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A MISSION CONCEPT FOR THE LARGEST TRANSIT SPECTROPHOTOMETRIC SURVEY OF EXOPLANET ATMOSPHERES

Abstract

In this work we present the concept mission: ARISTOTLE. This mission concept is a result of the collaborative efforts of the 45th Alpbach Summer School. The school focused on the topic of 'Exoplanets: Understanding Alien Worlds in Diverse Environments,' and brought together experts from leading European institutes with students and young professionals to develop concepts for future space missions. ARISTOTLE, aiming for a 2035 launch, has a primary science objective of characterizing the atmospheres of various exoplanet types, down to the precision required for warm Super-Earths around Sun-Like stars. This would be achieved by utilizing various observational methods, including transit spectroscopy, secondary eclipse spectroscopy, and phase curve observations. Notably, ARISTOTLE's capabilities are poised to surpass those of previous missions, enabling the characterization of fainter and colder planets, especially in the overlapping frequency range with ARIEL, presenting an opportunity for cross-experiment calibration.

The mission's focus extends beyond basic atmospheric characterization as performed by ARIEL. ARIS-

TOTLE will explore a wide range of spectral lines and biosignatures within its frequency range (from 2.5 to 23 μm). With this frequency range we aim to study chemical disequilibria, climate dynamics, suspected molecular precursors of life, potential biosignatures, and key molecules for sustaining life. This comprehensive approach seeks to gather data on atmospheric compounds, molecular overlaps, and their relevance in both biological and non-biological processes. ARISTOTLE's planet selection strategy emphasizes G and K star systems, with a focus on studying Super-Earths and Sub-Neptunes in habitable zones. The selection process is influenced by PLATO findings, and substantial observation time will be dedicated to interesting systems identified by both PLATO and TESS.

ARISTOTLE's scientific objectives extend to the study of protoplanetary disks and solar system objects like Uranus and Neptune, moons, and comets. These investigations offer insights into celestial body formation and composition, contributing to planetary science as well as the ongoing search for exomoons.

The ARISTOTLE mission is a significant advancement in exoplanet science, providing improved observational capabilities and a comprehensive approach to understanding exoplanet atmospheres and the broader celestial environment. Since the mission's goals are scientifically ambitious, we mainly use established technologies in order to make it technologically feasible. ARISTOTLE has incorporated lessons learned from previous missions like JWST (MIRI), ARIEL, and KEPLER to minimize development costs and risks, making it a pioneering mission in the exploration of exoplanet atmospheres.