Observing Jupiter

2006 Observing Project

Hamilton Amateur Astronomers

OBSERVING JUPITER

Please join our observing project for the summer and fall of 2006: the planet Jupiter.

Look out to the East just after sunset these summer nights to see Jupiter. It is low in the sky but piercingly bright to the naked eye. Binoculars of any size will show the four great Galilean moons of Jupiter, and a telescope of any aperture will show some detail on the cloud-bound disk of the planet.

Jupiter is the fifth planet from the Sun and is by far the largest planet in our Solar System. It is the fourth brightest object in the sky after the Sun, the Moon and Venus. Observers have been fascinated by Jupiter from antiquity. Since the invention of telescopes, the planet has been admired and intently studied. H.A.A. members may remember making detailed drawings of Jovian features in the past. Amateur imaging equipment now captures detail that until recently was the purview of large professional observatories.

Jupiter in 2006 is well worth watching by novice and the very experienced alike. The **Great Red Spot** (GRS) on the southern edge of the South Equatorial Belt has a companion **Red Spot Jr.**, the Oval BA located in the more slowly moving South Temperate Belt. There are many small white oval-shaped storms; at least 10 dark barges are spread around Jupiter's equator this year. The two great equatorial belts are quite active and have a dark brown colouration.

As Jupiter circles the sun, from the Earth, it appears to move along the *ecliptic*, passing through the twelve constellations of the zodiac. Astronomers know that the ecliptic ranges above and below the celestial equator. Depending on where a planet lies on the ecliptic, it may rise high in the sky during the night (like Saturn did earlier this year) or stay low. This year Jupiter is in Libra and will not higher than 30° above the horizon during the evening; for the next three years as it moves through Scorpius and then Sagittarius, Jupiter will remain low in our summer sky.

Observing Jupiter does not require a telescope, although the Hamilton Amateur Astronomers has a "loaner" program that will provide you on request with a 5" Newtonian reflector on a motorized alt-az mount and tripod, complete with eyepieces and a power source. Of course, you are also welcome to check our web site at www.amateurastronomy.org and join us at Binbrook Conservation Area on our observing nights, where you can chat with members and look through various telescopes or watch image-collection in progress!

Our 2006 ***Observing Jupiter*** project follows up on ***Observing Planetary Nebulae***, ***Observing Globular Clusters***, ***Observing Variable Stars*** and ***Observing Double Stars,*** our past projects, because the H.A.A. is an active observing group interested in helping you get involved with astronomy! Ask about our past project booklets.

OBSERVING JUPITER WITH THE NAKED EYE

Over the summer and fall of 2006 you can check the declining brightness of Jupiter, plot its position on a map of the sky and record its motion against the background stars in the constellation Libra (see centerfold map) without using any equipment.

In May, Jupiter is at *opposition*, that is, the sun, the earth and the planet are lined up and the face of the planet is entirely lit (like a "full moon"). At opposition the planet is at its brightest (magnitude -2.5) and its four moons are at their brightest – very sharp naked eyes may spot one or more moons near Jupiter without binoculars.

During May, Jupiter is in *retrograde motion* - moving W against the background stars until early June. This summer and fall Jupiter will move East against the stars. In late fall Jupiter will leave the constellation Libra, entering the constellation Scorpius ready to be observed in 2007.

JUPITER IN BINOCULARS

Binoculars or a small telescope will enable you to see the moons of Jupiter beside the planet's bright disk. Binoculars are best steadied by observing from a lounge chair with your elbows on the armrests, or by leaning the binoculars against a post or tree, by affixing them to a tripod or (best) a binocular mount.

The moons of Jupiter are named Io, Europa, Ganymede and Callisto in order of their distance from Jupiter. They are called "Jovian" (short for Jupiter) and "Galilean" (after Galileo, their discoverer).

The moons appear to move back and forth in a line, passing across the face of Jupiter or being eclipsed behind the planet's disk because their orbits all lie in nearly the same plane, which is tilted only 3° to us. In 2006 Callisto, the moon most distant from Jupiter, passes just above / below the planet as it orbits. You can see it as a 5th magnitude "star" seeming "out of line" with the others.

Data on the Galilean Moons

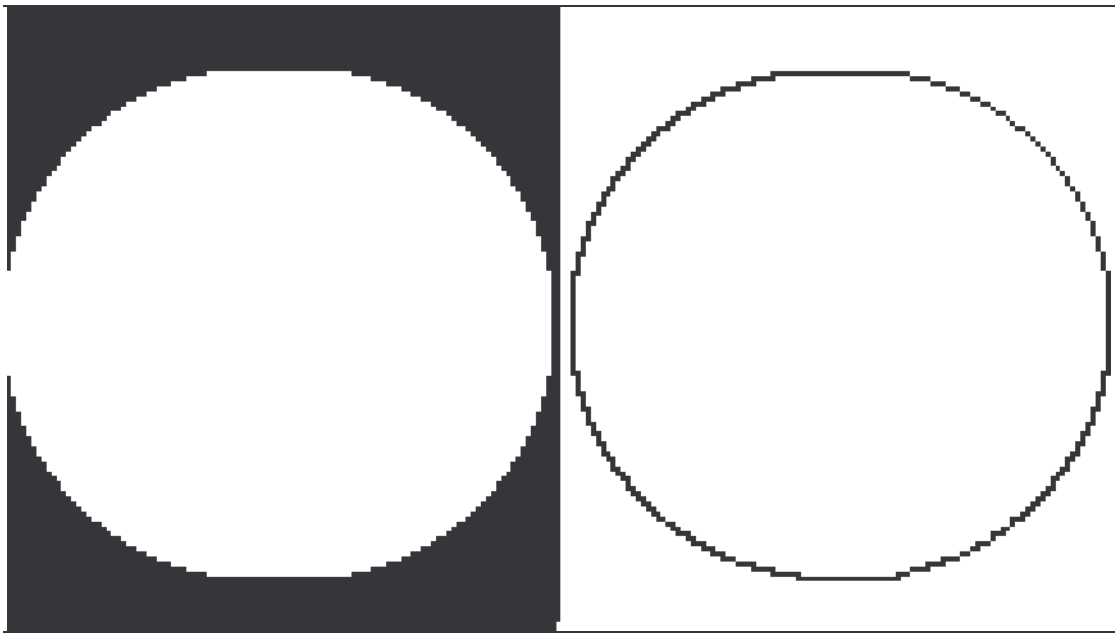
	Io	Europa	Ganymede	Callisto
Diameter	3,643 km	3,122	5,262	4,820
Distance from Jupiter	421,000 km	671,000	1,070,000	1,883,000
Orbital period	1.77 days	3.56	7.16	16.69
Mean visual magnitude	5.0	5.3	4.6	5.6
Density (in t /cubic m) (ice = 1.2)	3.53	3.01	1.94	1.83
Albedo (higher = more reflective)	0.62	0.68	0.44	0.19

JUPITER IN A SMALL TELESCOPE

Saturn is beautiful, but Jupiter has a larger disk with a variety of features to observe! The disk of Jupiter is so bright that observing from the city is no problem. Jupiter offers tremendous detail and a great variety of colour in the cloud formations and storms visible on its disk. As you gain experience, you will be able to detect more subtle detail. Jupiter's features are in a state of flux and are well worth watching.

The planet rotates 360° in less than 10 hours, so in an evening you will see more than half the planet's disk. Observers can draw what they see in pencil, using a template. Note your start time and draw quickly, features rotate quickly out of sight! The right side is for your initial sketch and any quick notes; the left side is for your finished product. pencil is fine; coloured pencil or even paints can give great results.

TEMPLATE FOR DRAWING JUPITER'S DISK



This is the template used by the Association of Lunar and Planetary Observers. Data that should accompany the form includes your name and mailing address, the observing site location, the date (m/d/y) and time (UT) accurate to one minute, the longitude of Jupiter's central meridian (CM) in System I and II, available from ALPO, telescope aperture, focal ratio and magnifications, filters used and the transparency and seeing conditions for this observation. More info about the ALPO Jupiter Section template is available at: www.lpl.arizona.edu/~rhill/alpo/jupstuff/jupdwg.html

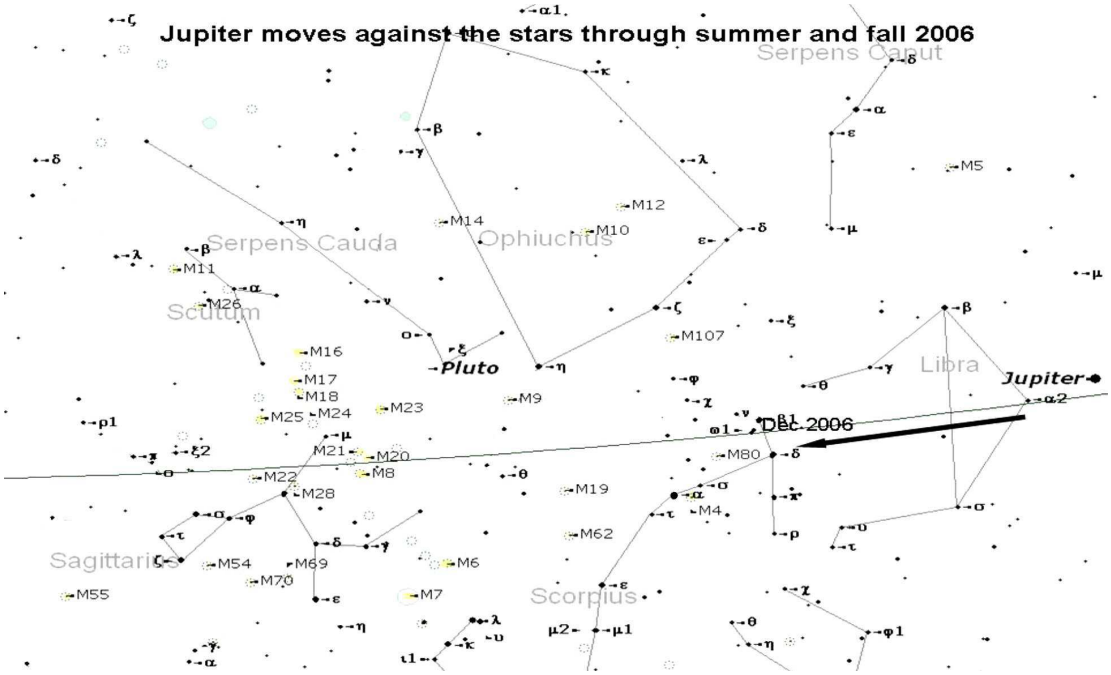
TRANSITS AND ECLIPSES OF THE JOVIAN MOONS

Jupiter's moons offer observable *transits.* A moon followed by its dark shadow, passes in front of the planet's disk. *Eclipses* of the moons are exciting to watch, as the moon slowly draws closer to the planet or suddenly pops out from behind it, like a white pimple on Jupiter's disk, then slowly drawing away. A moon may enter the long black shadow that lies behind Jupiter and suddenly dim by four magnitudes before it is eclipsed by the planet, or (this summer and fall) after it emerges from eclipse.

Io, Europa and Ganymede offer transits, shadow transits and eclipses in 2006. Times listed are *Universal time* (UT). Subtract 4 hours from UT to get EDT (our summertime "daylight savings time"), in the fall, subtract 5 hours from UT to get EST. Times are approximate; you can set up your telescope early, time the events as you observe them and record what you observed. Transits and eclipses last about two hours. During transits this summer and fall, Ganymede will appear dark while Io and Europa are bright and hardly visible against the cloud patterns on Jupiter. The shadow of the moon will follow it across the disk; shadows of the more distant moons will of course be larger than Io's shadow.

Key: Transit start time: T
Eclipse start time: E

Date		UT	Io	Europa	Ganymede
June	05	04h 30m			E
		08h 15m	E		
	06	05h 30m	T		
	07	02h 45m	E		
		23h 50m	T		
	11	05h 00m		T	
	12	07h 45m			E
	13	07h 30m	T		
	14	04h 30m	E		
	15	01h 45m	T		
	18	07h 20m		T	
	20	01h 45m		E	
		09h 10m	T		
	21	06h 20m	E		
	22	03h 30m	T		
	23	03h 30m			T
	27	04h 00m		E	
	28	08h 00m	E		
		23h 00m		T	
	29	04h 30m	T		
	30	02h 45m	E		
		04h 45m			T
		23h 59m	T		

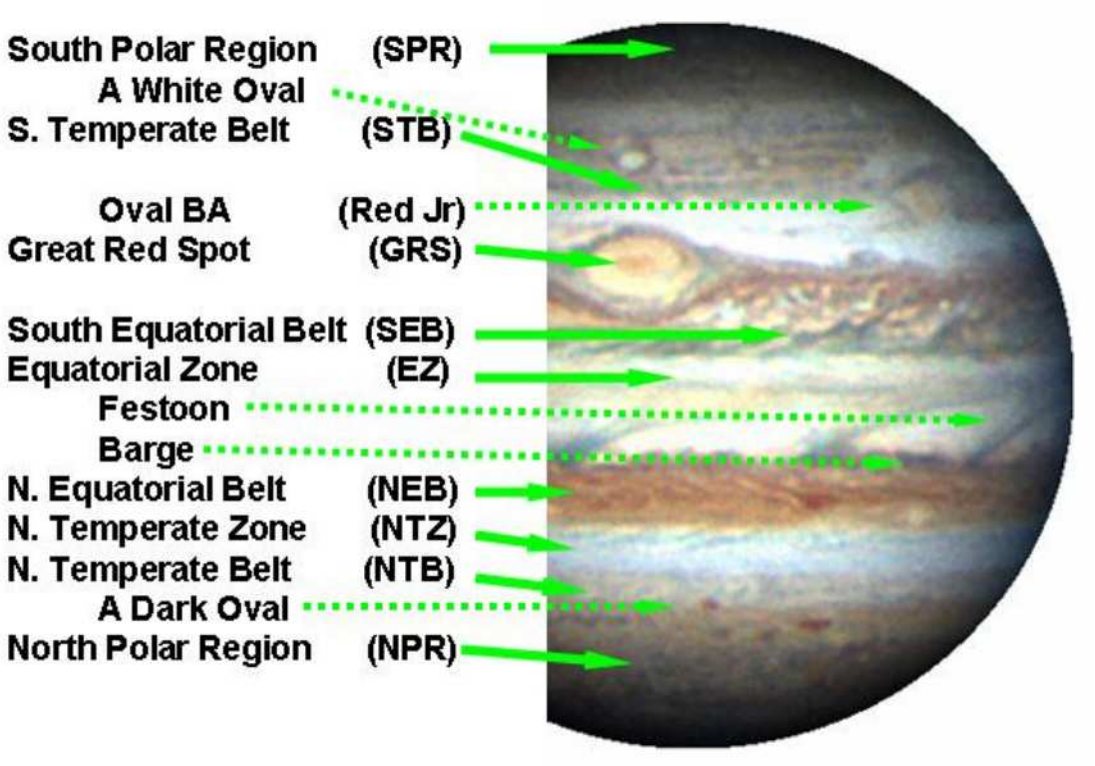

Jupiter moves against the stars through summer and fall 2006
Serpens Caput
Serpens Cauda
Ophiuchus
Scutum
Sagittarius
Scorpius
Libra
Pluto
Jupiter
Dec 2006
M5
M10
M11
M12
M14
M16
M17
M18
M19
M20
M21
M22
M23
M24
M25
M26
M28
M4
M54
M55
M6
M62
M69
M7
M70
M80
M9
M107

LABELS FOR JUPITER'S CLOUD FORMATIONS

Observing Jupiter, you are looking at the tops of thick cloud formations. The massive planet is 75% hydrogen and 25% helium with traces of methane and ammonia. Beneath the thick coloured clouds there is very little, if any "solid ground".

Three layers of cloud may float above Jupiter: ammonia ice, ammonium hydrosulfide and water ice. Clouds travel around Jupiter in bands like fast-moving streams. Dark spots and festoons may be transparent gases letting us see into the darker depths. Great storms like the GRS and Red Jr. swirl violently, drawing methane gases up from deep down, raising them above the belts, where the gas takes on a red colour.

Even a 60mm refractor will show the two great brown Equatorial Belts, but for serious study ALPO recommends at least a 6" aperture, though 5" Maksutovs with their excellent optics and long focal length are very good planetary observing scopes. Charts and images usually show South at top. Observers refer to the various Jovian features with designations as shown on the chart below:



CHANGING FEATURES ON JUPITER

Little change occurs in the two large, dark **polar regions** (SPR, NPR) likely because they rotate more slowly than the equatorial regions and receive little solar warmth.

The South Temperate Belt (STB) and South Temperate Zone (STZ) continue to be very active. Huge storms persisted through the latter half of the 20th century as three white ovals that combined into the giant white Oval BA in 1999-2000. Earlier this year BA turned light red. Observers nicknamed it "**Red Spot Jr."** This year you can watch the GRS and Red Jr. pass by each other. The two should be separated by a narrow bright area called the South Tropical Zone (STrZ). Will Red Jr. be disrupted?

The **Great Red Spot** (GRS) is the largest storm in our Solar System and has persisted for almost 200 years (some say over 350 years). It varies in size, in hue, in depth of colour, and in rotation period as it drifts slowly in longitude over time (currently it is at 108°) while streaking around Jupiter in under 9h 55m at over 10,000 mph. A bright ring called **Red Spot Hollow** (RSH) separates GRS from the SEB.

South Equatorial Belt (**SEB**) is the most active area of Jupiter. usually a very wide and distinctly brown belt, the SEB has been known to fade away almost completely over the course of several months while the GRS darkens. The sudden appearance of a pair of white and dark spots immediately preceding GRS signals the revival of SEB as dark gasses spew up into the SEB jet streams and are carried around the planet; as the belt darkens, the GRS usually fades. GRS leaves a very turbulent wake behind it in the SEB, and storms erupt in the SEB about 50° and 90° following the GRS, appearing as white ovals.

The North Equatorial Belt (**NEB**) is the most prominent belt on Jupiter due to its very dark colouration. Periodically (as in 1997 and 2004) the NEB belt thickens noticeably, spreading north. **Festoons** are blue-black features that start in NEB and are swept S toward the equatorial zone. In 2006 there are ten prominent festoons spread around the planet. **White plumes** appear in the same area as festoons, often beside or between them. White **rifts** erupt suddenly to disrupt the dark belt and persist for weeks. **Barges** appear as almost black, horizontal dashes along the NEB and were most noticeable in 2005. White **ovals** or **bays** appear at the edge of the NEB giving it an irregular appearance. Features on the NEB tend to be stretched or enlongated by jet stream shearing forces. The most prominent recent oval is "White Spot Z" which has persisted for several years.

The North Temperate Belt is a less prominent band that occasionally fades away, as in 2003. The jet stream driving this belt is the fastest moving on the planet and the belt usually sports several small dark oval-shaped storms.

THE GREAT RED SPOT

Observers and imagers love to see the Great Red Spot transit the disk of Jupiter. The GRS really was great and almost brick-red in the late 1960's. Since then it has lightened to a pink salmon hue and its size has diminished by one-third – but even today it could swallow three Earths! In a small telescope the GRS looks like a bite has been taken out of the now much darker South Equatorial Belt.

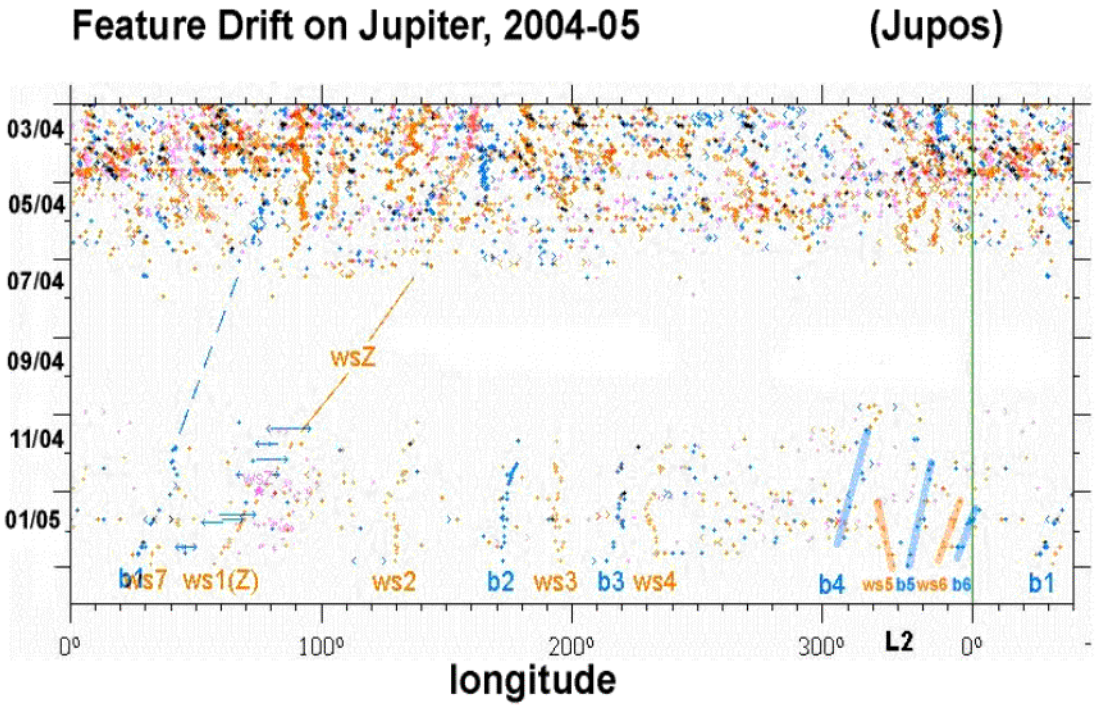
The GRS is a large atmospheric storm moving around Jupiter relative to other belts and spots. This summer you can watch as GRS and Red Spot Junior (a lesser storm a little to the south and moving at a different rate) approach each other. The chart below indicates when GRS crosses Jupiter's Central meridian (CM) at night on a 24h EDT clock. The storm is visible for over 90 minutes before / after CM transit.

CM TRANSITS OF GRS

June	6	00:45 EDT	July	2	02:14 EDT	July	28	23:37
		20:36			22:05		29	19:29
	7	06:30		4	03:52		30	05:25
	8	02:20			23:44		31	01:16
		22:15		6	05:31			21:08
	10	04:02		7	01:23	August	1	07:04
		23:53			21:14		2	02:55
	11	19:44		8	07:10			22:47
	12	04:41		9	03:01		4	04:34
	13	01:32			22:53		5	00:26
		21:22		11	04:40			20:17
	14	07:19		12	00:30		7	02:05
	15	03:10			20:24			21:56
		23:02		13	06:19		8	07:51
	17	04:49		14	02:10		9	03:44
	18	00:40			22:02			23:35
		20:32		16	03:49		10	19:27
	19	06:27			23:40		11	05:23
	20	02:19		17	19:32		12	01:14
		22:10		18	05:28			21:06
	22	03:57		19	01:19		14	02:53
		23:48			21:11			22:45
	24	05:35		21	02:58		16	04:32
	25	01:27			22:49		17	00:23
		21:18		23	04:37			20:15
	26	07:14		24	00:28		18	06:10
	27	03:05			20:19		19	02:03
		22:57		25	06:15			21:54
	29	04:44		26	02:07		21	03:42
	30	00:35			22:00			23:34
		20:27		28	03:46		22	19:25

MEASURING FEATURES AND TIMING TRANSITS

Amateurs with modest telescopes contribute to scientific study of Jupiter. For over 150 years the British Astronomical Association (BAA) and more recently ALPO observers have recorded continual observations, measured the size, shape and intensity of features, timed the CM transits of features, and shared their findings. Careful measurement has gleaned the rotation period of the various features and measured their drift in longitude over time.



Experienced HAA observers will remember making drawings of Jupiter in the 1990's prior to and following the impact of Comet Shoemaker-Levy. In addition to the circular drawings mentioned earlier, rectangular maps of Jupiter's surface features are also popular, showing the latitude and longitude (from careful timings and checking the System I and II information available from BAA and ALPO web sites). Jupos has a software program that permits you to scan your circular drawings and turn them into the rectangular charts.

Most recently, the application of inexpensive web-cams to planetary imaging has provided outstanding results to amateurs like Chris Go who graciously consented to my use of images from his web site: