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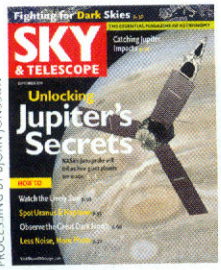
SKY & TELESCOPE

September 2011

VOL. 122, NO. 3



JUNO ART: NASA / JPL
JUPITER IMAGE: NASA; PROCESSING BY BJORN JONSSON

On the cover: An artist depicts Juno arriving at Jupiter in 2016. An image of Jupiter is featured in the background.

FEATURES

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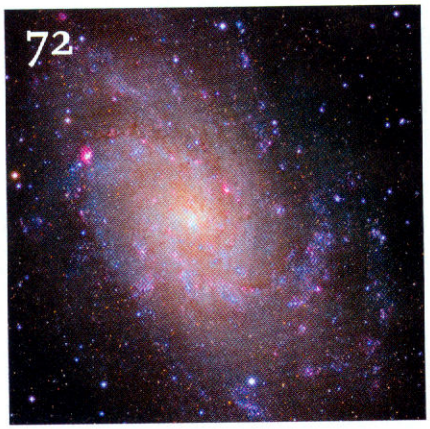
THIS MONTH'S SKY

S&T TEST REPORT



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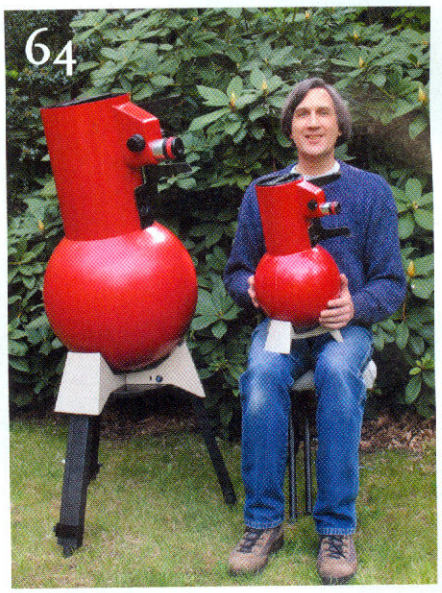

GARY SERONIK

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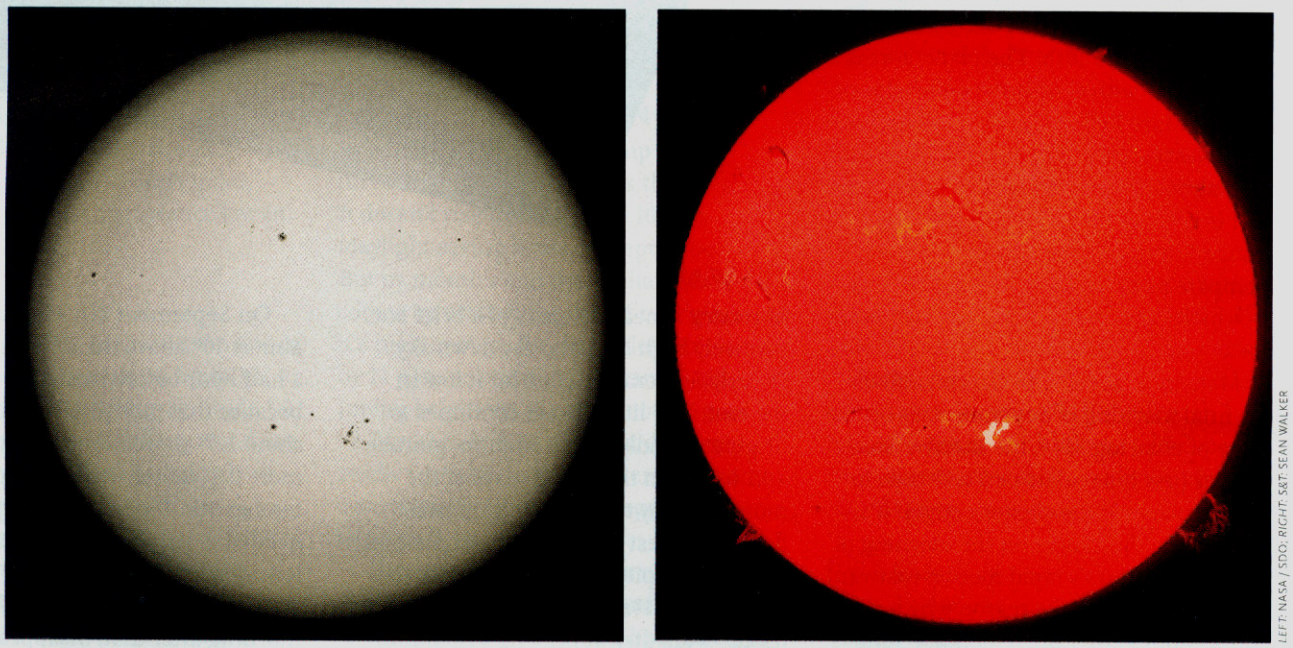
SKY & TELESCOPE (ISSN 0037-6604) is published monthly by Sky & Telescope Media, LLC, 90 Sherman St., Cambridge, MA 02140-3264, USA. Phone: 800-253-0245 (customer service/subscriptions), 888-253-0230 (product orders), 617-864-7360 (all other calls). Fax: 617-864-6117. Website: SkyandTelescope.com. Periodicals postage paid at Boston, Massachusetts, and at additional mailing offices. Canada Post Publications Mail sales agreement #40029823. Canadian return address: 2744 Edna St., Windsor, ON, Canada N8Y 1V2. Canadian GST Reg. #R128921855. POSTMASTER: Send address changes to *Sky & Telescope*, PO Box 171, Winterset, IA 50273. Printed in the USA.

Stephen W. Ramsden

Probing the Nearest Star

With the next solar maximum approaching, gear up to view the Sun.



LEFT: NASA / SDO; RIGHT: S&T: SEAN WALKER

The Sun offers endless daytime observing opportunities for amateurs. *Left:* Telescopes of any size equipped with safe solar filters can reveal dark sunspots across the photosphere, as seen here. *Right:* This image, taken at about the same time through a solar hydrogen-alpha filter, shows several giant prominences towering above the solar limb, and a bright flare erupting near the central meridian.

VISIBLE ON EVERY CLEAR DAY from nearly every location on Earth, the Sun is perhaps the easiest target to observe in the solar system. Now reawakening from an unusually long solar minimum, our Sun offers intriguing details to the careful observer using small telescopes and the proper techniques.

Observers today have more choices than ever to adapt their scopes to solar viewing. The easiest way to begin is to purchase a white-light solar filter. These devices block 99.999% of the Sun's light, revealing complex sunspot groups that churn across the photosphere. Sunspots are cooler regions of the photosphere that consist of oppositely charged magnetic polarity. As they form and decay and produce ever-changing groups, sunspots display a rhythmic dance of magnetic ferocity. A sunspot's black core is known as an *umbra*, which is often surrounded by a grayish *penumbra*. These features appear in stark contrast to the granulated photosphere even in small refractors, giving the observer a real-time view of the surface magnetic-force lines as they circulate in hotter material to fill the cooler regions in the sunspot's recessed umbra.

Regions of intense brightening known as *faculae* surround sunspots. Astronomers think faculae are electromagnetically related to sunspot groups. These fields of superheated photospheric plasma come and go in a ghostly partnership with meandering sunspot groups

Lucky observers may glimpse a rare white-light flare in the coming years. Richard Carrington viewed a particularly bright flare in 1859 (February issue, page 28), which touched off a geomagnetic storm that affected telegraph communications and produced auroras near the equator.

Beyond sunspots, the entire photosphere is riddled with granulation, a patchwork of bright areas bounded by darker lines. Granules are small cells of magnetically charged plasma bubbling up from the Sun's convective zone into the photosphere. They appear as dome-like structures, typically ranging from 500 to 1,000 miles (800 to 1,600 km) in diameter. Granules resemble the compli-

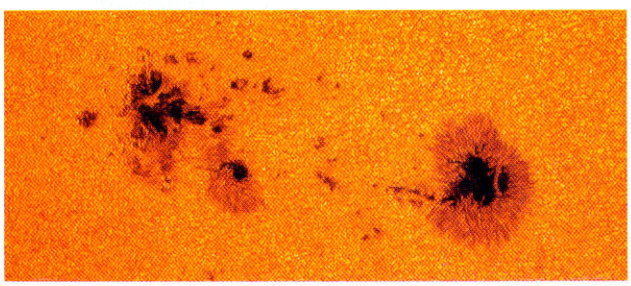
cated cellular structures seen in plant life or the grouped skin cells of our epidermis seen through a microscope.

These visible-light structures last for 4 to 6 minutes before falling back into the interior, only to be replaced by the next energy-releasing granules. Granulation and, for that matter, all of these features revealed in white light, remain mostly a mystery as astronomers continue to study data provided by space-based observatories and data recorded by professional and amateur astronomers using ground-based telescopes.

Beyond the broadband views, rapidly changing solar phenomena await observers willing to invest a bit more capital in their solar-observing arsenal. Solar observers have long been staring at narrowband views of the Sun through various filtration mechanisms and devices. The hydrogen-alpha wavelength (656.28 nanometers) reveals dramatic fluid motions and complex structures within the solar chromosphere, just above the photosphere, the region where white-light features are visible.

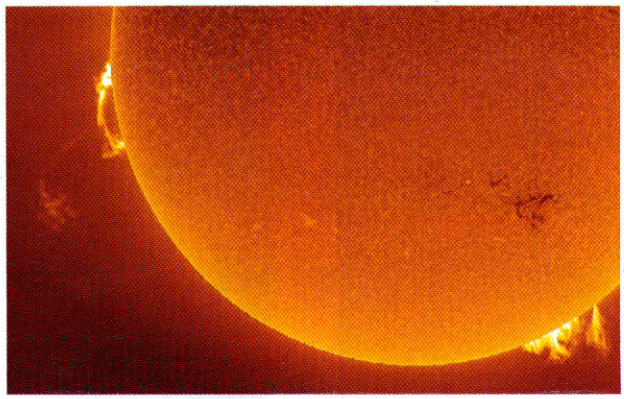
When observing through a telescope equipped with a specialized solar hydrogen-alpha filter, the features that initially catch your eye are delicate prominences dancing along the edge of the Sun. These are protuberances of relatively cool hydrogen plasma held aloft by powerful magnetic fields extending out to the solar corona. Appearing similar to licks of fire or massive loops, prominences can commonly span the length of 30 or more Earths. When a prominence is seen in front of the solar disk, it appears darker than the solar surface and is known as a *filament*. A prominence's brightness is directly proportional to the temperature of the plasma contained within these magnetic fields; prominences with hotter plasma appear brighter than those containing cooler gas.

Prominences can last anywhere from minutes to months and can change appearance rapidly, depending on the stability of the magnetic fields holding them aloft. When the magnetic field containing a prominence or filament becomes unstable, the plasma either falls back into the Sun, or in some cases, the prominence can erupt off the limb into space. An erupting prominence can sometimes develop into a full-blown coronal mass ejection,



EMIL KRAAIKAMP

Large telescopes using white-light solar filters offer breathtaking views of sunspots at high magnification, as well as tiny granules that form and decay within minutes.



STEPHEN W. RAMSDEN

Huge prominences, such as these exquisite examples recorded on June 5th, can change appearance within minutes. These prominences lasted for days, while the fainter arc at left was pulled back into the Sun within hours of this photo being taken.

launching billions of tons of superheated plasma at velocities approaching 1% of the speed of light.

Besides prominences, *spiculae* are visible along the solar limb, appearing as tiny "hair" prominences particularly around the Sun's polar regions. Bright areas within the chromosphere often surrounding sunspots are called *plages*. Solar flares can suddenly erupt from plage regions without warning. These powerful flares can outshine the entire Sun for a brief time and result in terrestrial radio interference, auroras, and satellite outages. In recent months, active regions have been crackling with dozens of C- and X-class flares. Astronomers have not yet been able to reliably predict flares, but if you spend a lot of time behind an H-alpha scope in the next few years, you'll surely catch several in action.

White-light and hydrogen-alpha solar observing are the most popular methods for amateurs to study the Sun. But other spectral bands reveal interesting solar phenomena. A calcium-K filter shows ionized calcium in the chromosphere as it emits and absorbs energy in the violet region of the spectrum. Some observers have little or no visual acuity at these wavelengths, so calcium-K observations are more useful when combined with imaging.

The introduction of affordable technologies in narrowband filters and specialized telescopes has generated a global boom in solar astronomy. Those of you who already own a narrowband solar scope already know how beautiful the Sun's fiery ballet of plasma can be. I invite the rest of you star lovers to come join the hottest thing in astronomy by taking the plunge into safe solar astronomy. As the Sun approaches solar maximum in the next two years, now is the best time to get acquainted with our stellar neighbor. ✦

Stephen W. Ramsden *operates the Charlie Bates Solar Astronomy Project (www.charliebates.org), a nonprofit public outreach program sharing views of the Sun worldwide.*