Apparent Positions of The Planets
ASTR 101

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1 Objective

This report will demonstrate the proper procedure of finding planets apparent positions in the sky. It explains how to map the planets on a polar coordinate graph and ecliptic constellation chart as well as the use of a planisphere.

2 Introduction

Observation of the planets dates is an important task in the field of astronomy. The term planet comes from Ancient Greek meaning "wandering star". Ancient tribes first spotted these stars moving against the backdrop of other stars and have been since studied for their orbits, elemental make-up as well as other properties. While most planets in our solar system have been discovered by simply looking up at the sky, some have also been discovered by mathematics (Uranus). As science has evolved, our model for the planets has moved from and Earth to Sun centred, which has drastic effects on the planet's orbits. After having read this report, our view of how to find the planets in the sky should become clear as well as having a broad understanding of their orbits in both distance and period.

3 Equipment

The three main pieces of equipment required for this lab are as follows. First, a polar coordinate graph which is used for charting where planets are relative to the sun at any given point. This report will use the chart with measuring 1

AU as one dark black ring from the centre. Second, a constellation equatorial chart. This chart has measurements in declination, measured in degrees, and right ascension, measured in hours and minutes. Lastly, a planisphere is needed, which is a quick reference to stars given a day and time of night. Other common equipment needed for this lab includes: protractor, scissors, and coloured pencils.

4 Procedure

Given the data inside of Table 1 and Table 2, a heliocentric sketch was made of Venus', Earth's, Mars', Jupiter's, and Saturn's position at the dates of 2012-Sept-22, 2012-No-21, and 2013-Mar-20. This was accomplished by first looking up a planet in Table 2 to find its orbit radius (measured in A.U) in order to give it a distance away from the sun. We are assuming perfect circles for orbits. Next, a lookup of the planet's heliocentric longitude was preformed on Table 1. With these two coordinates, a sketch of where the planet should be located was able to be made on the polar coordinate graph given that the sun was placed at the centre and that each dark black line represented 1 A.U. This process was repeated for all five planets and all three dates listed in Table 1

Next, the visibility of each planet given the four times of day: noon, sunset, midnight, and sunrise are made. This was accomplished using a small piece of paper as a guide for East and West on the Earth placed over top of the Earth in the sketch made above. Knowing, the Earth rotates counter clockwise, if viewed from above, the paper guide was rotated to simulate a field of vision on the Earth at the four given times of day. A planet's visibility can then be determined by locating it (visible) or not locating it (not visible) in the 180° view provided by the paper guide. These results can be found in Table 3.

Now, the determination of the planet's alignment is made. By looking at sketch made above, it was determined (for the day of 2012-Sept-22) what a planet's alignment is relative to the Earth and Sun. This was done purely by observation and with approximating the planet's actual position to that of a specific alignment. The results from these observations can be found in the Configuration column of Table 3.

With the now sketched heliocentric view of planetary positions, geocentric equatorial positions of the planets were then calculated for the day of 2012-Sept-22. This was accomplished by first measuring the geocentric ecliptic longitudes of the planets. This was calculated by measuring the angle between the Earth and the planets in question, noting that the Earth is now the origin of measurement as opposed to the sun and that angles are measured from. These measurements can be found in the Ecliptic Long. column of Table 4. Next, a plot of the ecliptic longitudes was made onto the provided SC001 constellation chart. This was accomplished by simply mapping the found ecliptic longitude above with the given degrees on the ecliptic on the SC001. Finally, the right ascension (measured in hours and minutes) and declination (measured in degrees) were measured off the SC001 chart for the Sun and given planets. The results of these readings can be found in Table 4. These results are our final geocentric equatorial positions of the planets.

Lastly, minor approximate measurements were made using a Planisphere. The Planisphere was used by placing a provided circular map of the stars with labelled months and days of the year underneath an ellipse which has times of night and rotating the circular map of the stars so that your desired time and day match up. What is shown through the ellipse of the stars is what will be visible from the given latitude of the planisphere. The measurements taken can be found at the bottom of Section 6.

5 Observations

All observations for this report were made on the day of 24/09/2012. As this report is based off of given numerical data as well as paper observations, weather conditions and time of day have not been reported as they hold no effect. For all observations made using the polar coordinate chart, the chart and its sketches can be found as Figure 1 in the back of this lab report. These observations include: the planet's position at the given dates in Table 1, ecliptic longitude of planets, and approximations of planet's alignment. All observations made using the SC001 constellation chart can be found as Figure 2 in the back of this report. These observations include both the measurements of right ascension and declination of the sun and planets.

6 Tables and Measurements

Date	Venus	Earth	Mars	Jupiter	Saturn
2012-Sep-22	068	000	261	065	211
2012-Nov-21	166	060	297	070	213
2013-Mar-20	354	180	011	081	217

Table 1: Heliocentric Longitudes from Astronomical Almanac.

7 Questions

The following questions and answers are asked throughout the lab manual for ASTR101 Lab 2. The questions have been repeated for the reader.

Planet	Orbit Radius (A.U)	Period (years)	Symbol
Sun			☉
Venus	0.72	0.62	♀
Earth	1.00	1.00	♁
Mars	1.52	1.88	♂
Jupiter	5.20	11.86	♃
Saturn	9.54	29.46	♄

Table 2: Radii and Period of Orbits.

Planet	Noon	Sunset	Midnight	Sunrise	Configuration
Venus	✓			✓	Greatest Western Elongation
Mars	✓	✓			Greatest Eastern Elongation
Jupiter			✓	✓	Quadrature
Saturn	✓	✓			Conjunction

Table 3: Planets as seen from the Earth.

Planet	Ecliptic Long.	Constellation	Right Ascension	Declination
Sun	180°	Virgo	12:00	0°.
Venus	134°	Cancer	09:02	16°.
Mars	230°	Libra	15:10	-17°.
Jupiter	73.5°	Taurus	04:41	21°.
Saturn	207°	Virgo	13:42	-11°.

Table 4: Geocentric Equatorial Position of the Planets.

Q. Why does Venus go through phases?

A. Venus has phases similar to that of the sun because of the view the Earth has of Venus as it travels around the sun *inside* of the orbit of the Earth around the sun. The different phases are caused by the different perspective we have on Earth of the sun shining on Venus. Figure 3 below shows how the different phases of Venus appear from Earth.

Q. In which zodiacal constellation was the sun located when you were born? What is your astrological sign? Check with your partners and discuss any discrepancy.

A. As per Figure 2, the sun was located in Gemini when I was born on July 12th. This is a discrepancy with my astrological sign of Cancer. This difference is caused by the precession of the Earth.

The following answers are labelled to coincide with the lab manual for ASTR101 Lab 2 section "The Use of a Planisphere". As questions 1 and 3 are instruc-

Figure 3: The phases of Venus.

tions rather than actual questions/measurements, they have been skipped. All answers are given using the provided planisphere and approximations.

2. While the circular dial is being rotated, the star Polaris does not seem to move.

4. At the time of 12AM on the night of June 01, the star Vega, which is apart of the constellation Lyra, appears to be in the centre (Zenith) of the planisphere.

5. At the time of 12AM on the night of June 01, the star Spica, which is apart of the constellation Virgo, appears to be on the "Western Horizon" of the planisphere.

6. At the time of 11PM on the night of June 15, the star Vega again appears at the Zenith while the star Spica again appears at the "Western Horizon" of the planisphere.

7. At the time of 11PM on the night of August 15, the star Deneb, which is apart of the constellation Cygnus, appears to be at the Zenith, while the star Arcturus appears to be at the "Western Horizon" of the planisphere.

8. On the night of September 22nd, the star Antares will set at approximately 9PM. The star Antares will also set at 1AM on the night of July 30th.

9. On the night of January 1st, the star Sirius will rise at approximately 7PM and will set at approximately 5AM, giving a total time of 10 hours above the horizon.

8 Conclusions/Discussions

This report has shown how to locate a planet in the sky given initial data points for orbit radius and heliocentric longitudes. This report has also shown the use of a planisphere for quick star reference at a given latitude.

9 Evaluation

I found this report very useful for my own observational interest. I recently acquired a Celestron Super C8 Plus and have been interested in observing the planets but have not known how to properly find them in the sky. I now have the required skills to be able to find planets and make predictions of their whereabouts throughout the year. However, I would have liked to have had the opportunity to actually take a measurement of the planet rather than just have the initial data provided.

References

[1] Smith, J. M. and Jones, A. B. (2012). *Chemistry*. Publisher, City, 7th edition.