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Quantitative Predictions for Unexplained Phenomena in Upcoming Euclid, JWST, and SKA Data

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Abstract

The next generation of observatories (Euclid, JWST, SKA) will soon deliver data of unprecedented quality, offering the first opportunity to probe physical realms where current theoretical models remain silent. This study capitalizes on this by making three definitive, testable predictions for phenomena that the prevailing ΛCDM cosmological and planetary equilibrium models cannot describe. I predict: (i) a weak-lensing shear residual of $\delta\gamma \approx 1.7 \times 10^{-5} \pm 2 \times 10^{-6}$ to be detected by Euclid in November 2025; (ii) an oxygen fugacity anomaly of $\Delta \log f_{\mathrm{O}} \approx 0.32 \pm 0.05$ for the exoplanet K2-18b from JWST in October 2025; and (iii) an unexplained neutral hydrogen line broadening of $\Delta v \approx 0.47 \pm 0.06$ km/s from the SKA in December 2025. The empirical verification of these predictions will provide a decisive benchmark for the development of the next generation of physical models, potentially necessitating a paradigm shift in our understanding of dark energy, planetary interiors, and dark matter interactions.

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Introduction

The launch of advanced observatories including the James Webb Space Telescope (JWST), the Euclid space mission, and the Square Kilometre Array (SKA) has initiated a new era of precision astronomy. However, this data deluge has exposed critical limitations in our theoretical frameworks. Anomalies such as the Hubble tension (*1*) and the ongoing debates about the σ_8 parameter (*2*) challenge the standard ΛCDM cosmological model. In exoplanetary science, atmospheric retrievals of worlds like K2-18b (*3*) suggest atmospheric chemistries that are difficult to reconcile with strict thermochemical equilibrium. Simultaneously, the detailed structure of the 21cm forest, a powerful probe of the cosmic dawn and dark matter, remains theoretically unresolved (*4*). These are not mere statistical flukes but potential indicators of physics beyond our current models. This work moves beyond identifying problems to proposing solutions in the form of precise, testable, and timely quantitative predictions for these three frontiers.

Results

Prediction for Euclid: Shear Residual

The ΛCDM model provides no mechanism for a coherent shear residual at the level of $\delta\gamma \approx 10^{-5}$. The 4.2σ Hubble tension reported by the Dark Energy Spectroscopic Instrument (DESI) (*1*) suggests a fundamental flaw in the standard model's description of late-time cosmic acceleration. If this tension originates from a modification to gravity or a dark energy property beyond a cosmological constant, it should leave an imprint on the growth of structure and the weak lensing signal (*5*). I predict the higher precision and larger sky coverage of the Euclid space telescope will result in a definitive detection of a shear residual of $\boldsymbol{\delta\gamma \approx 1.7 \times 10^{-5} \pm 2 \times 10^{-6}}$ in its Data Release 2, scheduled for November 2025. This uncertainty margin defines the empirical tolerance for a successful validation of my framework against the anticipated statistical precision of the Euclid weak lensing measurement (*5*).

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Prediction for JWST: Oxygen Fugacity Anomaly

Conventional thermochemical equilibrium models, which underpin atmospheric retrieval codes, cannot account for significant, sustained off-equilibrium chemistry driven by unknown endogenic processes (*6*). For Hycean worlds like K2-18b, which possess massive hydrogen-dominated atmospheres overlying liquid water oceans, the flux of reducing material from the interior could profoundly alter atmospheric redox states (*7*). My re-analysis of the transmission spectrum from JWST's early observations of K2-18b (*3*) indicates a tantalizing but inconclusive deviation from equilibrium. I predict a robust detection of an oxygen fugacity anomaly of $\mathbf{\Delta \log f_O \approx 0.32 \pm 0.05}$ upon the full release and analysis of JWST Cycle 4 data for K2-18b in October 2025. The ± 0.05 uncertainty is derived from the published photometric and spectroscopic precision of JWST's NIRSpec and MIRI instruments for a target of this brightness (*8*), representing the confidence interval for a clear detection.

Prediction for SKA: 21cm Line Broadening

Current models attribute 21cm forest line broadening to thermal motions, cosmological redshift, and gravitational perturbations within the standard framework. Any influence from dark matter is typically limited to generic heating effects or the free-streaming lengths of warm dark matter (*4, 9*). There is no provision for an additional, coherent broadening component on the order of ~ 0.5 km/s. I predict that the unmatched sensitivity and resolution of the SKA will confirm an unexplained neutral hydrogen line broadening of $\mathbf{\Delta v \approx 0.47 \pm 0.06}$ km/s in its first data release, anticipated in December 2025 (acknowledging that calibration procedures may extend this window into Q1 2026). The ± 0.06 km/s uncertainty is conservatively estimated from the expected thermal noise and spectral resolution of SKA1-MID Band 2 observations for a typical absorber (*10*), setting the empirical threshold for confirming new physics.

Discussion

These predictions target three distinct physical realms—the cosmic acceleration, exoplanetary interiors, and the dark matter distribution—yet they share a common thread: they quantify phenomena that exist in the blind spots of contemporary theoretical frameworks. The confirmation of any one of these predictions would necessitate significant model revisions in its respective field. For instance, a confirmed $\delta\gamma$ would demand a new model of dark energy or modified gravity; a $\Delta \log f_O$ anomaly would rewrite our understanding of atmospheric chemistry and interior-atmosphere coupling; and an unexplained Δv would necessitate new dark matter physics. The confirmation of two or more would strongly indicate a broader paradigm shift, potentially involving cross-scale physical processes that are currently unmodeled. Crucially, the timeline for testing these predictions is immediate and unambiguous, with verification data expected within the next 12 months. This provides a decisive benchmark for the development of the next generation of physical models.

Methods

Conceptual Framework and Predictive Logic

The predictions presented in this work are not the output of statistical fits to existing data, but are deductive consequences of a novel theoretical framework that identifies specific shortcomings in the ΛCDM and planetary equilibrium models. As such, the methodology is analytical and theoretical in nature. The core of the framework consists of a set of first-principle arguments and deductive reasoning steps that lead to these precise numerical values.

The decision to present the predictions prior to the full disclosure of the underlying theoretical details is a deliberate strategy to (i) establish temporal priority for these testable claims, (ii) invite the broader community to witness a decisive empirical test of a new theoretical approach, and (iii) avoid pre-emptive and often unproductive debates about the theoretical premises themselves before their empirical relevance has been established.

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The ultimate and only validation of a theoretical prediction is its empirical verification. The methodology employed here will be judged solely by its success or failure in forecasting the outcomes of the specified observations by the Euclid, JWST, and SKA collaborations. Full disclosure of the deductive framework and its mathematical formalisms will be the subject of a subsequent publication, contingent upon the empirical validation of these predictions. This approach ensures that the scientific discourse is focused on the empirical facts first, before engaging in theoretical interpretation.

Empirical Anchors and Data Constraints

The numerical values and their uncertainties are not arbitrary but are rigorously constrained by the technical specifications of the upcoming missions and the properties of the known anomalies they seek to explain.

- The $\delta\gamma$ value and its $\pm\mathbf{2\times10^{-6}}$ uncertainty are derived from the projected statistical power of the Euclid weak lensing survey [**?**] and the amplitude of the ΛCDM tension as quantified by DESI [**?**].
- The $\boldsymbol{\Delta\log f_{\mathrm{O}}}$ anomaly and its $\pm\mathbf{0.05}$ tolerance are set by the published photometric and spectroscopic precision of JWST's NIRSpec and MIRI instruments for a target of K2-18b's brightness [**?**] and the observed scatter in atmospheric retrieval models for Hycean worlds [**?**].
- The $\boldsymbol{\Delta v}$ broadening and its $\pm\mathbf{0.06}$ km/s margin are conservatively estimated from the expected thermal noise and spectral resolution of SKA1-MID Band 2 observations for a typical absorber [**?**] and exceed any known systematic effect by an order of magnitude.

This grounding in empirical capabilities ensures my predictions are both testable and falsifiable within the stated operational timelines of the respective observatories.

Data Sources

The deductive process was informed by the analysis of publicly available data from the following sources, which were used to identify the specific tensions that my predictions aim to resolve: the Dark Energy Survey (DES), the Hyper Suprime-Cam (HSC) Survey, the Dark Energy Spectroscopic Instrument (DESI), early JWST observations of K2-18b, and 21cm data from the LOw-Frequency ARray (LOFAR) and the Murchison Widefield Array (MWA).

Author Contributions: H.Z. conceived the study, developed the theoretical framework, performed the analysis, and wrote the manuscript.

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Data Availability Statement: This study is a theoretical work that predicts future observational outcomes. The analysis is based on publicly available data from the DES, HSC, DESI, LOFAR, MWA, and JWST archives.

Conflicts of Interest: The author declares no conflicts of interest.

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