OBSERVING THE SOLAR SYSTEM WITH THE ALPO

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Saturn e-Group: http://tech.groups.yahoo.com/group/Saturn-ALPO/

Observing the Solar System with the ALPO

- Founded by Walter H. Haas in 1947, ALPO membership is international and includes both amateur and professional astronomers.
- The official publication of the ALPO is *The Journal of the ALPO* (formerly *The Strolling Astronomer*) and is issued approximately 4 times a year as well as the *Digital JALPO* that was introduced in 2001.
- Membership is open to anyone interested in lunar and planetary observing, regardless of experience.
- Novices participate in the *Lunar & Planetary Training Program*, which offers instruction and practical exercises in basic techniques for recording observations.
- ALPO Website: *http://www.lpl.arizona.edu/alpo/*

Association of Lunar and Planetary Observers

Organizational Chart

Founder/Director Emeritus

Executive Director

Associate Director

Secretary/Treasurer

Board of Directors

- Solar Section
- Mercury Section
- Venus Section
- Mercury/Venus Transit Section
- Lunar Section
- Mars Section
- Minor Planets Section
- Jupiter Section
- Saturn Section

ASSOCIATION OF LUNAR & PLANETARY OBSERVERS

ALPO

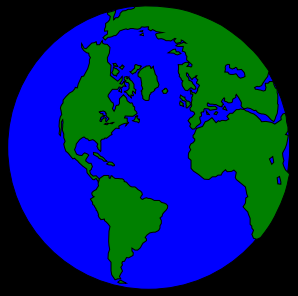
Founded 1947

- Remote Planets Section
- Eclipse Section
- Comets Section
- Meteors Section
- Meteorites Section
- Historical Section
- Computing Section
- Youth Section
- Lunar & Planetary Training Section

Guiding Principle of the ALPO

To encourage and coordinate regular, systematic investigations of the Sun, principal planets, and other members of our solar system with instrumentation normally available to amateur astronomers.

The ALPO has observers all over the world



Value of Amateur Planetary Observations

- Complete freedom to observe whenever desired for extended periods of time.
- Standardized systematic observations provide *long-term continuous records* for further study by professional astronomers.
- Earth-based monitoring by amateurs of changing atmospheric features on Saturn often help professionals select targets for high-resolution spacecraft imaging.
- Skilled observers routinely produce excellent digital images at various wavelengths that are useful to professional astronomers.

Why Observe the Solar System?

- Most solar system objects are *relatively bright & easy to find*.
- Many can be viewed from almost anywhere despite light pollution so *travel to a remote site is usually not necessary*.
- The *Sun* and *Moon* have substantial image size with significant detail that can be seen with small apertures with good optics.
- *Mercury* and *Venus* show phases like the Moon, & Venus exhibits peculiar cloud patterns, phase anomalies, & dark hemisphere phenomena (e.g., *Ashen Light*) in different color filters.
- *Mars*, *Jupiter*, and *Saturn* are dynamic worlds that exhibit variable phenomena that can be monitored with moderate apertures (*plus Mars and Saturn display seasonal effects*).

- The *Galilean satellites of Jupiter* and a few of *Saturn's moons* (when rings are near edgewise orientation) undergo *transits, eclipses, & occultations* that can be seen in smaller apertures.

- *Asteroids* change in brightness & they periodically occult stars; amateurs continue to discover new minor planets.

- *Uranus* and *Neptune* although quite faint & remote, variations in their brightness can be recorded using small-to-moderate apertures.

- *Meteors* enter our atmosphere with variable frequency, color, velocity, & brilliance (most observations can be carried out with the unaided eye).

- *Comets* vary in appearance and brightness, & optimum views occur with binoculars and RFT's (*amateur comet observers discover many new comets*).

What is Needed to Participate in ALPO Programs?

- There is *no inflexible minimum for aperture*, but a good starting point would be:
  - ✓ 7.5cm. (3.0in.) for refractors or Maksutovs
  - ✓ 15.2cm. (6.0in.) for Newtonian reflectors & Schmidt-Cassegrains.

- Some programs only require binoculars or an RFT (e.g., *comet-seeking*), and other programs can even be carried out with the unaided eye (e.g., *eclipse and meteor observing*).

- Color filters of known wavelength transmission and a variable-density polarizer are recommended.

- *Astronomical Almanac* or similar solar system ephemeris (e.g., *WIMP*, *WinJupos*, *Smartphone apps*, etc.) for accurate ephemerides of solar system objects are important.

- Digital imaging can occur with a good *CCD camera & Laptop* (PC or Mac) with software for capturing & processing of images.

The ALPO Saturn Observing Program

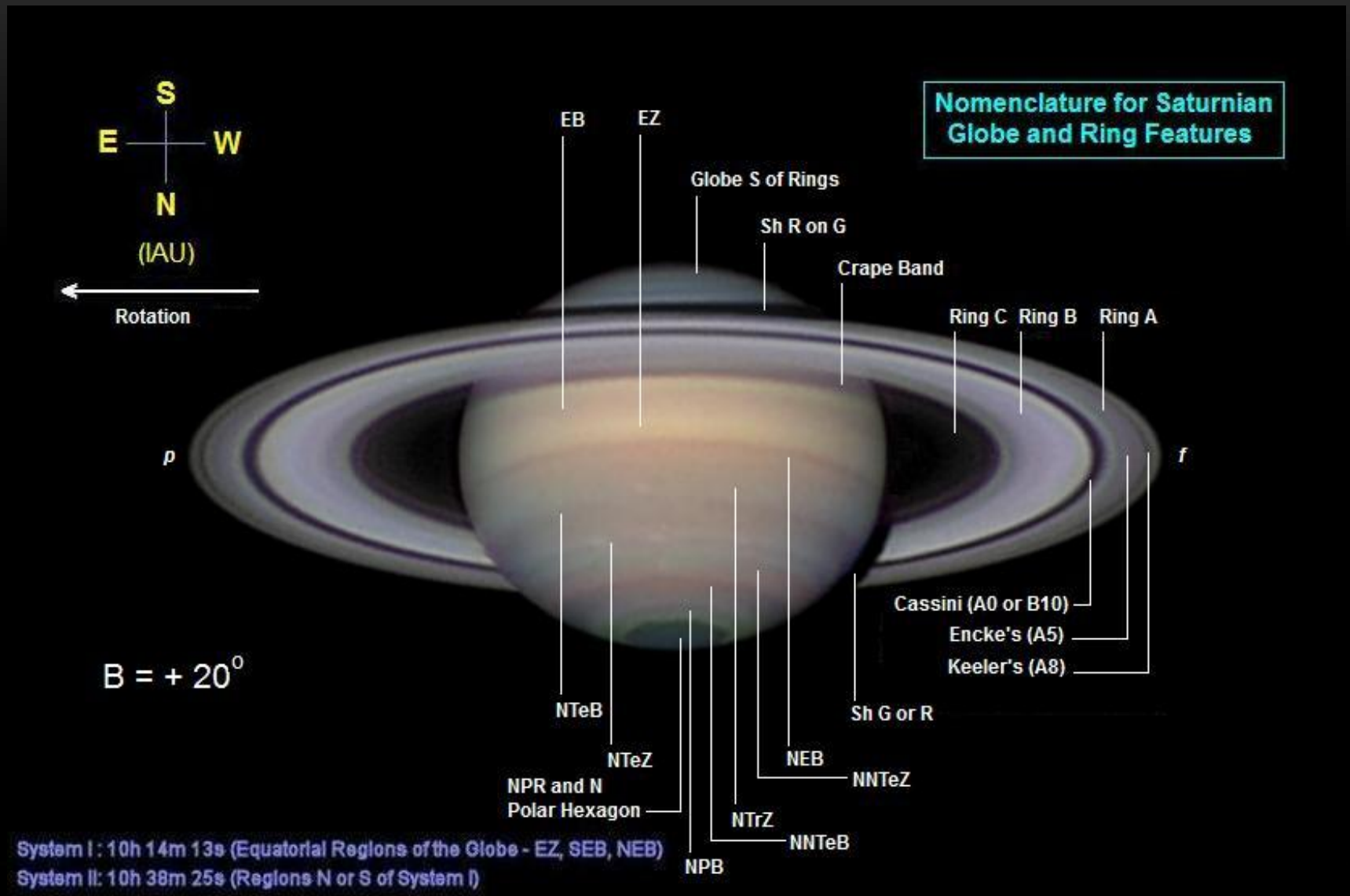
ALPO Saturn Observing Programs

- Visual numerical relative intensity estimates in integrated light & with color filters.
- Full-disc drawings using standard ALPO observing forms.
- Digital imaging of Saturn at various wavelengths.
- Central meridian (CM) transit timings of discrete detail on the globe.
- Visual estimates & measurements of belt & zone latitudes.
- Visual detection & imaging of "intensity minima“ in Saturn’s rings.
- Monitoring the bicolored aspect & brightness asymmetries around the circumference of Ring A.
- Accurate timing & imaging of stellar occultations by the globe & rings.
- Specialized studies at small ring inclinations or when they are edgewise to our line of sight (e.g., transits of satellites & their shadows across the globe).
- Visual observations & magnitude estimates of Saturn’s satellites.

Keys to Meaningful Results

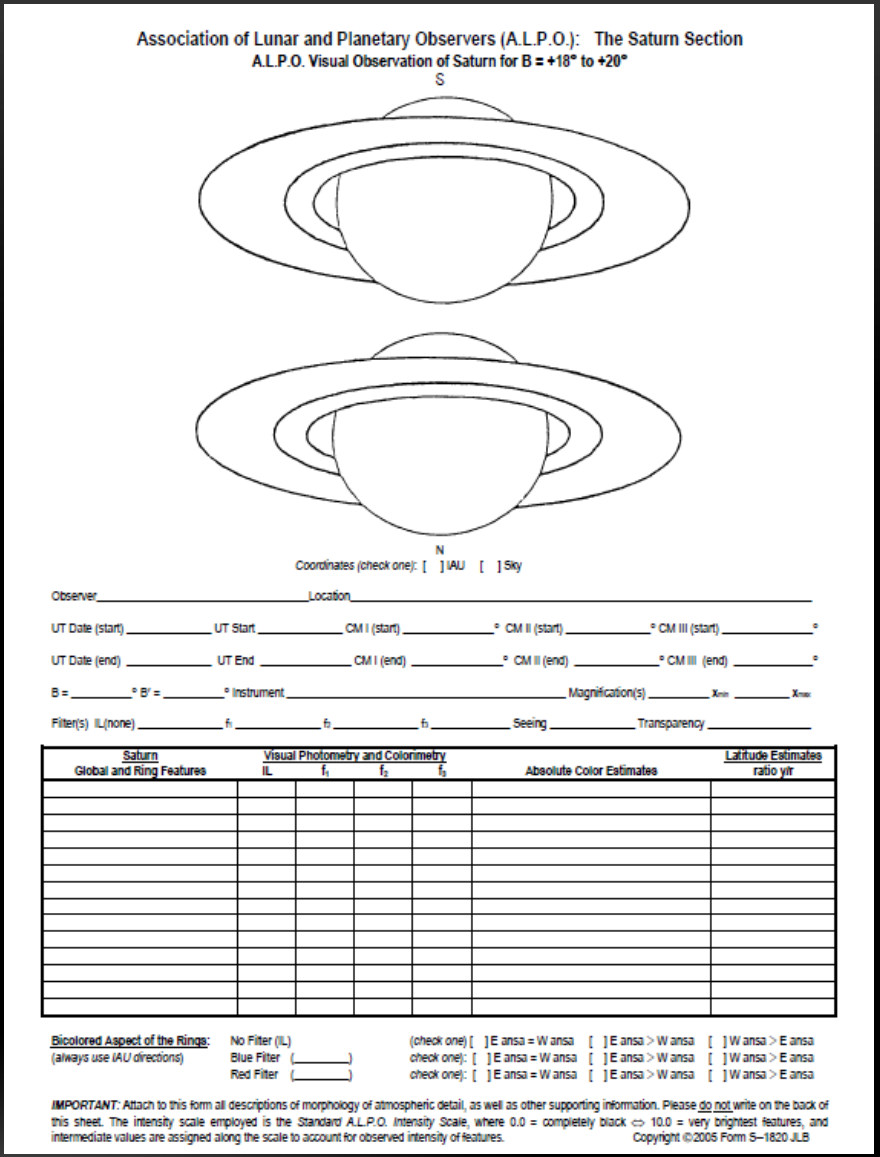
- Apparitions of Saturn last about 378 days from conjunction-to-conjunction
  - ✓ Plan your observing programs well ahead of the start of any given observing season
  - ✓ Start observing early when Saturn is just visible before sunrise
  - ✓ Continue observing through opposition until Saturn approaches conjunction
  - ✓ Keep good records (e.g., UT date & time, location, telescope, magnifications, filters)
- Use standard observing forms for recording data (available on ALPO Website).
- Submit observations, images, drawings with supporting data regularly.
- Strive for *simultaneous observations* (i.e., independent, systematic studies by two or more observers at the same time on a given date).

Standard Nomenclature for Saturn



Sample ALPO Saturn Drawing Blank

Although regular digital imaging of Saturn is very important, observers *should not neglect* to make routine visual numerical relative intensity estimates of globe and ring features.



Association of Lunar and Planetary Observers (A.L.P.O.): The Saturn Section

A.L.P.O. Visual Observation of Saturn for B = +18° to +20°

S

N

Coordinates (check one): [ ] IAU [ ] Sky

Observer _____ Location _____

UT Date (start) _____ UT Start _____ CM I (start) _____° CM II (start) _____° CM III (start) _____°

UT Date (end) _____ UT End _____ CM I (end) _____° CM II (end) _____° CM III (end) _____°

B = _____° B′ = _____° Instrument _____ Magnification(s) _____ x_{min} _____ x_{max}

Filter(s) IL/(none) _____ f_1 _____ f_2 _____ f_3 _____ Seeing _____ Transparency _____

Saturn Global and Ring Features	Visual Photometry and Colorimetry IL	f_1	f_2	f_3	Absolute Color Estimates	Latitude Estimates ratio y/r

Bicolored Aspect of the Rings: (*always use IAU directions*)
No Filter (IL) (*check one*) [ ] E ansa = W ansa [ ] E ansa > W ansa [ ] W ansa > E ansa
Blue Filter (_____) (*check one*): [ ] E ansa = W ansa [ ] E ansa > W ansa [ ] W ansa > E ansa
Red Filter (_____) (*check one*): [ ] E ansa = W ansa [ ] E ansa > W ansa [ ] W ansa > E ansa

IMPORTANT: Attach to this form all descriptions of morphology of atmospheric detail, as well as other supporting information. Please do not write on the back of this sheet. The intensity scale employed is the *Standard A.L.P.O. Intensity Scale*, where 0.0 = completely black <> 10.0 = very brightest features, and intermediate values are assigned along the scale to account for observed intensity of features.

Geocentric Phenomena in UT for Saturn

The Current 2013-14 Apparition

- Conjunction — 2013 Nov 06^{d} UT
- Opposition — 2014 May 10^{d}
- Conjunction — 2014 Nov 18^{d}

Opposition Data:

Equatorial Diameter Globe	18.6″
Polar Diameter Globe	16.6″
Major Axis of Rings	42.2″
Minor Axis of Rings	15.5″
Visual Magnitude (m_v)	$+0.1m_v$
B =	+21.6º
Declination	–15.4º

Remembering the Great NTrZ Storm of 2010-11

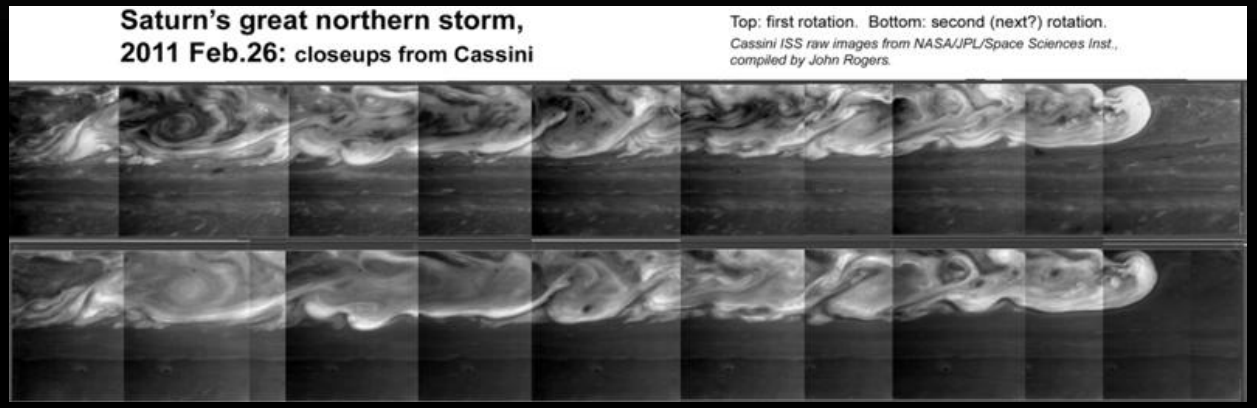
Reminiscing: The Great NTrZ Storm of 2010-11

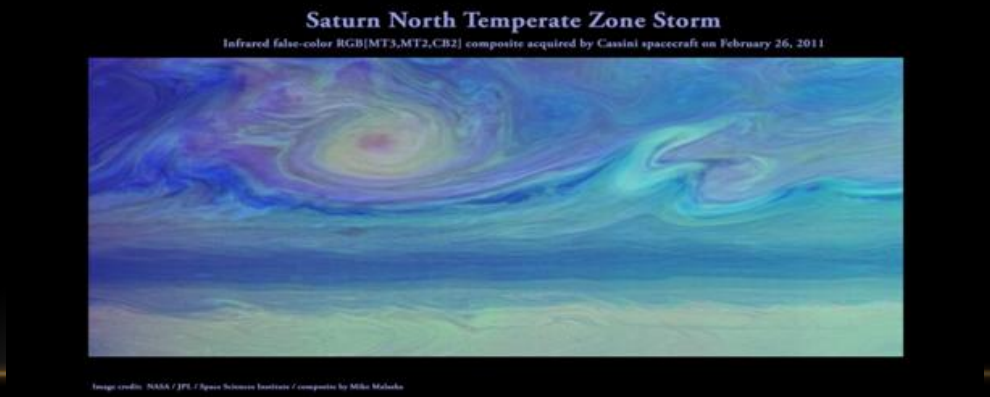
- First imaged by *Cassini* at 23:26UT on December 5, 2010 at 35°N Saturnigraphic latitude.
- On December 5th the storm's N to S width was ~1,300km & roughly 2,500km long.
- Nearly 3 weeks later, it's width expanded to ~10,000km, extending longitudinally nearly 1/3 the distance around Saturn (about 100,000km).
- By late February 2011, it had grown to 15,000km N to S and it's "tail" had encircled the entire planet!
- The storm eventually occupied the area between Saturnigraphic latitude 35°N & 40°N.

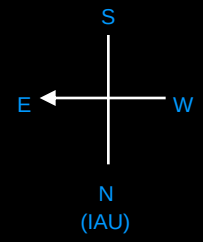
Images courtesy of NASA's Cassini Mission

Reminiscing: The Great NTrZ Storm of 2010-11

- White spots arise as columns of material break through the upper NH_4-ice clouds & spread out.
- Complex swirls intermix with darker material dredged up from deep within Saturn's atmosphere.







Reminiscing: The Great NTrZ Storm of 2010-11

- Some points to consider:
  - ✓ The NTrZ storm was 500 times larger than the those seen by *Cassini* in late 2009-10.
  - ✓ When the Sun was shining on the planet's S hemisphere prior to 2009, all observed storm activity was in the STrZ near 35°S Saturnigraphic latitude, referred to by *Cassini* scientists as "storm alley".
  - ✓ Now that the Sun is N of the rings, spring had begun in Saturn's N hemisphere.
  - ✓ The NTrZ storm's emergence at 35°N Saturnigraphic latitude showed how shifting seasons & solar illumination can dramatically stir up weather on Saturn.
  - ✓ The NTrZ storm was the largest & most intense ever recorded by the *Voyager* & *Cassini* spacecraft (observers will recall the Great White Spot imaged by the *Hubble Space Telescope* in 1990).

Reminiscing: The Great NTrZ Storm of 2010-11

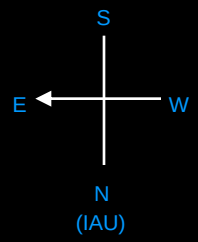
- How Amateurs Got Involved:

  - ✓ Soon after the first detection of the storm on December 5th, the *Cassini* team issued an appeal to amateur astronomers worldwide to collect as many images as possible.

  - ✓ Amateur's responded right away, submitting myriad images throughout the apparition, helping *Cassini* scientists track the storm as it developed over time.

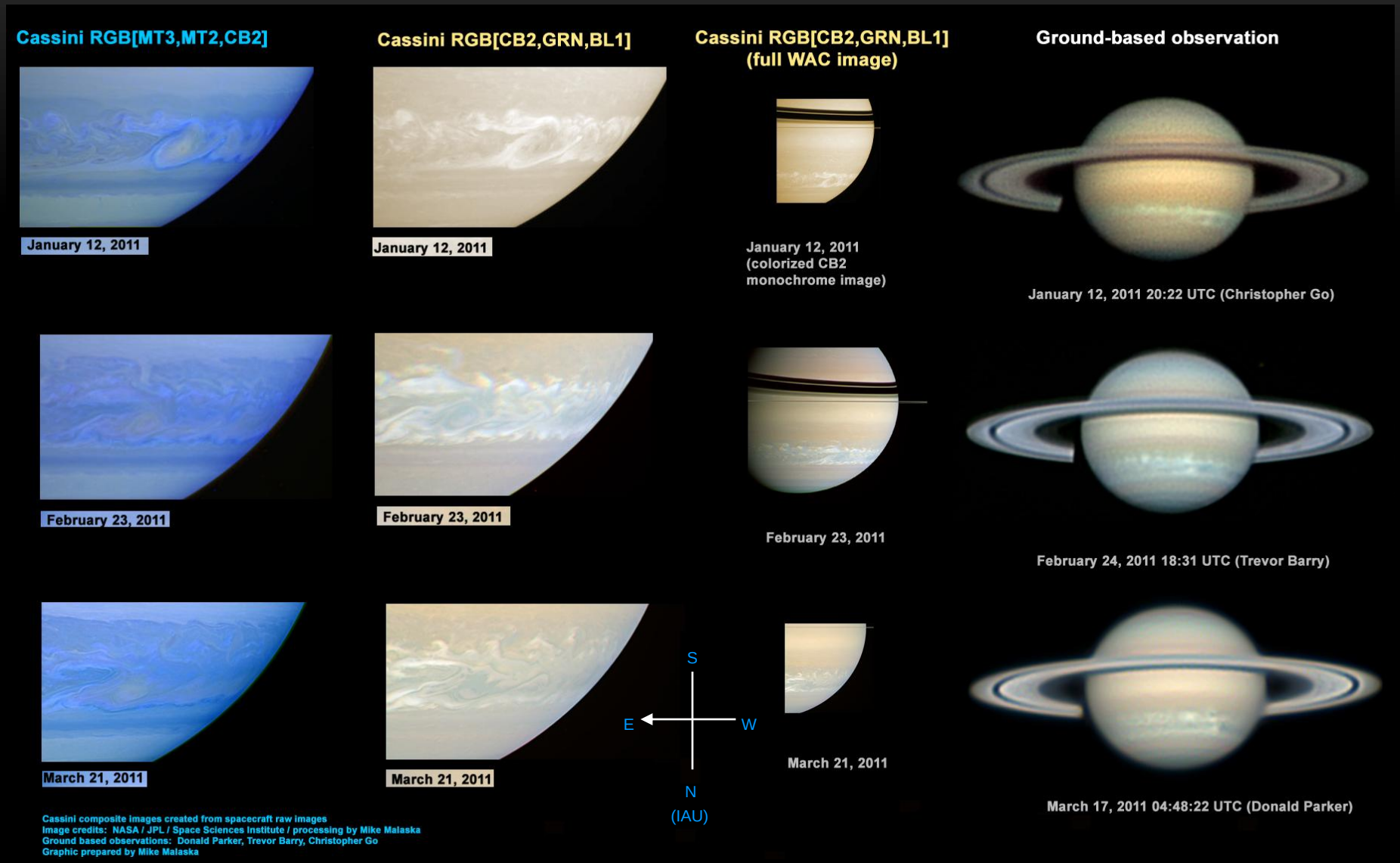
  - ✓ The first image received by the ALPO Saturn Section was on December 10, 2010.

Saturn 10 Dec 2010 18:01.8 Z CMIII:244.9
Anthony Wesley, Murrumbateman Australia



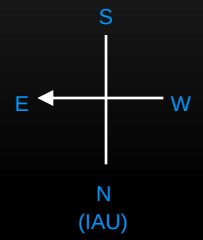
Reminiscing: The Great NTrZ Storm of 2010-11

Comparison of *Cassini* images with ALPO Ground-based images January thru March 2011



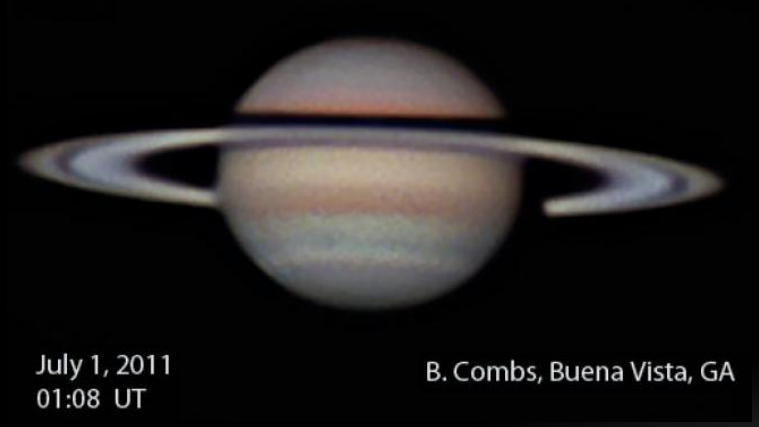
Reminiscing: The Great NTrZ Storm of 2010-11

- Some memorable contributions by amateur observers (December 2010 thru April 2011):

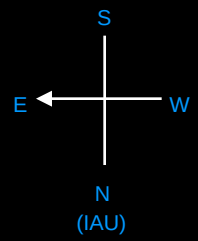


Reminiscing: The Great NTrZ Storm of 2010-11

- More memorable contributions by amateur observers (May thru July 2011):

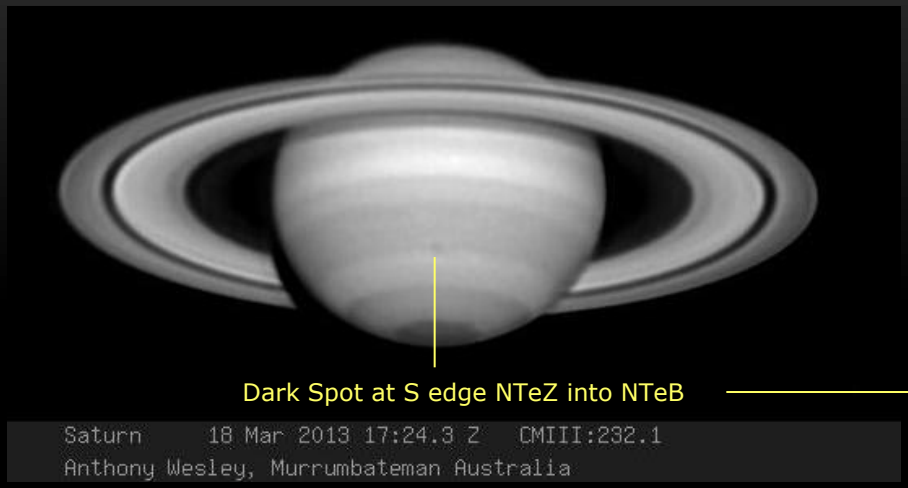


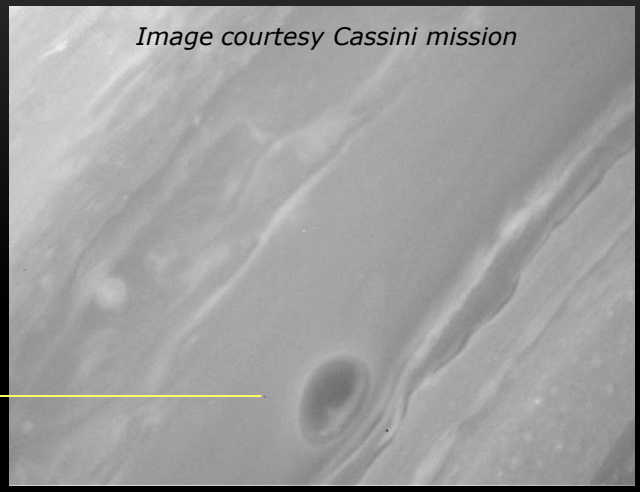
July 31st, 2011, 09:14 UTC, CMIII 225.2 degrees, Dia 16.6 arc sec's
Ring Op Earth 8.3 degrees, Alt 48 degrees, seeing 4 to 5/10
RGB image with 16" F 4.5 Newt working at F23.7 PGR Flea3
Primary by Mark Suchting, 1/30th wave Antares Secondary
Imaged at Broken Hill Australia by Trevor Barry



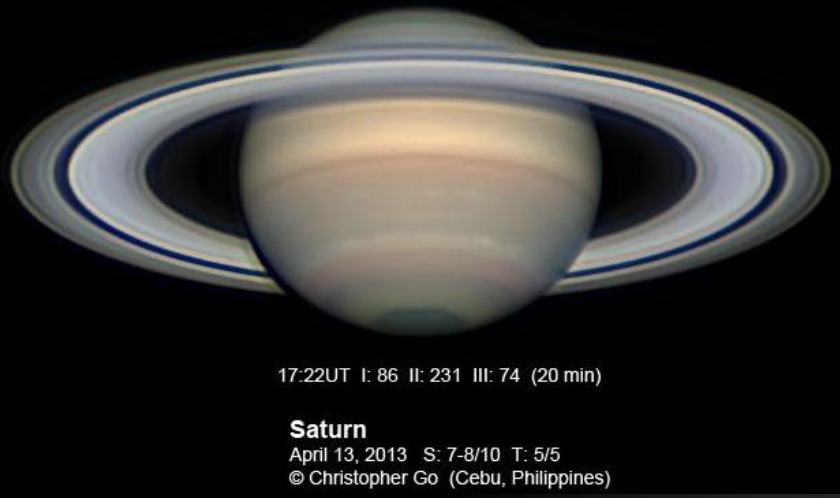
Gallery of Observations from the recent 2012-13 Apparition

Pre-Opposition Views of Saturn in 2012-13



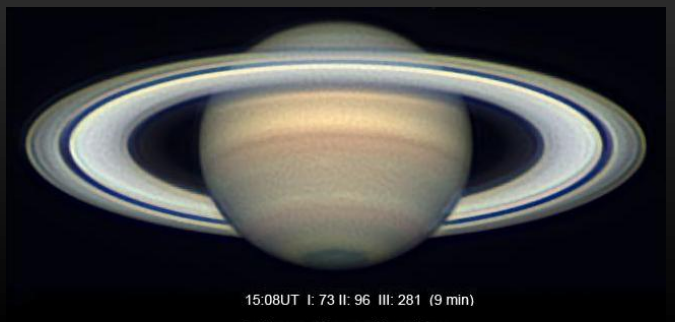


Shadow of the Globe on the Rings is toward the East (IAU) before Opposition



Saturn At Opposition in 2012-13: The Seeliger Effect

Paul G. Abel, Leicester UK.
2013 April 28 Disk Drawing: 0028UT, x250, Seeing: AIV-V, Transp: Excellent
CM1: 277 CM2: 320 CM3: 145.8
203mm Newtonian Reflector, x167 & x250. Filter: W#11

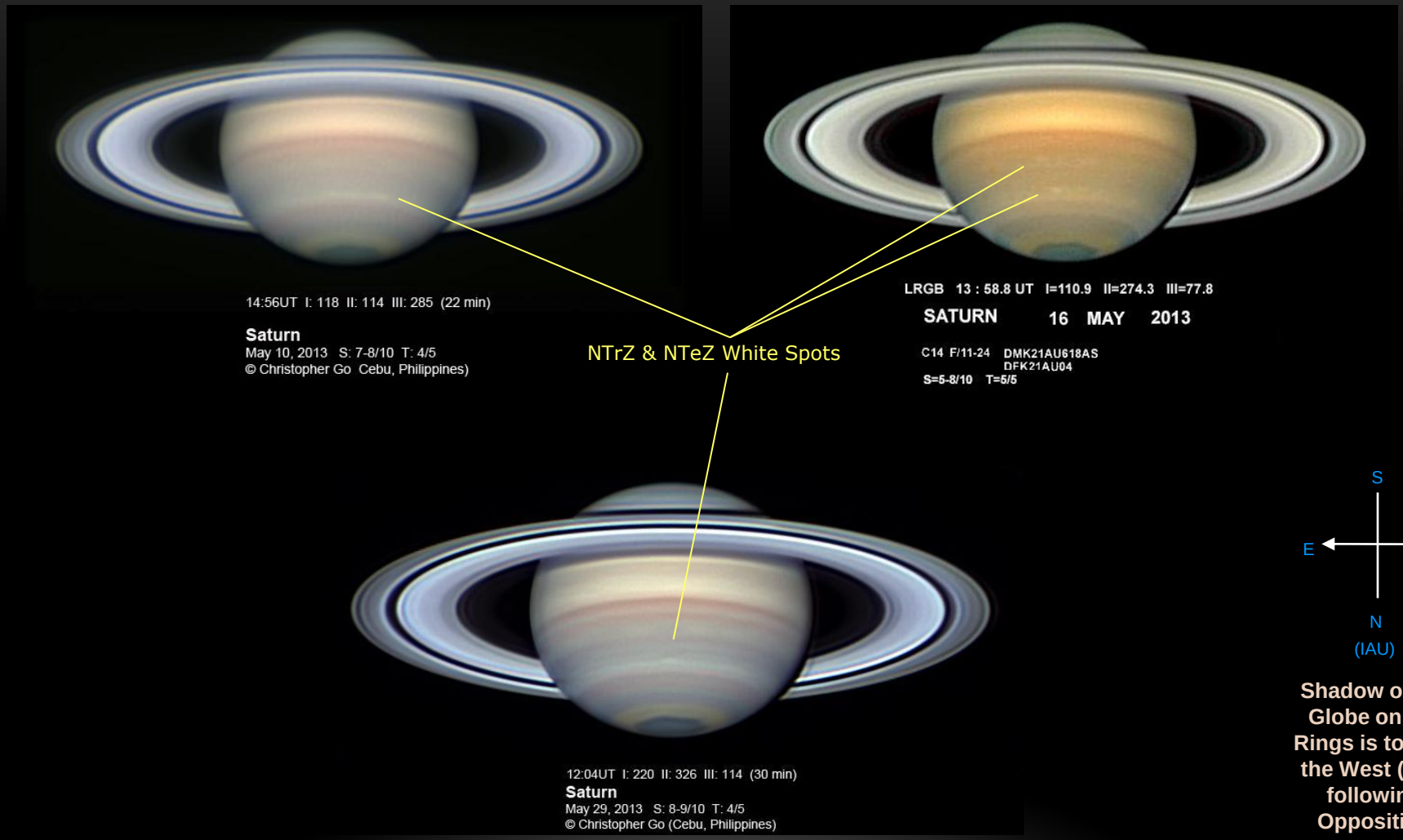


2012-13 Opposition Data:

2012 Apr 28^{d} UT
Eq Dia Globe = 18.7”
Po Dia Globe = 16.7”
Maj Axis Rings = 42.5”
Min Axis Rings = 13.3”
Visual Magn = +0.1
B = +18.2^{o}
Declination = –11^{o} 12′ 00″

- *The Seeliger Opposition Effect is an apparent brightening of the rings for a short interval near opposition.*
- *Caused by coherent back-scattering of μ-sized icy particles in the rings when the phase angle between Sun-Saturn-Earth is <0.3°.*

Post-Opposition Views of Saturn in 2012-13

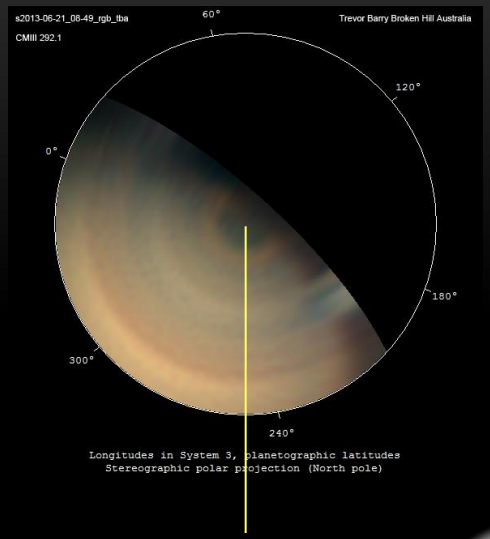


Shadow of the Globe on the Rings is toward the West (IAU) following Opposition

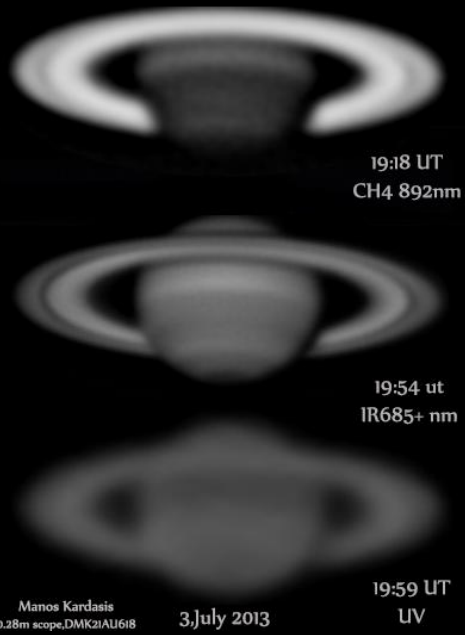
Post-Opposition Views of Saturn in 2012-13

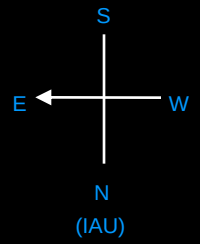
CM1 = 212.3 CM11 = 308.8 CM111 = 69.4
S2013_21_June_02_13_35_UT_MH

Seeing: 6/10 Trans: 7 Alt: 46 Deq: 18.0
C-14 F-13.2 ZWO ASI120MM Astronomik RGB Filters
Mike Hood Kathleen, GA (USA)



North Polar Hexagon

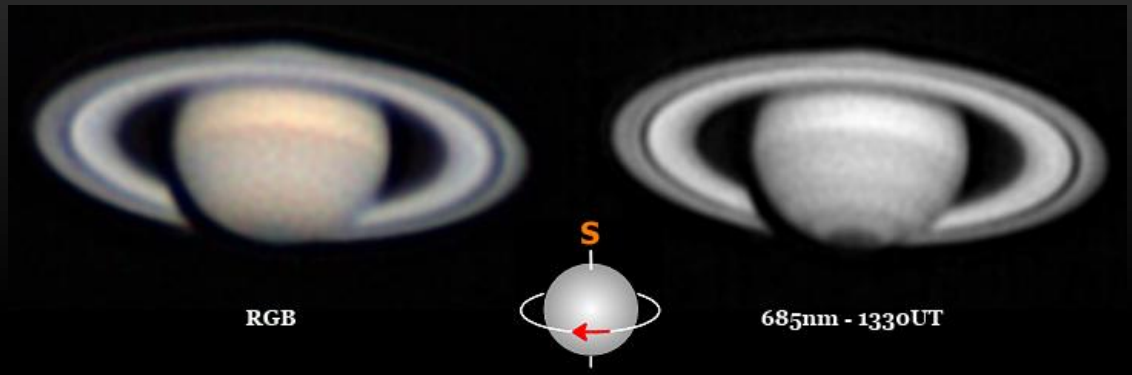




Shadow of the Globe on the Rings is toward the West (IAU) following Opposition

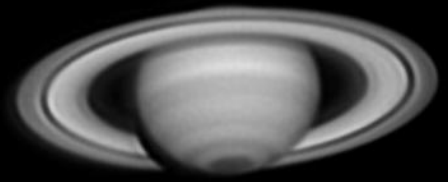
Gallery of Observations from the new 2013-14 Apparition

Pre-Opposition Views of Saturn in 2013-14

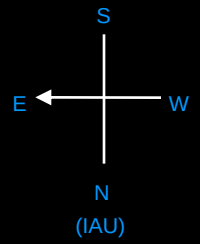


SATURN January 28, 2014 1322UT. Paul Maxson Mewlon 250 F/18, resized 1.5x CM I = 332.9 CM II = 116.2 CM III = 329.7 D = 16.5". ASI120MM camera.

January 29th 2014, 18:38 UTC, CMIII 238.5
Dia 16.5", Ring Op Earth 22.5 degrees, Alt 50 degrees, seeing 5 to 6/10
16" F4.5 Custom Newt working at F16.7 Mark Suchting Primary Antares 1/30th wave Secondary
RGB Image ZWO ASI120MM Trevor Barry Broken Hill Australia



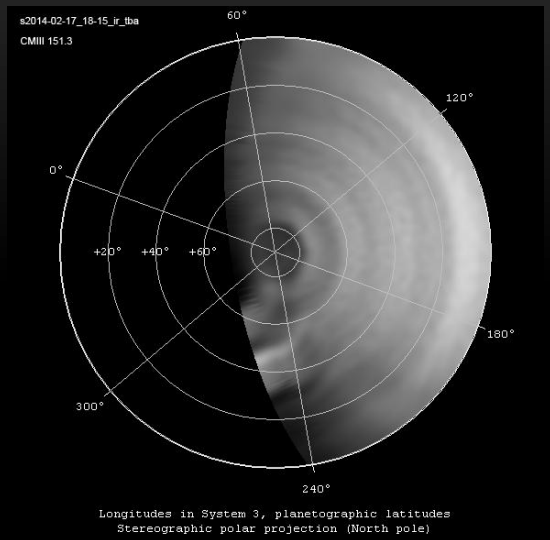
February 6th 2014, 18:37 UTC, CMIII 244.5
Dia 16.7", Ring Op Earth 22.6 degrees, Alt 55 degrees, seeing 4 to /10
16" F4.5 Custom Newt working at F16.7 Mark Suchting Primary Antares 1/30th wave Secondary
742nm IR Image ZWO ASI120MM Trevor Barry Broken Hill Australia



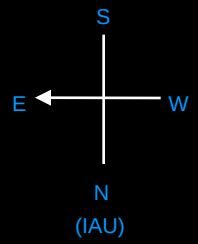
Shadow of the Globe on the Rings is toward the East (IAU) before Opposition

Pre-Opposition Views of Saturn in 2013-14

February 6th 2014, 18:48 UTC, CMIII 250.7
Dia 16.7", Ring Op Earth 22.6 degrees, Alt 57 degrees, seeing 4 to 5/10
16" F4.5 Custom Newt working at F16.7 Mark Suchting Primary Antares 1/30th wave Secondary
RGB Image ZWO ASI120MM Trevor Barry Broken Hill Australia



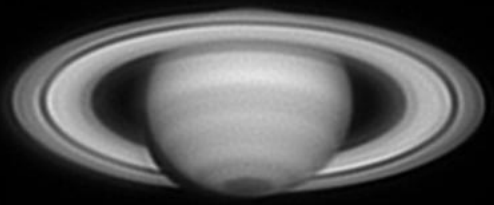
February 17th 2014, 18:02 UTC, CMIII 144
Dia 17.1", Ring Op Earth 22.6 degrees, Alt 56 degrees, seeing 5/10
16" F4.5 Custom Newt working at F16.7 Mark Suchting Primary Antares 1/30th wave Secondary
742nm IR Image ZWO ASI120MM Trevor Barry Broken Hill Australia



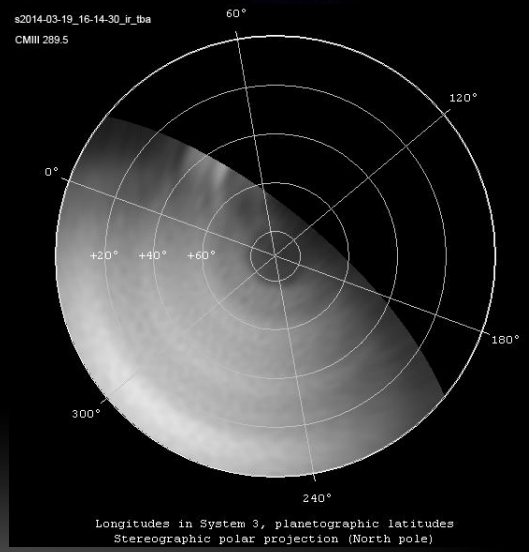
Shadow of the Globe on the Rings is toward the East (IAU) before Opposition

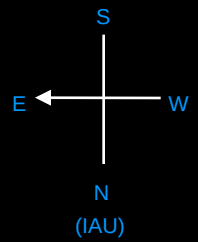
Pre-Opposition Views of Saturn in 2013-14

12" LX200 at f/18. Flea II color camera, 1600 out of 3900 frames. Seeing = 6(10), Transparency - 7(10). Rich Jakiel, Duck Dodgers Observatory, Lithia Springs, GA.



March 19th 2014, 16:14:30 UTC, CMIII 289.5
Dia 17.9", Ring Op Earth 22.5 degrees, Alt 58 degrees, seeing 5 to 6/10
16" F4.5 Custom Newt working at F16.7 Mark Suchting Primary Antares 1/30th wave Secondary
742nm IR Image ZWO ASI120MM Trevor Barry Broken Hill Australia





Shadow of the Globe on the Rings is toward the East (IAU) before Opposition

2004-14 Pro-Am Cassini Observing Patrol

- The Pro-Am effort began on April 1, 2004 when *Cassini* started observing Saturn at close range.
- ALPO observers are urged to participate in the project as the *Cassini* mission continues in 2013-14.
  - Using apertures ≥ 31.8cm (12.5in) Saturn should be imaged with 890nm narrow-band methane (CH_4) filters.
  - Imaging should occur regularly in search of individual features, their motions & morphology. These data can help suggest to the *Cassini* imaging team where (large-scale) targets might exist.
  - Suspected changes in belt & zone reflectivity (i.e., intensity) & color are useful, so *visual observers can participate by making visual numerical relative intensity estimates in Integrated Light & with color filters*.
  - The *Cassini* team combines ALPO images with data from *Hubble* & from ground-based observatories.
  - Observations should be sent to the ALPO Saturn Section for prompt forwarding to the *Cassini* team.

More About How to Observe Saturn

Saturn and How to Observe It is a comprehensive guide to ALPO Saturn observing programs and techniques.