BBC ASTRONOMY

(c)...Brilliant Computing
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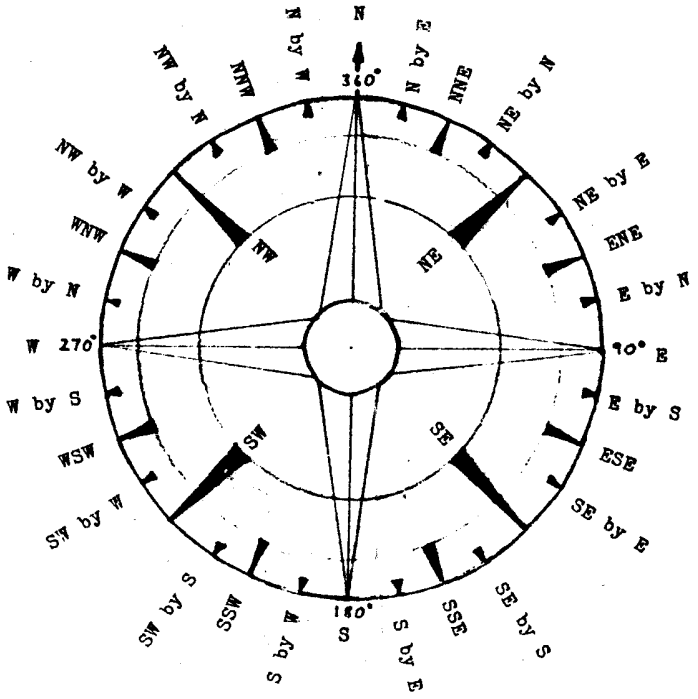

POINTS OF THE COMPASS and AZIMUTH

PLANET WATCHER

This program for the BBC Model B Microcomputer is loaded with the command

CHAIN"" (return)

It takes about five minutes to load. If you make a mistake using the program, press (escape).

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PLANET WATCHER is an aid to planetary astronomy, and will calculate the following data for an evening's viewing:
Julian Date; Rising & setting times (GMT) of the sun, moon, planets; Rising and setting bearings; transit time; Right Ascension and Declination for epoch 1950.0 (α_{50}, δ_{50}) and epoch of date (α_d, δ_d); Constellation in which each planet lies; Distance of planet from earth; Angular Diameter; Phase; Magnitude; Solar Elongation; Greenwich Hour Angle (GHA); Local Hour Angle (LHA); Altitude; Azimuth; Bearing; Parallax of Moon; Sidereal & Local times.

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GREENWICH MEAN TIME

All the data is presented for a 24 hour period lasting from noon GMT one day until noon the next. GMT is the same as British Winter Time, and all times of events given by the computer (e.g. "Sunrise occurs at 8^h25^m ") are GMT, on a 24 hour clock basis.
Thus 10^h30^m is half past ten in the morning, and 22^h30^m is half past ten at night, GMT.
Remember that British Summer Time is one hour ahead of GMT, so 10^h30^m GMT would be half past eleven a.m. in the summer (BST).
Many amateur astronomers have a clock permanently set to GMT all year round, and an internal GMT clock is provided in the program.

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HOW TO USE THE PROGRAM

Let us suppose you wish to go planet-watching on the evening of 9th January 1984. Having successfully loaded the program, you are asked for the DATE. YOU MUST INPUT TOMORROW'S DATE TO THE COMPUTER. In this case, 10.1.84 . This is because more observing is likely to be done after midnight (i.e. the early hours of the tenth) than before.

LATITUDE & LONGITUDE

After you have input tomorrow's date, and the computer has accepted it, you must input your latitude and longitude. You can find these with great accuracy from an Ordinance Survey Map, or less accurately by looking up where you live in the back of an Atlas.

That summarises the basic information available concerning the planets, sun and moon for tonight. The data can be used to plan an evening's viewing. E.g. if the full moon is in Libra tonight, and Saturn is also in libra, then it is not worth looking at Saturn as it will be blotted out by the Moon's light.

If Mercury's solar elongation is 5 degrees, then you may blind yourself if you turn binocculars onto it and catch the sun in the same field of view.

After deciding which planets are the best to view, you can work out when to view them, taking into consideration the data given to you. Suppose you decide to View Jupiter at 23^h00^m (11 p.m.). Because the night sky is rotating overhead, no planet holds its position for more than a few minutes, so you need to know the co-ordinates of Jupiter at exactly this time.

LOCAL CO-ORDINATES

First, you must press "X" on the keyboard as instructed in the menu, to move onto the next part of the program. You are then given a page to read, and when you have read it, press (return).

Now you must input the time you wish to view, in hours minutes and seconds, ~~effectly~~ as in the 'Clock' program on the BBC Welcome tape that came with the machine.

When you have input, e.g., $23^h0^m0^s$, you are again presented with a menu that uses the red function keys to select the planet in question. Pick f_4 for Mars, and you may get a page like this (this one is for 1.30 a.m.)

MARS (Virgo)
Co-ordinates for GMT $1^h30^m0^s$
GHA 19^h42^m
LHA 19^h37^m
Dec $-0^\circ40'$

Altitude $13^\circ59'$
Azimuth $109^\circ59'$

Bearing E.S.E.

Lets start at the bottom. The planet is on bearing East-South-East. This tells you roughly its direction. The AZIMUTH is $109^\circ59'$ - this tells you exactly its direction if you have a accurate compass. The ALTITUDE is how high the planet seems to be in the sky. If 0°, it is on the horizon. If 90°, it is vertically overhead. At $13^\circ59'$, Mars is not very high but is easily visible. Many telescopes have an ALTAZIMUTH MOUNTING, where the altitude and azimuth are read off the scale directly.

JULIAN DATE

appears top right. This is the 'astronomers calendar', which counts off the days since noon on January 1st 4713 BC. It is more convenient to use when talking of periods of 100 or more days than the ordinary calendar.

CONSTELLATION

The next line down is MARS ♂ (Virgo)

This simply tells you that Mars, whose symbol is ♂, lies tonight in the constellation Virgo. (If you haven't a clue where Virgo is, don't despair - more clues follow.)

Rising and Setting Times

Rises at 23^h47^m on bearing 91^c (E.) and sets at 11^h38^m on bearing 268^o (W.)

This tells you that Mars is visible from about midnight until half past eleven tomorrow. Sometimes a planet doesn't rise at all, and sometimes it stays above the horizon all the time. This happens near the poles (the lands of the midnight sun). If this is the case, the computer will say so. Sometimes the planet is a DAYTIME OBJECT, in which case the program may say something like

sets at 18^h 21^m on bearing 252^o (W.by S) and rises at 8^h12^m an bearing 107^o(E.S.E)

i.e. the planet disappears below the horizon at 6.21 in the evening, and doesn't appear again until after eight the next morning. Although it is called a 'daytime object', don't expect to see it in the daytime unless you have very special equipment.

Rise & Set Bearings

When a planet is just rising, or just about to set, it lies close to the horizon, and there is often a magnifying effect by the atmosphere. Thus a compass point and bearing is given for these events, as this can be a good time to view. (See the front cover for the "points of the compass".)

Transit Time

This is when the planet is at its highest point in the sky and is thus another good time to view it. However, you may think that 5^h42^m in the morning is not a good time to view anything!

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After this information on rising, setting, and transit comes a set of data that may seem impenetrable at first glance. However, bear with it - it is all fairly simple.

RIGHT ASCENSION & DECLINATION

The stars in the sky are all given their own 'stellar latitude & longitude' by astronomers, called declination (δ) and right ascension (α). If you want to find a planet on a star atlas, look up α_{50} and δ_{50} in exactly the same way you would look up longitude and latitude of a town in an earth-atlas.

However, because the earth is wobbling on its axis, these co-ordinates change by a fractional amount each year, so the exact position of a planet seen in the sky (as opposed to in a star map) is given by α_d and δ_d.
N.B. Right ascension is measured in hours and minutes, declination in degrees and minutes, by convention. One 'hour' is equal to 15 degrees.

DISTANCE 1.289 AU

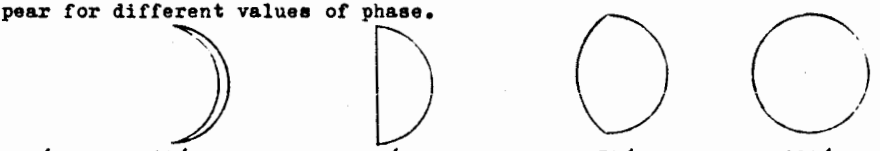
This means that Mars is 1.289 Astronomical Units from Earth tonight. One Astronomical Unit (AU) is the distance from the earth to the sun - about 93 million miles.

ANG.DIAM $0^{\circ}0'7''.26$

The Angular Diameter of a planet is how big it seems from earth. Tonight Mars has an Angular Diameter of 7.26 seconds. As a rough guide, a hair at arm's length is about 1 second wide, and the full moon is about 30 minutes ($\approx$ 1800 seconds) across.
The angular diameter varies with the distance of the planet from earth.

PHASE 90%

The amount of planet lit up is its phase. Here is how planets (and the moon) will appear for different values of phase.



0% new | 10% crescent | 50% half | 75% gibbous | 100% full

MAGNITUDE 1

This is the brightness of the planet. Paradoxically, the bigger the magnitude value, the dimmer the planet. If the magnitude is more than 6 then you will need a telescope or binocculars to see the planet as it will be too dim for the naked eye. The brightest stars have a magnitude of about 1, so Mars is a good, easily visible object tonight.
Very bright objects have NEGATIVE magnitudes; Venus at its best is -4, the full moon is -13, and the sun has a magnitude of -27.

ELONGATION 93 11'

This is the angle made by Sun-Earth-Planet. If the Elongation is small (less than about 10 degrees) then the planet will be very close to the sun and not visible without special equipment. Basically, the bigger the elongation, the better.

On the page for the sun and moon (key f_0) two symbols are used:

π is the moon's parallax

θ is the moon's angular diameter.

The entry in the atlas may look like this;

Stockport, England 53 25N 2 10W

This means latitude is 53 degrees 25 minutes (and 0 seconds) North, so when asked for latitude, input

Degrees	53	(return)
Minutes	25	(return)
Seconds	0	(return)

When you are asked for longitude, input

Degrees	2	(return)
Minutes	10	(return)
Seconds	0	(return)

This is all the information the computer needs to work out the basic planetary data, which takes about 20 seconds.

SUPPOSE YOU LIVE EAST OF GREENWICH:

your entry in the atlas may look like this -

Colchester, England 51 35N 0 55E

East Longitudes are NEGATIVE, so after inputting the latitude (51°35'0") correctly, you must input

Degrees	0	(return)
Minutes	-55	(return)
Seconds	0	(return)

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After you have correctly input tomorrow's date, your longitude and latitude, and been patient while the computer crunches the numbers, you are presented with a menu. By using the red function keys (top row) you can select which planet (or sun/moon) you wish to know about. Suppose you press f_4 for MARS:

1.1.82 Jul.Date 2444970.5
Lat 52°20'0"
Long 1°15'0"

MARS (Virgo)

rises at 23^h47^m on bearing 91° (E.)
and sets at 11^h38^m on bearing 268° (W.)
It transits at 5^h42^m.

α_{50}	12^h28^m	α_d	12^h30^m
δ_{50}	-0°29'	δ_d	-0°40'

Distance 1.289 AU
Ang.Diam 0 0'7".26
Phase 90%
Magnitude 1
Elongation 93 11'

A page like this one should appear. On the top left corner are the date (1.1.82) latitude (52°20'0") longitude (1°15'0") Check these are correct; if not, press (escape).

Remember that Altitude can be negative - i.e. below the horizon. If you come across a planet with an altitude of -25°30', you will need an extremely powerful telescope to see it!

GHA & LHA

The altitude and azimuth of a star or planet change minute by minute as the earth rotates on its axis, and thus to follow an object as it moves across the sky you have to adjust the telescope in two planes.

However, there is a type of mounting for telescopes, much favoured, called the 'equatorial mounting' which overcomes this problem. By slanting one axis to the correct angle, it can be done so that adjustment of the telescope in one plane only is needed to follow a star across the sky.

For this type of mounting, the planes are called 'hour angle' and 'declination' The declination is constant, and only the hour angle needs altering, which is often done by a clockwork motor. Further details can be obtained from most camera/telescope shops, if this interests you.

The computer gives the declination of the planet, and both the Greenwich Hour Angle (GHA) and Local Hour Angle (LHA), enabling you to locate the planet exactly.

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You can now play around with different times and dates, and view any selected page, by using the keys L B R as instructed in the menu.

THE CLOCK

An internal clock is provided with key f_3. When you first press f_3, you are requested to set the clock by inputting the correct time GMT. You must then put in the local time correction (If British Summer Time, input 1. If Winter Time, input 0.) The clock will then display, each time it is called with f_4, GMT, local time (LMT), Greenwich Sidereal Time (GST) and Local Sidereal Time (LST). The last two times are of more interest to advanced astronomers.

The clock runs with famous BBC accuracy (!) and can be corrected by following the computer's instructions, if it is out.