INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 10, Issue 6 - V10I6-1385)
Available online at: https://www.ijariit.com

Literature Review on Exoplanets and Detection Techniques

Anusha S
vijayanusha1014@gmail.com
Amrita Vishwa Vidyapeetham, Ettimadai, Tamil Nadu

ABSTRACT

The discovery of exoplanets since 1995 has revolutionized our understanding of planetary systems. This paper reviews major detection techniques such as radial velocity, transit photometry, direct imaging, gravitational microlensing, astrometry, and pulsar timing, focusing on their strengths, limitations, and findings. It also highlights significant missions like Kepler, TESS, Gaia, and future contributions of the JWST. A literature synthesis reveals the critical role of interdisciplinary approaches and advancing technology in the search for habitable exoplanets and extraterrestrial life.

KEYWORDS: *Astronomy, Exoplanets, Techniques, Detection*

1. INTRODUCTION

Exoplanets, or extrasolar planets, orbit stars beyond our solar system. Since the first confirmed detection in 1992, over 5,000 exoplanets have been discovered. This review evaluates key detection techniques, significant findings, and the evolving understanding of planetary diversity and habitability.

2. HISTORICAL BACKGROUND

Exoplanet science began in earnest with the discovery of pulsar planets in 1992 and the radial velocity detection of 51 Pegasi b in 1995. These milestones ushered in a new era of astronomy, enabling the systematic study of planetary systems.

3. TYPES OF EXOPLANETS

Gas Giants: Massive planets like Jupiter, with thick hydrogen-helium atmospheres.
Hot Jupiters: Gas giants with close-in orbits, experiencing intense heat.
Super-Earths: Planets with masses between Earth and Neptune, potentially rocky.
Mini-Neptunes: Smaller than Neptune, with substantial atmospheres.
Terrestrial Planets: Earth-like rocky planets, potentially habitable.
Ice Giants: Neptune-like planets with icy cores beneath thick atmospheres.
Rogue Planets: Free-floating planets untethered to stars.

4. DETECTION TECHNIQUES

4.1 Radial Velocity

Measures stellar wobble due to gravitational pull of orbiting planets. Effective for detecting large, close-in planets but limited for smaller or distant planets. Notable Discovery: 51 Pegasi b.

4.2 Transit Photometry

Detects brightness dips as planets transit their stars, allowing size, orbit, and atmospheric composition analysis. Requires specific orbital alignments. Notable Discovery: Kepler-186f.

4.3 Direct Imaging

Uses advanced optics to capture images of planets by blocking starlight. Effective for young, distant planets but technically challenging. Notable Discovery: HR 8799 planetary system.

4.4 Gravitational Microlensing

Relies on gravitational lensing effects to detect distant planets. Useful for wide orbits but limited by rare observation opportunities. Notable Discovery: OGLE-2005-BLG-390Lb.

4.5 Astrometry

Tracks tiny positional shifts in stars caused by orbiting planets. Provides precise mass and orbit data but demands exceptional precision. Notable Discovery: HD 176051 b.

4.6 Pulsar Timing

Measures timing variations in pulsar signals caused by orbiting planets. Highly precise but restricted to pulsar systems. Notable Discovery: PSR B1257+12.

5. NOTABLE MISSIONS AND SURVEYS

Kepler: Identified over 2,600 exoplanets, emphasizing Earth-sized and habitable-zone candidates.
TESS: Continues Kepler's legacy, focusing on nearby stars. Key discovery: TOI-700d.
Gaia: Astrometric mission expected to uncover thousands of exoplanets.
JWST: Designed for detailed atmospheric studies of exoplanets.

6. FUTURE DIRECTIONS

Advancements in telescope technology, data analysis, and interdisciplinary methods are set to expand exoplanetary science. A primary focus will be identifying habitable exoplanets and potential biosignatures, with efforts guided by missions such as the JWST and planned next-generation telescopes.

7. CONCLUSION

Exoplanet research has redefined planetary science, uncovered a diversity of worlds and hinted at the possibility of life beyond Earth. With rapid technological progress and collaborative scientific efforts, the next decades promise transformative discoveries.

REFERENCES

[1]. Beaulieu, J. P., et al. (2006). Discovery of a cool planet of 5.5 Earth masses through gravitational microlensing. Nature, 439(7075), 437-440.
[2]. Borucki, W. J., et al. (2014). Kepler-186f: A Potentially Habitable Planet in the Kepler-186 System. Science, 344(6181), 277-280.
[3]. Mayor, M., & Queloz, D. (1995). A Jupiter-mass companion to a solar-type star. Nature, 378(6555), 355-359.
[4]. Marois, C., et al. (2008). Direct Imaging of Multiple Planets Orbiting the Star HR 8799. Science, 322(5906), 1348-1352.
[5]. Muterspaugh, M. W., et al. (2010). The Phases Differential Astrometry Data Archive. The Astronomical Journal, 140(5), 1623-1637.
[6]. Wolszczan, A., & Frail, D. A. (1992). A planetary system around the millisecond pulsar PSR1257 + 12. Nature, 355(6356), 145-147.

