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Todd Shields

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(Bloomberg) -- Two days after Elon Musk's SpaceX launched 60 satellites in May as part of a mission to bring quick internet service to people worldwide, astronomers noticed something different. As some of the satellites zipped past the Lowell Observatory in Flagstaff, Arizona, telescopes trained on the night sky captured streaks of reflected sunlight that marred their view of a far-off star system. Astronomers now worry that the vast number of communications craft planned, including nearly 12,000 of Musk's Starlink fleet, will shine so brightly that they'll interfere with research that depends on delicate visual observations of distant galaxies and nearby asteroids. The new satellites will fly lower than many traditional craft, and will arrive in unprecedented numbers -- all told, more than double the roughly 5,000 satellites that are circling Earth now. "We just happened to be pointed in the right direction, and Starlink flew right through it" on May 25,

two days after launch, said Jeffrey Hall, director of the Lowell Observatory. The unexpected appearance helped to signal that, as Hall put it, "this is potentially a problem." Musk's Space Exploration Technologies Corp. is authorized to launch 11,943 satellites for its Starlink fleet, making it by far the leader in a total of nearly 13,000 low-Earth orbit satellites currently approved by the Federal Communications Commission, which coordinates trajectories and radio-frequency use. In addition, Amazon.com Inc.'s Jeff Bezos on Thursday filed to place 3,236 internet-beaming satellites into low-Earth orbit. The lower trajectories offer minimal lag time for data to bounce between the ground and the spacecraft, overcoming the signal lethargy that's limited internet-from-space schemes dependent on traditional communications satellites. Those older craft are parked some 22,000 miles (36,000 kilometers) above the Earth, an altitude that lets them appear to hover in one spot. At low-Earth orbit -- altitudes of just 112 to 1,200 miles -- satellites need to race around the globe to stay aloft, completing orbits in as little as 90 minutes. As one moves toward the horizon it will pass signal duties off to the next satellite coming by. Many satellites are needed if continuous, widespread coverage is the goal -- thus the constellations planned by Musk and others. There are currently 1,338 satellites in low-Earth orbit, according to a database compiled by the Union of Concerned Scientists. NASA, the U.S. space agency, tallied 4,972 satellites in its most recent count of payloads that are active and defunct. The number of stars visible to the unaided human eye isn't much more than 1,628, which is how many are registered at the 5th

magnitude of a brightness scale used by scientists, Robert Zinn, an astronomer at Yale University, said in an email. Abnormally favorable conditions (exceptional eyesight, total darkness with no light pollution, and no moonlight) could yield more. Plans for low-flying satellite fleets have been around for years. The realization that they might startle sky-watchers seems novel. A video of the Starlink satellites floating in a train across the sky has attracted more than 1.3 million views on the Vimeo video-sharing site. And Musk's public statements have varied. "Sats will be in darkness when stars are visible," Musk tweeted May 25, replying to solar system researcher Alex Parker, who on Twitter said the sight of SpaceX satellites launched two days earlier "gives me pause" because "they're bright and there are going to be a lot of them." Two days later, Musk tweeted that "Starlink won't be seen by anyone unless looking very carefully & will have ~0% impact on advancements in astronomy." He followed with a tweet saying, "We'll make sure Starlink has no material effect on discoveries in astronomy." Musk added that he'd sent a note to the Starlink team about "albedo reduction," or cutting the proportion of light reflected from the spacecraft. Astronomers Concerned Astronomers are studying the extent of the problem, said Pat Seitzer, former chair of the Committee on Light Pollution, Radio Interference, and Space Debris at the American Astronomical Society, which represents professional astronomers in North America. The satellites may be less bright once moved into planned higher orbits, and their visibility may vary with the seasons: their altitude means they'll stay out of the Earth's shadow and remain in

sunlight even after dusk for a longer period in the summer than the winter. "Our concern is just how bright they might be," said Seitzer, an astronomer at the University of Michigan. Radio Telescopes Astronomers who use radio telescopes that rely on the non-visible spectrum also may be affected. They'll need to adjust to a sky full of low-orbiting satellites, said Harvey Liszt, spectrum manager with the National Radio Astronomy Observatory based in Charlottesville, Virginia. The orbiting spacecraft will communicate via radio, generating celestial background noise that astronomers need to take into account as they listen for faint signals from distant reaches of the universe. "We will have to learn how to operate our electronics to detect weak cosmic signals in the presence of satellite signals at other frequencies that will be millions of times stronger," Liszt said by email. Trustees of the American Astronomical Society quickly passed a resolution expressing concern after Starlink burst upon their scene, and the century-old International Astronomical Union commented as well. "Reflections from the sun in the hours after sunset and before sunrise make them appear as slow-moving dots in the night sky," the union said in a June 3 statement. Though hard to pick out with the naked eye, "they can be detrimental to the sensitive capabilities of large ground-based astronomical telescopes." 500 Pounds SpaceX said it plans to raise the satellites to operate at an altitude of 342 miles, compared with their altitude after launch of 273 miles. "The observability of the Starlink satellites is dramatically reduced as they raise orbit," Eva Behrend, a SpaceX spokeswoman, said in an email. SpaceX will turn

the satellites and that may change their appearance, Behrend said. SpaceX hasn't disclosed the dimensions of the satellites, which it says weigh 500 pounds (227 kilograms) each. All 60 of the initial Starlink satellites were sent aloft in one mission, and fit into a rocket's fairing, or cargo bay, which is 43 feet (13 meters) long and 17 feet (5 meters) in diameter. Some traditional satellites tend to be larger. For instance, the high communications satellites that appear to hover over one spot can weigh 13,000 pounds or more. And the Union of Concerned Scientists database lists about 1,000 spacecraft that are heavier than Starlink satellites.

Humanity in Balance

The proposals for fleets serving up broadband from space fit a terrestrial policy imperative: to expand high-speed internet service to people and places left poorly served by traditional communications providers. It's not clear who can help if scientists determine the fleets of tomorrow will interfere with multi-million dollar telescopes that can detect objects millions of times dimmer than visible with the naked eye. The FCC ensures that satellite constellations don't cause radio interference and don't risk collisions, the agency said in 2017. Neil Grace, an FCC spokesman, declined to comment.

NASA doesn't regulate orbits or the spacecraft that enter them, said J.D. Harrington, a spokesman for the U.S. space agency. The Federal Aviation Administration regulates the safety of commercial launches and doesn't regulate satellites, said Greg Martin, a spokesman.

The legal arena "is really the Wild West" and "international space law doesn't really deal with this use of outer space at all," John Barentine, public policy director for the International

Dark-Sky Association, which works to protect night vistas from light pollution, said in an email. Concern extends to the purely aesthetic level, as some contemplate the visual blight brought to heavens untouched for millennia, but now marked by the satellite age. "Darkness and the inspiration that the natural night sky brings to humanity has resulted in great works of art, literature and music," Barentine said. "The prospect of losing all that is the prospect of severing a key tie between humanity and the natural world." To contact the reporter on this story: Todd Shields in Washington at tshields3@bloomberg.net To contact the editors responsible for this story: Jon Morgan at jmorgan97@bloomberg.net, Elizabeth Wasserman, Ros Krasny For more articles like this, please visit us at bloomberg.com ©2019 Bloomberg L.P.

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To contact the reporter on this story: Todd Shields in Washington at tshields3@bloomberg.net

To contact the editors responsible for this story: Jon Morgan at jmorgan97@bloomberg.net, Elizabeth Wasserman, Ros Krasny

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