Exoplanet Research Program Summary

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Abstract

The Exoplanet Research Program at the American Public University System (APUS) provides a structured framework for student participation in exoplanet observation and data analysis. The initiative integrates professional-grade photometric reduction techniques, remote telescope operations, and collaborative research practices to cultivate scientific proficiency among student investigators. Utilizing software platforms such as AstroImageJ and NASA's EXOTIC pipeline, participants perform transit photometry on targets identified by the Transiting Exoplanet Survey Satellite (TESS) and other observatories. The program's workflow emphasizes Python-based modeling, error quantification, and reproducible data processing standards aligned with contemporary astrophysical research protocols. Beyond its scientific contributions, the Exoplanet Research Program advances the educational integration of research within distance-learning institutions, demonstrating that meaningful, peer-validated exoplanet studies can be conducted by distributed student teams. This model underscores the growing role of remote-access observatories and open-source analytics in democratizing participation in professional astronomical research.

Keywords: Exoplanets, EXOTIC, AstroImageJ, American Public University System, Research, Astronomy, APUS, Transit Photometry

Resumen del programa de investigación de exoplanetas

Resumen

El Programa de Investigación de Exoplanetas del Sistema Universitario Público Americano (APUS) ofrece un marco estructurado para la participación estudiantil en la observación y el análisis de datos de exoplanetas. La iniciativa integra técnicas profesionales de reducción fotométrica, operaciones de telescopios remotos y

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prácticas de investigación colaborativa para cultivar la competencia científica entre los estudiantes investigadores. Utilizando plataformas de software como AstroImageJ y el sistema EXOTIC de la NASA, los participantes realizan fotometría de tránsito en objetivos identificados por el Satélite de Sondeo de Exoplanetas en Tránsito (TESS) y otros observatorios. El flujo de trabajo del programa se centra en el modelado basado en Python, la cuantificación de errores y estándares de procesamiento de datos reproducibles, alineados con los protocolos de investigación astrofísica contemporánea. Más allá de sus contribuciones científicas, el Programa de Investigación de Exoplanetas promueve la integración educativa de la investigación en instituciones de educación a distancia, demostrando que equipos de estudiantes distribuidos pueden realizar estudios de exoplanetas significativos y validados por pares. Este modelo subraya el creciente papel de los observatorios de acceso remoto y la analítica de código abierto en la democratización de la participación en la investigación astronómica profesional.

Palabras clave: Exoplanetas, EXOTIC, AstroImageJ, Sistema Universitario Público Americano, Investigación, Astronomía, APUS, Fotometría de Tránsito

系外行星研究计划概要

摘要

美国公立大学系统(APUS)的系外行星研究项目为学生参与系外行星观测和数据分析提供了一个结构化的框架。该项目整合了专业级的光度数据处理技术、远程望远镜操作和协作研究实践，旨在培养学生研究人员的科学素养。参与者利用AstroImageJ和NASA的EXOTIC数据处理流程等软件平台，对凌日系外行星巡天卫星(TESS)和其他天文台识别的目标进行凌日光度测量。该项目的工作流程强调基于Python的建模、误差量化以及符合当代天体物理研究规范的可复现数据处理标准。除了其科学贡献之外，系外行星研究项目还促进了远程教育机构中研究的教育融合，证明了分散的学生团队也能开展有意义且经同行验证的系外行星研究。这种模式强调了远程天文台和开源分析在普及专业天文研究参与方面的日益重要的作用。

关键词：系外行星，奇异行星，AstroImageJ，美国公立大学系统，研究，天文学，APUS，凌日测光

Exoplanet research has become a central focus in modern astrophysics, offering insight into planetary formation and the potential for habitable worlds beyond our Solar System. Universities increasingly seek to provide students with access to real-world data analysis, bridging theoretical coursework with empirical science. The American Public University System established the Exoplanet Research team to train student researchers in techniques commonly used in professional observatories. Participants gain exposure to photometric analysis software, data calibration procedures, and collaborative research workflows. The initiative aligns with national efforts to expand STEM education through active research participation.

Methods

The Exoplanet Research Program operates as a remote research group with weekly team meetings and monthly advisor reviews. Each project cycle begins with target selection, where students identify exoplanet candidates using data from the Transiting Exoplanet Survey Satellite (TESS) and other professionally published observations. The team employs internally developed scheduling techniques to calculate visibility windows and optimize telescope time across global observatories.

Observations are conducted via the Boston Observatory at APUS and the iTelescope Network, granting students access to telescopes across the world. Standard photometric calibration procedures are applied, including bias, dark, and flat-field corrections. Light curves are extracted using AstroImageJ and NASA's EXOTIC pipeline to determine transit parameters such as period, radius, and transit depth. Analyses are executed within Python environments, where students learn to process, model, and visualize stellar flux data. Peer review within the research team ensures quality control and accuracy. Data are compared with publicly available datasets for verification, and findings are compiled for presentation and publication.

Results

The Exoplanet Research program has achieved consistent results in detecting and modeling exoplanet transits with scientifically acceptable precision. Light-curve data generated through student analysis is aimed to match professional standards for small-telescope research.

Additionally, the Exoplanet Research Program developed observation-planning methods that target prioritization and scheduling. This program calculates when targets of interest will be observable from specific locations, improving efficiency and repeatability. Educationally, participants demonstrated measurable improvement in coding, data interpretation, and teamwork, validating the program's dual scientific and educational goals.

Discussion

The Exoplanet Research Program demonstrates that students can contribute meaningfully to professional-grade exoplanet research using remote telescope networks and open-source analysis tools. The program bridges academic instruction with practical application, showing that rigorous photometric work is achievable even within an online learning environment.

The Exoplanet Research Program's success also underscores the growing role of small-telescope photometry in verifying TESS candidates. By training students in tools such as AstroImageJ and NASA's EXOTIC, the program cultivates essential skills in coding, model fitting, and uncertainty analysis; competencies that extend beyond astronomy into data science and engineering. Educationally, the Exoplanet Research Program validates the value of observational, team-based research. Students learn to collaborate, communicate results, and apply scientific reasoning in authentic research settings. This dual focus on technical and interpersonal development positions the Exoplanet Research Program as a model for scalable, remote STEM engagement.

Conclusion

The American Public University System's Exoplanet Research Program demonstrates that student researchers can produce high-quality scientific outcomes while advancing their technical and analytical skills. By blending data analysis, collaboration, and open-source software use, Exoplanet Research Program contributes to the growing field of exoplanetary science and sets a precedent for scalable, remote student research initiatives. The program's continuing mission to educate, innovate, and discover aligns with the goals of the broader space science community and supports the advancement of space education at all levels.