[JJ] Evening Poster | P (Space and Planetary Sciences) | P-AE Astronomy & Extrasolar Bodies

[P-AE20]Exoplanet

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Thu. May 24, 2018 5:15 PM - 6:30 PM Poster Hall (International Exhibition Hall7, Makuhari Messe)

Exoplanetary science, which began with the discovery of a hot Jupiter in 1995, has reached a major turning point by the discovery of countless super-Earths by the Kepler mission. More recently, planets that are similar in size to the Earth and also receive similar amounts of stellar radiation (namely, located in the so-called habitable zone) have been discovered around nearby stars such as Proxima Centauri and TRAPPIST-1. As a result, not only theoretical, but also observational studies on the atmospheres and surface environments of Earth-like exoplanets have been started. Moreover, the number of planets discovered around early-type and late-type stars has become large enough that the occurrence rate and orbital distribution of planets around a wide variety of host stars have become clear. Thus, new observational insights, which become the basis of pan-planet formation theory, are now gathering. While exoplanets have been mainly targeted for astronomy until recently, it can be said that earth planetary science is finally becoming a research field to make a central contribution. In this session, we aim to share cutting-edge research results in exoplanetary science which is in such a transition period.

[PAE20-P05]Doppler tomographic measurement for the orbital obliquity of WASP-33b

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Keywords:Exoplanet, planetary orbit

The apparent angle between stellar spin axis and planetary orbital axis, which is called orbital obliquity (*λ*), is one of the important parameters for understanding the orbital evolution. If a planet has followed an orbital evolution like those in the solar planets evolve, its orbit will be aligned with the stellar spin. This orbit is called a prograde orbit (|*λ*|<90 deg) and many exoplanets orbit with the direction. However, it is clear that there are few exoplanets with retrograde orbits (|*λ*|>90 deg), which is the opposite case of our solar system. Doppler tomography (DT) is one of the methods to measure *λ*. In this method, when a planet covers part of the stellar surface during planetary transit, a planetary shadow appears in the stellar line profile which is broadened by its rapid stellar spin. Then, *λ* can be derived by the track of the shadow. The normalized distance by the stellar radius between the center of the stellar surface and path of the transit, which is called the impact parameter (*b*), can be measured by DT. Moreover, The planetary shadow appears more easily when the central star spins faster, which makes the measurement of these parameters more easily.

The previous study [1] found that the values of *λ* and *b* of the hot Jupiter WASP-33b, which has a 1.2-day period retrograde circular orbit around a rapidly rotating and pulsating A-type star, changed slightly from 2008 and 2014. They detected its orbital precession due to its slightly flattened central star. However, only two observational epochs, from 2008 and 2014, were used in the previous study [1]. Thus, in this study, we aim to confirm and more precisely measure the precession using a dataset from 2011, which should show values of *λ* and *b* intermediate to those in the previous study.

In our research, we used observational data of WASP-33 which was obtained using the High Dispersion

Spectrograph (HDS) on the 8.2m Subaru telescope on 19th October 2011 (UT). These data are composed of 35 spectral data taken from two hours before beginning of the planetary transit to one hour after the end of the transit. First we obtained the average line profile of each exposure from a large number of absorption lines by Least-Squares-Deconvolution (LSD). Then, considering the median of these line profiles as the stellar line profile, we calculated some necessary stellar parameters for calculation of *λ* and *b* of WASP-33b by *χ*^{2} fitting. Next, subtracting the average stellar line profile from the one from each exposure, we can get the planetary shadow showing a retrograde orbit and a component from stellar pulsations. In order to make the measurement of the planetary parameters more easily, we extracted only the planetary shadow by Fourier filtering used in the previous study [1]. Finally, we calculated *λ* and *b* of WASP-33b by *χ*^{2} fitting of the planetary shadow.

As a result, *λ* and *b* in 2011 we measured are separated values from ones in 2008 and 2014 measured in the previous study [1]. Thus, we also found the possibility of orbital precession of WASP-33b. Moreover, we verified that our values of *λ* and *b* are different from expected intermediate ones from the previous study [1], which shows the different orbital precession from the expected one of the previous study.

[1] Johnson et al. 2015