



1
00:00:00,010 --> 00:00:06,580

[music]

2
00:00:06,600 --> 00:00:12,040

Since the early 1990's, astronomers have known that extrasolar planets, or "exoplanets,"

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00:00:12,060 --> 00:00:15,560

orbit stars light-years beyond our own solar system.

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00:00:15,580 --> 00:00:21,080

Because most exoplanets are too far away to be directly imaged, characteristics such as size,

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00:00:21,100 --> 00:00:26,880

composition, and atmospheric makeup must be determined through a variety of indirect methods.

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00:00:26,900 --> 00:00:31,030

For instance, when an exoplanet passes in front of its star, or transits,

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00:00:31,050 --> 00:00:35,330

it blocks a fraction of the star's light and causes a dip in brightness.

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00:00:35,350 --> 00:00:41,380

Large planets block more light, so the size of the dip can be used to determine the size of the planet.

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00:00:41,400 --> 00:00:47,630

By observing an exoplanet's gravitational pull on its star, astronomers can also determine the planet's mass,

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00:00:47,650 --> 00:00:54,740

and thus calculate its density, to see if it is composed of rock like Earth, or gas like Saturn.

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00:00:54,760 --> 00:00:58,920

But to fully understand an exoplanet, astronomers must study its atmosphere,

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00:00:58,940 --> 00:01:02,550

and the information that they need is encoded during a transit.

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00:01:02,570 --> 00:01:07,980

As the planet crosses its star, its atmosphere absorbs certain wavelengths of light, or colors,

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00:01:08,000 --> 00:01:13,940

while allowing other wavelengths to pass through. Because each molecule absorbs distinct wavelengths,

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00:01:13,960 --> 00:01:19,480

astronomers spread the star's light into its spectrum of colors to see which wavelengths have been absorbed.

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00:01:19,500 --> 00:01:25,380

The dark absorption bands act as molecular fingerprints, revealing the atmosphere's chemical makeup.

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00:01:25,400 --> 00:01:29,250

Knowing the depth and density of the atmosphere is also important.

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00:01:29,270 --> 00:01:33,980

To figure this out, astronomers observe the transit at many different wavelengths.

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00:01:34,000 --> 00:01:37,560

At wavelengths where more absorption occurs, the planet will appear larger,

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00:01:37,580 --> 00:01:43,850

with the change in size indicating how deeply the atmosphere extends, and its density at different altitudes.

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00:01:43,870 --> 00:01:49,370

Measuring the depth of absorption at each wavelength gives astronomers the planet's transit depth curve,

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00:01:49,390 --> 00:01:56,530

which allows them to model the composition, height, and density of the atmosphere, providing a detailed picture

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00:01:56,550 --> 00:02:01,830

Recent studies suggest that exoplanets and their atmospheres come in a wide variety.

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00:02:01,850 --> 00:02:08,580

At one extreme are "hot Jupiters" like WASP 19 b, a boiling gas giant that orbits its star

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00:02:08,600 --> 00:02:15,300

far closer than Mercury orbits our Sun. Visitors who could survive the heat might complain about the air quality

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00:02:15,320 --> 00:02:21,780

planet WASP 19 b's jagged transit depth curve suggests a deep atmosphere of poisonous hydrocarbons,

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00:02:21,800 --> 00:02:26,180

with methane and hydrogen cyanide far more abundant than water.

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00:02:26,200 --> 00:02:32,380

By contrast, planet Gliese 1214 b is a comparatively inviting "waterworld."

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00:02:32,400 --> 00:02:37,150

Its nearly flat transit depth curve hints at a shallow atmosphere of pure steam,

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00:02:37,170 --> 00:02:46,050

enveloping an ocean thousands of kilometers deep, with an interior of hot ice: water solidified by extreme pres

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00:02:46,070 --> 00:02:51,280

As detection methods improve, astronomers will search the atmospheres of Earth-size planets

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00:02:51,300 --> 00:02:55,280

for signs of life such as water vapor, oxygen, and methane,

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00:02:55,300 --> 00:03:03,980

taking us one step closer to finding a world like our own, all thanks to some flickering starlight.