Discovery of New Extragalactic Planet Candidates: A Novel End-to-End Machine Learning Pipeline for Efficient Transit Detection in the X-ray Spectrum

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The discovery of M51-ULS-1b, the only extragalactic planet orbiting an X-ray Source (XRS), unveiled a gap in our current understanding of planetary formation and evolution. How this planet formed and survived under the intense radiation, tidal waves, and high variability of XRS remains a mystery, compelling us to seek more extragalactic planets to expand theories. Yet, observation challenges such as sparse sampling, data gaps, and noise obscure planetary transits, rendering them indistinguishable from inherent variability in XRS. This study introduces a GPU-accelerated machine-learning pipeline to surpass these difficulties and automate the identification of energy-independent transit candidates within XRS observed by the Chandra X-ray Observatory. The pipeline encompasses data extraction, pre-processing, and Bayesian-based feature engineering, culminating in a random forest model (RFM). Training over 1400+ real and synthetic observations, the model achieved a high accuracy of 98.6% in multiclass transit detection. Rigorous energy-independence filtering through ANOVA and p-testing was incorporated to ensure the consistency of transits across diverse X-ray energy bands. This verified the nature of the transiting body and enhanced the reliability of transit predictions. The RFM's robustness was substantiated through k-folding cross-validation, OOB error validation, and additional validation sets. In validation, the model successfully identified the transit of M51-ULS-1b and 13 new transits within eight distinct XRS. This pipeline's success marks a significant advancement in automating the discovery of extragalactic planets by facilitating promising transit targets for subsequent investigations into planetary formation within extreme environments.

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Second Award of $2,000
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