WASP-35 and HAT-P-30/WASP-51: Reanalysis using TESS and Ground-based Transit Photometry

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Abstract

High-precision transit observations provide excellent opportunities for characterizing the physical properties of exoplanetary systems. These physical properties supply many pieces of information for unveiling the internal structure, external atmosphere, and dynamical history of the planets. We present revised properties of the transiting systems WASP-35 and HAT-P-30/WASP-51 through analyzing newly available TESS photometry and ground-based observations obtained at the 1 m telescope of the Yunnan Observatories as well as from the literature. The improved system parameters are consistent with previous results. Furthermore, we find that the transits of HAT-P-30b/WASP-51b show possible timing variation that cannot be explained by a decaying orbit due to tidal dissipation and the Romer effect, while both apsidal precession and an additional perturbing body could reproduce this signal according to our comprehensive dynamical simulations. Because both systems are valuable targets that are suitable for transmission spectroscopy, we make some predictions for the atmospheric properties of WASP-35b and HAT-P-30b/WASP-51b based on the newly derived system parameters.

Unified Astronomy Thesaurus concepts: Exoplanet systems (484); Transit photometry (1709); Transit timing variation method (1710); Gaussian Processes regression (1930); Markov chain Monte Carlo (1889)

1. Introduction

Transiting exoplanets have been playing a fundamental role in revolutionizing planetary science for more than two decades. High-precision photometry during the transits and spectroscopic measurements provide perfect opportunities for characterizing the physical properties of transiting exoplanetary systems. This information gives first indications about the internal structure, external atmosphere, and dynamical history of the planetary systems. Therefore, it is important to enlarge the number of exoplanetary systems with accurately measured physical properties with the aim to analyze them statistically and to establish the formation and evolution models of planetary systems.

Long-term transit-monitoring observations and based on this, updated physical properties for known transiting exoplanetary systems, are essential for discovering additional bodies and scheduling further observations. A single transiting planet generally orbits its host star on a Keplerian orbit with a constant orbital period on a timescale of years, in which the influence of tidal effect and general relativity effects can be negligible because there is no effective accumulation. But transit timing variations (TTV; Agol et al. 2005; Holman & Murray 2005), which means that transits no longer appear at a fixed interval, would exist in principle if there are additional bodies in the planetary systems. In some cases, the gravitational interaction between planets will trigger relatively short-term TTVs (Agol et al. 2005; Holman & Murray 2005). The patterns of these TTVs (e.g., amplitude, frequency, and overall shape) strongly rely on the orbital parameters and masses of the planets involved (see, e.g., Agol et al. 2005; Holman & Murray 2005; Nesvorný & Morbidelli 2008; Lithwick et al. 2012; Xie et al. 2014). As the gravitational interactions among planets that induce the TTVs generally act on timescales much longer than the orbital periods, space-based transit survey missions, such as Kepler and the upcoming PLATO mission, and ground-based follow-up transit monitoring with longer baselines are more likely to capture such phenomena (Mazeh et al. 2013; Rowe et al. 2014; Holczer et al. 2016). Furthermore, the TTV technique is a powerful tool for understanding planetary systems: it can place a constraint on the existence of nontransiting exoplanets, thereby supplying missing pieces for the architecture of the systems due to the geometry bias that is inherent to the transit method (Xie et al. 2014; Zhu et al. 2018; Sun et al. 2021), and allowing for a better comparison with synthetic planetary system population models (see, e.g., Mordasini et al. 2009; Mordasini 2018; Wu et al. 2019). On the other hand, TTVs can also be used to measure the masses of the planets (see, e.g., Lithwick et al. 2012; Nesvorný et al. 2012) and therefore their density, which hence places strong constraints on their internal structures, as is the case for the Kepler-411 system (Sun et al. 2019), the Trappist-1 system (Grimm et al. 2018; Agol et al. 2021), and so on. The detection of individual dynamically hot systems also provides valuable constraints on planetary system formation theory, as the current orbit of a system can retain information about its past migration history (see, e.g., Delisle 2017; Nesvorný et al. 2021). In addition, many exoplanetary systems show temporal variations in their orbital properties, which may have several reasons, such as long-term effects of tidal forces, elliptical orbit...
precession, and mass loss; these mechanisms may mimic the above-mentioned TTVs generated by gravitational interactions with other bodies. Among these cases, orbital decay induced by tidal dissipation is a most interesting case in addition to gravitational interactions with other bodies. The orbital decay theory suggests that it tends to occur in planets with shorter orbital periods and higher masses; these types of TTV signals of hot giant planets could also be used to constrain the planetary tidal quality factor and study the dynamical history of planetary systems (Goldreich & Soter 1966). While direct observational evidences still remain sparse, further investigations will improve our understanding of the dynamical history of planetary systems. Fortunately, both space- and ground-based transit photometry can be used to search for TTVs. This will accumulate a large database and valuable targets.

To refine physical properties and investigate the TTV behavior of known transiting exoplanetary systems, both ground- and space-based transiting light curves are necessary. Since 2009, we have monitored the transit events of some known transiting exoplanetary systems by employing the 1 m telescope of the Yunnan Observatories (hereafter, YO-1m) in China, and we obtained a series of high-precision photometric data (see, e.g., Wang et al. 2013; Tan et al. 2013; Wang et al. 2014; Sun et al. 2015, 2017). For the ground-based transit observations, the most challenging aspect is the systematic noise due to the variable atmosphere of the Earth, so some noise reduction techniques (Tamuz et al. 2005; Collier Cameron et al. 2006; Rasmussen & Williams 2006; Carter & Winn 2009; Gibson et al. 2012; Wilson et al. 2021) have been developed and are widely used to handle this issue. Moreover, the Transiting Exoplanet Survey Satellite (TESS; Ricker et al. 2016, 2017) has been producing high-quality transiting light curves that are well suited to refine the physical properties of known planetary systems.

Here we focus on the planetary systems WASP-35 and HAT-P-30. Both of them have been observed by TESS in two sectors, and we also observed one transit event for each system using YO-1 m. Based on these light curves and radial velocity (RV) data from the literature, we refined their system parameters, analyzed the TTVs of these planetary systems, and made predictions about the atmospheric properties of them based on our refined physical parameters. We give a short introduction of the targets in Section 2. Then we describe the observations and data reduction in Section 3, and present the modeling in Section 4. The further analysis and discussion is given in Section 5. We finally summarize the study in Section 6.

2. Targets
2.1. WASP-35

WASP-35b was discovered by Enoch et al. (2011) in the Wide Angle Search for Planets (WASP) project. This transiting exoplanet system has an inflated \((M_p = 0.72 \pm 0.06 M_{\text{Jup}} \text{ and } R_p = 1.32 \pm 0.05 R_{\text{Jup}})\) hot Jupiter that orbits a metal-poor \(([Fe/H]= -0.15 \pm 0.09)\) host star with a period of 3.16 days. Through analyzing their photometric and spectroscopic observations at a series of ground-based telescopes, Enoch et al. (2011) confirmed the planetary nature of WASP-35b and suggested that the host star of WASP-35 lacks stellar activity. Later, Mortier et al. (2013, 2014) updated the physical parameters of the host star using a spectroscopic analysis, Kokori et al. (2021) reanalyzed and updated the ephemeris based on the light curves of Enoch et al. (2011), and Shan et al. (2021) refined and updated the ephemeris using data of TESS photometry.

2.2. HAT-P-30

HAT-P-30b (also known as WASP-51b) was discovered independently by Johnson et al. (2011) in the Hungarian-made Automatic Telescope Network and by Enoch et al. (2011) in the WASP project. HAT-P-30b is a transiting hot Jupiter \((M_p = 0.711 \pm 0.028 M_{\text{Jup}} \text{ and } R_p = 1.340 \pm 0.065 R_{\text{Jup}})\) orbiting a late F-type host star with a period of 2.81 days, and the orbit is circular. HAT-P-30 has a relatively bright \((V=10.4)\) host star, therefore it is very suitable for a study of the planetary atmosphere based on transmission spectra. Johnson et al. (2011) studied the Rossiter–McLaughlin effect of the HAT-P-30 system, and found that the orbit of HAT-P-30b was highly tilted with a sky-projected angle between the star’s spin axis and the planet’s orbit normal, \(\lambda = 73.5 \pm 9.0\). Maciejewski et al. (2016), Saha et al. (2021), Wang et al. (2021), and Edwards et al. (2021) acquired new transit light curves of HAT-P-30b based on several ground-based telescopes and measured the physical parameters. Davoudi et al. (2020) analyzed several relatively high-quality transit light curves of HAT-P-30b collected from the Exoplanet Transit Database (ETD).\(^7\) Kokori et al. (2021) reanalyzed and updated the ephemeris based on the light curves of Maciejewski et al. (2016), Johnson et al. (2011), and Enoch et al. (2011), and found no TTVs for HAT-P-30b.

3. Observations and Data Reduction

3.1. TESS Photometry

TESS is an all-sky space survey that is designed to search for transiting exoplanets orbiting the bright and nearby stars. These planet systems enable us to carry out follow-up observations and study their physical properties. TESS performs time-series photometry to monitor at least 200,000 main-sequence stars using four 100 mm telescopes with wide-field optical CCD cameras. The broad passband filter of TESS covers from 600 to 1000 nm, and the combined field of view of each sector is \(24 \times 96\) square degrees. Since its launch in 2018, TESS has completed 44 sectors of observations and collected many high-quality transiting light curves.

WASP-35 was observed by TESS in Sector 5 (2018 November 15–2018 December 11) and Sector 32 (2020 November 19–2020 December 17), and HAT-P-30 was observed by TESS in Sector 7 (2019 January 7–2019 February 2) and Sector 34 (2021 January 13–2021 February 9). The data were collected in a 2-minute cadence and were reduced by the pipeline developed by the Science Processing Operations Center (SPOC; Jenkins et al. 2016). We downloaded the light-curve files from the archives at the Mikulski Archive for Space Telescopes (MAST)\(^8\) and accessed the light curves using the Lightkurve python package (Lightkurve Collaboration et al. 2018). These data have been corrected for the instrumental systematic variations by using the SPOC pipeline, but some long-term trends still remained in the data. In order to alleviate the influence from the remaining trends, we employed

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\(^7\) See http://var2.astro.cz/ETD/
\(^8\) See https://archive.stsci.edu/mission/tess/
Gaussian Process (GP; Rasmussen & Williams 2006) to model these data (see below for further details). We finally obtained 15 complete transit light curves of WASP-35 and 16 complete transit light curves of HAT-P-30. The time system of these light curves is the barycentric Julian date (BJD), which can be used directly to determine the system parameters and ephemerides. Examples of raw TESS light curves are displayed in the top panels of Figures 1 and 2, respectively.

3.2. Ground-based Photometry

We observed the transit events of WASP-35 and HAT-P-30 using the Andor 4 × 4K CCD camera attached to the YO-1 m on 2018 November 20 and 18, respectively. The Johnson–Cousins R filter was used in both observations, and the field of view is 15 × 15 arcmin². During the two observations, the weather conditions and instrument status were good, and the exposure times were 120 s. The transit event of HAT-P-30b occurred at sunset, which resulted in a relatively larger dispersion at the beginning of the observation (see Figure 3). In addition, we collected two sets of high-quality light curves of HAT-P-30 from the CDS database. These light curves were observed by Johnson et al. (2011) using the KeplerCam imager of the 1.2 m telescope at the Fred Lawrence Whipple Observatory (FLWO-1.2m).

The data reduction follows the standard procedures, which were described in Wang et al. (2013). Our data reduction pipeline is based on the IRAF package, written in Python by means of the pyRAF interface, including image checking, image trimming, bias subtraction, flat-field correction, and cosmic-ray removal, and establishing astrometric solution, aperture photometry, and systematic error correction. To reach higher precision, the pipeline attempts a series of photometric apertures for the target and reference stars, and we select the best to minimize the dispersion of each light curve. The transit light curve is obtained by using the optimal aperture.

For ground-based observations, shallow transit signals are easily drowned out by the systematic errors due to the effect of the telluric atmosphere and imperfect observation conditions, so it is necessary to remove the systematic errors that hide in the above transit light curves. First, we employed the coarse decorrelation (Collier Cameron et al. 2006) and SYSREM algorithms (Tamuz et al. 2005) to diagnose and correct for them by using the pipeline mentioned above. At this point, there are still some long-term systematic trends in the transit light curves. We employed GP to diagnose and correct for them. Furthermore, in order to obtain accurate ephemerides of the targets, we converted the observing time into BJT by using the method proposed by Eastman et al. (2010).
3.3. Gaussian Processes

Gaussian Process (Rasmussen & Williams 2006) is a popular method that has been widely used to model time-series data in the exoplanet community for about a decade, such as modeling stellar activity signals in RV data and correcting instrumentally induced systematic errors in transit light curves (Gibson et al. 2012; Evans et al. 2015; Murgas et al. 2020; Hurt et al. 2021; Langellier et al. 2021). Instead of modeling instrumental systematic errors as a deterministic function with auxiliary measurement parameters, GP provides a nonparametric method to model systematic errors from the observed data set. Here, we used the code of Juliet (Espinoza et al. 2019) to correct long-term trends and instrumental systematic errors in TESS photometry data and the residual systematic errors in ground-based photometry data.

We modeled the photometric light curves in flux space separately depending on the instrument and the time of the observation using the code Juliet. For the photometry data sets, Juliet establishes a common model in which the light curve is modeled as a linear combination of the transit model and the noise model,

$$M(t) + \epsilon(t)$$

where $M(t)$ is the transit model with the dilution factor for the given instrument and the mean offset of out-of-transit flux, and $\epsilon(t)$ is the noise model that is being modeled by GP in the photometric light curve. Juliet uses the analytic transit light curve model of Mandel & Agol (2002) with a quadratic limb-darkening law and the limb-darkening coefficients ($q_1$ and $q_2$) proposed by Kipping (2013) to model the transit signals, and the code employs the batman package (Kreidberg 2015) to implement the transit light curve model.

We checked the nearby stars around WASP-35 and HAT-P-30 using the Gaia DR3 database (Gaia Collaboration et al. 2021). Neither of the fields seems to be especially crowded, and no other source was bright enough to make a perceptible impact. We therefore fixed the dilution factors of both targets to 1. For TESS photometry data, the state of the instrument may be different in different observation sectors, so we modeled the TESS data sector by sector. For the ground-based observations, the state of ground-based instrument and the weather changes from day to day, so we modeled the ground-based data day by day. In all of the model processes, we chose a celerite (approximate) Matern multiplied exponential kernel within Juliet implemented by the celerite package (Foreman-Mackey et al. 2017). For the analytic transit model part, the parameters are the orbital period $P$, the mid-transit time $T_0$, scaled semimajor axis $a/R_A$, the eccentricity $e$ (fixed to 0), the argument of periastron $\omega$ (fixed to 90°), the impact parameter $b$, the planet-to-star radius ratio $R_p/R_A$, the limb-darkening coefficients $q_1$ and $q_2$, the mean out-of-transit flux, the dilution factors (fixed to 1), and the jitter. The input values we used were obtained by Enoch et al. (2011) for WASP-35 and by Johnson et al. (2011) for HAT-P-30, and a wide normal prior was used in the GP. For the GP component, the hyperparameters were the amplitude of the GP, and two length scales corresponding to the Matern and the exponential part. We used a log-uniform prior for these hyperparameters. The amplitude of the GP varied from $10^{-6}$ to $10^6$, and the two length scales varied from $10^{-3}$ to $10^3$. Juliet uses the PyMultiNest package (Feroz et al. 2009; Buchner et al. 2014) with 500 live points to explore the parameter space. Finally, we obtained the raw light curves and the full median posterior model, namely the transit model plus the median GP process. So we could subtract the GP part of the model from the raw light curve to correct for the residual systematic errors in the photometry data and obtained the final light curves. The transit light curves before and after the GP correction with the best-fitting models and the residuals are shown in Figures 1, 2, 3, and 4.

4. Transit and RV Modeling

We used the Markov chain Monte Carlo (MCMC) technique to fit the final light curves and the RV curves of Enoch et al. (2011) and Johnson et al. (2011) simultaneously, and we derived the system parameters as well as the ephemerides for further analysis (Collier Cameron et al. 2007; Pollacco et al. 2008). The code that we employed to model the transit light curves and RV curves was developed by Collier Cameron et al. (2007). It is based on the analytic transit light curve model proposed by Mandel & Agol (2002) associated with the four-coefficient limb-darkening law. The input parameters include...
the orbital period $P$, the mid-transit time $T_0$, the transit duration $t_T$, the planet-to-star area ratio $\Delta F$, the impact parameter $b$, the semiamplitude of the RV curve $K_1$, the orbital eccentricity $e$, and the argument of periastron $\omega$. In order to accelerate the convergence of the system parameters, $e \cos \omega$ and $e \sin \omega$ are used to replace $e$ and $\omega$ in the MCMC processes. The mass and radius of the host stars were derived from the calibration for stellar masses and radii proposed by Enoch et al. (2010), which is based on the stellar effective temperature, metallicity, and surface gravity, and microturbulent velocity of host stars. The stellar parameters mentioned above were based on the results of Enoch et al. (2011) and Johnson et al. (2011), and we adopted a circular orbit ($e = 0$) in the following analysis of both of the targets, as neither Enoch et al. (2011) nor Johnson et al. (2011) found a significant nonzero eccentricity through fitting their RV curves. The Metropolis-Hastings algorithm was used to obtain the posterior probability distribution of the system parameters and the best-fit system parameters with uncertainties.

At the beginning of the analysis, we modeled all of the light curves and the RV curves simultaneously to derive the initial global system parameters of the planetary systems. The 12 RV measurements of WASP-35 were made by Enoch et al. (2011) between 2010 January 5 and 2010 February 14, and the RV curves of HAT-P-30 were observed by Enoch et al. (2011) and Johnson et al. (2011) between 2010 April 27 and 2011 January 4, including 39 data points. The inputs parameters were described above. We adopted a circular orbit ($e = 0$) and let other system parameters free in the MCMC calculations. We employed five chains of 17,000 MCMC steps, in which 2000 steps were burn-in samples and were eliminated in the statistics of the posterior probability distribution. This chain length was carefully considered; it had a balanced convergence of the solution and computation time (Wang et al. 2013).

Then we fitted them separately to derive the mid-transit times for the TTV analysis and to refine the ephemerides, using the above results as the input parameters. Other configurations followed the same procedure as above, except that the orbital periods were fixed as the input ones. The results of the mid-transit times of the targets are listed in Tables 1 and 2, combined with several mid-transit times from previous works and the ETD website. We used the linear ephemeris formula $T = T_0 \times E$ to fit the new mid-transit times and derived the orbital period values, where $T_0$ is the zeropoint of the epoch of mid-transit, $P$ is the orbital period, and $E$ is the the cycle number. We preformed the MCMC calculations to find the best-fitting linear ephemeris formula by using the emcee package (Foreman-Mackey et al. 2013). We ran 50,000 MCMC steps with 1000 burn-in steps to ensure convergence, and the final results are $T(\text{BJD}_{\text{TDB}} - 2450000) = 5531.4790700 \pm 0.0001500$ for the WASP-35 system and $T(\text{BJD}_{\text{TDB}} - 2450000) = 5523.9215745 \pm 0.0003904$ for the HAT-P-30 system.

Using the new orbital periods derived above as the input parameters and keeping them fixed, the final system parameters of the targets were calculated based on all the light curves and

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**Figure 4.** The transit light curves of HAT-P-30 observed using FLWO-1.2 m. The top row shows raw light curves with the best-fitting transit + noise model, the middle row shows light curves without the noise with the best-fitting transit model, and the bottom row shows the corresponding residuals.

**Table 1.** The Mid-transit Times of WASP-35

| Mid-transit Time (BJD$_{\text{TDB}}$ - 2450000) | Error (days) | Cycle Number | Source |
|-----------------------------------------------|--------------|--------------|--------|
| 5531.4790700                                 | 0.0001500    | 0            | Enoch et al. (2011) |
| 5540.1231974                                 | 0.0002673    | 920          | TESS   |
| 5543.2834342                                 | 0.0003904    | 921          | YO-1m  |
| 5543.2845042                                 | 0.0002821    | 921          | TESS   |
| 5546.4460079                                 | 0.0002735    | 922          | TESS   |
| 5549.6077501                                 | 0.0003029    | 923          | TESS   |
| 5552.7689812                                 | 0.0002756    | 924          | TESS   |
| 5555.9305639                                 | 0.0002782    | 925          | TESS   |
| 5559.0921595                                 | 0.0002948    | 926          | TESS   |
| 5562.2537745                                 | 0.0003173    | 927          | TESS   |
| 5575.8000120                                 | 0.0008600    | 1147         | ETD    |
| 5576.7683243                                 | 0.0003100    | 1153         | TESS   |
| 5576.7697320                                 | 0.0007200    | 1153         | ETD    |
| 5579.9301275                                 | 0.0003882    | 1154         | TESS   |
| 5583.0917244                                 | 0.0003045    | 1155         | TESS   |
| 5589.4143000                                 | 0.0003028    | 1157         | TESS   |
| 5592.5756463                                 | 0.0003310    | 1158         | TESS   |
| 5595.7378575                                 | 0.0003504    | 1159         | TESS   |
| 5595.7389020                                 | 0.0006300    | 1159         | ETD    |
| 5598.8988431                                 | 0.0003170    | 1160         | TESS   |
| 5602.6467690                                 | 0.0009600    | 1177         | ETD    |
| 5624.5411270                                 | 0.0006800    | 1263         | ETD    |
the RV curves following the same strategy as above. The final solutions of the system parameters for the WASP-35 and HAT-P-30 systems are listed in Tables 3 and 4 together with the

results of Enoch et al. (2011) and Johnson et al. (2011) for comparison. The final transit modeling results are shown in Figures 5 and 6.

5. TTV Modeling and Prospect for the Atmospheric Properties

5.1. TTV Signals

 Transit timing variations are generally parameterized with the deviations between the observed transit times and their expected values assuming a Keplerian motion for the planet. The TTVs for these two targets were computed based on our new observations, TESS photometry, transit observations collected from ETD, and transit observations in the literature. In Tables 1 and 2, discrepancies between the transit times derived from simultaneous TESS and ground-based observations exist for some transit events, which may mean that the timing uncertainties were slightly underestimated, especially for the ground-based transit light curves, which have a lower quality than those of TESS. Thus, we added a timing jitter to cope with this issue in the following TTV modeling. Refined orbital periods were obtained by linearly fitting all available transit times, that is, a total of 55 transit times of HAT-P-30b, and 22 transit times of WASP-35b. Figure 7 presents all the TTV measurements for the transiting exoplanet WASP-35b, and Figure 8 shows the same for HAT-P-30b.

As the degeneracy in the explanation for hot Jupiter TTVs mentioned in Section 1, we used four different models, namely a linear ephemeris model, an orbital decay model, the elliptical
orbit precession model, and a planetary interaction-induced TTV model, to fit the timing data of HAT-P-30b and WASP-35b. In this section we describe our analyses of the first three models, while the last analysis is presented in Section 5.2. Our timing analysis was partly similar to that of Patra et al. (2017), Yee et al. (2020), and Turner et al. (2021).

### Table 4
System Parameters of HAT-P-30

| Parameter | Johnson et al. (2011) | Enoch et al. (2011) | This work |
|-----------|-----------------------|---------------------|-----------|
| Orbital period (days) | 2.810595 ± 0.000005 | 2.810603 ± 0.000008 | 2.8106006 ± 0.0000004 |
| Transit epoch (BJD-2450000) | 5456.46561 ± 0.00037 | 5571.70135 ± 0.00016 | 5523.92157 ± 0.00043 |
| Transit duration (days) | 0.0887 ± 0.0015 | 0.0920 ± 0.0008 | 0.0916 ± 0.0004 |
| Planet/star area ratio | 0.0128 ± 0.0004 | 0.0122 ± 0.0002 | 0.0124 ± 0.0001 |
| Impact parameter | 0.854 ± 0.0004 | 0.87 ± 0.01 | 0.872 ± 0.003 |
| Stellar reflex velocity (m/s) | 92.67 ± 2.50 | 97.70 ± 6.40 | 92.67 ± 2.50 |
| Center-of-mass velocity (km/s) | 45.51 ± 0.18 | 44.77 ± 0.001 | 44.7 ± 0.002 |
| Orbital inclination (deg) | 83.6 ± 0.4 | 82.1 ± 0.1 | 82.56 ± 0.08 |
| Orbital eccentricity | 0.035 ± 0.024 | 0 (fixed) | 0 (fixed) |
| Stellar mass ($M_*$) | 1.242 ± 0.041 | 1.18 ± 0.03 | 1.175 ± 0.025 |
| Stellar radius ($R_*$) | 1.215 ± 0.051 | 1.33 ± 0.03 | 1.314 ± 0.015 |
| Stellar density ($\rho_*$) | 0.50 ± 0.02 | 0.5 ± 0.02 | 0.517 ± 0.012 |
| Stellar surface gravity (cgs) | 4.36 ± 0.03 | 4.26 ± 0.01 | 4.270 ± 0.007 |
| Stellar metallicity | +0.13 ± 0.08 | -0.08 ± 0.08 | -0.079 ± 0.079 |
| Stellar effective temperature (K) | 6304 ± 88 | 6250 ± 100 | 6252 ± 100 |
| Planet mass ($M_p$) | 0.711 ± 0.028 | 0.76 ± 0.05 | 0.723 ± 0.023 |
| Planet radius ($R_p$) | 1.340 ± 0.065 | 1.42 ± 0.03 | 1.426 ± 0.020 |
| Planet density ($\rho_p$) | 0.28 ± 0.04 | 0.26 ± 0.03 | 0.249 ± 0.011 |
| Planet surface gravity (log $g_p$) | 2.99 ± 0.04 | 2.93 ± 0.03 | 2.910 ± 0.015 |
| Planet effective temperature ($A=0$) (K) | 1630 ± 42 | 1710 ± 30 | 1704 ± 28 |

Figure 5. The final transit light curves of WASP-35 with the best-fitting transit models and the residuals.
The first model assumes a constant period,

\[ T_{\text{vis}}(E) = T_0 + P \times E, \]

where \( T_0 \) is the reference mid-transit time, and \( E \) is the cycle number.

The second model assumes that the planet has a constant orbital period decay rate,

\[ T_{\text{vis}}(E) = T_0 + P \times E + \frac{1}{2} \frac{dP}{dE} E^2, \]

where \( dP/dE \) is the decay rate.

Figure 6. The final transit light curves of HAT-P-30 with the best-fitting transit models and the residuals.

Figure 7. Transit timing variations after subtracting the constant-period model of WASP-35. The green and blue dots are the new transit times from TESS and YO-1m, the olive dots are from Enoch et al. (2011), and the orange dots denote the data points from ETD. The black curve shows the expected orbital decay model, and the red curve shows the apsidal precession model.
The third model assumes that the planet has a nonzero orbital eccentricity $e$ and that the argument of pericenter $\omega$ is precessing uniformly over time,

$$T_{\text{oa}}(E) = T_0 + P_a \times E - \frac{e P_a}{\pi} \cos(\omega(E))$$

$$\omega(E) = \omega_0 + \frac{d\omega}{dE} E$$

$$P_t = P_a \left(1 - \frac{1}{2} \frac{d\omega}{dE} \right),$$

where $P_a$ is the sidereal period, $P$ is the anomalistic period, and $d\omega/dE$ is the precession rate (Giménez & Bastero 1995).

For these models, we preformed the MCMC calculations to find the best-fitting parameters using the emcee package (Foreman-Mackey et al. 2013) and ran 50,000 MCMC steps with 1000 burn-in steps to ensure convergence. The results of the three timing model fittings are listed in Tables 5 and 6, and Figures 7 and 8 show the transit-timing data with the best-fitting orbital decay and apsidal precession models.

We used the Bayesian information criterion (BIC; Schwarz 1978) as the penalty to compare two different best-fit models, and the BIC is defined as

$$\text{BIC} = \chi^2 + k \log n,$$

where $k$ is the number of free parameters, and $n$ is the number of data points.

### 5.1.1. WASP-35

Figure 7 is the linear plot of TTV versus cycle for this planet. The deviations of the transit times from the linear ephemeris have an rms of 37 s. Compared with the constant-period model ($\chi^2_{\text{min}} = 22.807$) and the apsidal precession model ($\chi^2_{\text{min}} = 22.254$), the orbital decay model has a lower minimum chi-squared ($\chi^2_{\text{min}} = 22.168$). But we found that the constant-period model had the lowest BIC value, that is, the constant-period model was the favored model with $\Delta(\text{BIC}_{1,2}) = 2.452$ and $\Delta(\text{BIC}_{1,3}) = 8.720$. We assumed a multivariate Gaussian distribution for the posterior of all the parameters, the Bayes factor $B$,

$$B_{1,2} = \exp[-\Delta(\text{BIC})/2] = 3.408$$

$$B_{1,3} = \exp[-\Delta(\text{BIC})/2] = 78.257.$$  

This means that the observations of WASP-35 slightly favored the constant-period model.
### Table 6

| Parameter                  | Symbol | Unit       | Value     |
|----------------------------|--------|------------|-----------|
| Constant-period model      |        |            |           |
| Period                     | $P$    | days       | 2.8106006 ± 0.0000004 |
| Mid-transit time           | $T_0$  |BJD$_{TDB}$| 2455523.92157 ± 0.00043 |
| $N_{\text{dof}}$           |        |            | 53        |
| $\chi^2_{\text{min}}$      |        |            | 119.220   |
| BIC                        |        |            | 127.235   |
| Orbital decay model        |        |            |           |
| Period                     | $P$    | days       | 2.8106049 ± 0.0000019 |
| Mid-transit time           | $T_0$  |BJD$_{TDB}$| 2455523.92083 ± 0.00047 |
| Decay rate $dP/dE$         |        | days/orbit | $-6.24 \times 10^{-9} \pm 2.77 \times 10^{-9}$ |
| $N_{\text{dof}}$           |        |            | 52        |
| $\chi^2_{\text{min}}$      |        |            | 113.793   |
| BIC                        |        |            | 125.815   |
| Apsidal precession model   |        |            |           |
| Sidereal period            | $P_s$  | days       | 2.8106047 ± 0.0000011 |
| Mid-transit time           | $T_0$  |BJD$_{TDB}$| 2455523.91840 ± 0.00090 |
| Orbital eccentricity       | $e$    |            | 0.00323 ± 0.00065 |
| Argument of periastron     | $\omega_0$ | rad | 2.290 ± 0.325 |
| Precession rate $d\omega/dE$|        | rad/orbit | 0.00270 ± 0.00050 |
| $N_{\text{dof}}$           |        |            | 50        |
| $\chi^2_{\text{min}}$      |        |            | 100.051   |
| BIC                        |        |            | 120.088   |

#### 5.1.2. HAT-P-30

Figure 8 is the linear plot of TTV versus cycle for this planet. Compared with the TTV analysis of Kokori et al. (2021), our data set covers a longer time baseline and contains more data points. This exhibits a secular timing effect of HAT-P-30b. The deviations of the transit times from the linear ephemerides have an rms of 158 s. Compared with the constant-period model ($\chi^2_{\text{min}} = 119.220$) and the orbital decay model ($\chi^2_{\text{min}} = 113.793$), the apsidal precession model has a lower minimum chi-squared ($\chi^2_{\text{min}} = 100.051$). And we also found that the apsidal precession model had the lowest BIC value, that is, the apsidal precession model was the favored model with $\Delta(\text{BIC}_{3.1}) = 19.744$ and $\Delta(\text{BIC}_{3.2}) = 9.095$. We assumed a multivariate Gaussian distribution for the posterior of all the parameters, the Bayes factor $B$,

$$B_{3.1} = \exp[-\Delta(\text{BIC})/2] = 35.641$$

$$B_{3.2} = \exp[-\Delta(\text{BIC})/2] = 17.523.$$

This means that it is slightly favored over the apsidal precession model for the observations.

According to the constant-phase lag model for the tidal evolution suggested by Goldreich & Soter (1966), the decay rate is defined as

$$\frac{dP}{dt} = -\frac{27\pi}{16Q_*^2} \left( \frac{M_p}{M_*} \right) \left( \frac{R_*}{a} \right),$$

where $Q_*$ is the modified quality factor of the stellar tidal oscillations, $M_p$ is the planet mass, and $M_*$ is the stellar mass. For HAT-P-30, this yields

$$\frac{dP}{dt} = -553.08 \pm 245.52 \text{ ms yr}^{-1}.$$

Based on the decay rate of the orbital decay model, we derived the modified quality factor of

$$Q_*' = (8.10 \pm 3.62) \times 10^2.$$

This value is significantly lower than the typical values of $10^5$–$10^7$ for binary star systems (Meibom & Mathieu 2005; Meibom et al. 2015) and $10^5$–$10^6$ for hot Jupiters (Jackson et al. 2008; Husnoo et al. 2012; Barker 2020).

In addition, we also considered whether this TTV is caused by the Römer effect as in the WASP-4 system (Bouma et al. 2019, 2020). Because of the Doppler effect, if there is any line-of-sight acceleration of the system, it would lead to a decay of the orbital period,

$$\frac{dP}{dt} = \frac{\ddot{v}_r P}{c},$$

where $\ddot{v}_r$ represents the line-of-sight acceleration of the radial motion. We performed an independent RV modeling to test this possibility. We modeled all of the RV measurements simultaneously and other configurations followed the same procedure as above, except for a long-term linear trend $\ddot{v}_r$. Compared with the RV model with a long-term linear trend ($\chi^2 = 46.291$, BIC$_2 = 52.610$; see Figure 9), the RV model without a long-term linear trend has a lower $\chi^2$ ($\chi^2 = 46.260$) and BIC value (BIC$_1 = 50.999$), namely the best-fitting result prefers the RV model without a long-term linear trend. We assumed a multivariate Gaussian distribution for the posterior of all the parameters, the Bayes factor $B$,

$$B_{12} = \exp[-\Delta(\text{BIC})/2] = 2.237.$$

This means that the difference between the two RV models is minimal.

We preformed MCMC calculations to derive the value of the line-of-sight acceleration $\ddot{v}_r$. The configurations of the MCMC calculations are the same as above, and the value of the line-of-sight acceleration is

$$\ddot{v}_r = -0.013 \pm 0.017 \text{ m s}^{-1} \text{ day}^{-1}.$$

For HAT-P-30, this yields

$$\frac{dP}{dt} = -3.85 \pm 5.03 \text{ ms yr}^{-1}.$$

Based on the line-of-sight acceleration we obtained, the implied period derivative is about two orders of magnitude smaller than the Römer effect as in the WASP-4 system (Meibom & Mathieu 2005; Meibom et al. 2015) and $10^5$–$10^6$ for hot Jupiters (Jackson et al. 2008; Husnoo et al. 2012; Barker 2020).

#### 5.2. Upper Mass Limit of a Hypothetical Perturber

The results from our TTV measurements (see Section 5.1) allow us to infer the upper mass limit for an additional perturbing planet in each of these two systems, which assumes that all the TTV signals originate from the gravitational interactions among planets involved. Although inverting the TTV signals with their high cadence and high signal-to-noise ratio could be used to measure the mass and eccentricity of the
perturbing exoplanets, this is clearly not the case for HAT-P-30b and WASP-35b. However, the perturbation from the additional planet can be approximately quantified by the rms of the TTVs for our sparse measurements. The TTV effects are strongly amplified for orbital configurations in (or near) mean-motion resonances (MMR; Agol et al. 2005; Holman & Murray 2005), in which the detection of a low-mass planetary perturbing body is in principle permitted.

An upper mass limit can be obtained by employing a N-body code to perform direct orbit integrations, which is widely used in the literature (e.g., Wang et al. 2017, 2018a, 2018b; Cortés-Zuleta et al. 2020; Wang et al. 2021). Within the framework of the three-body orbital configuration, we numerically integrated the orbits of each of these two hot Jupiters and a hypothetic perturbing planet around their host star. To meet our need, we modified the TTV inversion code of Sun et al. (2019), who employed TTVFast (Deck et al. 2014) to perform direct orbit integrations. Summarily, our new code calculates the rms of synthetic TTVs, whose epochs are selected to be identical to those of the measured TTVs, considering a transiting exoplanet perturbed by an 1M_⊕ planet on an arbitrary orbital architecture. This configuration will help simplify computing an upper mass limit, as the amplitude of a TTV pattern is linearly proportional to the mass of the perturbing planet. Hence, the upper mass limit of a perturbing planet could be well estimated by the product of the rms of the measured TTVs divided by that of the synthetic TTVs.

This code was then applied to a series of orbital periods of the perturbing planet while fixing all the other orbital parameters. As the TTV patterns strongly depended on the perturber mass, the orbital period, the eccentricity, and the mutual inclination of the orbit (Agol et al. 2005; Holman & Murray 2005; Nesvorný & Morbidelli 2008; Lithwick et al. 2012; Xie et al. 2014), we performed orbital integrations in terms of three different orbital architectures for hypothetical perturbers in this study: (a) initially on a coplanar and circular orbit; (b) initially on a coplanar and slightly eccentric orbit (i.e., e_c = 0.2); and (c) initially on an inclined and slightly eccentric orbit (i.e., i_c = i_b − 30°, e_c = 0.2, where i_b and i_c denote the inclinations of the known transiting planet and the perturber, respectively). For clarity, hereafter we label these three different orbital architectures as Case a, Case b, and Case c, respectively. Except for the orbital period of the perturbing planet, the remaining orbital elements (i.e., the longitude of the ascending node Ω, the argument of periastron ω, and the mean anomaly M at a reference time) were fixed to selected values, Ω = Ω_b = 0, ω = ω_b = 90°, and M = M_b + 180°; and the orbital period of the hypothetical perturber P_c was searched from 1 day to 10P_b with a step of 0.007 days. We expect that the first setting would provide a most conservative estimate of the upper mass limit of a possible perturber (Bean 2009; Fukui et al. 2011; Hoyer et al. 2011, 2012; Cortés-Zuleta et al. 2020).

In addition, the RVs of the host star induced by a hypothetical perturber could place constraints on the perturber mass. If the planets are on noninteracting Keplerian orbits, the RVs of the host star are the sum of the RVs caused by each planetary component’s Keplerian motion (Ford 2006). Therefore, the residuals of the RVs of HAT-P-30 and WASP-35 after removing the contributions from both known planets could well present the RVs induced by additional bodies. Placing good constraints on the mass of the additional body through fitting RV curves requires a good coverage in its orbit phase and RV measurements with a high signal-to-noise ratio, however, which is not the cases for the hypothetical perturbers in HAT-P-30 and WASP-35. Therefore, we used the rms of the residuals of the HAT-P-30 and WASP-35 RVs instead of the residuals to statistically constrain the mass of the hypothetical perturber. The amplitude of RV curves K caused by a planet on its host star is scaled with the following formula:

\[
\left( \frac{M_p \sin i_p}{M_\odot} \right) = 11.19 \left( \frac{K}{\text{m/s}} \right) \sqrt{1 - e^2} \left( \frac{M_\star}{M_\odot} \right)^{2/3} \left( \frac{P_{\text{orb}}}{1 \text{yr}} \right)^{1/3}
\]

where M_p, M_\star, and P_{\text{orb}} are the mass of the planet, the mass of the host star, and the orbital period of the planet. For the orbital eccentricities (i.e., e_c ≤ 0.2) of the perturbers we assumed, the rms of the RV curves statistically equals about \sqrt{2}/2 times of the RV amplitude. We obtained the mass limits, that is, the yellow curves in Figures 10 and 11 of the hypothetical perturbers based on the rms of the HAT-P-30 and WASP-35 RV residuals derived in Section 4.

Some constraints could also be placed on the perturber mass by the requirement of long-term stability of the perturbing orbits. For this purpose, we computed the Mean Exponential Growth factor of Nearby Orbits (MEGNO; Cincotta & Simó 2000;
Goździewski et al. 2001; Cincotta et al. 2003), which was originally developed to study the global dynamics of nonaxisymmetric galactic potentials, by employing REBOUND to perform direct orbital integrations, and we calculated the associated variational equations of motion over a grid of initial values of orbital parameters (Rein & Liu 2012; Rein & Tamayo 2015, 2016). In addition to the orbital period of the perturber, here we also adjusted its mass; we integrated each initial grid point for 500 yr (i.e., \( \sim 10^9 \) of orbital periods of transiting exoplanets), which will highlight the location of weak chaotic high-order mean-motion resonances. MEGNO is often used to quantitatively measure the degree of stochastic behavior of a nonlinear dynamical system and thus detect the chaotic resonances (Goździewski et al. 2001; Hinse et al. 2010). In addition to integrating the Newtonian equations of motion, the associated variational equations of motion are calculated simultaneously to obtain the MEGNO at each integration time step. Following Cincotta & Simó (2000) and Cincotta et al. (2003), the MEGNO index is defined as

\[
Y(t) = \frac{2}{T} \int_0^T \frac{||\dot{\delta}(t)||}{||\delta(t)||} dt,
\]

where \( \delta/\dot{\delta} \) is the relative change in the variational vector \( \delta \). The time-averaged or mean \( Y(t) \) is parameterized with

\[
\langle Y(t) \rangle = \frac{1}{T} \int_0^T Y(t) dt.
\]

For the results in Figures 10 and 11, the time-averaged MEGNO index is always used to quantitatively differentiate between quasiperiodic and chaotic dynamics. The regular orbits that evolve quasiperiodically in time \( \langle Y \rangle \) will asymptotically approach 2.0 for \( \lim_{t \to \infty} \), while for chaotic orbits, it grows proportionally to the Lyapunov exponent \( \Lambda \) as \( (\Lambda/2)T \). For a chaotic orbital evolution, \( \langle Y \rangle \) significantly deviates from 2.0, with orbital parameters exhibiting erratic temporal evolutions. Importantly, MEGNO is unable to prove whether a dynamical system is evolving quasiperiodically. This indicates that a given system cannot be proven to be stable or bounded for all times. For a given initial condition, once MEGNO detected chaotic behaviors, however, there is no doubt about its erratic nature in the future (Hinse et al. 2010).

In the following parts, we present the results of each system for which we have calculated the rms scatter of TTVs (TTVRMS) in a series of orbital periods of a perturbing planet. In each of the three cases, we found the common instability regions located in the proximity of the transiting planet with MEGNO color-coded in yellow (corresponding to \( \langle Y \rangle > 3.5 \)).

5.2.1. WASP-35b

Through overplotting the TTVRMS for a certain value, we found similar results to those of Agol et al. (2005) and Holman & Murray (2005), which suggests that the TTVs are relatively
more sensitive to orbital architectures involving MMRs. Furthermore, the TTV\textsubscript{RMS} of Cases b and c are more complex, for which high-order MMRs (e.g., $P_c/P_b \approx 4:1, 5:1$, etc.) generate large TTV signals and thus the corresponding upper mass limit dramatically drops compared with that of Case a; interestingly, a perturbing body of only $\sim 0.606 \, M_{\oplus}$ located near 1:1 MMRs in Case b could well reproduce the measured TTV\textsubscript{RMS} of WASP-35 b. While overplotting the rms of RV residuals (RVR\textsubscript{RMS}) for a certain value without the component due to WASP-35b, we found that the constraints due to RVR\textsubscript{RMS} on the upper mass limit are more stringent than those due to TTV\textsubscript{RMS}. For HAT-P-30, a similar conclusion has been drawn. As shown in Figure 10, we found that a coplanar perturbing body of mass (upper limit) around $0.606 - 1 \, M_{\oplus}$ initially with a circular orbit will cause an rms of 37 s when located in the $P_c/P_b = 1:3$ and 2:1. For the perturber on more inclined and/or initially slightly eccentric orbits, the high-order resonances (i.e., $P_c/P_b = 4:1, 5:1$ and 6:1 for Case b and even $P_c/P_b = 7:1$ and 8:1 for Case c) appear beneath the upper mass limit of RVR\textsubscript{RMS} in addition to the co-orbital configuration (i.e., 1:1 MMR).

5.2.2. HAT-P-30b

For the HAT-P-30 system, the measured TTV\textsubscript{RMS} was 158s. Additional bodies in Case a with an upper mass limit as low as $\sim 0.356 \, M_{\oplus}$ at the 1:2 and $\sim 1.423 \, M_{\oplus}$ at the 2:1 MMR could cause the observed TTV scatter. Hypothetical planets of 0.712 $M_{\oplus}$, 1.423 $M_{\oplus}$, 2.135 $M_{\oplus}$, 2.846 $M_{\oplus}$, and 3.558 $M_{\oplus}$ could well produce the observed TTV\textsubscript{RMS} located near 1:1, 2:1, 3:1, 4:1, and 5:1 exterior MMRs in Case b, respectively; and 2.135 $M_{\oplus}$, 2.491 $M_{\oplus}$, 2.846 $M_{\oplus}$, 3.558 $M_{\oplus}$, 4.270 $M_{\oplus}$, and 4.981 $M_{\oplus}$ near 3:1, 7:2, 4:1, 5:1, 6:1 and 7:1 exterior MMRs in Case c, respectively. In Cases b and c, the structure of the upper mass limits is quite complex from 2:1 to 3:1 exterior MMRs; see Figure 11 for further details.

5.3. Prospect of the Atmospheric Properties

Transiting exoplanets offer the possibility of characterizing the planetary atmosphere using observations at different orbital phases. These observations include the transmission spectrum during the transit (Charbonneau et al. 2002; Deming et al. 2013), the emission spectrum at secondary eclipse (Showman & Guillot 2002; Cho et al. 2003), and the phase curve throughout the orbit (Cowan & Agol 2008; Mallama 2009). The transmission spectrum probes the wavelength-dependent extinction due to the planetary atmosphere at its day-night terminator region by using photometric or spectroscopic observations (Seager & Sasselov 2000; Brown 2001; Ehrenreich et al. 2006). Hot Jupiters have relatively low densities, a large radius, and hot equilibrium temperatures, which will lead to large atmospheric scale heights, namely, the planets have significant atmospheric structures and thus are ideal targets for atmospheric studies. Both WASP-35b and HAT-P-30b are hot Jupiters. Therefore, based on the new system parameters, we attempt to predict the atmospheric properties of WASP-35b and HAT-P-30b.

For the transmission spectra, the amplitude of the transmission signals in a cloud-free atmosphere is proportional to the atmospheric scale height $H$, 

$$H = \frac{k_B T_{eq}}{\mu m_b}$$

where $k_B$ is Boltzmann’s constant, $T_{eq}$ is the temperature of the planet, $\mu m_b$ is the mean molecular mass, and $g_b$ is the surface gravity of the planet (Seager & Sasselov 2000; Brown 2001; Ehrenreich et al. 2006). According to de Wit & Seager (2013), hot Jupiters should have an H/He-dominated atmosphere, and the mean molecular mass is approximately 2.3 amu, so the atmospheric scale height for WASP-35b is about to 550 km, and it is 750 km for HAT-P-30b. So, both WASP-35b and HAT-P-30b should have distinct atmospheres. The spectral features in the transmission spectra could have an amplitude of 5-10$H$, which is suitable for studying the properties of their atmospheres (Sing et al. 2013).

For hot Jupiters, the spectral features in the optical transmission spectrum are expected to have Na, K, TiO and VO. According to the dichotomy of highly irradiated, close-in giant planets proposed by Fortney et al. (2008) and the newly derived system parameters, both WASP-35b and HAT-P-30b are at the boundary between the pL and pM classes. Therefore, we could expect that alkali metal absorption lines as well as TiO and VO likely appear in their high-precision transmission spectra. Madhusudhan et al. (2011) found that the abundances of TiO and VO were strongly affected by the C/O ratio. In general, the upper atmospheric absorptions in the optical may lead to thermal inversions, such as the strong optical absorption of TiO and VO (Fortney et al. 2008) as well as the absorption of alkali metal at high C/O ratios (Mollière et al. 2015). H$_2$O, CO, CH$_4$, CO$_2$ and H$_2$ are the main chemical and spectroscopic species that dominate the C/O ratio in the hot-Jupiter atmosphere, and the series of reactions can be summarized as

$$CO + 3H_2 \rightleftharpoons CH_4 + H_2O.$$

WASP-35b and HAT-P-30b have relatively high temperatures ($T_{eq} > 1400K$). A simple way to estimate the C/O ratio of the atmosphere is observing the transmission spectra of H$_2$O and CH$_4$ in the near- to mid-infrared. Both of the systems have zero eccentricities, which means that the planet remains at a constant distance from its host star, which avoids an orbit-induced thermal response of the planetary atmospheric temperature and hence chemistry (Visscher 2012). Clouds and haze are common in the planetary atmospheres and strongly impact observations of transmission spectra (Sing et al. 2013; Spyrotos et al. 2021). Uniform global clouds can obscure the absorption features of prominent chemical species, patchy clouds can mimic high mean molecular weight atmospheres (Fortney 2005; Line & Parmentier 2016), and haze can produce a significant slope in the optical passband in transmission spectra (Lecavelier Des Etangs et al. 2008). According to the theory of Lecavelier Des Etangs et al. (2008), assuming a power law for the cross section with a wavelength in the form of $\sigma = \sigma_0 (\lambda/\lambda_0)^{\gamma}$, the slope induced by Rayleigh scattering is given by

$$\frac{\mu g_b}{k_B} \frac{dR_p}{d \ln \lambda} = \alpha T_{eq}.$$
cloud atmosphere, the observable atmosphere would be smaller than a pure gaseous atmosphere, so that the amplitude of the absorption features would be small or the transmission spectra would flatten and be featureless.

6. Conclusions

Based on the new photometric data observed by TESS, the YO-1 m, and published photometric and RV data from the CDS database and ETD website, we have carried out a reanalysis for the transiting exoplanetary systems WASP-35 and HAT-P-30 by using the MCMC technique. The system parameters and ephemerides of the WASP-35 and HAT-P-30 systems have been refined. The refined system parameters are consistent with previous results with higher precisions. For each system, the uncertainty of the orbital period we obtained is one order of magnitude lower than the previous value. Moreover, we find that the transits of HAT-P-30b show possible timing variation that cannot be explained with a decaying orbit due to tidal dissipation and the Rømer effect, while both apsidal precession and an additional perturbing body could reproduce the signal.

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