Paper ID: 87636
student

IAF SYMPOSIUM ON ONGOING AND NEAR FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS (A7)
Interactive Presentations - IAF SYMPOSIUM ON FUTURE SPACE ASTRONOMY AND SPACE PHYSICS (IP)

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SUSTAINING THE MOORE'S LAW ANALOG FOR EXOPLANETS

Abstract

In 1965, Gordon Moore noted a trend that the number of transistors in an integrated circuit approximately doubles every two years. Over the ensuing decades, the celebrated "Moore's Law" and its variants have become benchmarks for the semiconductor industry to measure its progress and guide research efforts. The consequences of Moore's Law cannot be overstated: digital electronics are intertwined in every facet of modern technology. An analogous trend is emerging within astronomy, where researchers have noted that the number of known exoplanets has doubled every 2-3 years. This exponential growth forecasts 50k discoveries by 2031, 500k by 2038, and a staggering five million by 2045.

Like the realization of Moore's Law has propelled the electronics industry, the opportunity to sustain this doubling timescale for exoplanet discoveries would be transformative. Discovering exoplanets at-scale would be a driver for achieving long-standing scientific goals, such as understanding the universe's habitability, the astrophysics of planet-formation, and the role of galactic environments in shaping the attributes of planets. An exponentially increasing exoplanet census promises to identify exceptional targets for follow-up, working in tandem with forthcoming instrumentation for characterizing already-known worlds.

Here, we examine the motivation, feasibility, and technical needs to further realize this Moore's Law analog. We develop a roadmap for collaboration between academic research and the space industry, both of which must play critical roles in this scientific endeavor. Space-based survey telescopes must increase in aperture size, field-of-view, and resolving power, and substantial onboard data processing will be needed to manage communications bandwidth. Advancements in imaging and data management for exoplanet discovery would be synergistic with commercial efforts in remote sensing, global communication networks, and space domain awareness.

On timescales of several years, we assess the opportunity to sustain exponential growth through published estimates of the yields for NASA's Transiting Exoplanet Survey Satellite (TESS), the ESA's Planetary Transits and Oscillations of Stars (PLATO) mission, and other in-progress and in-development campaigns. To estimate longer-term discovery trends, we calculate the technical requirements and determine the requisite onboard computing advances from first principles.

In conclusion, the Moore's Law analogy for exoplanets sets an ambitious, yet achievable roadmap for collaboration that transcends traditional boundaries between academic research and the space industry. For our efforts, humanity will deepen its understanding of Earth's place in the cosmos and advance technologies of practical importance.