This presentation and its contents is intended solely for the purpose of exhibiting observational activities and programs organized and conducted by the ALPO Saturn Section and its associates. The data, images and other information contained herein shall not be reproduced, used or distributed, in whole or in part, without expressed written authorization of the ALPO Saturn Section.
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.alpo-astronomy.org/](http://www.alpo-astronomy.org/)
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 available for further study by professional astronomers.

• Earth-based monitoring by amateurs of changing atmospheric features on planets such as Mars, Jupiter and Saturn often help professionals select targets for high-resolution imaging with large telescopes and spacecraft.

• Skilled observers routinely produce detailed drawings and 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 observed with moderate apertures.

• **Asteroids** change in brightness & they periodically occult stars; amateurs have played a major role in discovery of new minor planets.

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

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

• **Comets** vary in appearance and brightness for viewing 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 is:
  ✓ 7.5cm. (3.0in.) for refractors or Maksutos
  ✓ 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.).

• *CCD cameras* are important for capturing detailed images for subsequent processing using applicable software.
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 and measurements of belt & zone latitudes.
- Visual detection and imaging of "intensity minima" in Saturn’s rings.
- Monitoring the bicolored aspect and brightness asymmetries around the circumference of Ring A.
- Accurate timing and imaging of stellar occultations by the globe and rings.
- Specialized studies at small ring inclinations or when they are edgewise to our line of sight (e.g., transits of satellites and their shadows across the globe).
- Visual observations and 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
  - Begin 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

- **Globe S of Rings**
- **Sh R on G**
- **Crape Band**
- **Ring C**
- **Ring B**
- **Ring A**
- **Cassini (A0 or B10)**
- **Encke's (A5)**
- **Keeler's (A8)**
- **Sh G or R**
- **NPB**
- **NTrZ**
- **NNTeB**
- **NNTeZ**
- **NEB**
- **NPR and N Polar Hexagon**
- **System I: 10h 14m 13s (Equatorial Regions of the Globe - EZ, SEB, NEB)**
- **System II: 10h 38m 25s (Regions N or S of System I)**

*B = +20°*
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.
Geocentric Phenomena in UT for Saturn

The Current 2013-14 Apparition

- Conjunction 2013 Nov 06<sup>d</sup> UT
- Opposition 2014 May 10<sup>d</sup>
- Conjunction 2014 Nov 18<sup>d</sup>

**Opposition Data:**
- Equatorial Diameter Globe 18.6"
- Polar Diameter Globe 16.6"
- Major Axis of Rings 42.1"
- Minor Axis of Rings 15.6"
- Visual Magnitude (m<sub>v</sub>) +0.1m<sub>v</sub>
- B = +21.8<sup>°</sup>
- Declination −15.4<sup>°</sup>
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 and 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.
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”.

✓ With the Sun now situated N of the rings since late 2009, spring has begun in Saturn’s N hemisphere.

✓ The NTrZ storm’s emergence at 35°N Saturnigraphic latitude demonstrated how shifting seasons and more direct 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 5\textsuperscript{th}, the \textit{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 \textit{Cassini} scientists track the storm as it developed over time.

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

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{saturn_image.png}
\caption{Saturn image on December 10, 2010 by Anthony Wesley, Murrumbateman Australia}
\end{figure}
Reminiscing: The Great NTrZ Storm of 2010-11

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

Cassini RGB[MT3,MT2,CB2]

Cassini RGB[CB2,GRN,BL1]

Cassini RGB[CB2,GRN,BL1] (full WAC image)

Ground-based observation

Cassini composite images created from spacecraft raw images
Image credits: NASA/JPL/Space Science Institute / processing by Mike Malaska
Ground based observations: Donald Parker, Trevor Barry, Christopher Go
Graphic prepared by Mike Malaska
Reminiscing: The Great NTrZ Storm of 2010-11

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

  ![Saturn Image 1](image1)
  ![Saturn Image 2](image2)
  ![Saturn Image 3](image3)
  ![Saturn Image 4](image4)

Saturn - 30 Dec 2010 18:49.2 Z CRIII:267.0
Anthony Wesley, Murrumbateman Australia

18:17 UT I: 84 II: 314 III: 35
February 9, 2011 S: 7.8/10 T: 4/5
© Christopher Go (Cebu, Philippines)

14 March, 2011
05:07 UT

APRIL 8th, 2011
23:47 UTC

D. Peach, Selsey, UK
Eq Diam=19.29" Alt: 36°
Reminiscing: The Great NTrZ Storm of 2010-11

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

**7 May 2011**
04:01:27 UT
CM1=323.0 CM2=281.7 CM3=258.2

**JUNE 9th, 2011**
20:32 UTC

**July 1, 2011**
01:08 UT

**July 31st, 2011**, 09:14 UTC, CMII 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 PCR Flea3 Primary by Mark Suchting, 1/30th wave Antares Secondary Imaged at Broken Hill Australia by Trevor Barry
Gallery of Observations from the 2012-13 Apparition
Pre-Opposition Views of Saturn in 2012-13

Dark Spot at S edge NTeZ into NTeB

Image courtesy Cassini mission

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

Saturn 16 Mar 2013 17:24.3 Z CMII:232.1
Anthony Wesley, Murrumbateman Australia

17:22UT l 86 II: 231 III: 74 (20 min)

Saturn
April 13, 2013 S: 7-B/10 T: 5/5
© Christopher Go (Cebu, Philippines)

Paul G. Abel, Leicester UK,
2013 April28 Disk Drawing: 0028UT, x250, Seeing: A/V-V, Transp: Excellent
CM1: 277  CM2: 320  CM3: 145.8
203mm Newtonian Reflector, x167 & x250. Filter: W#11
The **Seeliger Opposition Effect** is an apparent brightening of the rings for a short interval near opposition.

Caused by coherent back-scattering of \( \mu \)-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

Saturn
May 10, 2013 S: 7-9/10 T: 4/5 © Christopher Go Cebu, Philippines

Saturn
May 29, 2013 S: 8-9/10 T: 4/5 © Christopher Go (Cebu, Philippines)

LRGB 13:58.6 UT #110.9 II=274.3 III=77.8 SATURN 16 MAY 2013
C14 F/11-24 DMK21AU618AS
S=5-8/10 T=8/15

12:04UT I: 220 II: 326 III: 114 (30 min) Shadow of the Globe on the Rings is toward the West (IAU) following Opposition

NTrZ & NTeZ White Spots

(NOTE: Adapted by Tony Renshaw, D. H. Turcotte, L. W. Castillo, D. A. Labrador, C. E. Schurter, and C. D. Wilson, ALPO Saturn Section of the IAU)
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 Current 2013-14 Apparition
Pre-Opposition Views of Saturn in 2013-14

Saturn 14 Jan 2014 18:02.1 Z CMIII:296.3
Anthony Wesley, Narrabri, New South Wales, Australia

RGB

685 nm - 1330 UT

SATURN January 28, 2014 13:22 UT. 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 f/16.7 Mark Sutherland Primary Antares, 1/30th wave Secondary
RGB image ZWO ASI120MM Trevor Barry Broken Hill Australia

February 8th 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 f/16.7 Mark Sutherland Primary Antares, 1/30th wave Secondary
742 nm IR Image ZWO ASI120MM Trevor Barry Broken Hill Australia

ALPO SATURN SECTION

August 27, 2014
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 37 degrees, seeing 4 to 5/10
16" F4.5 Custom Newt working at F16.7 Mark Sutherland Primary Antares 1/30th wave Secondary
RGB Image ZWO AS120MM 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 Sutherland Primary Antares 1/30th wave Secondary
742nm IR Image ZWO AS120MM Trevor Barry Broken Hill Australia

SATURN
13 MARCH 2014

LRGB
04 H 03.5 UT
I 77 III 53
Derotation 5 mn (L)

IR 685 nm+
04 H 29.9 UT
I 93 III 67
Derotation 10 mn

R+IR 610 nm+
03 H 51.0 UT
I 70 III 47
Derotation 10 mn

Christophe Pellier

Gregory 250 F/32
PLA-Mx + ADC

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

S
E
W
N
(IAU)

Le 55
Dia 17.7"
De +22.6
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, CMII 265.5
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 742mm IR Image ZWO ASI120MM Trevor Barry Broken Hill Australia

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

Longitudes in System 3, planetographic latitudes Stereographic polar projection (North pole)
Pre-Opposition Views of Saturn in 2013-14

NTrZ white spots (red image) as well as high N latitude dark spots (1 possibly at edge of North Polar Hexagon)
Saturn At Opposition in 2013-14: The Seeliger Effect

- **The Seeliger Opposition Effect** is an apparent brightening of the rings for a short interval near opposition.

- **Caused by coherent back-scattering of \( \mu \)-sized icy particles in the rings when the phase angle between Sun-Saturn-Earth is <0.3°.**

---

2013-14 Opposition Data:

2014 May 10\(^{\text{d}}\) UT
Eq Dia Globe = 18.6"
Po Dia Globe = 16.6"
Maj Axis Rings = 42.1"
Min Axis Rings = 15.6"
Visual Mag = +0.1
B = +21.8°
Declination = −15.4°
Post-Opposition Views of Saturn in 2013-14

203mm Newtonian Reflector, x250 integrated light, Paul G. Abel, Leicester UK

Disk Drawing: 2234UT, x230, Seeing: AIV, CM1: 350, CM2: 140.6, CM3: 206.6
508mm (20") PlaneWave Dall-Kirkham University of Leicester Observatory, x230 and x255
B = 21.9, D = 22.1, Disk Diameter = 18.5", Ls = 57°, Paul G. Abel and Hugh Sasse, Leicester UK

May 23rd 2014, 13:36 UTC, CMIII 347.7
DIA 19.6", Ring Op Earth 21.5 degrees, Alt: 73 degrees, seeing 6 to 7/10
16" F4.5 Custom Newt working at F16.7 Mark Schurmg Primary Antare 1/20th wave Secondary
RGB Image ZWO ASI120MM Trevor Barry Broken Hill Australia

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

ALPO SATURN SECTION
Post-Opposition Views of Saturn in 2013-14

July 2nd 2014, 11:04 UTC, CMIII 294.5
Dia 17.9", Ring Op Earth 21 degrees, Alt 73 degrees, seeing 4 to 5/10
16" F4.5 Custom Neat working at F16.7 Mark Sucking Primary Antares 7/30th wave Secondary
RGB Image ZWO ASI120MM Trevor Barry Broken Hill Australia

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

S2014_19 June_02-54-42_UT_MH
CM1 = 345.5 CM11 = 236.1 CM111 = 278.9
Seeing: 5/10 Trans: 6 Alt: 43 Deq: 18.2
TEC 200 ED @ F-25 ZWO ASI 120MM Astronomik RGB Filters
Mike Hood Kathleen, GA (USA)
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 (CH₄) 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) and 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 and 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.

2nd Revised Edition due out late 2015