**TESS and JWST Unveil Disintegrating Planetary Interiors**

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At the 2025 Meeting of the American Astronomical Society, two teams of astronomers—centered at Penn State and MIT—independently announced new discoveries about an extreme form of planetary destruction: apparently rocky planets disintegrating under the intense heat of their host stars.

The Penn State team presented novel measurements of a rocky planet’s interior composition using the James Webb Space Telescope (JWST), while the MIT team presented the discovery of the nearest and most rapidly disintegrating planet to date using the Transiting Exoplanet Survey Satellite (TESS). Both space observatories stared at thousands of stars in search for tiny, periodic dips of light—called *transits*—due to orbiting planets on orbits that fortuitously take them between Earth and the Sun. Normally, these dips are symmetric and occur every several weeks or months—once every time the planet orbits its star.

In rare cases, planets orbit their stars every *few hours*, because they are extremely close to their stars, called *ultra-short period planets* or USPs. Disintegrating planets are an extremely rare subcategory of USPs—only those hot enough to evaporate their surfaces and small enough that they cannot hold onto the material gravitationally can be observed. This material leaves the planet in a dynamic, chaotic process that makes the transit signal change strength every orbit. Equally as characteristic is the formation of a dust tail, much resembling that of a comet tail, as the dust escapes into space.

“These planets are literally spilling their guts into space for us, and with *JWST* we finally have the means to study their composition and see what planets orbiting other stars are really made of,” said Nick Tusay, a PhD student at Penn State working in the Center for Exoplanets and Habitable Worlds, and the lead author of one of the studies.

“It’s remarkable that directly measuring the interior of planets in the Solar System is so challenging—we have only limited sampling of the Earth’s mantle, and no access to that of Mercury, Venus, or Mars—but here we have found planets hundreds of light years away that are sending their interiors into space and backlighting them for us to study with our spectrographs,” said Jason Wright, Professor of Astronomy and Astrophysics, co-author of the Penn State study, and Tusay’s PhD supervisor. “It’s a remarkable and fortuitous opportunity to understand terrestrial planet interiors,” he added.

The Penn State team trained *JWST*’s spectrograph at K2-22, a star discovered by the *Kepler* spacecraft—as part of its extended *K2* mission—to host one of these evaporating planets, K2-22b. This planet orbits every 9.1 hours and has a surface temperature of 2100K—enough to not just melt but vaporize iron and rock into the vacuum of space.

“K2-22b has an asymmetric transit profile, as the planet’s dusty cloud of effluents comes into view in front of the star, showing evidence of extended tails like a comet,” said Tusay. Tusay’s team compared the spectrum of the star before and after transit with the spectrum during the event.

“We didn’t know what to expect,” said Wright, who also co-authored an earlier study on how to use JWST to probe these exoplanetary tails. Some astronomers expected that these planets would have already lost all of their outer materials, and just be a bare iron core. “We were hopeful they might still have their mantles, or potentially even crust material that was being evaporated. *JWST*’s mid-infrared spectrograph MIRI was the perfect tool to check, because crustal, silicate mantle, and iron core materials would all transmit light in different ways that *JWST* could distinguish spectroscopically,” Wright added.

“We were unfortunate that we did not observe the planet when its tail was very dense, so our spectrum was weaker and harder to interpret than we anticipated,” said Tusay. Still, they found a spectrum broadly consistent with the idea that the material is from a silicate material, for instance from a mantle. The team also found unexpected, narrow features at 4.5 and 5.1 microns. This was not in any of the team’s original models, and appears to be consistent with carbon dioxide (CO2) and nitric oxide (NO) —two compounds usually associated with icy bodies like comets, not the mantles of terrestrial planets like Earth or Mercury. “It was actually sort of a ‘who-ordered-that?’ moment,” said Tusay.

The team hopes that now that they have established the validity of the technique, they can make further use of *JWST* to verify these features at higher significance, and to gather data to help theorists better model this strange object.

Studies of such planets also took a big leap forward thanks to the efforts of the MIT team, who announced the discovery of a new disintegrating planet found by *TESS*, orbiting the star BD+05 4868 A.

“The disintegrating planet orbiting BD+05 4868 A has the most prominent dust tails to date,“ said Marc Hon, a postdoctoral researcher at the MIT TESS Science Office and the leader of the MIT study. “The dust tails emanating from the rapidly evaporating planet are gigantic. Its length of approximately 9 million km encircles over half the planet’s orbit around the star every 30 and a half hours.” he added.

The extent of the dust tails from BD+05 4868 Ab are revealed by the extended transit duration, lasting up to fifteen hours, and the significant depth of the transits, which block over one percent of the star’s emitted light. Like K2-22b, instead of a single comet-like tail, BD+05 4868 Ab has two – one leading and one trailing the planet's orbit. The presence of two distinctive tails is attributed to the presence of dust grains of varying sizes emanating from the planet. The leading tail is believed to contain larger dust grains, comparable in size to desert sand, while the trailing tail primarily consists of finer grains, similar in size to soot particles.

Based on the extent of BD+05 4868 Ab’s dust tails, the MIT study infers that the planet must be rapidly disintegrating at a rate of about a Moon’s worth of material every million years. With BD+05 4868 Ab taken to be about the mass of the Moon, the planet will completely evaporate within one to two millions of years, which is swift on cosmic timescales. “The rate at which the planet is evaporating is utterly cataclysmic, and we are incredibly lucky to be witnessing the final hours of this dying planet,” said Hon.

“What’s also highly exciting about BD+05 4868 Ab is that it has the brightest host star out of the other disintegrating planets —about 100 times brighter than K2-22—establishing it as a benchmark for future disintegrating studies of such systems ,” said Avi Shporer, a Research Scientist at the MIT Kavli Institute for Astrophysics and Space Research, and a co-author of the MIT project. “Prior to our study, the three other known disintegrating planets were around faint stars, making them challenging to study,” he added.

The two teams have jointly submitted a *JWST* proposal to study BD+05 4868 A in the same manner as K2-22. “The data quality we should get from BD+05 4868 A will be exquisite,” said Shporer, adding “These studies have proven the validity of this approach to understanding exoplanetary interiors, and opened the door to a whole new line of research with *JWST*.”

arXiv links:

Hon et al. “A Disintegrating Rocky Planet with Prominent Comet-like Tails Around a Bright Star” <https://arxiv.org/abs/2501.05431>

Submitted to AAS Journals

Tusay et al. “A Disintegrating Rocky World Shrouded in Dust and Gas: Mid-IR Observations of K2-22b using JWST”

<http://arxiv.org/abs/2501.08301>

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