Jupiter Elevation Angle Determination at Baghdad Location

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Abstract

In this paper the elevation angle of Jupiter at Baghdad location according to its coordinate for the period (2005-2020) has been studied. The Radio Jove pro. Edition program is used to achieve the Jupiter elevation angle at this time period. In 2007, 2008 the path of Jupiter is appeared near the horizon when the monitor trying to observe it. While in 2013, 2014 it's reached its maximum value then its return to reached its minimum value at 2019, 2020 according to the position of Jupiter in Baghdad for this period.

Keywords: Jupiter radio emission, Jupiter elevation angle, observing Jupiter, Jupiter radio signal

تحديد الارتفاع الزاوي لكوكب المشتري لمدينة بغداد

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الخلاصة

في هذا البحث الارتفاع الزاوي لكوكب المشتري في بغداد حسب الاحداثيات الديكارتيه الخاص بها للفتره من (2005–2020) قد درست .استخدم برنامج (Radio Jove pro.) لتحديد زاويه الارتفاع لكوكب المشتري وللفتره الزمنيه المذكوره اعلاه .من خلال تتبع مسار كوكب المشتري. لوحظ بان ارتفاع المشتري في سنه 2007و 2008 يكون اقرب ما يمكن للافق بالنسبه لراصد يحاول رصد الكوكب من على سطح الارض بينما في سنه 2013و 2014 زاويه ارتفاع الكوكب تصل اعلى نقطه ثم يعود للنزول ليصل الى اقرب مستوى من الافق في سنه 2019و 2020 وفقا لموقع المستوي في السماء وبالنسبه الى راصد في بغداد

Introduction

Jupiter is the largest and most massive planets in the solar system containing 71% percent of all the plantery matter [1]. Its diameter is approximately 11 times as large as the Earth's and 1/10 as large as the sun's. Despite its huge size and tremendous internal pressure, the density of it is only 1330 Kg/m^3 (1.33 times the density of water). This is only 25% of the Earth's density.

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The outer layers of it, and the other giant plants, consists of the almost entirely of transparent gas, clouds of liquid and solid droplets produce wealth of colored features. The largest and the most famous one of these features is, the Great Red Spot (GRS), an immense rotating cloud pattern that found in the southern hemisphere, which was discovered by Giovanni Gassini in 1665. The colors of it range from reddish- pink to blue-gray. Although it's certainly colorful, its colors are much more subdued than those of the Earth. In addition to the Great Red Spot there were other features on the surface of Jupiter called dark brown oval, which dark gases oval is in the lower hemisphere. Belts and zone are also features exist on the surface of Jupiter, their intensities are changeable [2] Belts are defined as warm gases from the interior of Jupiter rise upward, produce low, warm and dark clouds, while zones produce high, cool and light clouds [3].

The magnetic field of Jupiter cloud tops is 14 times as strong as the magnetic field at the surface of the Earth. Jupiter clouds are much farther from the internal dynamo that produces its magnetic field than the Earth's surface is from the Earth's dynamo, so the magnetospheres of Jupiter resemble the Earth's. They obstruct the flow of the solar wind, Jupiter as the Earth's magnetosphere does and cause it to flow around them; the solar wind compresses the magnetic fields on the Sun ward sides and stretches them to great length on the night sides. The strong magnetic fields of Jupiter produce magnetospheres much larger than the Earth's [4].

Jupiter's magnetosphere would produce glowing area covering four times the area of the full moon. The magneto tail of Jupiter extends at least 650 MKm behind Jupiter, as shown in figure -1. The inner magnetospheres of Jupiter trap energetic ions and electrons in the Jovian equivalent of the Earth's Van Allen belts. When particles in these belts penetrate into the upper atmospheres of Jupiter they produce the strong magnetic field of Jupiter carves a huge magnetosphere out of the solar wind [5].

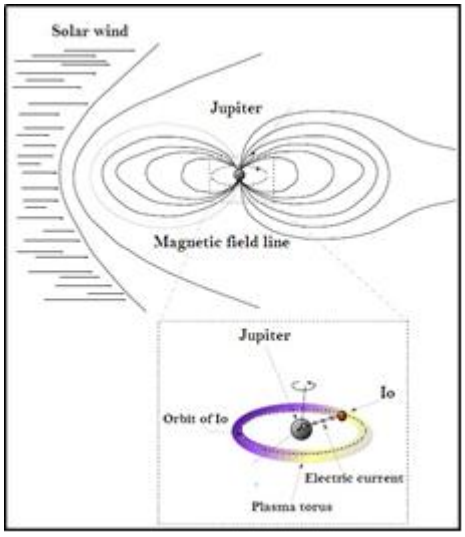

Figure 1- The magnetosphere of Jupiter [7]

Jupiter Radio Emission

Jupiter emits two types of radio radiations thermal and non-thermal radiation. Thermal radiation from the atmosphere, which is occurred at high frequency range, is caused by the interactions between electrons and atoms or molecules in a hot dense medium[6]. The amount of radiation emitted depends on the temperature of the material producing it. Non-thermal radiation results from the radio bursts originating on Jupiter's surface, it is called non-thermal, because it does not originate from the energy that every object with a temperature above absolute zero is radiating at all times [7, 8]. This kind of radiation is divided into decimetric (DIM) and decametric (DAM) (bursts) radiation both of these two radiations considered as a part of synchrotron radiation, which is produced when charged particles in the speed of light flow through a strong magnetic field [2], as shown in figure -2 [8].

The DAM radiation occurs at wavelength of tens of meters, and frequency range (10-40) MHz, which is described as a complex and highly organized in the frequency time domain. The observations of Jovian DAM radiation is the only one that can be observed from Earth. The studies of the Jovian

radiation show, in particular, its great variability. Many kinds of changes of radiation are observed with time scales from milliseconds to days [9]. The DIM radiation occurs at wavelength range (1-10) cm and frequency range (40-400) MHz, which is more constant than the DAM radiation. It is thought to be caused by electrons orbiting along magnetic

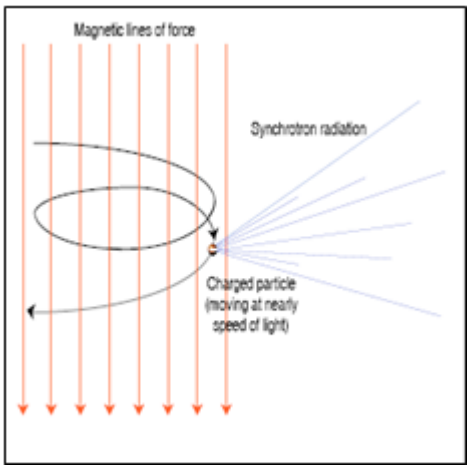

Figure 2- The synchrotron radiation [7]

Field lines and interacting with the motion of Io's satellite. These two kinds of radiation remain the main components. No other planets in the solar system emit these two radiations, at frequency below about 10 MHz the hectometric radiation (HOM) is occurred [10]

Jupiter Position in the Earth Sky

In summer the Sun passes high overhead in the northern hemisphere while in winter it is lower in the southern sky [11]. Using the equator as a reference, the north or south position of a celestial body is known as declination. Jupiter's declination goes true changes similar to the Sun, but it takes nearly 12 year for a complete cycle [12]. Its declination directly effects how high it will appear in the sky. The highest point in Jupiter's daily track across the sky occurs at transit. Transit is when a celestial body is crossing the observer's meridian, when the object on the observer's longitude[13] . The maximum elevation angle (angle measured upward from the southern horizon) of Jupiter depends on the declination of Jupiter and the latitude of the observer. The further north, an observer is located; the lower in the southern sky Jupiter will be appeared. According to the observer standing

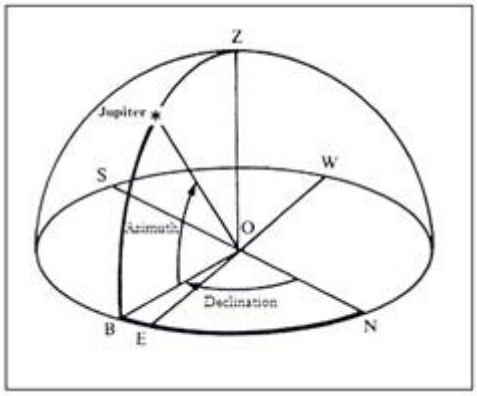

Figure 3- Explains Jupiter position in the sky [12].

On the Earth to observing Jupiter, his coordinates must be determined where the observer coordinate in this case is, the horizon coordinates, which is, azimuth and altitude of an object in the sky that are referred to the plane of the observer's horizon as show in figure -3.

Study of Jupiter Elevation Angles for (2005-2020) Year:

The goal of this section is to study the elevation angle of Jupiter for the period from (2005-2020) at a location of Baghdad, the radio JOVE pro. software is used to fined the result of Jupiter elevation angle from table [(3-1) to(3-16)] are carried out on the first day for each month by entering latitude, longitude and date.

From our analysis to the result it's found that the elevation angle of Jupiter (height of the Jupiter above the equator when the monitor observe above the horizon). The elevation angle of Jupiter reached minimum value in (2008) where it's value is (33.38) degree at hour (8:15) where this time is represented the time when Jupiter is at peak above the equator in the other word when Jupiter is at maximum value of it's path above the horizon as shown in figure-4.

The path of it will be continues in rise also it reach maximum value in January in 2012 where its elevation equal (78.57) degree approximate at time (16:10) hours. Then the Jupiter will be return to its minimum value at January in (2020) to reached 28degree that's mean the Jupiter is complete full cycle approximating of (11.7) year. By examining the elevation angle of Jupiter which is taken to the first day to the each month in the each year notice it is changing from year to year so at (2005) the elevation angle of Jupiter at January equal (51.26) degree while at 2006 its equal (42.11) degree and in (2007) equal (35.74) degree. After that it is return to reduce to reached (33.38) degree in (2008) and (35.76) degree in (2009) that's mean the position of Jupiter is approach to the horizon in this year while it will be rise after (2010) to reach (54.11) degree and its continues rising to reached (74.98) degree at the first day of April (2013), and after that it will be decline reach its minima elevation angle at the December in (2020).

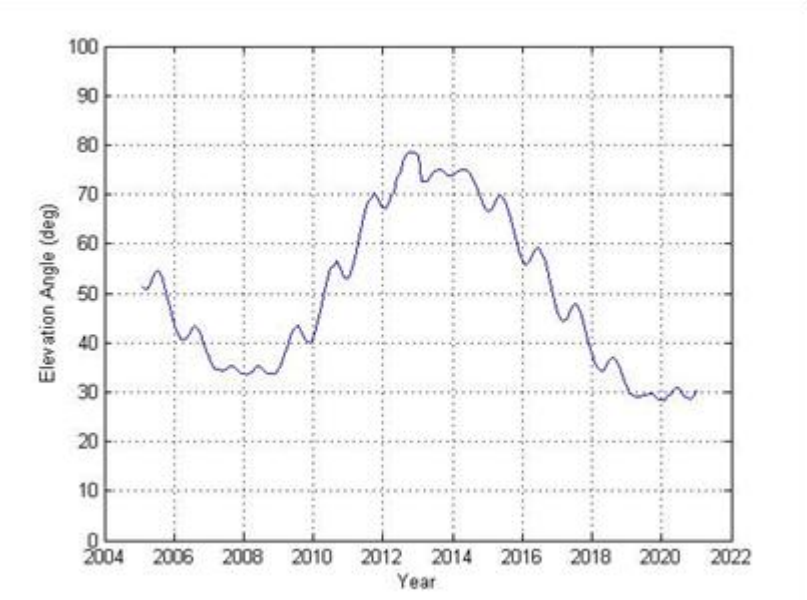

Figure 4- The elevation angle at transit during 2005 to 2020

As shown in tables (1) to (16). for observer at Baghdad by its longitude and latitude by especial.

The figure (4) plot the curve from tables [(3-1) to (3-16)].The declination of Jupiter changes each year for complete cycle it takes nearly approximately (12) year which is evident from figure-4.

It is note from the figure that in the middle of year (2008) the declination of Jupiter is very close to the equator. While in (2014) Jupiter is at its maximum northern declination then repetition after twelve's

year to see the Jupiter declination is very close to the equator in (2020).Thus the Jupiter complete cycle at approximately (12) year.
The declination of Jupiter contributes directly to show how high it will appear in the sky. The highest point in the daily track of Jupiter across the sky occurs when celestial body crosses the meridian of the observer called transit. Jupiter maximum elevation angle depended on its declination and the latitude of the observer.

Conclusion

The path of Jupiter is changing from year to another and its complete cycle each 12 years without returning to the same position exactly. Jupiter elevation angle has an approaching value in the year 2005, 2006, while its value was different in 2013, and 2014 where this variety of the value that depends on path of jupiter in the sky.

Table 1- Elevation angle of Jupiter in 2005

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	51.26	03:15
February	50.65	01:15
March	51.12	23:15
April	52.56	21:05
May	54	19:00
June	54.43	16:40
July	54.15	14:55
August	52.77	13:10
September	50.47	11:10
October	48.19	09:35
November	45.92	08:05
December	43.56	06:20

Table 2- Elevation angle of Jupiter in 2006

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	42.11	05:00
February	40.8	01:30
March	40.6	3:00
April	40.85	23:10
May	41.81	21:00
June	42.79	18:40
July	43.34	16:40
August	42.93	14:40
September	41.87	13:00
October	39.95	11:00
November	38.57	10:00
December	36.91	08:00

Table 3- Elevation angle of Jupiter in 2007

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	35.74	06:30
February	34.79	05:30
March	34.62	03:30
April	34.41	01:30
May	34.37	23:55
June	34.78	21:10
July	35.19	19:10
August	35.23	16:40
September	34.99	14:40
October	34.4	13:40
November	33.74	11:10
December	33.63	10:00

Table 4- Elevation angle of Jupiter in 2008

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	33.38	08:15
February	33.81	07:00
March	34.06	05:10
April	34.81	03:40
May	35.12	01:55
June	34.98	23:55
July	34.38	21:30
August	33.82	19:10
September	33.64	17:10
October	33.65	15:10
November	33.82	13:10
December	34.64	11:40

Table 5- Elevation angle of Jupiter in 2009

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	35.76	10:40
February	37.49	08:45
March	39.07	07:10
April	41.05	05:50
May	42.46	04:00
June	43.14	02:00
July	43.3	00:20
August	42.23	22:00
September	40.93	19:50
October	40.14	17:45
November	40.03	15:20
December	41.16	13:40

Table 6- Elevation angle of Jupiter in 2010

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	54.11	14:00
February	55.96	12:05
March	58.63	11:05
April	61.46	09:10
May	64.07	08:05
June	66.71	06:05
July	68.64	04:30
August	69.77	03:05
September	70.26	01:05
October	69.88	22:40
November	68.35	20:20
December	67.29	18;10

Table 7- Elevation angle of Jupiter in 2011

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	72.68	03.21
February	72.53	01.10
March	72.78	23.15
April	73.56	21.35
May	74.3	20.05
June	74.84	18.30
July	75.02	17.00
August	74.87	15.30
September	74.4	13.30
October	73.92	12.10
November	73.71	10.20
December	73.89	08.20

Table 8- Elevation angle of Jupiter in 2012

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	44.78	12:00
February	44.22	10:15
March	44.5	08:15
April	45.81	06:10
May	47.17	03:55
June	47.95	01:55
July	47.66	00:00
August	46.36	22:00
September	44.38	20:10
October	42.05	18:25
November	39.59	17:25
December	37.76	15:30

Table 9- Elevation angle of Jupiter in 2013

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	74.36	06:00
February	74.81	03:40
March	75.10	01:55
April	74.98	23:55
May	74.73	22:00
June	74.07	20:30
July	73.09	18;55
August	71.7	17:20
September	69.93	15:35
October	68.51	14:10
November	67.15	12:20
December	66.47	10:50

Table 10- Elevation angle of Jupiter in 2014

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	28.26	17:50
February	29.04	15:50
March	29.38	14:50
April	30.4	12:55
May	30.83	10:45
June	30.75	08:50
July	30.18	06:50
August	29.23	04:50
September	28.85	01:50
October	28.54	00:50
November	29.17	22:55
December	30.34	20:50

Table 11- Elevation angle of Jupiter in 2015

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	29.71	15:00
February	29.53	13:50
March	29.22	12:20
April	29.01	10:20
May	29.02	08:20
June	29.28	06:20
July	29.45	04:20
August	29.67	01:50
September	29.54	23:50
October	29.05	21:50
November	28.46	20:50
December	28.46	18:50

Table 12- Elevation angle of Jupiter in 2016

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	66.72	08;20
February	67.96	06:10
March	69.14	04:10
April	69.79	02:00
May	69.54	00:00
June	68.58	22;10
July	66.92	20:20
August	65.02	19;00
September	62.66	17:20
October	60.31	15:55
November	58.14	14:10
December	56.53	12:25

Table 13- Elevation angle of Jupiter in 2017

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	42.98	11:55
February	45.44	10:30
March	47.92	09:10
April	50.68	07:30
May	53.09	05:50
June	55.21	04:10
July	65.54	02:30
August	56.72	00:30
September	55.58	22:10
October	54.2	20:10
November	52.95	17;50
December	52.98	15:59

Table 14- Elevation angle of Jupiter in 2018

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	67.16	16:10
February	67.93	14:10
March	69.06	12:40
April	70.79	11:30
May	73.65	09:30
June	74.21	08:30
July	76.32	06:50
August	77.91	05:00
September	78.51	03:10
October	78.57	1:30
November	78.56	23:10
December	78.07	21:05

Table 15- Elevation angle of Jupiter in 2019

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	55.77	10:30
February	56.18	08:30
March	57.42	06:30
April	58.56	04:30
May	59.07	02:30
June	58.78	00:30
July	57.87	22:30
August	56.15	20:30
September	53.66	18:55
October	50.92	16:55
November	48.57	15:30
December	46.44	13:55

Table 16- Elevation angle of Jupiter in 2020

month	Elevation angle of Jupiter (deg)	Hours (hh:mm)
January	35.88	13:35
February	34.86	12:00
March	34.45	10:30
April	34.44	08:05
May	35.4	06:00
June	36.37	03:40
July	37	01:55
August	36.74	23:50
September	35.75	21:50
October	34.23	20:50
November	32.71	18:50
December	31.35	17:00

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