

論文 / 著書情報
Article / Book Information

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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

論文要旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	地球惑星科学 地球惑星科学	系 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of	（ 理学 ）
学生氏名： Student's Name	TENG Huanyu		審査員主査： Chief Examiner	佐藤 文衛	

要旨（和文 2000 字程度）

Thesis Summary (approx.2000 Japanese Characters)

In the wake of the first confirmation of 51 Peg b, the concerted efforts of planet hunters have resulted in the discovery of over 5000 planets. These discoveries, including thousands of gas giant planets, have pushed forward the observational constraints on planet formation and migration mechanisms. However, further observational evidence is needed to refine and augment these theories.

The Okayama Planet Search Program (OPSP), and its collaborative East Asian Planet Search Network (EAPS-Net), are radial velocity surveys, which were undertaken with the aim of identifying planets orbiting evolved intermediate-mass stars, mainly late-G and early-K giant stars, whose intrinsic radial variability are usually quiet. The overarching goal of this research initiative was to gain insight into the correlation between planetary properties and stellar mass, thereby imposing stringent limitations on the theories surrounding planet formation and migration in more massive stars.

The present study describes our ongoing efforts to operate and refine the OPSP in conjunction with the EAPS-Net framework. Specifically, we have focused on conducting a thorough search for planets and conducting precise orbital characterization of these companions. To this end, we have analyzed the database of the programs, strategically re-prioritized the target list, and carried out intensive observations of the most promising stars known to host planets.

The present study also outlines our efforts to enhance the precision of planet mass measurement by re-estimating the masses of stars within the OPSP list. Leveraging the precise photometry provided by the Transiting Exoplanet Survey Satellite (TESS), we have employed an asteroseismic method to measure the stellar mass with a prospective accuracy better than ~10% of 86 stars encompassed within the OPSP. Furthermore, we have employed TESS photometry to simulate asteroseismic jitter, which is the predominant jitter source for our stars, in radial velocity. This aims to discover small planets around more massive stars.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

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学生氏名： Student's Name	TENG Huanyu		審査員主査： Chief Examiner	佐藤 文衛	

要旨 (英文 300 語程度)

Thesis Summary (approx.300 English Words)

Prior to 2018, a total of 28 planetary systems were initially reported within the EAPS-Net framework. As of mid-2023, this number has increased to 40, with the discovery of 8 new systems from data mining efforts and the confirmation of an additional 4 systems via the continuation of the survey. Our discoveries have unveiled an array of diverse planetary systems that have survived around evolved stars. These include several cool Jupiters, multiple-planet systems, a warm Jupiter, and wide-orbit planets.

Furthermore, we have revisited the radial velocity variations of the 32 planetary systems that were previously confirmed within the EAPS-Net prior to 2018, utilizing the latest data. As a result, we have refined the corresponding orbital parameters and have confirmed the presence of a new planet. In addition, we have detected several intriguing radial velocity variations that may indicate either planetary orbital motion or intrinsic activities of the host star.

In this study, we have conducted an investigation into the statistics of planet properties as a function of host star properties. We have observed that the host stars of planets discovered within the framework tend to exhibit lower metallicity compared to the average level of host stars for evolved planets. We infer that this trend may be attributed to the stringent B-V color cut-off employed in the star selection process for the survey, which excludes redder and potentially metal-rich stars.

It has been widely observed that planets tend to preferentially form around metal-rich stars, a phenomenon known as the planet metallicity correlation (e.g., Fischer et al. 2005). In our analysis of intermediate-mass stars, encompassing both main-sequence and evolved stars, we have confirmed this positive correlation for planets around main-sequence stars. However, our findings do not support a similar correlation for planets around evolved stars. Furthermore, we have identified a distinct gap at approximately 4 Jupiter masses (similar to Santos et al. 2017), below which planets tend to form via core accretion, and above which via gravitational disk instability.

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学生氏名： Student's Name	TENG Huanyu		審査員主査： Chief Examiner	佐藤 文衛	

要旨（英文 800 語程度）

Thesis Summary (approx.800 English Words)

In addition, we have focused on evolved stars spanning a wider range of stellar masses, and have investigated the relationship between metallicity and multiplicity of planetary systems. For planets below 5 Jupiter masses, we have discovered that multiple-planet systems tend to be more commonly found around metal-rich stars, which supports the notion of a correlation between metallicity and planetary system architecture.

Generally, we confirm the diversity of giant planets around evolved stars. The analysis of the OPSP data and its collaborative EAPS-Net shows that only low-mass giant planets are observed within the close-in region, while high-mass giant planets, including brown dwarfs, are found in wide orbits. The absence of close-in massive giant planets and the lack of less massive giant planets may be attributed to their non-existence and observational biases, respectively. In addition, a positive correlation between planet mass and stellar mass is observed for stars in the range of $\sim 1\text{-}3M_{\odot}$, but this correlation does not align with the entire sample of evolved stars. Careful consideration is needed due to potential stellar activities that can pretend planetary signals and bias the population of planets. Additionally, this correlation does not exist in solar-mass range by introducing stars in different evolutionary stages, and careful consideration is needed in the selection effect in the statistics.

In future investigations, we expect to continue the OPSP and the collaborative EAPS-Net. We plan to continue planet search and characterization as well as to accurately measure the stellar properties. We will refer these studies to the extension of the EAPS-Net program, from which we continue our insights into the origin and evolution of planetary systems by studying the planetary systems in their evolved stages.

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