

# Tatooine Found! Discovery, Confirmation, and Characterization of the First-Ever Circumbinary Planet Detected Using Doppler Spectroscopy

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Since the first discovery of an exoplanet in 1989, new stellar companion detections have strengthened astronomers' understanding of the Universe's origins, components, and future. By utilizing Doppler spectroscopy, also known as the Radial Velocity (RV) method, to analyze the spectra of 1,100 FGK yellow dwarf stars ( $V = 8-11$ ) observed by the SDSS-III MARVELS high precision ( $\sim 12$  m/s at  $V=10$ ) investigation, this research discovered 9 giant planets, 1 brown dwarf, 2 spectroscopic binary stars, and 1 unique P-type circumbinary planet (CBP), of which only 23 have been detected thus far. Subsequently, a novel confirmation method was created to evaluate the authenticity of the circumbinary; N-body simulations, regression analysis, and an innovative spectrum creation/orbital parameter recovery software developed in MATLAB confirmed the CBP as the first object of its kind detected using Doppler spectroscopy. This breakthrough technique was also used to (1) tightly constrain the circumbinary's orbital parameters and (2) provide deeper insights into its unique binary stellar environment. Moreover, a comprehensive characterization of the circumbinary revealed that the CBP spends its entire orbit within its binary habitable zone. Although this giant planet is uninhabitable, it likely possesses terrestrial moons, which may harbor liquid water, a catalyst critical to the thriving of life. By proving that RV spectrographs can detect rare stellar systems such as CBPs, the refinement of Doppler spectroscopy's precision to approximately 0.1 m/s is proposed, thus allowing for Earth-like terrestrial planets to be located within their habitable zones. These planets demonstrate a high potential for hosting extraterrestrial life.

## Awards Won:

National Aeronautics and Space Administration: Top Award of \$5,000