

Astronomy

The world's best-selling astronomy magazine

How **NEW RESEARCH**
DARK MATTER
reveals the
cosmos p. 16

Inside the
Tarantula
Nebula p. 24

» **PLUS**

Observing peculiar
galaxies p. 40

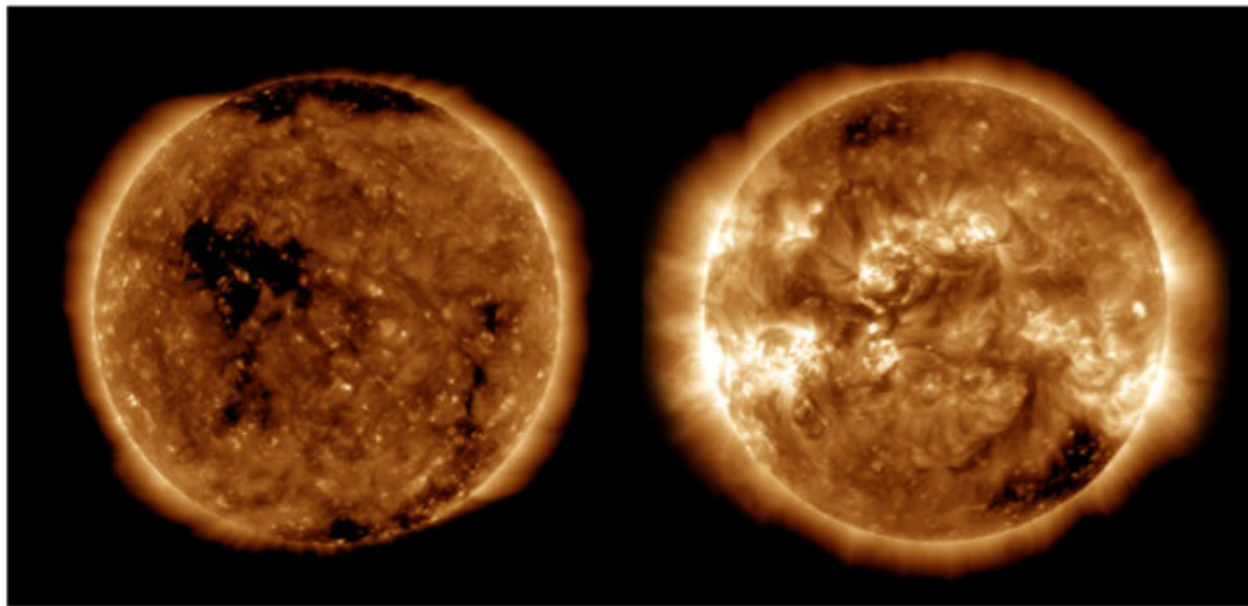
The inside scoop
on variable stars p. 54

H-alpha imaging with
Canon's Ra camera p. 44

www.Astronomy.com

**BONUS
ONLINE
CONTENT
CODE p. 4**

Artemis delays may expose astronauts to hazardous space weather



AT EXTREMES. Our Sun undergoes an 11-year cycle during which its activity peaks (right, from April 2014) and wanes (left, from October 2019). NASA'S SOLAR DYNAMICS OBSERVATORY/JOY NG

NASA's Artemis program aims to land astronauts on the Moon by 2024. But spaceflight delays are common, so it was no surprise when, in a February interview with *Ars Technica*, NASA acting administrator Steve Jurczyk said 2024 may no longer be a realistic goal.

According to a paper published May 20 in *Solar Physics*, the delay might have a potentially dangerous consequence: increasing the risk that astronauts and spacecraft will be exposed to extreme space weather.

Space weather results from activity on the Sun and sends energetic particles racing through the solar system. The largest and most extreme events can damage satellites or spacecraft and disrupt power grids on Earth. This radiation also poses serious health risks to astronauts above Earth's protective atmosphere, and the most extreme events could sicken or even kill astronauts if they aren't protected by shielding.

The Sun has a regular 11-year cycle driven by changes brought on when its magnetic field flips. It entered cycle 25 in December 2019. Each cycle has a minimum and a maximum of activity, and astronomers have long known that mild to moderate

outbursts and space weather are more likely to occur during a maximum, as well as during solar cycles that yield more sunspots.

In their new paper, the authors analyzed 150 years of records and found that the most extreme — and rarest — space weather events follow this same pattern. Their analysis also showed that extreme space weather events occur earlier in even-numbered solar cycles and later in odd-numbered solar cycles. They think this behavior could be related to the overall polarity of the Sun's magnetic field during each subsequent cycle — i.e., which way is north and which way is south. That polarity flips during each solar maximum, so it starts out pointing different ways during even- and odd-numbered cycles, which begin at solar minimum.

All this means that if Artemis is pushed back into the latter half of the 2020s — during odd-numbered solar cycle 25 — the risk from extreme space weather will increase. While extreme storms are less likely between now and 2026, the researchers say, the interval between 2026 and 2030 will carry a higher likelihood of big events that mission planners may have to consider.

In this case, forewarned is definitely forearmed. — ALISON KLESMAN



ESA/HUBBLE, R. SAHAI

HUBBLE HIGHLIGHTS A TWO-FACED NEBULA

The word *nebula* is itself a nebulous term: It means any cloud of dust and gas in space. So astronomers have broken down the category into several types, including emission nebulae such as NGC 2313, seen here in a recent Hubble Space Telescope snapshot. As their name suggests, emission nebulae emit their own light, releasing energy that is absorbed from a nearby star — in this case, V565 at the center of the image. NGC 2313 was once further classified with the now-defunct term *cometary nebula*, thanks to its lopsided appearance, which makes it look a bit like a comet with a tail. This occurs because a dense region of dust obscures the bright gas on the right side of the image, dimming and reddening half the nebula's splendor. —A.K.