SunTracker

Solar Eclipses Calculated and Displayed

Version for Commodore 64/128; Apple II; IBM PC

Publisher: Zephyr Services, 1900 Murray Ave.,Pittsburgh,PA 15217

For Commodore 64/128 Computers

After turning on the disk drive and the computer, type

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LOAD "SUN",8
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When the program has loaded in, type

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RUN
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The above commands are, as usual, terminated with a press of the RETURN key. Note that in the instructions below, sometimes upper case letters are used for emphasis. Data entries and replies should be made in unshifted mode, however.

The running program will then automatically load in two other programs from the same disk. Then the program will be ready to start. Then follow the detailed directions below.

For Apple II Computers

The disk supplied will load and run if placed in drive 1 and the computer turned on. If you already have the computer on, then with the computer prompt showing on screen, you can place the disk in drive 1 and enter: RUN SUN Then the program will load and run. Then follow the detailed directions below.

For IBM PC & Compatible Computers

At the A> prompt, place the disk in drive A:, then enter: SUN and the program will load and run. Then follow the detailed directions below. (You may also place all the files from the disk onto a hard disk and run from the C> prompt.)

Detailed Directions

You will see the prompt FUNCTION:. To perform each function, just press one key (without RETURN) when you see this prompt. The possibilities are:

S - This requests that the machine tell you what will be the middle of the eclipse seasons for a given year. After you press S, the machine will prompt you to enter the year number. After entering the full year number (do not leave out the 19 in years 19xx), press the RETURN key, and the machine will supply the dates, according to the Gregorian calendar, that the sun will cross the nodes of the moon's orbit in that year. From about 2 or 3 weeks before this date to about 2 or 3 weeks after, any new moon would produce a solar eclipse, and any full moon a lunar one.

The capital A or D following the date tells you if the sun is passing through the Ascending or Descending node of the moon's orbit. Don't worry if you don't know what this means. If you do know, then the information will help you decide whether eclipses before or after this date are more promising for your hemisphere (northern or southern).

For each date you are given, the program lists the age of the moon on that date -- that is, the number of days past new moon phase. Remember that new moon occurs every 29 or 30 days. This allows you to investigate likely dates for eclipses, using subsequently described commands (for solar eclipses).

I - Input a date. After you hit the I key, the computer will ask you to input a date, which you enter in numeric form, MO,DA,YEAR, separated by commas, using the full year number (do not omit the 19 in our century, as in all date input), followed by a comma and a G or a J to indicate whether you entered the Gregorian calendar date or the Julian calendar date. If you are seeking a historical eclipse prior to 1582, the date given in the history book is probably according to the Julian calendar. The calendar we now use is the Gregorian. Years B.C. must be entered in astronomical form; that is, 1 B.C. is entered as 0, 2 B.C. as -1, 3 B.C. as -2, etc.

E - Pressing the E key in response to the FUNCTION: prompt causes the program to compute eclipse elements or the nearest new moon to the last date input via I or output via S (see above). It is not necessary to know what these elements (called Besselian elements) are, but they are listed, and they must be present in the computer before you can tell the computer to draw a map. They will be present in the computer either if you give this command or the L command described below. In either case, the values are listed, and if you know what they mean you can use this description (identified by variable name printed in a string before the values):

JD- the Julian Date rounded to the nearest integer (not to be confused with the Julian calendar date, this is a sequential numbering of days from 4713 B.C. used by astronomers).

YE,MO,DA- The Gregorian calendar date year, month and day.

TO- An arbitrary time during the eclipse, in hours past midnight, from which variations in elements are computed (time given in Ephemeris Time).

DT- The value of delta T, the difference ET - UT, measured in hours.

XO,X1,X2,X3- The value of the x coordinate of the moon's shadow at t-zero, its rate of change per hour, and coefficients of time (in hours) squared and cubed. Measured in earth equatorial radii.

YO,Y1,Y2,Y3- The same for the y coordinate.

L2(O),L2(1),L2(2),L2(3)- The value of l-2, at t-zero, its rate of change, and the coefficients of the square and cube terms of time (l-2 is the radius of the umbra, negative for total, positive for annular, at the fundamental plane).

LL- The difference l-1 - l-2. (l is the radius of the penumbra).

DO,D1- Value of d and its rate of change (declination of direction from which shadow axis comes). (degrees)

MU(O),MU(1)- Value of mu (Ephemeris hour angle of shadow axis and its rate of change (degrees, degrees/hour).

TF(1),TF(2)- tan(f-1) and tan(f-2), the angular radii of the penumbral and umbral cones.

Note that when computed by the E command here, several values are exactly 0. The 12-mile accuracy provided does not necessitate some of the higher coefficients of time. The value of delta T is a smoothed approximation to that irregular and somewhat unpredictable value.

L - Load eclipse elements from disk. If you have the EclipseMaster program, more accurate elements can be computed there than can be obtained from the E command given above. This is not too important for the map, where resolution is only about 70 miles anyway, but the effect on the 12-mile accuracy of E-computed elements can be substantial in the listed values of latitude and longitude on the central line. The EclipseMaster program can put eclipse elements on a disk seq file. The L command given here will input the file from the disk, using the Gregorian date in the computer.

Be sure, then, to use an I command preparatory to the L, and input the date in Gregorian form using the year, month and day exactly as in shown on the directory of the diskette (file name is "ECL year mo da", only single spaces separating items; note that the order of date elements is different from input order For IBM the file is xxxxxxx.ECL, xxxxxxx = Julian day #).

The elements are listed after loading as described under E above. If several are zero, that means they are only approximate elements, of the same accuracy as is obtainable with E above; in that case rerun EclipseMaster using the appropriate command for accurate elements (they take longer to compute and are accurate within 1 mile rather than the 12-mile accuracy obtainable in a shorter of computation).

D - Display solar eclipse map. Once the eclipse elements are present through either the E or L command, the map can be drawn. After D is pressed, in most instances you will be asked if you wish to choose the longitude to be aligned with the long axis of the screen. Ordinarily you will press the N key, for "no". We will get back to this later, but for now let the program determine what it thinks is the optimum longitude.

When you reply N, the blank map will be loaded in from disk and appear on the screen, and the central line will start to be drawn in. (Sometimes if the path is near enough to the equator (the dotted circle) an equatorial map will be used and you will not even be asked if you want to choose the longitude, and the map formation will start without any further reply after the D command.)

As the central line forms, data are shown for points on the central line at the bottom of the screen. Each new line shows Universal Time (hrs:min with decimal of minute), latitude of point on central line (decimal degrees), longitude, width of the path of totality or annularity in kilometers, width in miles, duration of totality or annularity in minutes:seconds as seen from the central line, and the altitude in the sky that the sun will be as seen from the central line (degrees). If the eclipse is total, widths and duration will be negative. If the eclipse is annular, they will be positive.

When the program has finished drawing the central line a bell will ring and the lines of text at the bottom will disappear. Press the space bar momentarily to flip to the full text display of all the points on the central line. Repeated pressings alternate the text with the map. Use of most any key will do this, but do not use Q or C for this purpose as they do special things described below.

Note that if approximate elements are in the machine, such as those computed by E within this program, accuracy of the path of the central line is limited to 12 miles. This is higher than the 70-mile resolution of the map, but the text shows latitude and longitude to the hundredth of a degree. But 12-mile accuracy is equivalent to a possible error of about .2 degrees on the earth's surface.

Whether looking at the text or the map, once the map has been finished, pressing Q or C will do certain things:

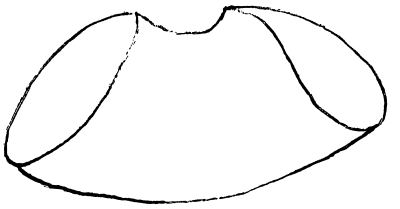
Q- quit this eclipse display. The machine will then accept further primary commands (S,I,E,L,D,etc.).

C- continue with further drawing on this map. This will be described below.

If you only wanted to see the central line, you would press Q when you were finished. But if you want to see the boundary of the visibility of the eclipse as partial, you will press C when you are ready for the machine to continue into that phase. (Some eclipses are partial altogether and there will be no central line, thus the text lines disappear immediately on the bottom and the terminal bell is heard immediately; press C to see the bound of partial eclipse).

When you do press C, the program will ask "Bound of how many percent?". If you wish the entire area of visibility as a partial eclipse to be enclosed within the bound the machine is to draw in, reply 0 (zero) and press RETURN. If it were desired to have the area from which the eclipse was at least 50% magnitude drawn in, you would reply 50 instead of 0. (50% magnitude means that 50% of the sun's diameter is covered.)

When you have given your response the machine will start drawing in the boundary of visibility. In general the boundary will look something like this (north is on top here, but will probably be left or right on the screen if eclipse is not near enough to the equator to use an equatorial projection):



The loops at the west and east ends are areas where the eclipse is in progress (with at least the given magnitude) while the sun is rising or setting respectively. The other two lines are the limits of visibility as the path crosses the earth. Sometimes the two loops merge into one figure-8, and there is only the southern or northern of the boundary lines; this happens when the shadow axis falls sufficiently far from the center of the earth so that the full penumbra never falls completely on the earth's surface.

As the bound forms, sometimes it seems as if nothing is happening, as the program attempts to fill the gap to the east and west loops, but be patient and wait for the bell that indicates the bound is done. (Be sure the volume is up so you hear it.)

When the boundary is finished, the machine will again ring a bell. If there is no eclipse at all of the given magnitude the program may hang up. (If no part of the bound appears within one minute, exit the program and restart again.)

After the limit is drawn, you can again type C for continue, if for example you had done bound of 0% and now wish to do bound of 50%. Or you can press Q to quit.

We will defer description of the capability of choosing the longitude of orientation of the map until the example is described below.

O - The EclipseMaster program can compute the elements of an occultation of a star or planet by the moon. The area of visibility of such an occultation can be shown using the D command above, if you first load the elements of the occultation using this O command. It works the same way as the L command except that the disk file name begins OCCN instead of ECL (xxxxxxx.OCN for IBM), but that is transparent to the user.

Example of use:

First find the eclipse seasons for 1970. Use the S function.

function: s

The machine will ask for the year, to which you reply 1970 (RETURN). You will then get a list:

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Mar 4 1970 Greg    A   Moon 26 days old
Aug 24 1970 Greg   D   Moon 22 days old
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Thus March 4, the middle of an eclipse season, occurs just 3 or 4 days before a new moon, so we expect a solar eclipse around March 7 or 8. Let's investigate. When you are asked for a function, reply I and then proceed to enter the date 3,8,1970,g in response to the request that you enter a date (the G is for the Gregorian calendar we now use).

The next function to use is E. After about 20 seconds the program lists the elements, including the date 1970 3 7, or March 7, 1970. Note that some elements may be broken by the right edge of the screen and thus split into two lines.

To see the map press D (for display), then reply N to whether you wish to specify longitude. The central line will begin to appear. When it is finished a bell is heard and you can press the space bar to flip between the list of points on the central line and the map.

One of the points on the central line, at 18:30.5 UT is, considering the accuracy of our elements, lat. 34.7 deg.N (north is positive), long. 78.7 deg.W (west is positive), at which point the path of totality (negative indicates total) is 136 km wide (84 miles). From that point on the central line totality lasted 2 min., 58 sec., and the sun was 47.3 deg. up in the sky. If you have the EclipseMaster program you may wish to compare to more accurate computations.

When you have viewed the map and text, press C to continue the map drawing. Reply 0 to "how many percent?" (be sure to press RETURN). The bound of the partial phase of the eclipse will start to form. Note that on the map longitude 90 deg.W extends out to the left. Be patient as the bound forms; when you hear a bell (assuming your volume is up), you can continue. When the bound has formed, note that at the top of the screen towards the left a portion of the boundary has been flattened against the edge of the viewable area of the screen.

It turns out that a better choice of central longitude could have been used, than the one chosen by the computer. As the longitude must be an integral multiple of 45 deg., a choice of 135 is the next available one. You can wait for the drawing to finish (hear the bell), press Q, press D, then reply Y to whether you wish to specify the longitude, and then specify 135.

Note that when the central longitude is 135, it appears on the right side of the screen. Only so many maps fit on the disk and 135 serves also as -45 (negative is east longitude). Allow the central line to finish, listen for the completion bell, press C to continue, ask to see the bound of 0%, and see the improved results.

Note that the northern eclipse limit runs approximately north-south in Alaska, connecting the top of the western loop (containing Hawaii) to the top of the eastern loop (containing Iceland). In this eclipse the eastern loop itself forms a figure-8 and if you look closely you can see the crossover point near the north pole. Also note that the southern limit (the line going through South America in this eclipse) usually does not quite connect to the southern edges of the two loops, but it is easy to imagine the proper connection, which is tangent to those loops. In this case the gap is larger at the western loop, but its tangency to the western loop is easily imagined.

When the finish of the bound is announced by the bell, press C to continue and this time specify 50%. The inner band that will appear forms the area of visibility of at least half the sun's diameter being covered by the moon.

At any time after the display is completed you can flip between the list of points on the central line and the map by pressing any character key except Q or C (space bar is recommended).

You may terminate the program entirely by pressing stop-restore(C64); ctrl-reset(Apple); ctrl-break(IBM).

Any graphics dump program may be used to send the hi-res screen to the printer(C64 or Apple). For IBM, run graphics.com(on DOS disk) before Moontracker, then use shift+PrtSc to print screen on a graphics printer.