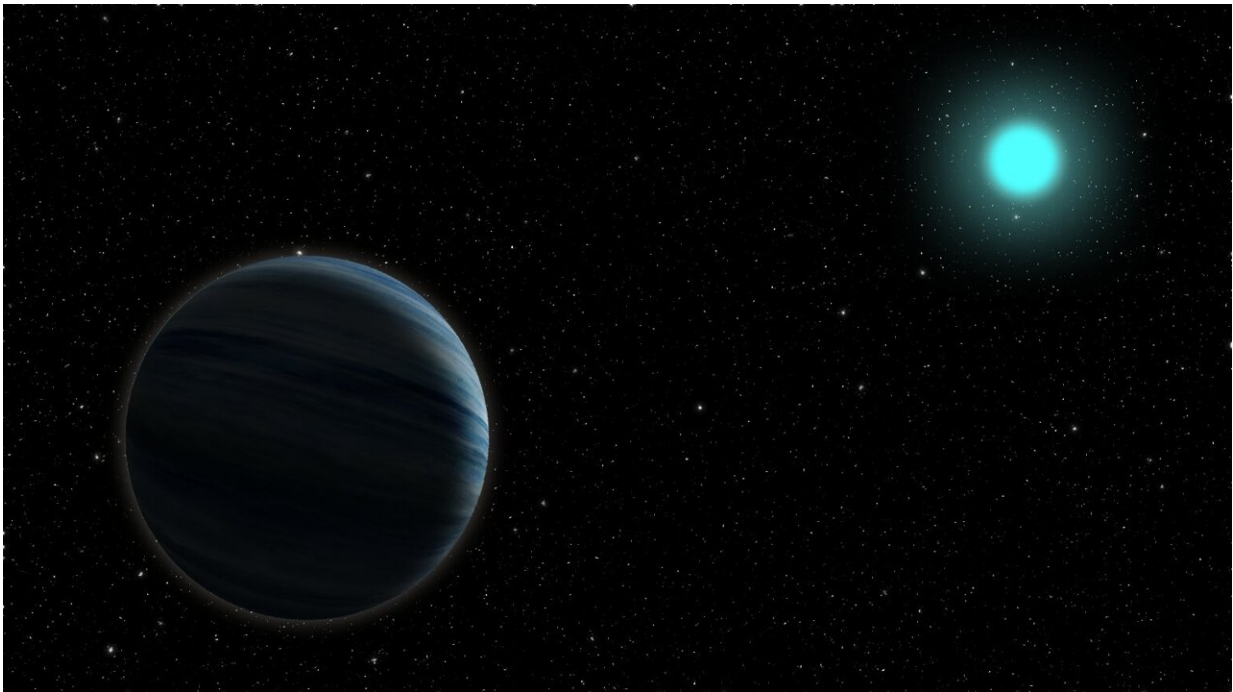


# Brightest stars in the night sky can strip Neptune-sized planets to their rocky cores

August 12 2022, by Robert Sanders

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Artist's concept of a Neptune-sized planet, left, around a blue, A-type star. UC Berkeley astronomers have discovered a hard-to-find gas giant around one of these bright, but short-lived, stars, right at the edge of the hot Neptune desert where the star's strong radiation likely strips any giant planet of its gas. Credit: Steven Giacalone, UC Berkeley

Over the last 25 years, astronomers have found thousands of exoplanets around stars in our galaxy, but more than 99% of them orbit smaller



stars—from red dwarfs to stars slightly more massive than our sun, which is considered an average-sized star.

Few have been discovered around even more massive stars, such as A-type stars—bright blue stars twice as large as the sun—and most of the exoplanets that have been observed are the size of Jupiter or larger. Some of the brightest stars in the night sky, such as Sirius and Vega, are A-type stars.

University of California, Berkeley, astronomers now report a new, Neptune-sized planet—called HD 56414 b—around one of these hot-burning, but short-lived, A-type stars and provide a hint about why so few [gas giants](#) smaller than Jupiter have been seen around the brightest 1% of stars in our galaxy.

Current exoplanet detection methods most easily find planets with short, rapid orbital periods around their stars, but this newly found planet has a longer orbital period than most discovered to date. The researchers suggest that an easier-to-find Neptune-sized planet sitting closer to a bright A-type star would be rapidly stripped of its gas by the harsh stellar radiation and reduced to an undetectable core.

While this theory has been proposed to explain so-called hot Neptune deserts around redder stars, whether this extended to hotter stars—A-type stars are about 1.5 to 2 times hotter than the sun—was unknown because of the dearth of planets known around some of the galaxy's brightest stars.

"It's one of the smallest planets that we know of around these really [massive stars](#)," said UC Berkeley graduate student Steven Giacalone. "In fact, this is the hottest star we know of with a planet smaller than Jupiter. This planet's interesting first and foremost because these types of planets are really hard to find, and we're probably not going to find many like



them in the foreseeable future."

## Hot Neptune desert

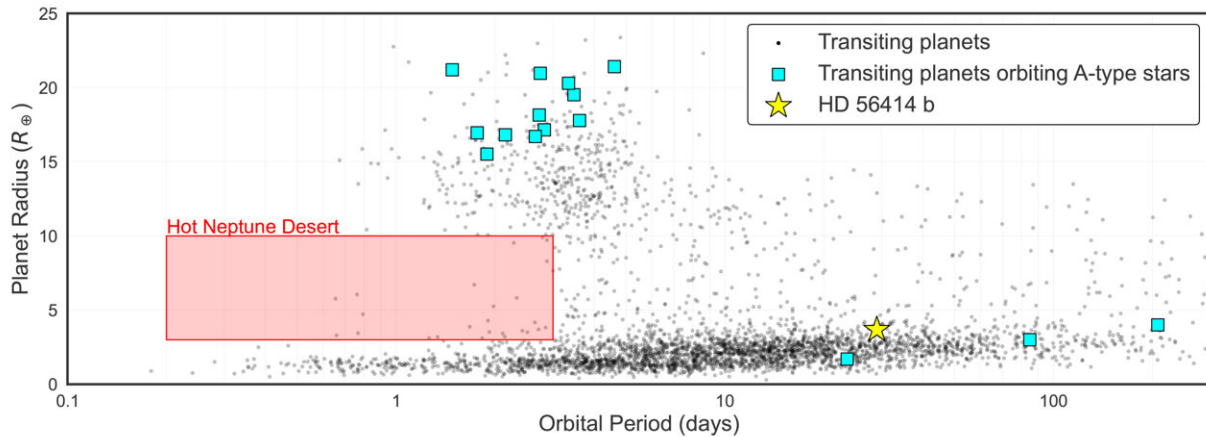
The discovery of what the researchers term a "warm Neptune" just outside the zone where the planet would have been stripped of its gas suggests that bright, A-type stars may have numerous unseen cores within the hot Neptune zone that are waiting to be discovered through more sensitive techniques.

"We might expect to see a pileup of remnant Neptunian cores at short orbital periods" around such stars, the researchers concluded in their paper.

The discovery also adds to our understanding of how [planetary atmospheres](#) evolve, said Courtney Dressing, UC Berkeley assistant professor of astronomy.

"There's a big question about just how do planets retain their atmospheres over time," Dressing said. "When we're looking at smaller planets, are we looking at the atmosphere that it was formed with when it originally formed from an accretion disk? Are we looking at an atmosphere that was outgassed from the planet over time? If we're able to look at planets receiving different amounts of light from their star, especially different wavelengths of light, which is what the A stars allow us to do—it allows us to change the ratio of X-ray to [ultraviolet light](#)—then we can try to see how exactly a planet keeps its atmosphere over time."





Astronomers have found thousands of exoplanets (black dots) around stars in the Milky Way galaxy, but few Neptune-sized planets have been discovered in short-period orbits around their stars, creating what astronomers call a Hot Neptune desert (pink region, representing planets with radii 3-10 times that of Earth with orbital periods under 3 days). A new-found Neptune-sized planet (yellow star) suggests that they don't survive long enough to detect. The planets on this chart were discovered when they crossed in front of or transited their star, dimming its light. Current techniques are limited to finding planets in close, short-period orbits, less than about 100 days. Credit: Graphic by Steven Giacalone, using data courtesy of NASA

Giacalone and Dressing reported their discovery in a paper accepted by *The Astrophysical Journal Letters* and posted online.

According to Dressing, it's well-established that highly-irradiated, Neptune-sized planets orbiting less massive, sun-like stars are rarer than expected. But whether this holds for planets orbiting A-type stars is not known because those planets are challenging to detect.

And an A-type star is a different animal from smaller F, G, K and M dwarfs. Close-in planets orbiting sun-like stars receive high amounts of



both X-ray and [ultraviolet radiation](#), but close-in planets orbiting A-type stars experience much more near-ultraviolet radiation than X-ray radiation or extreme ultraviolet radiation.

"Determining whether the hot Neptune desert also extends to A-type stars provides insight into the importance of near-ultraviolet radiation in governing atmospheric escape," she said. "This result is important for understanding the physics of atmospheric mass loss and investigating the formation and evolution of small planets."

The planet HD 56414 b was detected by NASA's TESS mission as it transited its star, HD 56414. Dressing, Giacalone and their colleagues confirmed that HD 56414 was an A-type star by obtaining spectra with the 1.5-meter telescope operated by the Small and Moderate Aperture Research Telescope System (SMARTS) Consortium at Cerro Tololo in Chile.

The planet has a radius 3.7 times that of Earth and orbits the star every 29 days at a distance equal to about one-quarter the distance between Earth and the sun. The system is roughly 420 million years old, much younger than our sun's 4.5-billion-year age.

The researchers modeled the effect that radiation from the star would have on the planet and concluded that, while the star may be slowly whittling away at its atmosphere, it would likely survive for a billion years—beyond the point at which the star is expected to burn out and collapse, producing a supernova.

Giacalone said that Jupiter-sized planets are less susceptible to photoevaporation because their cores are massive enough to hold onto their hydrogen gas.

"There's this balance between the central mass of the planet and how



puffy the atmosphere is," he said. "For planets the size of Jupiter or larger, the planet is massive enough to gravitationally hold on to its puffy atmosphere. As you move down to [planets](#) the size of Neptune, the [atmosphere](#) is still puffy, but the planet is not as massive, so they can lose their atmospheres more easily."

Giacalone and Dressing continue to search for more Neptune-sized exoplanets around A-type [stars](#), in hopes of finding others in or near the hot Neptune desert, to understand where these [planets](#) form in the [accretion disk](#) during star formation, whether they move inward or outward over time, and how their atmospheres evolve.

**More information:** Steven Giacalone et al, HD 56414 b: A Warm Neptune Transiting an A-type Star, *The Astrophysical Journal Letters* (2022). [DOI: 10.3847/2041-8213/ac80f4](https://doi.org/10.3847/2041-8213/ac80f4) , [iopscience.iop.org/article/10.3847/2041-8213/ac80f4](https://iopscience.iop.org/article/10.3847/2041-8213/ac80f4)

Provided by University of California - Berkeley

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