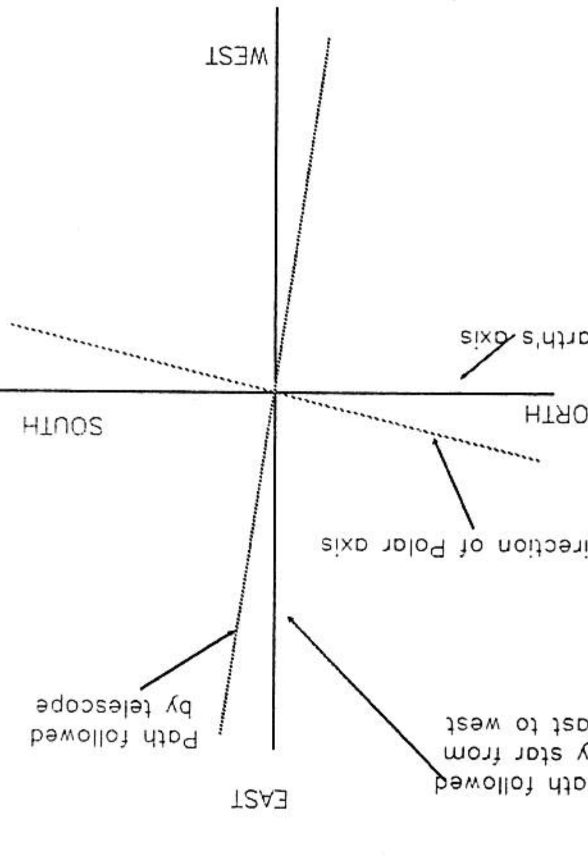
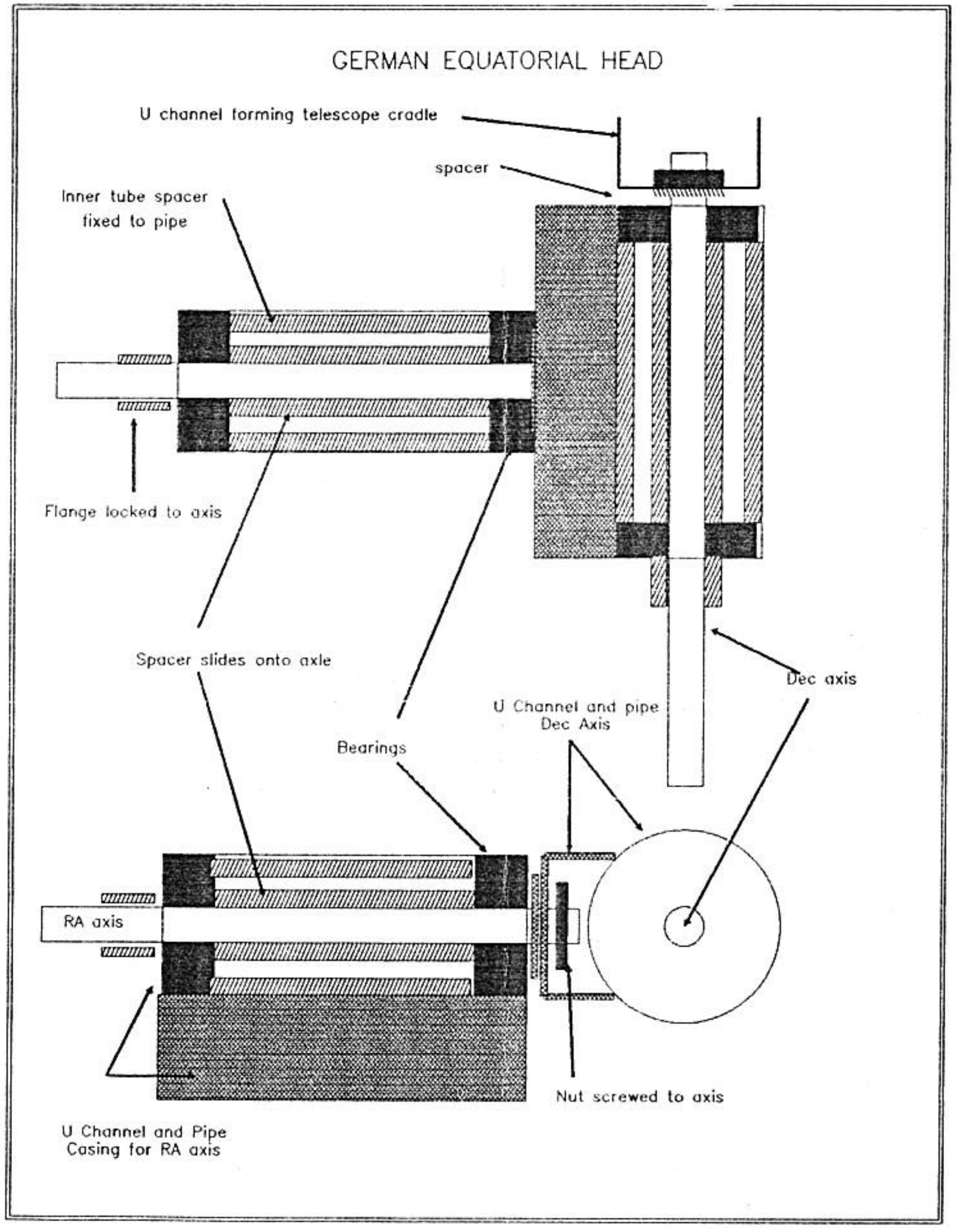


Diagram 2



GERMAN EQUATORIAL HEAD

eyepiece (actually the center of rotation which you determined earlier) your telescope will be aligned fairly closely to the pole.

The second method is in my opinion more simple and can be used to obtain very accurate alignment. Once again the polar axis should be adjusted approximately to the same angle as your latitude and the mounting positioned facing approximately south. Now place a high power eyepiece preferably with cross hairs in the telescope. Find a bright star near the celestial equator on the zenith. (i.e. one that is slightly north of directly overhead). Place this star on the cross hairs or in the center of the eyepiece and follow it for a while by adjusting the telescope in RA only (do not adjust the declination axis). From diagram 2 you will see that if the star appears to drift towards the south, the southern end of your mounting is pointing too far west. If the star appears to move north, your mounting is pointing too far east. Adjust the mounting and track the star again. (Remember that a telescope reverses the field of view. To determine north and south in the eyepiece push the telescope north in declination while looking through the eyepiece. New stars will then enter the field of view on the northern side and will leave the field of view on the southern side.) By repeating the observation/ adjustment cycle enough times it is possible to obtain very accurate polar alignment. The mounting is, however, now only accurately adjusted in azimuth. In order to achieve the same accuracy in altitude, point the telescope at a star near the celestial equator but this time find one near the western horizon. Now when the star appears to drift south in declination, it means that the polar axis is pointing too low. If it drifts north the telescopes axis is pointing too high. This is the easiest method in my opinion to align a telescope since it does not require a view of the pole and can use bright stars.

J W Swart.

BUILDING A GERMAN EQUATORIAL

This month there is very little to say about the mounting and I will merely be giving plans for the head of the mounting. These plans all use commonly available objects such as various pipes, U channel steel etc and are therefore the simplest plans to work with. Such a mounting will not require access to expensive machinery. Next month we will look putting the pieces together.

USING LIGHT

During the course of the last century a certain philosopher was commenting on knowledge which the human race could never acquire. As an example he cited that we could never hope to know what the stars are made of but he was proven wrong within a space of only thirty years. The light which comes to us from the distant reaches of space seems at first glance to be quite innocuous but it is packed with information that we only have to learn to interpret in order to open up vast possibilities. This article looks at what we currently can learn from this ancient light.

All matter is at some temperature. That is to say that there are no atoms drifting around which are not warmed to at least a few degrees Kelvin. Any matter at whatever energy level, radiates some of that energy into space. In the center of a star where the temperatures are very high the matter radiates a continuous spectrum which contains the whole range of radiation from low to high frequencies. Such a spectrum is not particularly useful on its own but luckily this is not the whole story.

It is the electrons surrounding an atom that encode information into a spectrum. When an electron is hit by radiation it jumps to a higher energy level than is usual and in doing so it absorbs some of that radiation. At a later stage, that electron "cools down" and tends to return to its normal energy level by emitting the excess energy as radiation. What makes this so useful is that the atoms of a particular element have certain distinct frequencies that are absorbed or emitted in this manner and which appear in a spectrum as a pattern of absorption or emission ines that can be clearly recognised.

The continuous spectrum emitted at he heart of a star passes through he cooler outer atmosphere of the tar and there certain atoms absorb adiation. The spectrum of a star herefore consists basically of a ontinuous spectrum which has absorption patterns encoded in it. Other material such as interstellar gas may be heated by high energy adiation (i.e. ultraviolet) and later as the atoms "cool down" they emit ght in specific patterns. A nebula uch as the Orion nebula is lit up in his fashion and what we see is not the ultraviolet radiation but the light emitted by the electrons returning to their normal energy levels. This gives us two very useful types of spectrum, the absorption and the emission spectrum. These features in a spectrum were noticed in spectra by the Bavarian optician Fraunhofer as far back as 1814.

From the patterns encoded in the spectrum we can tell accurately what elements are present at the source and from the relative strengths of the patterns we can even determine the relative proportions in which those elements occur. Because the temperature has an effect on the emission or absorption spectrum we can also determine the temperature at the surface of a star. We can determine the stuff from which stars are made as well as how hot that stuff is!.

In 1842 Christian Doppler showed that the frequency of sound varied when the source thereof and the observer were in motion relative to one another. In 1848 Armand Fizeau showed that this principle also applied to light. If a star is moving away from or towards the earth the pattern of emission of a particular element is shifted towards the red of the blue end of the spectrum. The amount of this shift relative to the normal position of the pattern in a spectrum can tell us quite accurately at what relative velocity the source of the light is moving toward or away from us.

This is an exceptionally useful feature of a spectrum that can reveal vast amounts of information. In studying the spectrum of a nova for instance it is possible to accurately measure the velocity of the gases blown off the face of the star, and in due course the manner in which they might slow down or even fall back onto the star. Pulsating variable stars which alternately swell up and shrink back can also be monitored in this way. We can determine the rates at which different stars are moving radially (towards or away from us) and if we monitoring their proper (lateral) motion across the sky we can determine their real motion is space. This enables us to paint a picture of the streams and groups of stars in our vicinity. On a small scale, we can see the dynamic motion taking place in the galaxy! Over a long enough time period we will be able to use this method to understand the dynamics which move stars in clusters.

In a rapidly rotating star the one side is approaching us and the other side is receding from us. This has the effect of broadening the normal spectral lines and from the amount of broadening we can estimate the rotation rate of that star.

In 1894 Pieter Zeeman discovered that a spectrum is slightly modified when the source lies in a magnetic field. This occurs because electrons rotate and constitute in affect a small electric current. When an electric current flows in a magnetic field a force is generated. (This is the principle used in electric motors.) This force has the effect of causing secondary spectral lines on either side of the normal absorption or emission lines. The separation of these lines is proportional to the strength of the magnetic field and it is therefore even possible to measure the strength of such fields in the vicinity of the source.

Apart from stars interstellar gas can also be studied. Since gas is at a lower temperature its emission is at lower energy in the radio end of the spectrum. Radio astronomers have been able to use some of these methods to study the movement of gas clouds in the galaxy and have therefore been able to map a large enough portion of the galaxy to confirm that it is a spiral galaxy.

Moving further out spectral analysis enables us to determine the rate of recession of distant galaxies and quasars. This in turn can be converted to distances and has been the basis of our study of cosmology. The innocuous spectrum has given us a glimpse of an expanding universe and the ancient big bang which started is all.

EDITORIAL

Once again we have a Great Dark Sky Weekend looming. In order not to encourage the weather I will say no more about that at this stage. Once again this editor is worrying about the poor postal services in our country. Of all the thousands of contributions to Urania, not one is getting through to the editor. Perhaps you should hand them to me personally at the monthly meetings. I look forward to a Urania in which the articles next month are written by various members who express their delight with the GDSW.

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