The Sun
Solar Observing Guide

Daytime astronomy — sunspots, prominences, eclipses, equipment, and safety.

Solar Cycle 25 maximum is happening now — best solar observing in over a decade.

SAFETY FIRST — read this every time

Looking at the Sun without proper filtration causes permanent retinal damage in seconds. The damage is painless because the retina has no pain receptors — you don't feel the burn happening. The danger is invisible and immediate.

The non-negotiable rules

NEVER look directly at the Sun	Without certified solar filtration. Not 'briefly'. Not 'just to glance'. Not 'when it's near the horizon and looks dim'. Not 'with sunglasses'. Sunglasses are 100,000× too transparent.
Eclipse glasses must be ISO 12312-2 certified	Print this number on the temple of any pair you buy. Buy from **American Paper Optics, Rainbow Symphony, Thousand Oaks, Baader**, or other reputable suppliers. Reject unlabeled glasses or counterfeits. Inspect for any pinholes or scratches before each use; discard if damaged.
Solar filters go on the OBJECTIVE end	On the front of the telescope, before light enters. **Never** use 'eyepiece sun filters' or anything that screws into the eyepiece — they crack from focused heat and the burst sends concentrated solar energy directly into your eye.
Cover the FULL aperture	The filter must completely cover the front of the telescope. No gaps. No partial coverage. Tape over any finderscope or remove it — finderscopes can also focus the Sun and burn things (or you) at the back.
Inspect every time	Before pointing at the Sun, hold the filter up to a bright light source and look for pinholes or scratches. Even a small defect can let through enough sunlight to damage your eye. If in doubt, throw it out.
Children require active supervision	Kids are curious and impulsive. Don't just hand them eclipse glasses and a telescope. An adult should be present and watching during any solar observation session.

During a total solar eclipse	Eclipse glasses come off ONLY during the brief totality phase, and only along the path of totality. Glasses go back on the moment the bright photosphere returns. Outside the path of totality (partial eclipse), glasses stay on the entire time.

About the Sun

Our nearest star — 1.39 million kilometers in diameter (109 Earths across), 150 million km away. Surface temperature 5,500°C; core temperature 15 million°C. The Sun has been fusing hydrogen into helium for 4.6 billion years and has another 5 billion to go before exhausting its hydrogen core and becoming a red giant. From an observing standpoint the key fact is that the Sun has an **11-year activity cycle**. Sunspots, flares, and prominences peak around solar maximum and almost disappear at solar minimum. Where we are in the cycle determines whether observing is fascinating or boring on a typical day.

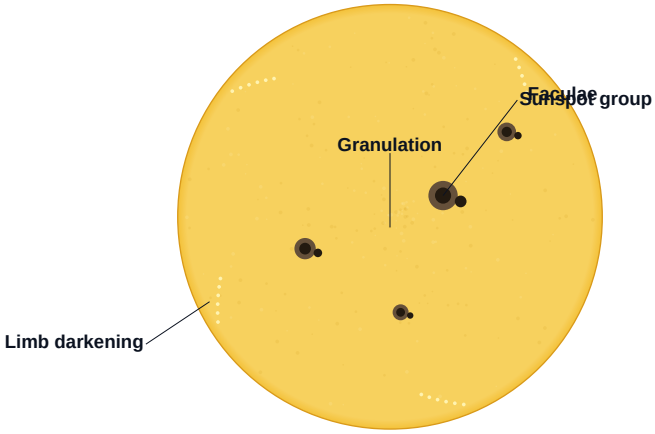
Where we are now: Cycle 25

Cycle started	December 2019
Maximum predicted	Mid-2024 to late 2025
Peak smoothed sunspot number	approximately 165 sunspot number (SILSO May 2024 prediction)
Next minimum	Approximately 2030

Cycle 25 turned out significantly stronger than initial predictions — early forecasts called it weak (similar to the quiet Cycle 24), but observed activity from 2022 onwards suggested it would exceed Cycle 24's peak. The smoothed sunspot number reached its predicted maximum in late 2024, and observations through 2025–2026 show continued high activity (often 150+ daily spot count) with frequent X-class flares and aurora-triggering geomagnetic storms. **Right now is the best solar observing window in over a decade** — the Sun typically shows 5–15 visible sunspot groups on any clear day, and Hα prominences are abundant.

What you see in white light

White-light observation (solar filter on a regular telescope or eclipse glasses naked-eye) shows the photosphere — the visible 'surface' of the Sun. Below are the features visible. The illustration shows a typical near-maximum solar disk with all major feature types labeled.



Sunspots

COMMON — MAIN ATTRACTION NEAR SOLAR MAXIMUM

Dark patches on the photosphere where strong magnetic fields suppress convection. The dark center is the **umbra** (~3,500K, cooler than 5,500K surface); surrounding gray ring is the **penumbra**. Spots come in pairs or groups (active regions) and rotate across the disk over ~14 days as the Sun rotates.

Sunspot groups

COMMON — ACTIVE REGIONS

Sunspots cluster into magnetically connected groups, classified by the Mt. Wilson scheme (alpha = single polarity, beta = bipolar pair, gamma = mixed, delta = complex with opposite polarities in same penumbra — the most flare-productive). Big delta groups can be bigger than Earth and produce M- and X-class flares.

Granulation

ALWAYS — FINE SURFACE TEXTURE

The 'orange-peel' texture of the photosphere — convection cells about 1,000 km across (Earth-sized). Each granule lasts ~10 minutes before being replaced. Needs steady seeing and a quality scope (4-inch+) to see clearly.

Faculae

COMMON — BRIGHT PATCHES NEAR LIMB

Bright filamentary regions visible especially near the solar limb. Magnetically active areas where the photosphere is slightly hotter than average. Often surround sunspot groups; persist after spots fade.

Limb darkening

ALWAYS

The Sun appears noticeably dimmer at the edge than at the center. You're looking through more of the cooler upper photosphere at the limb than at center. Easy to see in any white-light view.

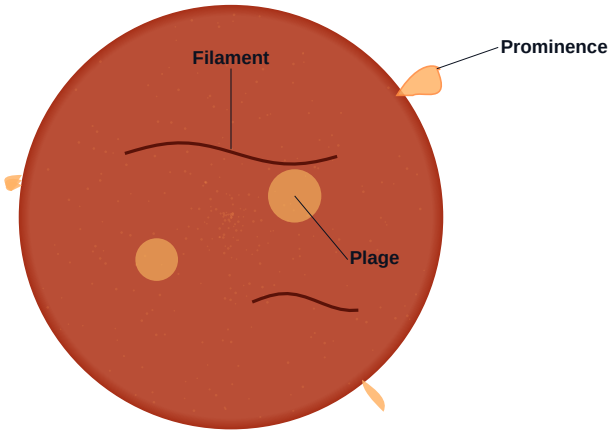
Mercury / Venus transits

RARE — MERCURY 2032, VENUS 2117

Mercury transit visible from Canada next: **November 13, 2032**. The previous Venus transit was June 6, 2012; the next is December 11, 2117 — once in a lifetime literally. Always use solar filters during all phases.

What you see in hydrogen-alpha (Hα)

An Hα solar telescope filters out everything except the deep red 656.3 nm Hα emission line, revealing the chromosphere just above the photosphere. Completely different view — prominences loop off the limb, dark filaments cross the disk, plages glow around active regions. Hα observation is more involved (specialized telescope required, $700+) but the views are spectacularly more dynamic than white light.



Prominences

COMMON — BRIGHT LOOPS AT THE LIMB

Arcs and loops of glowing plasma extending off the solar limb, suspended by magnetic fields. Best viewed at the edge of the disk where they appear bright against the dark background. Can change shape over hours; some persist for weeks. The most dramatic Hα feature for newcomers.

Filaments

COMMON — DARK THREADS ON THE DISK

Same physical objects as prominences, but viewed against the bright disk where they appear as dark threads. A single feature is a 'filament' on the disk and a 'prominence' when it rotates over the limb. Long filaments can stretch hundreds of thousands of km.

Plages

COMMON AROUND ACTIVE REGIONS

Bright Hα regions of the chromosphere above magnetically active areas. Usually surround sunspots and persist longer than the spots themselves. Show as bright patches on the otherwise textured disk.

Sunspot magnetic structure

WHEN SUNSPOTS PRESENT

Hα reveals the magnetic field structure around sunspots that's invisible in white light — the 'fibrils' radiating from the spot, swirls, and bright arches connecting opposite-polarity regions.

Solar flares

RARE — MINUTES TO HOURS; CHECK SPACE WEATHER FEEDS

Sudden brightenings near complex sunspot groups. M-class and X-class flares are the most dramatic; observers can sometimes catch the brightening live. Strong flares produce auroras 1-3 days later when the CME arrives at Earth.

Spicules

ALWAYS — FINE 'GRASS' COVERING THE DISK

Tiny short-lived plasma jets covering the entire chromosphere — looks like fine 'grass' or fur on the surface. Requires excellent seeing and high-quality Hα equipment to resolve.

Equipment

Buy ONLY from reputable astronomy retailers. Counterfeit and damaged solar filters are sold online via marketplace sellers (Amazon third-party, eBay, AliExpress) — even if marked 'ISO 12312-2', the counterfeit may not actually meet the standard. Stick with B&H;, OPT, High Point Scientific, Astronomics, Khan Scope, KW Telescope, or other established astronomy dealers.

Eclipse glasses (ISO 12312-2) — $2-15 per pair

The cheapest entry point. ISO 12312-2 is the safety standard — must be on every pair you buy. Check for damage before each use. Gives a small naked-eye view of the Sun showing major sunspot groups and partial eclipses. Buy from reputable brands: **American Paper Optics, Rainbow Symphony, Thousand Oaks**. **Discard old glasses** if the filter shows any pinholes or scratches.

Baader AstroSolar film — $25-50 (DIY filter kit)

The amateur favorite for white-light observing through binoculars or telescope. Visual density 5.0 film cuts sunlight by 100,000×. You construct a custom-fit filter that covers the FULL aperture of your scope's objective. Lightweight, safe, gives a clean white-yellow Sun image with sunspots sharply defined. Far more economical than glass filters for larger apertures.

Glass solar filters — $50-300+

Pre-made glass filters that fit specific telescope apertures. Brands: **Thousand Oaks, Orion, Celestron**. More durable than film, but can introduce slight color cast. Always inspect for cracks before each use. Glass filters threaded for the front of the scope are safe; never use 'sun filters' that thread into eyepieces — they can crack from focused heat.

Hα solar telescope (entry) — $700-1,500

Coronado PST (Personal Solar Telescope) is the standard entry-level Hα scope at ~$800. 40mm aperture, narrow Hα bandpass shows prominences, filaments, plages. Smaller field than Lunt models. **Daystar SolarScout** is a comparable alternative.

Hα solar telescope (advanced) — $2,000-10,000+

Lunt LS50T, LS60T, LS80T, LS100T series — different apertures with double-stack options for higher contrast. **Daystar Quark** is an alternative — turns a regular refractor into an Hα scope via a 4× Barlow + filter unit. Gives larger image scale than dedicated Hα scopes.

Solar finder — $30-100

Pointing a telescope at the Sun without a regular finderscope (don't use it!) is hard. **Tele Vue Sol-Searcher**, **Baader SunFinder**, or simple shadow-pin finders project a small Sun image onto a screen so you can center the scope safely without looking through anything.

Upcoming solar eclipses

After the spectacular April 8, 2024 total solar eclipse across eastern North America, the next decade is sparse for North American total eclipses — most upcoming totality paths cross other continents. The 2045 total across the western US is the next major continental US event. Listed below are the notable upcoming solar eclipses with North American visibility considerations.

Date	Type	Path	Notes
Aug 12, 2026	Total solar eclipse	Iceland, Spain, Russia	Total path crosses Greenland, Iceland, Spain, Portugal — North America sees a partial eclipse only (50-80% in eastern Canada).
Feb 17, 2026	Annular solar eclipse	Antarctica only	Path of annularity falls entirely on Antarctica. Not visible from Canada or US.
Aug 2, 2027	Total solar eclipse	Spain, North Africa, Saudi Arabia	Famous 6-minute totality through Egypt and Saudi Arabia — the longest total eclipse of the 21st century. Not visible from North America.
Jan 26, 2028	Annular solar eclipse	South America, Spain, Portugal	Annular path through northern South America. Not visible from Canada.
Jul 22, 2028	Total solar eclipse	Australia, New Zealand	Sydney is in the path of totality — popular destination for eclipse chasers. Not visible from North America.
Aug 12, 2045	Total solar eclipse	Western US, Caribbean	Long-duration totality (6+ minutes) crosses the western and southern United States. Most accessible major North American total eclipse for decades after 2024.
Mar 30, 2033	Total solar eclipse	Alaska	Path of totality through Alaska — a bucket-list trip. Visible only in Alaska from the North American continent.

Eclipse safety reminder: Solar eclipse glasses must be worn during the entire eclipse, with one exception — during the brief totality phase of a TOTAL solar eclipse, when the Moon completely covers the Sun, glasses come off so you can see the corona. Glasses go back on the instant the bright photosphere returns. Annular and partial eclipses never have a 'glasses off' phase — the Sun is always at least partly visible and dangerous.

Practical observing tips

Best time of day	10 AM to 3 PM local time is the sweet spot. Sun is high enough that atmospheric distortion is minimal, but not so high that thermal currents from the heating ground are at their worst. Mid-morning often beats midday for steady seeing.
Best season	Spring through early fall — the Sun is higher (better seeing). Winter Sun at 22° altitude has 3× more atmosphere to look through than summer's 68° altitude. Long winter shadows also mean very steep light angle through any obstructions.
Aiming the scope safely	Don't use the regular finderscope (cap it or remove it). To aim: position so the telescope's shadow on the ground is smallest (perpendicular to the Sun direction). A solar finder makes this easier — they project a small Sun image onto a screen for centering without looking through anything.
Solar rotation	The Sun rotates roughly every 25 days at the equator (slower at the poles — it's a fluid, not solid). A sunspot group near the central meridian today will be at the limb in about 7 days, then disappear behind, then reappear on the eastern limb 14 days later. Drawing or photographing a spot group nightly is a satisfying multi-day project.
Sketching beats imaging	For sunspot observation, a 5-minute pencil sketch teaches you more than a photo. You're forced to look carefully — to count spots within a group, to notice penumbral structure, to observe limb darkening. The historic AAVSO Solar Section database is built on amateur drawings.
Space weather context	Real-time data: **spaceweather.com** shows current sunspot count, today's Sun image, and active region maps. **swpc.noaa.gov** (NOAA Space Weather Prediction Center) shows official solar activity reports and aurora forecasts. **solarham.com** tracks active region complexity.
Aurora link	Big sunspot groups produce flares and CMEs. CMEs that hit Earth produce auroras 1–3 days later. Watching the Sun and watching aurora forecasts are linked activities — when you see a complex delta-class spot group, set an aurora alert for 1–3 days hence.

One more time: The Sun's radiation can permanently damage your retina without you feeling anything. Use ISO 12312-2 eclipse glasses for naked-eye viewing. Use a properly fitted full-aperture solar filter on the front of any binoculars or telescope. Inspect for damage every time. When in doubt, don't.