ExoClock Project. III. 450 New Exoplanet Ephemerides from Ground and Space Observations

Journal Item

The Astrophysical Journal Supplement Series, 265:4 (20pp), 2023 March https://doi.org/10.3847/1538-4365/ac9da4

ExoClock Project. III. 450 New Exoplanet Ephemerides from Ground and Space Observations

A. Kokori[1], A. Tsiaras[1,2], B. Edwards[1,3], A. Jones[4,5], G. Pantelidou[6], G. Tinetti[1], L. Bewersdorff[4], A. Iliadou[6], Y. Jongen[4,7], G. Lekkas[8], A. Nastasi[9,10], E. Poultourtzidis[6], C. Sidiropoulos[8], F. Walter[4,11,12], A. Wünsche[13], R. Abraham[4,14], V. K. Agnihotri[4], R. Albanesi[4,15], E. Arce-Mansego[4,16], D. Arnot[17], M. Audejean[4], C. Aumasson[13], M. Bachschmidt[4], G. Baj[4], P. R. Barroy[4,18,19], A. A. Belinski[20], D. Bennett[4,5,21], P. Benni[4], K. Bernacki[22], L. Betti[23,24], A. Biagini[9,24,25], P. Bosch[26], P. Brandebourg[4], L. Brát[12], M. Bretton[13], S. M. Brincat[4,27], S. Brouillard[4,28], A. Bruzas[17], A. Bruzzone[4,29], R. A. Buckland[5,17,30], M. Caló[4], F. Campos[4], A. Carreño[4], J. A. Carrion Rodrigo[4], R. Casali[4], G. Casalnuovo[4], M. Cataneo[31,32], C.-M. Chang[33], L. Changeat[4], V. Chowdhury[4], R. Ciantini[23,24], M. Cilluffo[4,31], J.-F. Coliac[4], G. Conzo[4,34], M. Correa[4,35,36], G. Coulon[4], N. Crouzet[37,38,99], M. V. Crow[4,5,30], I. A. Curtis[4], D. Daniel[4], B. Dauchet[4], S. Dawes[4,5,30], M. Deldem[4], D. Deligeorgopoulos[4,39], G. Dransfield[40], R. Dymock[4,5], T. Eenmäe[41], N. Esseiva[4], P. Evans[4,42], C. Falco[9], R. G. Farfán[4], E. Fernández-Lajús[43,44], S. Ferratfiat[13], S. L. Ferreira[4], A. Ferretti[4,29], J. Fiołka[22], M. Fowler[4,5,45], S. R. Futcher[4,5,46], D. Gabellini[4], T. Gainey[4], J. Gaitan[4], P. Gajdoš[47], A. García-Sánchez[4,48], J. Garlitz[4], C. Gillier[4,49], C. Gison[17], J. Gonzales[4], D. Gorshanov[50], F. Grau Horta[4], G. Grivas[6], P. Guerra[26], T. Guillot[51], C. A. Haswell[17], T. Haymes[4,5], V.-P. Hentunen[52], K. Hills[4,5,53], K. Hose[4], T. Humbert[4], F. Hurter[4,54], T. Hynek[55], M. Irzyk[4], J. Jacobsen[4], A. L. Jannetta[4], K. Johnson[4], P. Jóźwik-Wabik[22], A. E. Kaeouach[4], W. Kang[56,57], H. Kiiskinen[4,58], T. Kim[56,59], Ü. Kivila[4,60], B. Koch[4], U. Kolb[17], H. Kučáková[12,61], S.-P. Lai[33,62], D. Laloum[4,27], S. Lasota[22], L. A. Lewis[17], G.-I. Liakos[4], F. Libotte[4,35,36], F. Lomoz[12,63], C. Lopresti[4,64], R. Majewski[4], A. Malcher[22], M. Mallonn[65], M. Mannucci[4,66], A. Marchini[67], J.-M. Mari[4,68], A. Marino[4,69], G. Marino[4,70], J.-C. Mario[4], J.-B. Marquette[71], F. A. Martínez-Bravo[4], M. Mašek[12,72], P. Matassa[4], P. Michel[4], J. Michelet[4], M. Miller[4,5,27], E. Miny[4,73], D. Molina[4,74], T. Mollier[4], B. Monteleone[4], N. Montigiani[4,66], M. Morales-Aimar[4,27,75], F. Mortari[4], M. Morvan[1], L. V. Mugnai[10,76], G. Murawski[4], L. Naponiello[23,24], J.-L. Naudin[4], R. Naves[4], D. Néel[4], R. Neito[41], S. Neveu[4,19,77], A. Noschese[4], Y. Öğmen[4], O. Ohshima[4], Z. Orbanic[4], E. P. Pace[23,24], C. Pantacchini[4], N. I. Paschalis[4], C. Pereira[4,78], I. Peretto[4,79], V. Perroud[4], M. Phillips[4,5,80], P. Pintr[81], J.-B. Pioppa[4,27,68], J. Plazas[4], A. J. Poelarends[82], A. Popowicz[22], J. Purcell[4], N. Quinn[4,5], M. Raetz[4,83,84], D. Rees[85], F. Regembal[4], M. Rocchetto[1], P.-F. Rocci[19,27,77], M. Rockenbauer[86], R. Roth[87], L. Rousselot[4,77], X. Rubia[4,35], N. Ruocco[4,88], E. Russo[4,31], M. Salisbury[4,5], F. Salvaggio[4,70], A. Santos[4], J. Savage[4,5], F. Scaggiante[89], D. Sedita[4], S. Shadick[90], A. F. Silva[4,16], N. Sioulas[4], V. Školník[4,12], M. Smith[4], M. Smolka[12], A. Solmaz[91,92], N. Stanbury[4], D. Stouraitis[4], T.-G. Tan[4], M. Theusner[4], G. Thurston[4,5], F. P. Tifner[4], A. Tomacelli[4,69], A. Tomatis[4], J. Trnka[12,93,100], M. Tylšar[94], P. Valeau[4], J.-P. Vignes[4], A. Villa[4,95], A. Vives Sureda[4], K. Vora[4], M. Vrašťák[12], D. Walliang[4,96], B. Wenzel[83,86], D. E. Wright[4,5,97], R. Zambelli[4], M. Zhang[98], and M. Zíbar[12]

[1] University College London, Gower Street, London, WC1E 6BT, UK; anastasia.kokori.19@ucl.ac.uk
[2] INAF—Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, I-50125 Firenze, Italy
[3] AIM, CEA, CNRS, Université Paris-Saclay, Université de Paris, F-91191 Gif-sur-Yvette, France
[4] Amateur Astronomer[101]
[5] British Astronomical Association, Burlington House, Piccadilly, Mayfair, London, W1J 0DU, UK
[6] Department of Physics, Aristotle University of Thessaloniki, University Campus, Thessaloniki, 54124, Greece
[7] Observatoire de Vaison-La-Romaine, Départementale 51, près du Centre Equestre au Palis, F-84110 Vaison-La-Romaine, France
[8] Department of Physics, University of Ioannina, Ioannina, 45110, Greece
[9] GAL Hassin—Centro Internazionale per le Scienze Astronomiche, Via della Fontana Mitri, F-90010 Isnello, Palermo, Italy
[10] INAF—Osservatorio Astronomico di Palermo, Piazza del Parlamento, 1, I-90134 Palermo, Italy
[11] Štefánik Observatory, Strahovská 205, 118 00 Praha 1, Czech Republic
[12] Czech Astronomical Society, Fričova 298, 251 65 Ondřejov, Czech Republic
[13] Observatoire des Baronnies Provençales, Route de Nyons, F-05150 Moydans, France
[14] East Sussex Astronomical Society, 35 Mount Street, Battle, East Sussex, TN33 0EG, UK
[15] ARA Associazione Romana Astrofili, Via Vaschetta, 1 I-02030 Frasso Sabino (RI), Italy
[16] Asociación Valenciana de Astronomía, C/ Profesor Blasco, 16 Bajo, Valencia, Spain
[17] School of Physical Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK
[18] Département de Physique, Université de Picardie Jules Verne, 33 rue St Leu, F-80000 Amiens, France
[19] Observatoire Jean-Marc Salomon—Planète Sciences, 73, rue des Roches, 77760 Buthiers, France
[20] Sternberg Astronomical Institute, M.V. Lomonosov Moscow State University, 13, Universitetskij pr., 119234, Moscow, Russia
[21] Bristol Astronomical Society, Bristol, UK
[22] Department of Electronics, Electrical Engineering and Microelectronics, Silesian University of Technology, Akademicka 16, 44-100 Gliwice, Poland
[23] Dipartimento di Fisica e Astronomia, Università degli Studi di Firenze, Largo E. Fermi 2, I-50125 Firenze, Italy
[24] Osservatorio Polifunzionale del Chianti, Strada Provinciale, Castellina in Chianti, I-50021 Barberino Val D'elsa (FI), Italy
[25] University of Palermo, Piazza Marina, 61, I-90133 Palermo (PA), Italy
[26] Observatori Astronòmic Albanyà, Camí de Bassegoda S/N, Albanyà E-17733, Girona, Spain
[27] AAVSO, 49 Bay State Road, Cambridge, MA 02138, USA
[28] Association AstroQueyras, 05350 Saint-Véran, France
[29] Gruppo Astrofili Frentani, via Aterno 16, I-66034 Lanciano (CH), Italy
[30] Crayford Manor House Astronomical Society Dartford, Parsonage Lane Pavilion, Parsonage Lane, Sutton-at-Hone, Dartford, Kent, DA4 9HD, UK
[31] Associazione Cernuschese Astrofili, Via della Martesana, 75, I-20063 Cernusco sul Naviglio (MI), Italy
[32] Argerlander-Institut für Astronomie, Auf dem Hügel 71, D-53121 Bonn, Germany
[33] Department of Physics, National Tsing Hua University, 101, Section 2, Kuang-Fu Road, Hsinchu 300044, Taiwan
[34] Gruppo Astrofili Palidoro, Via Pierleone Ghezzi, 75, I-00050 Palidoro (RM), Italy
[35] Agrupació Astronomica Sabadell, Carrer Prat de la Riba, 116, E-08206 Sabadell, Barcelona, Spain
[36] Groupe Européen d'Observations Stellaires (GEOS), 23 Parc de Levesville, 28300 Bailleau l'Evêque, France

[37] Leiden Observatory, Leiden University, Postbus 9513, 2300 RA Leiden, The Netherlands
[38] European Space Agency (ESA), European Space Research and Technology Centre (ESTEC), Keplerlaan 1, 2201 AZ Noordwijk, The Netherlands
[39] Artemis Astronomical Group of Evrytania, Aiolou 1, Karpenisi, Evrytania, 36100, Greece
[40] School of Physics & Astronomy, University of Birmingham, Birmingham, B15 2TT, UK
[41] Tartu Observatory, Observatooriumi 1, Tõravere, 61602 Tartu maakond, Estonia
[42] El Sauce Observatory, Coquimbo Province, Chile
[43] Facultad de Ciencias Astronómicas y Geofísicas—Universidad Nacional de La Plata, Paseo del Bosque s/n, 1900 La Plata, Buenos Aires, Argentina
[44] Instituto de Astrofísica de La Plata (CCT La Plata—CONICET/UNLP), 1900 La Plata, Argentina
[45] South Wonston Exoplanet Factory, South Wonston, UK
[46] Hampshire Astronomical Group, Hinton Manor Lane, Clanfield, Waterlooville, PO8 0QR, UK
[47] Institute of Physics, Faculty of Science, Pavol Jozef Šafárik University, Park Angelinum 9, 040 01 Košice, Slovakia
[48] Agrupación Astronómica de Madrid, Madrid, Spain
[49] Club d'Astronomie de Lyon Ampère, Place de la Nation, F-69120 Vaulx-en-Velin, France
[50] Pulkovo Observatory, Pulkovskoye Shosse, 65, St Petersburg, 196140, Russia
[51] Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Lagrange Laboratory, Nice, France
[52] Taurus Hill Observatory, 79480 Varkaus, Finland
[53] The Royal Astronomical Society, Burlington House, Piccadilly, London, W1J 0DU, UK
[54] Les Pléiades, Société d'astronomie, CH 2610 St Imier, Switzerland
[55] Darksky Beskydy, Komenského 654/26, Ostrava-Poruba, Czech Republic
[56] National Youth Space Center, Goheung, Jeollanam-do, 59567, Republic of Korea
[57] Spacebeam Inc., Cheongju-si, Chungcheongbuk-do, 28165, Republic of Korea
[58] Jyväskylän Sirius ry, Jyväskylä, Finland
[59] Department of Astronomy and Space Science, Chungbuk National University, Cheongju-City, 28644, Republic of Korea
[60] Science Centre AHHAA, Sadama 1, Tartu, 51004, Estonia
[61] Silesian University Opava, Opava, 74601, Czech Republic
[62] Institute of Astronomy, National Tsing Hua University, 101, Section 2, Kuang-Fu Road, Hsinchu 300044, Taiwan
[63] Sedlčany Observatory, Ke Hvězdárně, 264 01 Sedlčany, Czech Republic
[64] GAD—Gruppo Astronomia Digitale, Italy
[65] Leibniz Institute for Astrophysics Potsdam (AIP), An der Sternwarte 16, D-14482 Potsdam, Germany
[66] Associazione Astrofili Fiorentini, Firenze, Italy
[67] University of Siena—Dept. of Physical Science, Earth and Environment—Astronomical Observatory, Via Roma 56, I-53100 Siena, Italy
[68] Groupement d'Astronomie Populaire de la Région d'Antibes, 2, rue Marcel-Paul, F-06160 Juan-Les-Pins, France
[69] Unione Astrofili Napoletani, Salita Moiariello, 16, CAP I-80131 Napoli (NA), Italy
[70] Gruppo Astrofili Catanesi, Via Milo, 28, I-95125 Catania (CT), Italy
[71] Laboratoire d'astrophysique de Bordeaux, Univ. Bordeaux, CNRS, B18N, allée Geoffroy Saint-Hilaire, F-33615 Pessac, France
[72] FZU—Institute of Physics of the Czech Academy of Sciences, Na Slovance 1999/2, Prague 182 21, Czech Republic
[73] Blois Sologne Astronomie, rue de la Bondonnière, F-41250 Fontaines-en-Sologne, France
[74] Asociación Astronómica Astro Henares, Centro de Recursos Asociativos El Cerro, C/ Manuel Azaña, s/n 28823 Coslada, Madrid, Spain
[75] Observadores de Supernovas, Spain
[76] Department of Physics, La Sapienza Università di Roma, Piazzale Aldo Moro 2, I-00185 Roma, Italy
[77] Société Astronomique de France, 3, rue Beethoven, F-75016 Paris, France
[78] Instituto de Astrofísica e Ciências do Espaço, Departamento de Física, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, PT1749-016 Lisboa, Portugal
[79] MarSEC (Marana Space Explorer Center), c/a Pasquali, Marana di Crespadoro VI, I-36070, Italy
[80] Astronomical Society of Edinburgh, Edinburgh, UK
[81] Institute of Plasma Physics AS CR, v.v.i., TOPTEC Centre, Sobotecka 1660, 511 01 Turnov, Czech Republic
[82] Wheaton College Observatory, Wheaton College, 501 College Avenue, Wheaton, IL 60187-5501, USA
[83] Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne e.V., Germany
[84] Volkssternwarte Kirchheim e.V., Kirchheimer Hauptstrasse 9, D-99334 Wachsenburg OT, Kirchheim, Germany
[85] The Paradigm Factor Ltd., Bramble Well, Rye Road, Rye Foreign, Rye, East Sussex, TN31 7SX, UK
[86] University of Vienna, Universitätsring 1, A-1010 Vienna, Austria
[87] TURM Observatory, Department of Physics, Technische Universität Darmstadt, D-64289 Darmstadt, Germany
[88] AstroCampania, Campania, Italy
[89] Gruppo Astrofili Salese, Santa Maria di Sala, Italy
[90] Department of Physics and Engineering Physics, University of Saskatchewan, Saskatoon, SK, S7N 5E2, Canada
[91] Çağ University, Space Observation and Research Center, Mersin, 33800, Turkey
[92] Çukurova University, UZAYMER, Adana, 01330, Turkey
[93] Observatory Slaný, Nosačická 1713, 274 01 Slaný, Czech Republic
[94] Hvězdárna Prostějov, Kolářovy sady 3348, 796 01 Prostějov, Czech Republic
[95] Associazione Astrofili Alta Valdera, Pisa, Italy
[96] Société Lorraine d'Astronomie, BP 70239, F-54506 Vandœuvre Les Nancy, France
[97] Basingstoke Astronomical Society, Cliddesden Primary School, Cliddesden, Basingstoke, Hampshire, RG25 2QU, UK
[98] Department of Astronomy, California Institute of Technology, Pasadena, CA 91125, USA
Received 2022 July 11; revised 2022 September 20; accepted 2022 September 29; published 2023 February 14

[99] ESA Research Fellow (2018–2021).
[100] Deceased 2017, permission obtained from the Observatory Slany management.
[101] A list of associated private observatories that contributed to this work can be found in Appendix A.

Abstract

The ExoClock project has been created to increase the efficiency of the Ariel mission. It will achieve this by continuously monitoring and updating the ephemerides of Ariel candidates, in order to produce a consistent catalog of reliable and precise ephemerides. This work presents a homogenous catalog of updated ephemerides for 450 planets, generated by the integration of ∼18,000 data points from multiple sources. These sources include observations from ground-based telescopes (the ExoClock network and the Exoplanet Transit Database), midtime values from the literature, and light curves from space telescopes (Kepler, K2, and TESS). With all the above, we manage to collect observations for half of the postdiscovery years (median), with data that have a median uncertainty less than 1 minute. In comparison with the literature, the ephemerides generated by the project are more precise and less biased. More than 40% of the initial literature ephemerides had to be updated to reach the goals of the project, as they were either of low precision or drifting. Moreover, the integrated approach of the project enables both the monitoring of the majority of the Ariel candidates (95%), and also the identification of missing data. These results highlight the need for continuous monitoring to increase the observing coverage of the candidate planets. Finally, the extended observing coverage of planets allows us to detect trends (transit-timing variations) for a sample of 19 planets. All the products, data, and codes used in this work are open and accessible to the wider scientific community.

Unified Astronomy Thesaurus concepts: Ephemerides (464); Transits (1711); Amateur astronomers (34); Photometry (1234); Open source software (1866)

Supporting material: machine-readable tables

1. Introduction

The number of exoplanets discovered already exceeds 5000 and continues to increase daily. The characterization of exoplanets will be the main goal of future space missions. The Ariel mission aims to observe the atmospheres of 1000 planets in 2029, in order to investigate their nature (Tinetti et al. 2018). Ariel will observe thousands of transits, and to increase the mission efficiency, it is necessary to have precise ephemerides. Proper planning is important to avoid wasting the precious observing time of Ariel and other future space missions.

For various reasons, the accuracy of predicting transit times is impeded. For example, the uncertainties of the initial ephemerides causes degeneracies over time in the precision of the predicted transit time (e.g., Mallonn et al. 2019b). The insufficient number of available data for each planet is another factor that generates biases in calculating the ephemerides (e.g., Benneke et al. 2017; Mallonn et al. 2019b).

To overcome the above problems and create a complete catalog of precise ephemerides for a large number of planets, it is essential to use all the available data resources. These resources consist of data from the literature, data obtained by telescopes from the ground, and finally data from space telescopes. The ExoClock project (Kokori et al. 2021, 2022) is an open, integrated platform, with the aim of continuously monitoring the ephemerides of the Ariel candidate targets (Edwards & Tinetti 2022). The organization of the project is thoroughly described in Kokori et al. (2021), and the first large-scale catalog of updated ephemerides for 180 planets was produced in Kokori et al. (2022), by combining observations from ground-based telescopes and the literature.

The benefits of using small, ground-based telescopes to observe transiting exoplanets have previously been emphasized (e.g., Beck et al. 2019; Mallonn et al. 2019b; Zellem et al. 2020; Edwards et al. 2021a), and their use in large-scale studies has already been proven in Kokori et al. (2022). While small telescopes are efficient, maximum effectiveness is achieved by utilizing all of the available resources, including other ground-based networks, data from the literature, and also data from space resources. Space telescopes are effective in observing challenging transits that are not easily accessible from ground-based telescopes. Moreover, TESS (Ricker et al. 2014) has been scanning the sky since 2019, and will continue to provide light curves for many known exoplanets, which can be used for updates to the ephemerides (Ivshina & Winn 2022). Therefore, to produce a complete catalog of ephemerides for all planets, it is important to use data from both space- and ground-based telescopes.

In this study, we integrate data from the ExoClock network, midtime points from the literature, data from the Exoplanet Transit Database (ETD; Poddaný et al. 2010), and data from space telescopes (Kepler—Koch et al. 2010a; K2—Howell et al. 2014; and TESS—Ricker et al. 2014). The integration of ∼18,000 midtime points, in total, allows the generation of a complete analysis of ephemerides for 450 planets. There are several benefits of this integrated analysis: biases are minimized, better precision is achieved, and long-term phenomena can be identified for each planet, which may be indicative of trends (e.g., transit-timing variations, or TTVs). The integrated design and approach of the ExoClock project highlights where there are gaps in the available data. The ExoClock network of ground-based telescopes can then be flexibly directed to make observations to address such gaps and extend the coverage.

In all aspects of the research cycle, the ExoClock project operates with an Open Science Framework (European Commission 2016; Dai et al. 2018). Open science advances the progress of scientific research by encouraging collaborations and reproducibility. During all stages of the scientific process, the project follows open science practices; the data, tools, and codes used for the analysis are all open and accessible to anyone. All data used in this study are open and publicly available (e.g., the data obtained from the ExoClock network and the data from space telescopes). Additionally, open science means the cocreation of scientific research through collaborations between various scientific communities as well as citizen involvement (European Commission 2016). In this respect, the project is open to contributions from any interested person or community. The collaborative perspective helps to ensure the most effective use of resources. Such collaborations are important to avoid instances of overlapping and wastes of observing time—and, to a further extent, they also foster innovation in science.

2. Data

In this study, we integrated light curves from the ExoClock network, the ETD, and the MAST Archive (for the Kepler, K2, and TESS space missions), and midtransit times from the literature, to update the ephemerides of 450 exoplanets. All the light curves were acquired before the end of 2021, and the literature midtransit times were published by the end of 2021. We analyzed all the light curves, regardless of their source, using the stellar and planetary parameters included in the Exoplanet Characterization Catalog (ECC), a dedicated catalog prepared and maintained within the ExoClock project (Kokori et al. 2021), and the open-source Python package PyLightcurve (Tsiaras et al. 2016). For every light curve, PyLightcurve performs the following operations:

1. calculates the limb-darkening coefficients (LDCs) using the ExoTETHyS package (depending on the filter used for the observation; Morello et al. 2020);
2. converts the time formats to barycentric Julian date (BJD_{TDB});
3. finds the maximum likelihood model for the data (an exposure-integrated transit model together with a trend model—linear with airmass, linear with time, or quadratic), using the Nelder–Mead minimization algorithm included in the SciPy package (Virtanen et al. 2020);
4. removes outliers that deviate from the maximum likelihood model by more than 3 times the standard deviation (STD) of the normalized residuals;
5. scales the uncertainties by the rms of the normalized residuals, to take into account any extra scatter; and
6. finally, performs a Markov Chain Monte Carlo optimization process using the emcee package (Foreman-Mackey et al. 2013).

After this analysis, the quality of each light curve was evaluated individually, with the light curves that fulfilled one or more of the criteria below being excluded:

1. the autocorrelation and Shapiro statistic indicate non-Gaussian normalized residuals at a 3σ level or more;
2. the transit signal-to-noise ratio ($S/N = Depth/\sigma_{Depth}$) is lower than 3;
3. the Rp/Rs differs by more than 3σ from the literature value (for the ExoClock and ETD observations) or the weighted average of the mission (for the space observations); and
4. the $O - C$ value is not in agreement (3σ) with the other observations obtained during the same observing period (∼a month).

The final list of 450 planets includes those planets for which we collected data points at three or more different epochs and for which we could determine an ephemeris of better or equal quality to the initial ephemeris. Table 1 summarizes the observations that were used to produce the ephemerides of the 450 planets in this work. In addition, Figures 1 and 2 show the distributions of the precision and the coverage of the transit midtime points that were used. As coverage, we define the percentage of years (since the first observation in the database) for which at least one observation exists. We need to note here that 99% of the observations used have transit midtime uncertainties lower than 10 minutes, and that the median coverage of all sources combined together is 50%, while individual sources do not reach more than 29%.

2.1. ExoClock—Summary and Quality of Data

Currently, the ExoClock network consists of 540 participants—80% of whom are amateur astronomers—and 450 telescopes, with sizes ranging between 6 and 40 inches, of which 80% are smaller than 17 inches. Figure 3 shows the distribution of the observations used in this work among the different telescope sizes. The large majority of the observations come from small- and medium-scale telescopes and amateur observers (73%), who are the key part of our network. The ExoClock network is organized in such a way as to maximize the coverage of the planets and to ensure the high quality and homogeneity of the results. To achieve this, we have defined a prioritization system, we provide a personal scheduler for each telescope, we support the observers with the data analysis (by means of educational material, user-friendly software, and regular meetings) and, finally, we perform the light curve modeling and evaluation (as described above) on the ExoClock website. For more details on the organization of the ExoClock project and the ExoClock network, we refer the interested reader to Kokori et al. (2021).

2.2. Data from Space Telescopes

For the first time in the ExoClock project, we have integrated light curves from space telescope observations. More specifically, we have included light curves from Kepler, K2, and TESS (from before the end of 2021). First, we downloaded the long-cadence light curves for the targets on the ExoClock target list. We then identified the transits inside those light curves and isolated them, including a baseline of one transit duration before and one after the event. Finally, the analysis and evaluation of each light curve were conducted as described above, using a quadratic detrending function. As some of the space-based light curves contained gaps, we only considered those light curves that were at least 80% complete, both in transit and out of transit—i.e., the total exposure time was more than 0.8 times the transit duration before, during, and after the transit.

From the analysis of the space-based light curves, and especially from the TESS light curves, it became clear that, for a nonnegligible number of planets, the parameters in the ECC (as derived from the literature) were producing transits of shorter or longer duration than the actual observations. For these planets, we let the reduced semimajor axis (a/R_s) vary, in order to account for the differences in the duration. The ECC has been updated accordingly, and the planets for which the a/R_s was adjusted have been marked. Table 6 includes the adjusted a/R_s values, which are marked with an asterisk. With the exception of Kepler-396 c, Kepler-854b, and TOI-201b, which did not have values for their inclinations (i) in the discovery papers, we decided to fix i to the literature values, as a/R_s and i are strongly correlated when they are both free parameters. In a future work, we plan to provide analysis for both parameters, but the scope of this work is to provide a set of parameters that will produce a reliable duration. Between a/R_s and i, we decided to leave a/R_s free, as it is more flexible for the determination of the duration (only small changes are required, and there is no upper limit, as with i).

Finally, we need to note here that the modeling of the Kepler light curves did not produce Gaussian residuals. This was most probably due to the fixed LDCs used. However, we decided not

Table 1
Summary of the Observations Used in This Work

	ExoClock	ETD	Kepler	K2	TESS	Literature	Total
Data Points	2911	184	5763	371	6499	2442	18170
Years	2007–2021	2001–2021	2009–2013	2014–2018	2018–2021	2004–2020	2001–2021
Planets	302	40	21	49	371	340	450
Median $\sigma_{T_{\rm mid}}$	1.3 minutes	1.7 minutes	0.5 minutes	0.6 minutes	1.1 minutes	0.6 minutes	0.8 minutes
Median Coverage	20%	18%	29%	17%	20%	17%	50%

Note. As coverage, we define the percentage of years (since the first observation in the database) for which at least one observation exists.

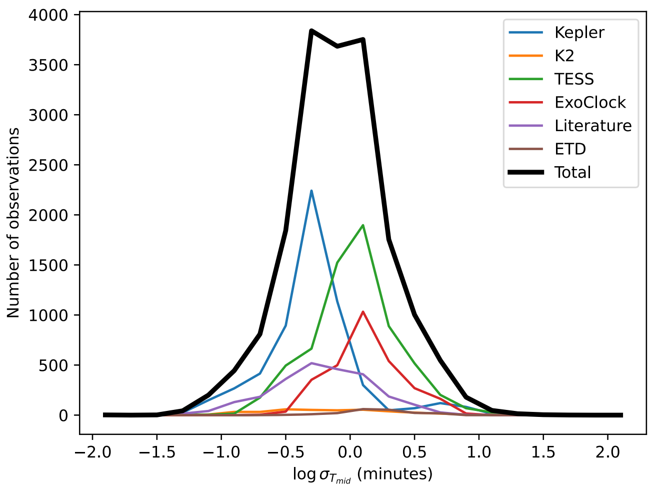

Figure 1. The distribution of the transit midtime uncertainties among the different sources.

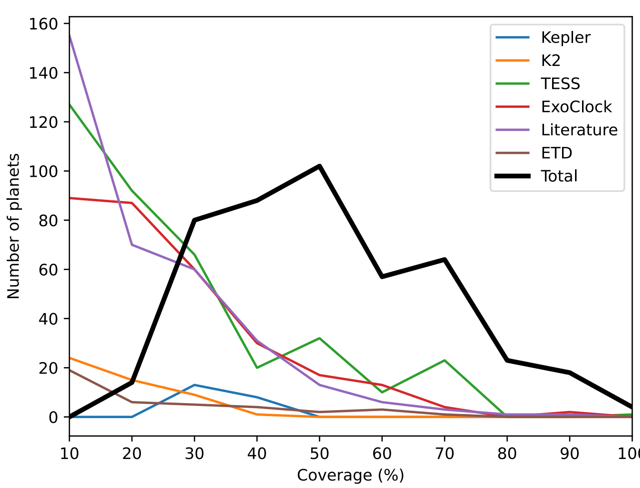

Figure 2. The distribution of the coverage among the different sources. As coverage, we define the percentage of years (since the first observation in the database) for which at least one observation exists.

to allow the LDCs to vary, in order to maintain a homogeneous analysis pattern for all observations.

2.3. ETD

The ETD (Poddaný et al. 2010), which has been run by the Czech Astronomical Society since 2009, is currently the largest database of transit follow-up observations, with more than 10,000 transit light curves for more than 350 exoplanetary systems. The collaboration between ExoClock and ETD started

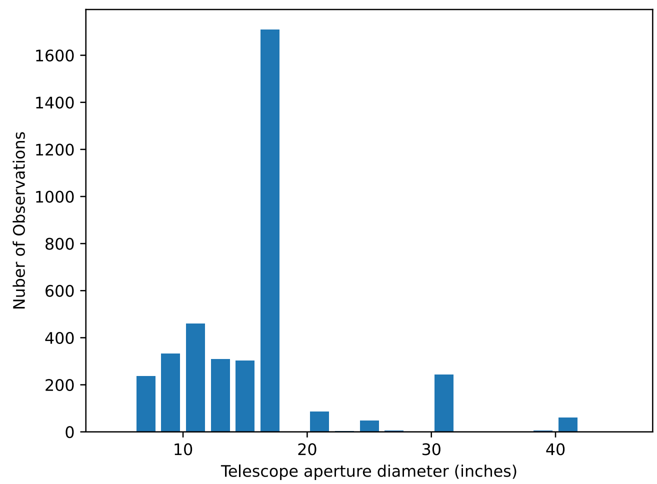

Figure 3. The number of observations received from the ExoClock network, as a function of the telescope size.

in 2020, and it is described in Kokori et al. (2022). In this study, we included 184 observations for 40 planets provided by the ETD network. In order to maintain homogeneity and reliability in our analysis, the ETD observations were analyzed and evaluated through the ExoClock website, using the same methodology and validation criteria as for the ExoClock network data. The collaboration with ETD is critical to avoiding duplications and wasting resources. We aim to continue our collaboration and gradually integrate more data from ETD in future publications. Such data can increase the coverage of certain planets in the period before ExoClock observations.

2.4. Midtime Points from the Literature

As we did not reanalyze the original light curves, we could not apply the same criteria as for the ExoClock, ETD, and space light curves. From the available data, we excluded midtransit time values that referred only to ephemerides, rather than to individual transits (with the exception of the discovery papers). We also excluded midtransit time values with uncertainties greater than 5 minutes, and midtransit time values that originated from Kepler, K2, TESS, and ETD, to avoid duplications.

3. Results

3.1. Ephemerides

Here we present the updated ephemerides for 450 of the 570 planets that are currently on the ExoClock target list. To calculate the new ephemerides, we used all the available data from all the sources described in the previous section. First, we

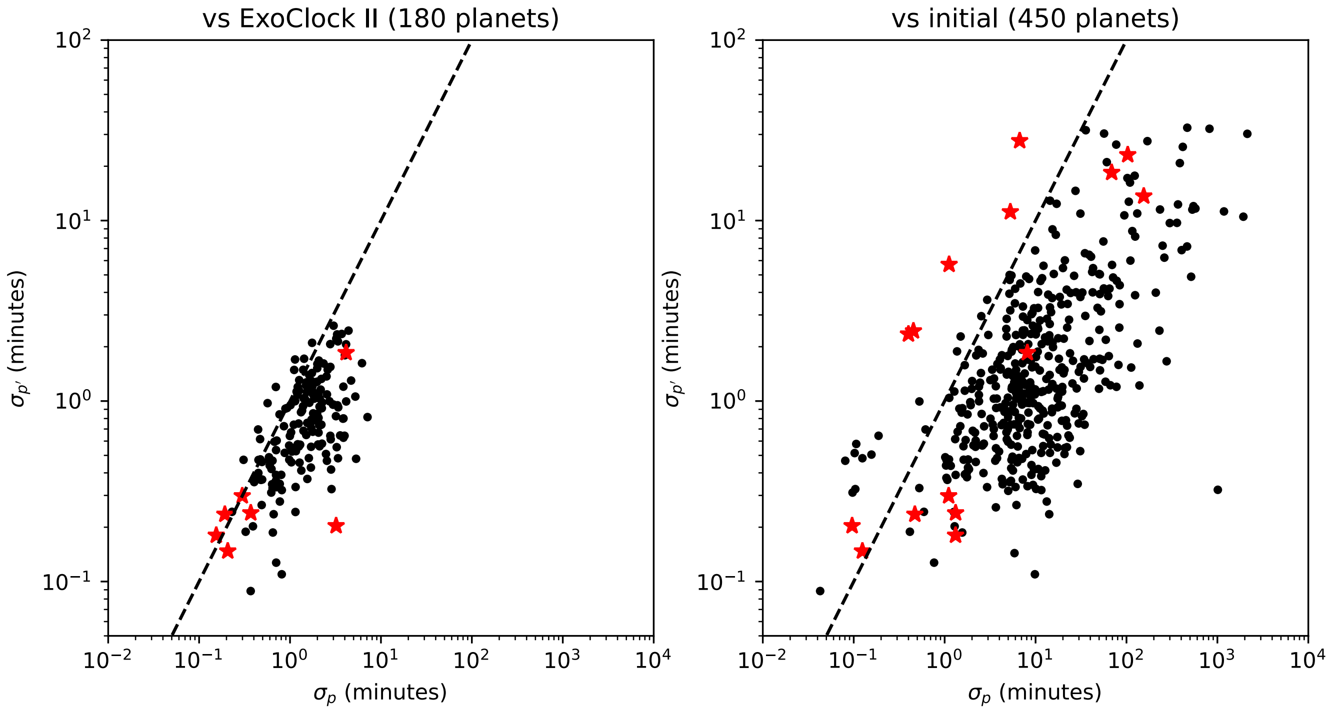

Figure 4. Comparisons of the 2029 prediction uncertainties between this work and ExoClock II (left) and the ephemerides used at the beginning of the project (right). The red stars indicate the planets for which TTV signals have been found. In both panels, the dashed lines show the $\sigma_{p'} = \sigma_p$ lines.

calculated an updated zero-epoch point, as the weighted average of the available epochs. We then fitted a line on the epoch versus midtransit time data, using the emcee package (Foreman-Mackey et al. 2013). After the first fit, we scaled up the uncertainties by the rms of the normalized residuals, to account for excess noise, and performed the fit again. Table 7 provides all the new ephemerides and references to the literature values that were used.

Figure 4 shows the uncertainties in the 2029 predictions, before and after the updates presented in this work (σ_p and $\sigma_{p'}$, respectively), while Table 2 lists five categories of the status of the ephemerides. "Significantly improved" refers to those ephemerides that were giving 2029 predictions with uncertainties greater than the target uncertainty of one-twelfth of the transit duration, D, ($\sigma_p > D/12$), as described in Kokori et al. (2021). The term "drifting" refers to the ephemerides that were giving 2029 predictions that were drifting more than the target uncertainty ($|p - p'| > D/12$). Of the remaining ephemerides, the term "improved" refers to those ephemerides for which the 2029 prediction uncertainties have been improved by more than 1 minute ($\sigma_{p'} < \sigma_p - 1$), while "no change" refers to those ephemerides for which the 2029 prediction uncertainties have not changed by more than 1 minute ($|\sigma_{p'} - \sigma_p| < 1$). Finally, in this work, we introduce the "TTVs" flag, which refers to ephemerides that deviate from linear behavior.

3.2. Deviations from Linear Ephemerides

For all the planets, we calculated the generalized Lomb–Scargle periodogram on the linear ephemeris residuals, to identify deviations from the linear ephemeris. We concluded that periodograms are more reliable in detecting such deviations, since other diagnostics—such as the reduced chi square, the autocorrelation, or Gaussianity tests on the residuals—are strongly affected by red noise, discontinuity, and low numbers of data, respectively. This is due to the sparsity of the data and to red noise in the timing measurements. The TTVs flag has been given to those planets with periodograms that had peaks with a False Alarm Probability (FAP) lower than 0.13%. We estimated the FAP for each planet as follows. First, we produced periodograms (Pa) for 100,000 series of white noise with the same sampling, then we produced periodograms (Pb) for 100,000 series where we varied the midtime data within their uncertainties. Finally, the FAP for each period was defined as the percentage of Pb that had greater power than the 99.87% (3σ) upper limit of the Pa periodograms. The detected periodicities were categorized as short-term or long-term, based on the time span of all the available data. The long-term periodicities are those that are close to or longer than the total time span of the data used.

Table 2
Categories of Ephemerides in Comparison with the Previous ExoClock Publication and the Values at the Beginning of the Project

	Versus ExoClock II (180 planets)	Versus Initial (450 planets)
Significantly Improved	0.0%	31.8%
Drifting	1.1%	12.9%
Improved	31.7%	41.1%
No Change	63.3%	10.0%
TTVs	3.9%	4.2%

4. Data Release C

The third data release of the ExoClock project includes two data products: the Catalog of Observations (ExoClock, ETD, and space observations) and the catalog of ExoClock ephemerides. All data products and their descriptions can be found through the Open Science Framework repository: 10.17605/OSF.IO/P298N.

Table 3
Distribution Characteristics of the Ephemerid Drift S/Ns

	Versus ExoClock II (180 planets)	Versus Initial (450 planets)	Normal Distribution
STD	1.50	37.00	1.00
Kurtosis	1.75	262.02	0.00
68th Percentile	1.28	1.79	0.995
95th Percentile	3.42	5.23	1.959
99th Percentile	5.13	25.96	2.576

Note. Those between this work and the previous ExoClock publication are shown in the first column and those between this work and the ephemerides at the beginning of the project are shown in the second column. Planets with TTVs have been excluded. In the ideal case of a normal distribution, these parameters should be close to the values in the third column.

4.1. Catalog of Observations

The Catalog of Observations contains all the light curves and literature midtime points that are summarized in Table 1. In the online repository, each light curve is accompanied by:

1. metadata regarding the planet, the source, the observation, the instrument, and the data format;
2. the pre-detrended light curve, filtered for outliers and converted to BJD_{TDB} and flux formats, with scaled uncertainties;
3. the fitting results, including the detrending method used and its parameters;
4. the detrended light curve, enhanced with the detrending model, the transit model, and the residuals; and
5. the fitting diagnostics on the residuals.

4.2. Catalog of ExoClock Ephemerides

The new catalog of ExoClock ephemerides contains the updated ephemerides for the 450 planets studied in this work (see also Table 7), accompanied by metadata regarding the planet and flags concerning the detection of TTVs.

5. Discussion

5.1. Follow-up Efficiency

From the comparison between the ephemerides in ExoClock II and this work, we conclude that the biases in the ephemerides produced by ExoClock are decreasing. This is based on the fact that the number of significantly improved or drifting ephemerides is very small (Table 2, first column). Moreover, the drifts found between ExoClock II and this study are closer to a normal distribution, as seen in the first column of Table 3. These values highlight the reliability of the produced ephemerides and support the view that the ExoClock project is working effectively toward achieving its goal.

5.2. Need for Continuous Monitoring

As indicated in Table 2 (second column), approximately 45% of the initial ephemerides have large uncertainties or drifts (the "significantly improved" or "drifting" categories). This is similar to the percentage reported in ExoClock II, indicating that a significant number of the ephemerides derived in the discovery papers (including the TESS discoveries) need to be corrected to be appropriate for the efficient planning of Ariel. Moreover, as shown in Tables 2 and 3 (first columns), although the ExoClock ephemerides have reduced biases, they are not completely bias-free. Our sample of 180 planets in ExoClock II is not large enough to determine the coverage needed to produce completely bias-free ephemerides, but we can see that coverages of 60% or more are necessary to avoid unexpected drifts larger than 5 minutes in our 2029 predictions. Finally, as discussed in the previous section, some planets show long-term trends. Such trends can only be identified when the coverage is close to 100%. For all these reasons, follow-up observations are important, and continuous monitoring is essential.

The most important factor for increasing the coverage involves continuing to integrate all the available resources and prioritizing the follow-up observations accordingly.

5.3. Follow-up Capabilities

From the large number of observations so far obtained by the ExoClock network, and with the TESS light curves analyzed in this study, we can more precisely estimate the capabilities of these resources and plan efficiently for the future. In Appendices C and D, we provide detailed calculations of the S/N calibrations that we performed on both the ExoClock and TESS data to produce the equations below.

The minimum telescope aperture diameter (in inches) necessary to observe a planet with the ExoClock network ($D_{\rm min}$) is given by:

$$D_{\rm min} = \frac{0.135 + 10^{-2.99+0.2R}}{5.1d}\sqrt{\frac{7200 + t_{14}}{900\pi t_{14}}}, \tag{1}$$

where R is the magnitude of the host star in the R Cousins filter, d is the relative transit depth, and t_{14} is the total duration of the transit in seconds.

By placing an upper limit of a 40 inch aperture on the ExoClock network, we estimate that we can follow up 88% of the currently known Ariel candidates. Figure 5 shows the distribution of available planets per magnitude and telescope size, where we can see that even with telescopes up to 16 inches, 75% of the targets can be observed.

For the TESS observations, the transit S/N that can be achieved is given as:

$$S/N^{\rm TESS}_{\rm transit} = \frac{0.65d\sqrt{t_{14}/90}\ \times 10^3}{0.135 + 10^{-2.43+0.2G_{\rm RP}+0.0039G_{\rm RP}^2}}, \tag{2}$$

where $G_{\rm RP}$ is the magnitude of the host star in the GAIA Rp filter, d is the relative transit depth, and t_{14} is the total duration of the transit in seconds.

By placing a lower limit of $S/N = 3$ on the TESS observations, we estimate that we can follow up 90% of the currently known Ariel candidates. By combining the two resources, we can reach up to 95% of the candidates. For the remaining targets, we plan to use other facilities, such as CHEOPS (Benz et al. 2021) and Twinkle (Edwards et al. 2019), or combined multiple ground-based observations.

With this calibration of our ground-based network and TESS, we are in a good position to achieve the most productive use of both resources. We can avoid wasting valuable space telescope time—at facilities like CHEOPS or Twinkle—on following up targets that can be efficiently monitored from the ground, while at the same time we can readily identify the most difficult targets that will definitely require observations from space.

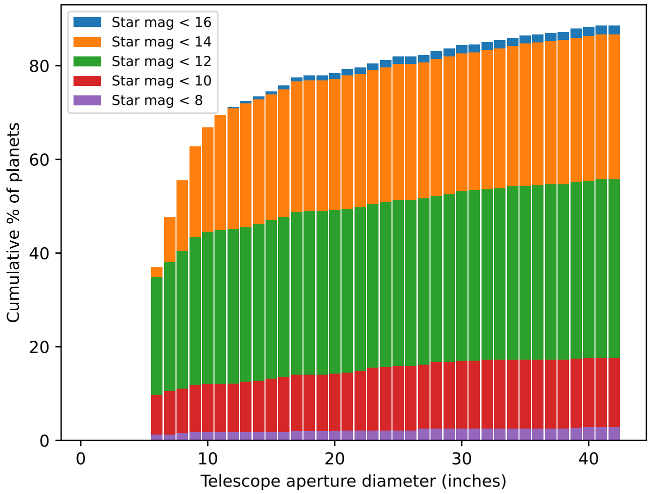

Figure 5. The distribution of the available planets per magnitude and telescope aperture diameter.

5.4. TTV Signals

Our analysis reveals 19 planets with statistically significant signals in the residuals of their linear ephemeris fit (Table 4). Eleven of these planets—namely, HD106315c, HD108236b, K2-19b, KOI-94 c, KOI-94d, KOI-94e, Kepler-18d, Kepler-396 c, TOI-216.01, TOI-216.02, and TOI-431b—have one or more additional transiting planets in their planetary systems. Hence, it is no surprise that they show TTVs, due to the interactions with other planets in the systems. It is beyond the scope of this work to study the dynamics of these systems, but we are flagging them in the ExoClock project, so that observers will continue to monitor them, to help with future dynamic analysis. For the remaining eight planets, we investigate the different scenarios below. In addition to the periodograms for the residuals of the linear ephemeris fit, we also apply a quadratic ephemeris fit and study the periodograms of these residuals, too (Figure 6).

HAT-P-7b. An attempt to detect a third body in the system, either an additional planet or companion star, has been made using radial velocity data over a 2 yr span of observations. Analysis from radial velocity data has suggested the presence of a companion star, but the results were controversial (Winn et al. 2009a). A possible detection of another Saturn-sized planet in the system has also been suggested by Ballard et al. (2011), but the significance for the detection was low.

Our results show a significant signal for a long-term periodicity of approximately 2243 epochs, or 4950 days, which is close to, but still lower than, the total time span of the data used. Moreover, we found a significant quadratic term of $6.95 \pm 0.52 \times 10^{-10}$, and after removing it, the long-term periodicity disappeared. The above results suggest that the signal is not yet periodic, but that it has a positive curvature at the moment. This means that the planet is not decaying, leaving the possibilities of a third-body or orbital precession open.

KOI-12b. Masuda (2017) has suggested the presence of a second planet, based on the same data (Kepler).

Our results indicate a few significant short-term periodicities, between approximately 20 and 200 epochs. Moreover, we found a nonsignificant quadratic term of $-2.49 \pm 0.97 \times 10^{-7}$, and after removing it, the signals from the short-term periodicities remain strong. From the above, we cannot reach a clear conclusion, because the multiple short-term periodicities could be caused by stellar activity. More data are required to narrow down the possible scenarios.

Table 4
Planets Identified with Deviations from a Linear Ephemeris

Planet	Short-term	Long-term	Data Points
HAT-P-7b	No	Yes (2243.1 E)	652
HD106315c	Yes (multiple)	Yes (multiple)	8
HD108236b	Yes (multiple)	Yes (multiple)	9
K2-19b	Yes (multiple)	Yes (multiple)	16
KOI-12b	Yes (71.3 E)	No	73
KOI-94 c	Yes (15.0 E)	No	54
KOI-94d	Yes (13.0 E)	No	25
KOI-94e	Yes (7.4 E)	Yes (38.0 E)	8
Kepler-18d	Yes (17.6 E)	No	82
Kepler-396 c	Yes (multiple)	Yes (44.8 E)	14
Qatar-1b	Yes (327.0 E)	No	265
TOI-216.01	Yes (14.4 E)	Yes (50.2 E)	15
TOI-216.02	Yes (35.1 E)	Yes (111.0 E)	26
TOI-431b	Yes (multiple)	No	21
TrES-3b	Yes (multiple)	Yes (4138.1 E)	231
WASP-4b	Yes (multiple)	No	111
WASP-12b	Yes (multiple)	Yes (5173.5 E)	308
WASP-19b	Yes (multiple)	Yes (4465.2 E)	119
WASP-56b	Yes (multiple)	No	25

Note. "Long-term" refers to variations with periodicities that are close to or longer than the total time span of the data used. In brackets, we indicate the peak periodicity in epochs (E), while the "multiple" label refers to cases where more than one periodicity is significant.

Qatar-1b. The first TTV analysis for the Qatar-1 system was carried out by von Essen et al. (2013). The authors claimed that there are possible TTVs on Qatar-1b, either due to a weak perturbator in resonance with Qatar-1b or to a massive body similar to a brown dwarf. The follow-up TTV studies by Maciejewski et al. (2015) and Collins et al. (2017) did not detect any signals of an additional planet in the system, while Püsküllü et al. (2017) found weak evidence of TTVs. It was also reported by Covino et al. (2013) that the orbital period of the planet in the Qatar-1 system is much shorter than the rotation period of the star, so the tides produce the decay of the orbit. The most recent analysis, by Su et al. (2021), concluded that no TTV frequencies could be identified.

Our data cover a time span that is double compared to previous studies, and our results indicate a statistically significant short-term periodicity, at approximately 327 epochs, or 465 days. Moreover, we found a nonsignificant quadratic term of $1.13 \pm 0.72 \times 10^{-10}$, and after removing it, the short-term periodicity was not affected. The above results suggest that the signal is periodic, and in combination with the low eccentricity of the planet, this means that a perturbator scenario is favored.

TrES-3b. So far, studies have concluded that there is no evidence of TTVs for Tres-3b (Kundurthy et al. 2013; Püsküllü et al. 2017). Christiansen et al. (2011) mentioned that a long-term variability in the light curve of Tres-3b may be due to star spots. Additionally, the lack of periodic TTVs implies that another planetary body is absent, according to the study by Mannaday et al. (2020). Finally, precession can be ruled out, due to the very low value of eccentricity, whereas the possibility of slow orbital decay cannot (Mannaday et al. 2020).

Our results show multiple significant short-term periodicities, as well as one prominent long-term periodicity, at

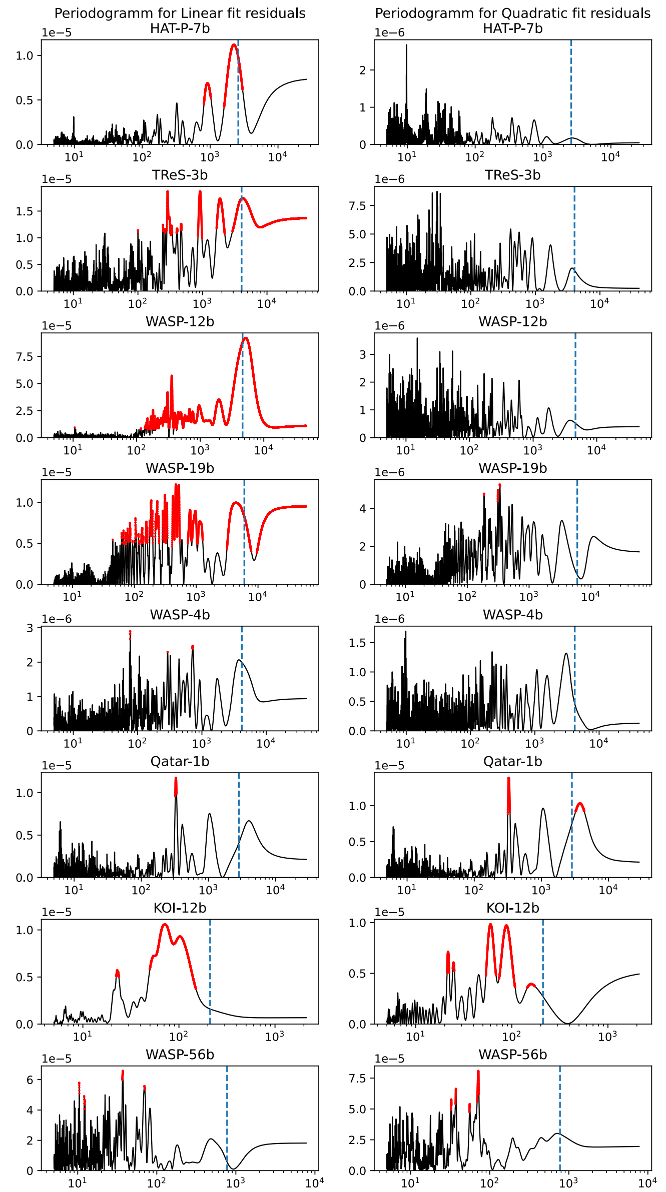

Figure 6. Periodograms for the fitting residuals (linear and quadratic) for the eight planets with TTVs, but without transiting companions. The red parts indicate periods with FAPs lower than 0.13%, and the vertical lines indicate the total time span of the data used.

approximately 4138 epochs, or 5400 days. The long-term signal is longer than the total time span of the data. Moreover, we found a significant quadratic term of $-1.68 \pm 0.34 \times 10^{-10}$, and after removing it, both the short-term and the long-term periodicities disappeared. The above results suggest that the signal is not yet periodic, with a negative curvature at the moment. In combination with the low eccentricity of the planet, this means that the orbital decay scenario is favored.

WASP-4b. From the initial observations of WASP-4b, it was assumed that TTVs might be present (Wilson et al. 2008). However, a follow-up study by Petrucci et al. (2013) concluded that the system does not show significant TTV trends. Baluev et al. (2015) proposed that TTVs probably exist in the WASP-4 system, with a magnitude of 10–20 s and an unknown nature. Additionally, a significant quadratic term in the $O - C$ diagram was reported in the study by Bouma et al. (2019), with the most probable explanation being the planet's orbital decay. Southworth et al. (2019) stated that the TTV variations have a smaller magnitude than had previously been detected, and orbital decay or a third body in the system are both problematic hypotheses. More recently, it has been suggested that the line-of-sight acceleration is the most probable reason for the TTVs (Bouma et al. 2020a). Finally, Baluev et al. (2020) have confirmed the existence of quadratic TTVs in the system, without making a new proposal for the origins.

We found a significant quadratic term of $-1.29 \pm 0.22 \times 10^{-10}$, although a long-term periodicity is not shown. In addition, the short-term periodicities disappeared after removing the quadratic term. The above results suggest that timing data alone do not provide any indications toward an interpretation. To further investigate this behavior, other types of data or a longer time span will be required.

WASP-12b. WASP-12b is one of the very first exoplanets to have a verified nonlinear ephemeris, due to orbital decay (Maciejewski et al. 2016a). It is also possible that the planet is undergoing apsidal precession, as the data indicate that its orbit might be slightly eccentric (Yee et al. 2020). According to Weinberg et al. (2017), the measured rate of orbital decay would only be reasonable if WASP-12b were a subgiant that experiences evolutionary changes causing a rapid orbital decay to the planet. The TTVs that were reported later support this idea, but additional data are needed to confirm this (Maciejewski et al. 2018). More recent data show that the orbit is decaying, with occultation times occurring about 4 minutes earlier after 10 yr (Yee et al. 2020). WASP-12b is likely to be engulfed by its host star several million years from now (Yee et al. 2020).

Our results show multiple significant short-term periodicities, as well as one prominent long-term periodicity, at approximately 5173 epochs, or 5650 days. The long-term signal is longer than the total time span of the data. Moreover, we found a significant quadratic term of $-5.24 \pm 0.17 \times 10^{-10}$, and after removing it, both the short-term and the long-term periodicities disappeared. The above suggest that the signal is not yet periodic, with a negative curvature at the moment. In combination with the low eccentricity of the planet, this means that the orbital decay scenario is favored.

WASP-19b. A nonlinear ephemeris has previously been reported (Mancini et al. 2013a; Espinoza et al. 2019a). Petrucci et al. (2020) conducted the first empirical study of orbital decay, using 74 complete transit light curves covering a 10 yr period. Their results did not show any signs of orbital decay or periodic variations that could indicate the existence of additional bodies.

Our results show multiple significant short-term periodicities, as well as one prominent long-term periodicity, at approximately 4465 epochs, or 3520 days. The long-term signal is longer than the total time span of the data. Moreover, we found a significant quadratic term of $-0.87 \pm 0.13 \times 10^{-10}$, and after removing it, the majority of the short-term periodicities and the long-term periodicity disappeared. The above results suggest that the signal is not yet periodic, with a negative curvature at the moment. In combination with the low eccentricity of the planet, this means that the orbital decay scenario is favored.

WASP-56b. A search for TTVs in the WASP-56 system was recently carried out in a study by Wang et al. (2021), but statistically significant trends (at levels of 3σ) were not found.

Our results indicate a few significant short-term periodicities, between approximately 10 and 100 epochs. Moreover, we found a nonsignificant quadratic term of $-2.09 \pm 0.82 \times 10^{-8}$, and after removing it, the signals from the short-term periodicities above 50 epochs became stronger. From the above, we cannot reach a clear conclusion, as the multiple short-term periodicities could be caused by stellar activity. With more data in the future, we will be able to narrow down the possible scenarios.

6. Conclusion

In this study, we present a homogeneous analysis of the ephemerides of 450 planets that are currently known candidates for the Ariel mission. The ephemerides resulted from the integration of data from the ExoClock network, midtime points from the literature, data from the ETD, and data from space telescopes (the Kepler, K2, and TESS missions).

The results show that the ephemerides produced by the ExoClock project are less biased, and hence more reliable for future predictions, compared to the initial ephemerides reported in the literature, although continuous monitoring is also necessary, as 40% of the initial ephemerides for new planets require refinement in order for the goals of the project to be achieved. The integrated approach of the project allows us to monitor up to 95% of the Ariel candidates, while identifying missing data and prioritizing observations for specific targets. The ExoClock network effectively facilitates the effort of obtaining such high-priority observations, while observations of more difficult targets can be requested from other space telescopes, like CHEOPS and Twinkle.

The ExoClock project, after 3 yr of continuous operation, development, and interaction, between several communities of academics and nonacademics, has became a sustainable platform for providing reliable ephemerides for the Ariel candidate planets. The dynamic evolution of the project is now being achieved; new ideas can be implemented, with a focus on more specific targets of special interest (such as the ones flagged for TTVs). We plan to continue operating ExoClock within the Open Science Framework, with the twofold objective of monitoring the ephemerides and fostering the democratization of science.

All the data products and their descriptions can found through the OSF repository: 10.17605/OSF.IO/P298N

The ExoClock project has received funding from the UKSA/STFC grants ST/W00254X/1 and ST/W006960/1.

This work has made use of data collected with the TESS mission, obtained from the MAST data archive at the Space Telescope Science Institute (STScI). Funding for the TESS mission is provided by the NASA Explorer Program. STScI is operated by the Association of Universities for Research in Astronomy, Inc., under NASA contract NAS 5-26555.

We would like to acknowledge the support provided by the administrators, designers, and developers of the ETD project and of the Czech Astronomical Society, both for the ExoClock project as well as for the efforts of the whole amateur community through its 10+ yr of operation.

This work has made use of observations made by the MicroObservatory, which is maintained and operated as an educational service by the Center for Astrophysics, Harvard & Smithsonian, as a project of NASA's Universe of Learning, supported by NASA Award No. NNX16AC65A.

This work has made use of observations made by the LCOGT network, as part of the LCOGT Global Sky Partners project "ORBYTS: Refining Exoplanet Ephemerides" (PI: B. Edwards).

ASTEP has benefited from the support of the French and Italian polar agencies IPEV and PNRA, and from INSU, the European Space Agency (ESA), through the Science Faculty of the European Space Research and Technology Center (ESTEC), the University of Birmingham, the European Union's Horizon 2020 research and innovation program (grant agreement No. 803193/BEBOP), the Science and Technology Facilities Council (STFC; grant No. ST/S00193X/1), the Laboratoire Lagrange (CNRS UMR 7293), and the Université Côte d'Azur, through Idex UCAJEDI (ANR-15-IDEX-01).

Members from the Silesian University of Technology were responsible for (1) the planning of observations; (2) the automation of the work in observatories; and (3) the processing of the data from the SUTO network. P.J.W. acknowledges support from grants BKM-574/RAu-11/2022 and 32/014/SDU/10-22-20. Other authors from the Silesian University of Technology acknowledge grant BK-246/RAu-11/2022.

A.A.B. is supported by the Ministry of Science and Higher Education of the Russian Federation under the grant 075-15-2020-780 (N13.1902.21.0039).

M. Cataneo, E.R., and M. Cilluffo thank the City Council and Management of Cernusco sul Naviglio for supporting the activity of the Associazione Cernuschese Astrofili and for the construction of the public observatory "G. Barletta."

B.E. is a Laureate of the Paris Region fellowship program, supported by the Ile-de-France Region. This project has received funding under the Horizon 2020 framework program for research and innovation, under the Marie Sklodowska-Curie grant agreement No. 607 945298.

P. Gajdoš is supported by the Slovak Research and Development Agency, under contract No. APVV-20-0148 and internal grant VVGS-PF-2021-2087 of the Faculty of Science, P. J. Šafárik University in Košice.

C.A.H. and U. Kolb are supported by STFC, under grant ST/T000295/1.

M. Mašek is supported by MEYS (Czech Republic), under the project MEYS LTT17006.

L.V.M. is funded by ASI grant No. 2021-5-HH.0.

Software: Django, PyLightcurve (Tsiaras et al. 2016), ExoTETHyS (Morello et al. 2020), Astropy (Astropy Collaboration et al. 2013), emcee (Foreman-Mackey et al. 2013), Matplotlib (Hunter 2007), Numpy (Harris et al. 2020), SciPy (Virtanen et al. 2020).

Appendix A
Supplementary Information

Here, we append extra information regarding the data sources and results. More specifically, Table 5 includes a list of the amateur private observatories contributing to this work, which is followed by a description of the ASTEP telescope. Table 6 includes a list of the parameters used in the analysis of the individual light curves and their respective references, where the asterisks indicate orbital parameters (a/R_s or i) that were adjusted, based on TESS data, to match the observed durations. Table 7 provides all the new ephemerides and references to the literature values used.

ASTEP (Antarctic Search for Transiting ExoPlanets) is a 40 cm telescope that is installed at the Concordia Station, Dome

Table 5
Amateur Private Observatories Contributing to This Work

Observer(s)	Observatory
Richard Abraham	The Green Observatory, UK
Vikrant Kumar Agnihotri	Cepheid Observatory, Rawatbhata, India
Raniero Albanesi	157 Frasso Sabino
Enrique Arce-Mansego	Vallbona Observatory, Valencia, Spain
Matthieu Bachschmidt	Gonachon, France
Giorgio Baj	Observatory M57, Saltrio, Italy
David Bennett	Rickford Observatory
Paul Benni	Acton Sky Portal, Acton, MA, USA
Leon Bewersdorff	Observatory Kipshoven, Germany
Patrick Brandebourg	Observatoire du Guernet, Bretagne, France
Luboš Brát	ALTAN Observatory
Stephen M. Brincat	Flarestar Observatory (MPC: 171), San Gwann, Malta
Sebastien Brouillard	Observatoire de Saint-Véran—Paul Felenbok, France
Mauro Caló	Cavallino Observatory, Tuscany, Italy
Fran Campos	Puig d'Agulles Observatory, Vallirana, Spain
Alfonso Carreno	Observatorio Zonalunar (MPC: J08)
Roland Casali	Alto2000 Observatory, Italy
Giovanni Battista Casalnuovo	Filzi School Observatory, Laives, Italy
Jean-François Coliac	OABAC—Observatoire pour l'Astronomie des Binaires et l'Astronomie Collaborative
Giuseppe Conzo	Explorer Orbanic Observatory, Croatia
Mercedes Correa	Sirius B, Spain
Gilles Coulon	Sadr Chili
Martin Valentine Crow	Burnham Observatory, Burnham on Crouch, UK
Ivan Anthony Curtis	ICO, Adelaide, South Australia
Dominique Daniel	LMJ-OBS, Carpentras, France
Bruno Dauchet	Saint Véran Observatory, France
Simon Dawes	William James II Observatory, Bexleyheath, UK
Marc Deldem	Les Barres Observatory, Lamanon, France
Dimitrios Deligeorgopoulos	Artemis Observatory, Evrytania, Greece
Nicolas Esseiva	Observatoire de la Perdrix
Rafael González Farfán	Uraniborg Observatory, Écija, Sevilla, Spain
Salomon Louw Ferreira	PESCOPE
Davide Gabellini	Hypatia Observatory, Italy
Trevor Gainey	Kismet Observatory, Berkshire, UK
Josep Gaitan	MAS MOIXA (MPC: C86)
Alberto García-Sánchez	Observatorio Rio Cofio, Robledo de Chavela, Spain
Joe Garlitz	Elgin Observatory GJP
Christophe Gillier	CALA Observatory, France
Juanjo Gonzales	Cielo Profundo J01
Ferran Grau Horta	Observatori de Ca l'Ou, Sant Martí Sesgueioles, Spain
Tim Haymes	Tim Haymes Southside Observatory, north Oxfordshire, UK
Ken Hose	Quarryview Observatory / HQR
Francois Hurter	Albireo Observatory, Switzerland
Jens Jacobsen	Egeskov Observatory
Kevin Johnson	Holbrook Observatory, East Sussex, UK
Adrian Jones	I64, Maidenhead, UK
Aziz Ettahar Kaeouach	High Atlas Observatory, Oukaimeden, Morocco
Bernd Koch	Soerth B72, Germany
Didier Laloum	Observatoire Privé du Mont, 40280 Saint-Pierre-du-Mont, France
Massimiliano Mannucci	Osservatorio Astronomico Margherita Hack, Firenze, Italy
Antonio Marino	Telescopio Remoto Colacevich, c/o Osservatorio Astronomico di Capodimonte di Napoli
Giuseppe Marino	Osservatorio GAC "Luigi Sturzo," Italy
Jean-Claude Mario	Observatoire de la Cabergue
Fernando Antonio Martínez-Bravo	Chile
Paolo Arcangelo Matassa	P.M.P.H.R. Deep Sky (MPC: K81), Atina (FR), Italy
Philip Michel	Verulamium Private Observatory, St Albans, UK
Mike Miller	Georgetown Observatory, Georgetown, TX, USA
David Molina	Anunaki Observatory, Madrid
Thomas Mollier	Tomastro Observatory, France
Mario Morales-Aimar	Observatorio de Sencelles, Spain
Fabio Mortari	Hypatia Observatory, Italy
Gabriel Murawski	MGAB Observatory
Jean-Louis Naudin	Gatinais French Observatory (GFO)
Ramon Naves	Montcabrer (MPC: 213)
David Néel	Le Cat Etoiles, France
Alphonso Noschese	Elianto Observatory
Yenal Öğmen	Green Island Observatory IAU B34
Osamu Ohshima	Ohshima Tamashima Observatory
Zlatko Orbanic	Explorer Orbanic Observatory, Croatia
Christian Pantacchini	Observatoire de Benayes, France
Nikolaos I. Paschalis	Nunki Observatory, Skiathos, Greece
Valère Perroud	Observatoire de Duines, France
Mark Phillips	Forthimage Observatory, Edinburgh, Scotland
Jean-Bernard Pioppa	La Roque Esclapon, France
Jean Plazas	Ribot Observatory
Jeff Purcell	Omaha, NE, United States
Manfred Raetz	Privat Observatory Herges-Hallenberg, Germany
François Regembal	HRT Observatory, Spain
Jose Angel Carrion Rodrigo	OAO Observatorio Aras de los Olmos
Lionel Rousselot	Vierzon Observatory, France
Xesco Rubia	Stupa Observatori, Centelles, Catalonia, Spain
Nello Ruocco	Osservatorio Astronomico Nastro Verde, Sorrento, Italy
Mark Salisbury	POST, UK
Fabio Salvaggio	WBRO (K49), Italy
John Savage	Z42, Rushay Farm Observatory, Dorset, UK
Danilo Sedita	Osservatorio Sedita Castrofilippo, Italy
Alvaro Fornas Silva	Centro Astronómico Alto Turia (CAAT)
Nick Sioulas	NOAK Observatory L02, Greece
Vojtěch Školník	Broumov NM Observatory, Czech Republic
Miroslav Smolka	Motešice Observatory, SK
Dimitris Stouraitis	Galileo Observatory, Greece
Thiam-Guan Tan	Perth Exoplanet Survey Telescope, Australia
Geoffrey Thurston	I67, Hartley Wintney, UK
Fernando Pablo Tifner	MPC: I32
Andrea Tomacelli	Telescopio Remoto Colacevich UAN, c/o Osservatorio Astronomico di Capodimonte di Napoli
Alberto Tomatis	Alto Observatory, Italy
Pierre Valeau	Observatoire de l'Aiguillon sur Mer, France
Jean-Pascal Vignes	Deep Sky Chile, Chile
Alberto Villa	Oss Astr G. Galilei, Libbiano (MPC: B33)
Antoni Vives Sureda	Anunnaki Observatory
Kuldip Vora	Cepheid Observatory, Rawatbhata, India
Martin Vrašťák	Žilina-Mojš, LSO, Slovakia
David E. Wright	Yorick Observatory, Hampshire, UK
Roberto Zambelli	Roberto Zambelli Observatory
Martin Zíbar	Chlumčany

Table 6
Parameters Used in the Analysis of the Individual Light Curves and the Respective References, where the Asterisks Indicate Orbital Parameters (a/R_s or i) That Were Adjusted, Based on TESS Data, to Match the Observed Durations

Planet	Ephemeris (Before This Update)	Stellar Parameters	Transit Parameters		
	T_0 (BJD_{TDB})	T_{eff} (K)	R_p/R_s	a/R_s	i (deg)
	P (days)	$\log(g)$ (cgs)	e	ω (deg)	
55Cnce	$2,455,962.0727^{+0.0007}_{-0.0007}$	$5234.0^{+30.0}_{-30.0}$	$0.0187^{+0.0004}_{-0.0004}$	$3.47^{+0.07}_{-0.07}$	$83.6^{+0.6}_{-0.6}$
	$0.736545^{+9e-07}_{-9e-07}$	$4.45^{+0.08}_{-0.08}$	…	…	
	Sulis et al. (2019)	Demory et al. (2011)	Sulis et al. (2019)		
CoRoT-11b	$2,454,597.6797^{+0.0003}_{-0.0003}$	$6440.0^{+120.0}_{-120.0}$	$0.107^{+0.0005}_{-0.0005}$	$6.89^{+0.08}_{-0.08}$	$83.17^{+0.15}_{-0.15}$
	$2.99433^{+1.1e-05}_{-1.1e-05}$	$4.22^{+0.23}_{-0.23}$	…	…	
	Gandolfi et al. (2010)	Gandolfi et al. (2010)	Gandolfi et al. (2010)		
CoRoT-19b	$2,455,257.4418^{+0.0006}_{-0.0006}$	$6090.0^{+70.0}_{-70.0}$	$0.0786^{+0.0004}_{-0.0004}$	$6.7^{+0.1}_{-0.1}$	$88.0^{+0.7}_{-0.7}$
	$3.89713^{+2e-05}_{-2e-05}$	$4.07^{+0.03}_{-0.03}$	…	…	
	Guenther et al. (2012)	Guenther et al. (2012)	Guenther et al. (2012)		
CoRoT-2b	$2,457,347.04314^{+0.00012}_{-0.00012}$	$5696.0^{+70.0}_{-70.0}$	$0.1667^{+0.0006}_{-0.0006}$	$6.7^{+0.03}_{-0.03}$	$87.84^{+0.1}_{-0.1}$
	$1.742997^{+1.1e-07}_{-1.1e-07}$	$4.42^{+0.12}_{-0.12}$	…	…	
	Kokori et al. (2022)	Chavero et al. (2010)	Alonso et al. (2008b)		
EPIC211945201b	$2,458,113.9399^{+0.0004}_{-0.0004}$	$6025.0^{+100.0}_{-100.0}$	$0.0407^{+0.0003}_{-0.0003}$	$23.1^{+0.5}_{-0.5}$	$87.9^{+0.06}_{-0.06}$
	$19.49213^{+1e-05}_{-1e-05}$	$4.25^{+0.1}_{-0.1}$	…	…	
	Chakraborty et al. (2018)	Chakraborty et al. (2018)	Chakraborty et al. (2018)		

Note. Table 6 is published in its entirety in machine-readable format. A portion is shown here for guidance regarding its form and content. A complete listing of all references used is provided in the table notes.

References: Alonso et al. (2008b), Anderson et al. (2008), Burke et al. (2008), Johns-Krull et al. (2008), McCullough et al. (2008), Noyes et al. (2008), Pál et al. (2008), Pollacco et al. (2008), Torres et al. (2008), Wilson et al. (2008), Bakos et al. (2009), Barbieri et al. (2009), Carter et al. (2009), Charbonneau et al. (2009), Christian et al. (2009), Gillon et al. (2009a), Hartman et al. (2009), Hebb et al. (2009), Hellier et al. (2009a), Hellier et al. (2009b), Johnson et al. (2009b), Joshi et al. (2009), Latham et al. (2009), Lister et al. (2009), Shporer et al. (2009b), Skillen et al. (2009), West et al. (2009a), West et al. (2009b), Anderson et al. (2010), Bakos et al. (2010), Bouchy et al. (2010), Buchhave et al. (2010), Chavero et al. (2010), Dunham et al. (2010), Gandolfi et al. (2010), Hebb et al. (2010), Hellier et al. (2010), Kipping et al. (2010), Koch et al. (2010b), Kovács et al. (2010), Latham et al. (2010), Maxted et al. (2010a), Maxted et al. (2010b), Narita et al. (2010), Pál et al. (2010), Queloz et al. (2010), Smalley et al. (2010), Southworth et al. (2010), Street et al. (2010), Torres et al. (2010), Alsubai et al. (2011), Anderson et al. (2011a), Bakos et al. (2011), Barros et al. (2011), Beky et al. (2011), Borucki et al. (2011), Buchhave et al. (2011), Chan et al. (2011), Christiansen et al. (2011), Cochran et al. (2011), Demory et al. (2011), Enoch et al. (2011a), Enoch et al. (2011b), Faedi et al. (2011), Fortney et al. (2011), Fukui et al. (2011), Gillon et al. (2011), Hartman et al. (2011a), Hartman et al. (2011b), Hartman et al. (2011c), Hellier et al. (2011), Howard et al. (2011), Johnson et al. (2011), Kipping et al. (2011), Knutson et al. (2011), Mandushev et al. (2011), Maxted et al. (2011), Nutzman et al. (2011), Santerne et al. (2011), Simpson et al. (2011), Smalley et al. (2011), Southworth et al. (2011), Triaud et al. (2011), Anderson et al. (2012), Bakos et al. (2012), Barros et al. (2012), Beatty et al. (2012), Berta et al. (2012), Bonfils et al. (2012), Bryan et al. (2012), Guenther et al. (2012), Hartman et al. (2012), Hellier et al. (2012), Howard et al. (2012), Lendl et al. (2012), Quinn et al. (2012), Sato et al. (2012), Siverd et al. (2012), Smalley et al. (2012), Smith et al. (2012), Southworth et al. (2012c), Bayliss et al. (2013), Boisse et al. (2013), Faedi et al. (2013), Faigler et al. (2013), Gibson et al. (2013a), Gillon et al. (2013), Gómez Maqueo Chew et al. (2013), Hébrard et al. (2013), Mancini et al. (2013b), Masuda et al. (2013), Maxted et al. (2013a), Mohler-Fischer et al. (2013), Nascimbeni et al. (2013a), Penev et al. (2013), Pepper et al. (2013), Smith et al. (2013), Southworth et al. (2013), Triaud et al. (2013), Weiss et al. (2013), Anderson et al. (2014a), Anderson et al. (2014b), Biddle et al. (2014), Bieryla et al. (2014), Brown et al. (2014), Collins et al. (2014), Delrez et al. (2014), Endl et al. (2014), Gillon et al. (2014), Hartman et al. (2014), Hellier et al. (2014), Jordán et al. (2014), Knutson et al. (2014b), Lendl et al. (2014), Maciejewski et al. (2014), Morello et al. (2014), Neveu-VanMalle et al. (2014), Nikolov et al. (2014), Smith et al. (2014), Southworth et al. (2014), Wang et al. (2014a), Wang et al. (2014b), Wong et al. (2014), Zhou et al. (2014), Almenara et al. (2015), Anderson et al. (2015a), Bakos et al. (2015a), Bakos et al. (2015b), Berta-Thompson et al. (2015), Bieryla et al. (2015), Bourrier et al. (2015), Brahm et al. (2015), Ciceri et al. (2015), Damasso et al. (2015a), Damasso et al. (2015b), Esteves et al. (2015), Fulton et al. (2015), Hartman et al. (2015a), Hartman et al. (2015b), Hartman et al. (2015c), Hellier et al. (2015), Huang et al. (2015a), Juncher et al. (2015), Lillo-Box et al. (2015), Mancini et al. (2015a), Motalebi et al. (2015), Narita et al. (2015), Smith (2015), Southworth et al. (2015a), Sozzetti et al. (2015), Triaud et al. (2015), Wong et al. (2015), Addison et al. (2016), Barros et al. (2016), Brahm et al. (2016a), Brahm et al. (2016b), Ciceri et al. (2016), Crossfield et al. (2016), Dai et al. (2016), de Val-Borro et al. (2016), Delrez et al. (2016), Eastman et al. (2016), Espinoza et al. (2016), Evans et al. (2016), Fischer et al. (2016), Fukui et al. (2016), Grziwa et al. (2016), Hartman et al. (2016), Hay et al. (2016), Hirano et al. (2016), Holczer et al. (2016), Hoyer et al. (2016), Johnson et al. (2016), Kuhn et al. (2016), Maciejewski et al. (2016b), Mancini et al. (2016a), Mancini et al. (2016b), Mann et al. (2016), Maxted et al. (2016), Močnik et al. (2016), Morton et al. (2016), Rabus et al. (2016), Rodriguez et al. (2016), Santerne et al. (2016), Sedaghati et al. (2016), Sinukoff et al. (2016), Southworth & Evans (2016), Southworth et al. (2016), Spake et al. (2016), Turner et al. (2016b), West et al. (2016), Wong et al. (2016), Zhou et al. (2016), Alsubai et al. (2017), Anderson et al. (2017), Beatty et al. (2017b), Bento et al. (2017), Collins et al. (2017), Crossfield et al. (2017), Crouzet et al. (2017), Dittmann et al. (2017), Dressing et al. (2017), Eigmüller et al. (2017), Espinoza et al. (2017), Gaudi et al. (2017), Gillon et al. (2017), Grunblatt et al. (2017), Kirk et al. (2017), Lam et al. (2017), Lendl et al. (2017b), Lund et al. (2017), McLeod et al. (2017), Močnik et al. (2017a), Močnik et al. (2017b), Niraula et al. (2017), Oberst et al. (2017), Palle et al. (2017), Pepper et al. (2017), Shporer et al. (2017), Southworth et al. (2017), Stevens et al. (2017), Temple et al. (2017), Triaud et al. (2017), Vanderburg et al. (2017), Wyttenbach et al. (2017), Zhou et al. (2017), Bayliss et al. (2018a), Bayliss et al. (2018b), Bento et al. (2018), Brahm et al. (2018a), Brahm et al. (2018b), Burdanov et al. (2018), Chakraborty et al. (2018), Ciardi et al. (2018), David et al. (2018a), David et al. (2018b), Demangeon et al. (2018), Gandolfi et al. (2018), Giles et al. (2018), Henning et al. (2018), Hirano et al. (2018), Johnson et al. (2018a), Johnson et al. (2018b), Jones et al. (2018), Mayo et al. (2018), Raynard et al. (2018), Rodriguez et al. (2018a), Rodriguez et al. (2018b), Siverd et al. (2018), Soto et al. (2018), Temple et al. (2018), Van Eylen et al. (2018), Wang et al. (2018a), Wang et al. (2018b), Yu et al. (2018a), Yu et al. (2018b), Yu et al. (2018c), Alsubai et al. (2019a), Alsubai et al. (2019b), Barkaoui et al. (2019), Beatty et al. (2019), Bouma et al. (2019), Cañas et al. (2019), Crossfield et al. (2019), Espinoza et al. (2019b), Esposito et al. (2019), Günther et al. (2019), Hartman et al. (2019), Hedges et al. (2019), Hellier et al. (2019a), Hellier et al. (2019b), Hellier et al. (2019c), Johns et al. (2019), Jones et al. (2019), Kipping et al. (2019), Korth et al. (2019), Kossakowski et al. (2019), Kostov et al. (2019), Lendl et al. (2019), Luque et al. (2019), Mallonn et al. (2019b), Ment et al. (2019), Nielsen et al. (2019), Quinn et al. (2019), Rice et al. (2019), Rodriguez et al. (2019a), Rodriguez et al. (2019b), Shporer et al. (2019), Smith et al. (2019), Sulis et al. (2019), Temple et al. (2019a), Temple et al. (2019b), Turner et al. (2019), Vanderspek et al. (2019), Vines et al. (2019), Wang et al. (2019a), Wang et al. (2019b), Winters et al. (2019), Zhou et al. (2019a), Zhou et al. (2019b), Badenas-Agusti et al. (2020), Bouma et al. (2020b), Brahm et al. (2020), Burt et al. (2020), Carleo et al. (2020), Cloutier et al. (2020), Crouzet et al. (2020), Dalba et al. (2020), Davis et al. (2020), Demory et al. (2020), Dorval et al. (2020), Dreizler et al. (2020), Gilbert et al. (2020), Hartman et al. (2020), Huang et al. (2020), Jenkins et al. (2020), Jordán et al. (2020), Kanodia et al. (2020), Maciejewski (2020), Mann et al. (2020), Nielsen et al. (2020a), Nielsen et al. (2020b), Rodriguez et al. (2020), Schanche et al. (2020), Shporer et al. (2020), Stefansson et al. (2020), Teske et al. (2020), Addison et al. (2021), Bakos et al. (2021), Cabot et al. (2021), Cointepas et al. (2021), Daylan et al. (2021), de Leon et al. (2021), Demangeon et al. (2021), Hedges et al. (2021), Hobson et al. (2021), Kossakowski et al. (2021), Lacedelli et al. (2021), Lindor et al. (2021), Luque et al. (2021), Martin et al. (2021), Moutou et al. (2021), Murgas et al. (2021), Newton et al. (2021), Osborn et al. (2021a), Osborn et al. (2021b), Rodriguez et al. (2021), Sozzetti et al. (2021), Gan et al. (2022), Khandelwal et al. (2022), Kokori et al. (2022), Montalto et al. (2022).

(This table is available in its entirety in machine-readable form.)

Table 7
Updated Ephemerides and Data Sources

Planet	T_0 (BJD_{TDB}) P (days)	References for Literature Data Used
55Cnce	2,459,370.807543 ± 0.000093 0.73654625 ± 0.00000015	Winn et al. (2011a)
CoRoT-11b	2,456,019.96220 ± 0.00037 2.99427803 ± 0.00000049	Gandolfi et al. (2010)
CoRoT-19b	2,455,701.71540 ± 0.00048 3.8971379 ± 0.0000016	Guenther et al. (2012)
CoRoT-2b	2,457,683.44158 ± 0.00016 1.74299705 ± 0.00000015	Alonso et al. (2008b), Öztürk & Erdem (2019)
EPIC211945201b	2,458,094.44793 ± 0.00024 19.4921498 ± 0.0000077	

Note. Table 7 is published in its entirety in a machine-readable format. A portion is shown here for guidance regarding its form and content. A complete listing of all references used is provided in the table notes.

References: Alonso et al. (2004), Charbonneau et al. (2006), McCullough et al. (2006), O'Donovan et al. (2006), Holman et al. (2006), Bakos et al. (2007a), Bakos et al. (2007b), Burke et al. (2007), Charbonneau et al. (2007), Cameron et al. (2007), Gillon et al. (2007a), Gillon et al. (2007b), Holman et al. (2007), Kovács et al. (2007), Mandushev et al. (2007), Narita et al. (2007), O'Donovan et al. (2007), Shporer et al. (2007), Torres et al. (2007), Winn et al. (2007a), Winn et al. (2007b), Alonso et al. (2008a), Alonso et al. (2008b), Anderson et al. (2008), Bean & Seifahrt (2008), Burke et al. (2008), Gibson et al. (2008), Gillon et al. (2008), Hébrard et al. (2008), Irwin et al. (2008), Johnson et al. (2008), McCullough et al. (2008), Miller-Ricci et al. (2008), Narita et al. (2008), Noyes et al. (2008), Pál et al. (2008), Pollacco et al. (2008), Ribas et al. (2008), Wilson et al. (2008), Winn et al. (2008a), Winn et al. (2008b), Bakos et al. (2009), Barbieri et al. (2009), Cáceres et al. (2009), Carter et al. (2009), Christian et al. (2009), Gibson et al. (2009), Gillon et al. (2009a), Gillon et al. (2009b), Hartman et al. (2009), Hebb et al. (2009), Hellier et al. (2009a), Hellier et al. (2009b), Johnson et al. (2009a), Joshi et al. (2009), Knutson et al. (2009), Latham et al. (2009), Lister et al. (2009), Nutzman et al. (2009), Pál et al. (2009), Rabus et al. (2009), Raetz et al. (2009a), Raetz et al. (2009b), Shporer et al. (2009a), Shporer et al. (2009b), Skillen et al. (2009), Southworth et al. (2009), Sozzetti et al. (2009), West et al. (2009a), Winn et al. (2009b), Winn et al. (2009c), West et al. (2009b), Agol et al. (2010), Anderson et al. (2010), Bakos et al. (2010), Bouchy et al. (2010), Buchhave et al. (2010), Burke et al. (2010), Christiansen et al. (2010), Colón et al. (2010), Dittmann et al. (2010), Gandolfi et al. (2010), Gibson et al. (2010), Hebb et al. (2010), Hrudkova et al. (2010), Kipping et al. (2010), Kovács et al. (2010), Maciejewski et al. (2010), Maxted et al. (2010b), Mislis et al. (2010), Narita et al. (2010), Queloz et al. (2010), Smalley et al. (2010), Southworth et al. (2010), Street et al. (2010), Torres et al. (2010), Tripathi et al. (2010), Alsubai et al. (2011), Anderson et al. (2011a), Anderson et al. (2011b), Bakos et al. (2011), Barros et al. (2011), Beaulieu et al. (2011), Beky et al. (2011), Berta et al. (2011), Buchhave et al. (2011), Chan et al. (2011), Christiansen et al. (2011), Dragomir et al. (2011), Enoch et al. (2011a), Enoch et al. (2011b), Faedi et al. (2011), Fukui et al. (2011), Fulton et al. (2011), Gillon et al. (2011), Hartman et al. (2011a), Hartman et al. (2011b), Hartman et al. (2011c), Hellier et al. (2011), Johnson et al. (2011), Kipping et al. (2011), Maciejewski et al. (2011a), Maciejewski et al. (2011b), Maciejewski et al. (2011c), Mandushev et al. (2011), Maxted et al. (2011), Nascimbeni et al. (2011a), Nascimbeni et al. (2011b), Nutzman et al. (2011), Pál et al. (2011), Sanchis-Ojeda et al. (2011), Simpson et al. (2011), Smalley et al. (2011), Triaud et al. (2011), Winn et al. (2011a), Winn et al. (2011b), Anderson et al. (2012), Bakos et al. (2012), Barros et al. (2012), Beatty et al. (2012), Dittmann et al. (2012), Eibe et al. (2012), Gillon et al. (2012), Guenther et al. (2012), Hartman et al. (2012), Haswell et al. (2012), Hellier et al. (2012), Howard et al. (2012), Hoyer et al. (2012), Knutson et al. (2012), Lee et al. (2012), Lendl et al. (2012), Montalto et al. (2012), Quinn et al. (2012), Sada et al. (2012), Sato et al. (2012), Siverd et al. (2012), Smalley et al. (2012), Smith et al. (2012), Southworth et al. (2012a), Southworth et al. (2012b), Southworth et al. (2012c), Stevenson et al. (2012), Todorov et al. (2012), Barros et al. (2013), Bean et al. (2013), Becker et al. (2013), Blecic et al. (2013), Boisse et al. (2013), Ciceri et al. (2013), Covino et al. (2013), Deming et al. (2013), Dragomir et al. (2013), Faedi et al. (2013), Fraine et al. (2013), Fukui et al. (2013), Gómez Maqueo Chew et al. (2013), Gibson et al. (2013a), Gibson et al. (2013b), Gillon et al. (2013), Hébrard et al. (2013), Harpsøe et al. (2013), Hoyer et al. (2013), Huitson et al. (2013), Kundurthy et al. (2013), Lendl et al. (2013), Lewis et al. (2013), Line et al. (2013), Maciejewski et al. (2013a), Maciejewski et al. (2013b), Mancini et al. (2013a), Mancini et al. (2013b), Mancini et al. (2013c), Maxted et al. (2013a), Maxted et al. (2013b), Mohler-Fischer et al. (2013), Nascimbeni et al. (2013b), Nikolov et al. (2013), Penev et al. (2013), Pepper et al. (2013), Sing et al. (2013), Smith et al. (2013), Southworth et al. (2013), Tregloan-Reed et al. (2013), Triaud et al. (2013), Turner et al. (2013), von Essen et al. (2013), Wang et al. (2013), Addison et al. (2014), Anderson et al. (2014a), Anderson et al. (2014b), Beatty et al. (2014), Bieryla et al. (2014), Brown et al. (2014), Cáceres et al. (2014), Chen et al. (2014), Collins et al. (2014), Delrez et al. (2014), Fukui et al. (2014), Gillon et al. (2014), Granata et al. (2014), Hartman et al. (2014), Hellier et al. (2014), Jordán et al. (2014), Knutson et al. (2014a), Lendl et al. (2014), Mancini et al. (2014a), Mancini et al. (2014b), Mancini et al. (2014c), Murgas et al. (2014), Neveu-VanMalle et al. (2014), Pearson et al. (2014), Seeliger et al. (2014), Smith et al. (2014), Southworth et al. (2014), Stevenson et al. (2014), Van Grootel et al. (2014), Wang et al. (2014b), Zhao et al. (2014), Zhou et al. (2014), Anderson et al. (2015a), Anderson et al. (2015b), Bakos et al. (2015a), Bakos et al. (2015b), Berta-Thompson et al. (2015), Bieryla et al. (2015), Brahm et al. (2015), Dragomir et al. (2015), Fulton et al. (2015), Hartman et al. (2015a), Hartman et al. (2015b), Hartman et al. (2015c), Hellier et al. (2015), Hinse et al. (2015), Huang et al. (2015b), Juncher et al. (2015), Kammer et al. (2015), Kreidberg et al. (2015), Maciejewski et al. (2015), Mallonn et al. (2015a), Mallonn et al. (2015b), Mancini et al. (2015a), Mancini et al. (2015b), Mislis et al. (2015), Narita et al. (2015), Nikolov et al. (2015), Petrucci et al. (2015), Raetz et al. (2015), Seeliger et al. (2015), Sing et al. (2015), Southworth et al. (2015a), Southworth et al. (2015b), Sun et al. (2015), Tregloan-Reed et al. (2015), Wong et al. (2015), Barros et al. (2016), Brahm et al. (2016a), de Val-Borro et al. (2016), Delrez et al. (2016), Eastman et al. (2016), Espinoza et al. (2016), Grziwa et al. (2016), Hartman et al. (2016), Hay et al. (2016), Hoyer et al. (2016), Jiang et al. (2016), Kirk et al. (2016), Kjurkchieva et al. (2016), Kuhn et al. (2016), Lendl et al. (2016), Maciejewski et al. (2016a), Maciejewski et al. (2016b), Mallonn & Strassmeier (2016), Mancini et al. (2016a), Mancini et al. (2016b), Maxted et al. (2016), Neveu-VanMalle et al. (2016), Parviainen et al. (2016), Rabus et al. (2016), Rodriguez et al. (2016), Sada & Ramón-Fox (2016), Sedaghati et al. (2016), Southworth et al. (2016), Spake et al. (2016), Stevenson et al. (2016), Turner et al. (2016a), Turner et al. (2016b), Villanueva et al. (2016), West et al. (2016), Wong et al. (2016), Zhou et al. (2016), Alsubai et al. (2017), Anderson et al. (2017), Barstow et al. (2017), Beatty et al. (2017a), Beatty et al. (2017b), Bento et al. (2017), Brown et al. (2017), Chen et al. (2017), Collins et al. (2017), Crouzet et al. (2017), Dittmann et al. (2017), Esposito et al. (2017), Gaudi et al. (2017), Gillon et al. (2017), Grunblatt et al. (2017), Hellier et al. (2017), Huitson et al. (2017), Kirk et al. (2017), Kozłowski et al. (2017), Lam et al. (2017), Lendl et al. (2017a), Lendl et al. (2017b), Louden et al. (2017), Lund et al. (2017), Mancini et al. (2017), McLeod et al. (2017), Moyano et al. (2017), Murgas et al. (2017), Niraula et al. (2017), Oberst et al. (2017), Püsküllü et al. (2017), Palle et al. (2017), Patra et al. (2017), Pepper et al. (2017), Stefansson et al. (2017), Stevens et al. (2017), Sun et al. (2017), Temple et al. (2017), Triaud et al. (2017), Turner et al. (2017), Wakeford et al. (2017), Wang et al. (2017), Wilkins et al. (2017), Zhou et al. (2017), Alexoudi et al. (2018), Bayliss et al. (2018b), Bento et al. (2018), Brahm et al. (2018a), Brahm et al. (2018b), Bruno et al. (2018a), Bruno et al. (2018b), Burdanov et al. (2018), Chen et al. (2018), Delrez et al. (2018), Demangeon et al. (2018), Evans et al. (2018), Henning et al. (2018), Johnson et al. (2018b), Kirk et al. (2018), Maciejewski et al. (2018), Mancini et al. (2018), Nikolov et al. (2018), Petrucci et al. (2018), Raynard et al. (2018), Siverd et al. (2018), Sokov et al. (2018), Southworth et al. (2018), Temple et al. (2018), Tregloan-Reed et al. (2018), Tsiaras et al. (2018), Wang et al. (2018a), Wang et al. (2018b), Zhao et al. (2018), Öztürk & Erdem (2019), Addison et al. (2019), Alsubai et al. (2019a), Alsubai et al. (2019b), Barkaoui et al. (2019), Casasayas-Barris et al. (2019), Espinoza et al. (2019a), Espinoza et al. (2019b), Hartman et al. (2019), Hellier et al. (2019a), Hellier et al. (2019b), Hellier et al. (2019c), Kirk et al. (2019), Lendl et al. (2019), Mallonn et al. (2019a), Mallonn et al. (2019b), Mancini et al. (2019), Ment et al. (2019), Murgas et al. (2019), Nielsen et al. (2019), Rodriguez et al. (2019a), Rodriguez et al. (2019b), Southworth et al. (2019), Temple et al. (2019a), Temple et al. (2019b), Turner et al. (2019), Vines et al. (2019), von Essen et al. (2019), Wang et al. (2019b), Zhou et al. (2019a), Zhou et al. (2019b), Alderson et al. (2020), Anisman et al. (2020), Bastürk et al. (2020), Beatty et al. (2020), Bourrier et al. (2020), Brahm et al. (2020), Changeat et al. (2020), Chen et al. (2020), Cortés-Zuleta et al. (2020), Crouzet et al. (2020), Demory et al. (2020), Dorval et al. (2020), Ehrenreich et al. (2020), Garhart et al. (2020), Guo et al. (2020), Hartman et al. (2020), Huang et al. (2020), Kain et al. (2020), Maciejewski (2020), Mancini et al. (2020), Mannaday et al. (2020), Mansfield et al. (2020), Murgas et al. (2020), Patra et al. (2020), Petigura et al. (2020), Pluriel et al. (2020), Schanche et al. (2020), Skaf et al. (2020), Stefansson et al. (2020), Wakeford et al. (2020), Weaver et al. (2020), Yan et al. (2020), Yee et al. (2020), Zellem et al. (2020), Bakos et al. (2021), Bell et al. (2021), Bonfanti et al. (2021), Cabot et al. (2021), Chen et al. (2021), Edwards et al. (2021a), Edwards et al. (2021b), Guilluy et al. (2021), Kirk et al. (2021), Lindor et al. (2021), Maxted et al. (2022), Mugnai et al. (2021), Rodriguez et al. (2021), Saha et al. (2021), Salisbury et al. (2021), Sariya et al. (2021), Spyratos et al. (2021), Su et al. (2021), Wang et al. (2021), Yip et al. (2021), Khandelwal et al. (2022) Montalto et al. (2022).

(This table is available in its entirety in machine-readable form.)

C, Antarctica, which operates during the polar winter, from March to September (Fressin et al. 2005; Daban et al. 2010; Mékarnia et al. 2016). The continuous night and excellent atmospheric conditions make it well suited to high-precision time-series photometry, such as that for exoplanet transit observations. The telescope was installed in 2010 and upgraded in 2022. The project is a collaboration between Laboratoire Lagrange (CNRS UMR 7293), the University of Birmingham, and the European Space Agency.

Appendix B
Transit S/N Calculation

For a light curve with a standard deviation of std, a total observing time of T, individual points with exposure times of t_e, and overheads of t_o, the uncertainty of the relative flux (σ_F) that can be achieved is:

$$\sigma_F = \frac{\mathrm{std}}{\sqrt{T/(t_e + t_o)}}. \tag{B1}$$

In the case of a transit (assuming that it is square), the transit depth (d) is the difference between the out-of-transit relative flux (F_{oot}) and the in-transit relative flux (F_{int}). Hence, the uncertainty on the transit depth (σ_d) is:

$$\sigma_d = \sqrt{\sigma^2_{F_{\mathrm{oot}}} + \sigma^2_{F_{\mathrm{int}}}} = \sqrt{\mathrm{std}^2\frac{(t_e + t_o)}{T_{\mathrm{oot}}} + \mathrm{std}^2\frac{(t_e + t_o)}{T_{\mathrm{int}}}} = \mathrm{std}\sqrt{(t_e + t_o)\left(\frac{1}{T_{\mathrm{oot}}} + \frac{1}{T_{\mathrm{int}}}\right)} = \mathrm{std}\sqrt{\frac{(t_e + t_o)(T_{\mathrm{oot}} + T_{\mathrm{int}})}{T_{\mathrm{oot}}T_{\mathrm{int}}}}. \tag{B2}$$

Hence, the square-transit S/N is:

$$\mathrm{S/N}_{\text{square-transit}} = \frac{d}{\sigma_d} = \frac{d}{\mathrm{std}}\sqrt{\frac{T_{\mathrm{oot}}T_{\mathrm{int}}}{(t_e + t_o)(T_{\mathrm{oot}} + T_{\mathrm{int}})}}. \tag{B3}$$

Finally, due to the fact that in reality the transits are not squares, and because we are also fitting light curves for extra parameters, there is an additional x-factor for estimating the final transit S/N:

$$\mathrm{S/N}_{\mathrm{transit}} = x\mathrm{S/N}_{\text{square-transit}} = x\frac{d}{\mathrm{std}}\sqrt{\frac{T_{\mathrm{oot}}T_{\mathrm{int}}}{(t_e + t_o)(T_{\mathrm{oot}} + T_{\mathrm{int}})}}. \tag{B4}$$

From simulations, which we verified with current ExoClock and TESS observations, the x-factor is equal to 0.85 for linear or airmass detrending and equal to 0.65 for quadratic detrending. We need to note that for linear and airmass detrending, the x-factor is stable, regardless of the length of the out-of-transit observations. However, for quadratic detrending, in order to maintain the x-factor of 0.65, we need to observe one transit duration before and one after the transit, otherwise the x-factor becomes lower. For example, an observation of a 3 hr long transit, with 1 hr of observations before and after, has an x-factor of 0.5, instead of 0.65.

Appendix C
Transit S/N Predictions for ExoClock

To predict the transit S/N, we need to have predictions for all the values included in Equation (B4). The most uncertain one is the std, which we predicted from the performance of the current telescopes. Figure 7 (left) shows the std of the current observations made using an R Cousins filter, normalized to a 1 s exposure and a telescope size of 1 inch, as a function of the R_C magnitude. We have modeled this behavior as follows:

$$\mathrm{std}^{\mathrm{ExoClock}}_{\mathrm{norm}} = 0.135 + 10^{-2.99+0.2R}. \tag{C1}$$

Hence, the predicted std for a light curve obtained by a telescope of diameter D with an exposure time of t_e will be:

$$\mathrm{std}^{\mathrm{ExoClock}} = \frac{\mathrm{std}^{\mathrm{ExoClock}}_{\mathrm{norm}}}{\sqrt{\pi(D/2)^2 t_e}} = \frac{0.135 + 10^{-2.99+0.2R}}{\sqrt{\pi(D/2)^2 t_e}}, \tag{C2}$$

and the predicted transit S/N will be:

$$\mathrm{S/N}^{\mathrm{ExoClock}}_{\mathrm{transit}} = x\frac{d\sqrt{\pi(D/2)^2 t_e}}{0.135 + 10^{-2.99+0.2R}}\sqrt{\frac{T_{\mathrm{oot}}T_{\mathrm{int}}}{(t_e + t_o)(T_{\mathrm{oot}} + T_{\mathrm{int}})}}. \tag{C3}$$

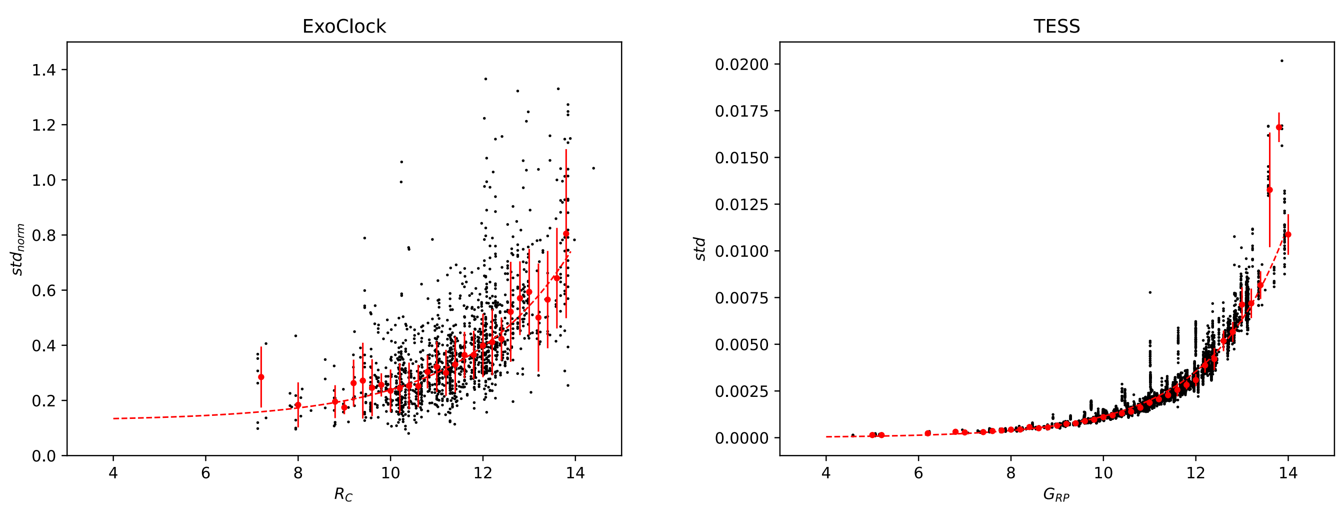

Figure 7. The standard deviations of the light curves as a function of magnitude, for the ExoClock (left; normalized for a 1 inch telescope and a 1 s exposure) and the TESS (right) light curves, together with the models derived. The red errorbars indicate the medians and standard deviations of the data, in bins of 0.2 mag.

The ExoClock scheduler calculates the minimum telescope size necessary to observe a transit, based on the following assumptions:

1. the targeted $S/N_{\rm transit}$ is 6;
2. the detrending model is expected to be the airmass model, hence $x = 0.85$;
3. the observation includes 1 hr before and 1 hr after the transit, hence $T_{\rm oot} = 7200$ s;
4. the observation includes the full transit, hence $T_{\rm int} = t_{14}$, in seconds; and
5. the overheads and the exposure time are equal, hence $t_e = t_o$.

Hence, the minimum telescope size is:

$$6 = 0.85\frac{d\sqrt{\pi(D_{\rm min}/2)^2 t_e}}{0.135 + 10^{-2.99+0.2R}}\sqrt{\frac{7200t_{14}}{(t_e + t_e)(7200 + t_{14})}}$$

$$D_{\rm min} = \frac{0.135 + 10^{-2.99+0.2R}}{5.1d}\sqrt{\frac{7200 + t_{14}}{900\pi t_{14}}}. \quad \text{(C4)}$$

Appendix D
Transit S/N Predictions for TESS

As far as the TESS observations are concerned, the calculation is less complicated, as many of the parameters are fixed. The std can be predicted from the performance of the telescope. Figure 7 (right) shows the std of the current observation, as a function of the $G_{\rm RP}$ magnitude. For TESS, there is no need to normalize to the telescope size and the exposure time, as these are fixed. We have modeled this behavior as follows:

$$\text{std}^{\rm TESS} = (0.135 + 10^{-2.43+0.2G_{\rm RP}+0.0039G_{\rm RP}^2}) \times 10^{-3}. \quad \text{(D1)}$$

Moreover, for TESS, the detrending model is the quadratic ($x = 0.65$), the exposure time is 2 minutes ($t_e = 120$), overheads are negligible ($t_o = 0$), and the observations are continuous, so we can select the out-of-transit observations to be equal to one transit duration before and one transit duration after the transit ($T_{\rm oot} = 2t_{14}$, in seconds), while the in-transit observing time is equal to a full transit duration ($T_{\rm int} = t_{14}$, in seconds). Hence, the predicted transit S/N will be:

$$\text{S/N}_{\rm transit}^{\rm TESS} = \frac{0.65d\sqrt{t_{14}/90}}{0.135 + 10^{-2.43+0.2G_{\rm RP}+0.0039G_{\rm RP}^2}} \times 10^3. \quad \text{(D2)}$$

ORCID iDs

A. Tsiaras https://orcid.org/0000-0003-3840-1793
B. Edwards https://orcid.org/0000-0002-5494-3237
G. Tinetti https://orcid.org/0000-0001-6058-6654
A. A. Belinski https://orcid.org/0000-0003-3469-0989
G. Conzo https://orcid.org/0000-0002-2412-1558
N. Crouzet https://orcid.org/0000-0001-7866-8738
P. Evans https://orcid.org/0000-0002-5674-2404
P. Gajdoš https://orcid.org/0000-0003-1478-3256
T. Guillot https://orcid.org/0000-0002-7188-8428
U. Kolb https://orcid.org/0000-0001-8670-8365
S.-P. Lai https://orcid.org/0000-0001-5522-486X
D. Laloum https://orcid.org/0000-0002-8515-955X
M. Mallonn https://orcid.org/0000-0003-2865-042X
J.-B. Marquette https://orcid.org/0000-0002-7901-7213
M. Morvan https://orcid.org/0000-0001-8587-2112
L. V. Mugnai https://orcid.org/0000-0002-9007-9802
A. J. Poelarends https://orcid.org/0000-0003-3540-5692
A. Solmaz https://orcid.org/0000-0002-3076-164X
T.-G. Tan https://orcid.org/0000-0001-5603-6895
M. Tylšar https://orcid.org/0000-0002-0967-0006
M. Zhang https://orcid.org/0000-0002-0659-1783

References

Addison, B., Wright, D. J., Wittenmyer, R. A., et al. 2019, PASP, 131, 115003
Addison, B. C., Tinney, C. G., Wright, D. J., & Bayliss, D. 2014, ApJ, 792, 112
Addison, B. C., Tinney, C. G., Wright, D. J., & Bayliss, D. 2016, ApJ, 823, 29
Addison, B. C., Wright, D. J., Nicholson, B. A., et al. 2021, MNRAS, 502, 3704
Agol, E., Cowan, N. B., Knutson, H. A., et al. 2010, ApJ, 721, 1861
Alderson, L., Kirk, J., López-Morales, M., et al. 2020, MNRAS, 497, 5182
Alexoudi, X., Mallonn, M., von Essen, C., et al. 2018, A&A, 620, A142
Almenara, J. M., Damiani, C., Bouchy, F., et al. 2015, A&A, 575, A71
Alonso, R., Barbieri, M., Rabus, M., et al. 2008a, A&A, 487, L5
Alonso, R., Brown, T. M., Torres, G., et al. 2004, ApJL, 613, L153
Alonso, R., Auvergne, M., Baglin, A., et al. 2008b, A&A, 482, L21
Alsubai, K., Mislis, D., Tsvetanov, Z. I., et al. 2017, AJ, 153, 200
Alsubai, K., Tsvetanov, Z. I., Pyrzas, S., et al. 2019a, AJ, 157, 224
Alsubai, K., Tsvetanov, Z. I., Latham, D. W., et al. 2019b, AJ, 157, 74
Alsubai, K. A., Parley, N. R., Bramich, D. M., et al. 2011, MNRAS, 417, 709
Anderson, D. R., Gillon, M., Hellier, C., et al. 2008, MNRAS, 387, L4
Anderson, D. R., Hellier, C., Gillon, M., et al. 2010, ApJ, 709, 159
Anderson, D. R., Collier Cameron, A., Hellier, C., et al. 2011a, A&A, 531, A60
Anderson, D. R., Barros, S. C. C., Boisse, I., et al. 2011b, PASP, 123, 555
Anderson, D. R., Collier Cameron, A., Gillon, M., et al. 2012, MNRAS, 422, 1988
Anderson, D. R., Collier Cameron, A., Delrez, L., et al. 2014a, MNRAS, 445, 1114
Anderson, D. R., Brown, D. J. A., Collier Cameron, A., et al. 2014b, arXiv:1410.3449
Anderson, D. R., Collier Cameron, A., Hellier, C., et al. 2015a, A&A, 575, A61
Anderson, D. R., Triaud, A. H. M. J., Turner, O. D., et al. 2015b, ApJL, 800, L9
Anderson, D. R., Collier Cameron, A., Delrez, L., et al. 2017, A&A, 604, A110
Anisman, L. O., Edwards, B., Changeat, Q., et al. 2020, AJ, 160, 233
Astropy Collaboration, Robitaille, T. P., Tollerud, E. J., et al. 2013, A&A, 558, A33
Baştürk, Ö., Yalçınkaya, S., Esmer, E. M., et al. 2020, MNRAS, 496, 4174
Badenas-Agusti, M., Günther, M. N., Daylan, T., et al. 2020, AJ, 160, 113
Bakos, G. Á., Kovács, G., Torres, G., et al. 2007a, ApJ, 670, 826
Bakos, G. Á., Shporer, A., Pál, A., et al. 2007b, ApJL, 671, L173
Bakos, G. Á., Howard, A. W., Noyes, R. W., et al. 2009, ApJ, 707, 446
Bakos, G. Á., Torres, G., Pál, A., et al. 2010, ApJ, 710, 1724
Bakos, G. Á., Hartman, J., Torres, G., et al. 2011, ApJ, 742, 116
Bakos, G. Á., Hartman, J. D., Torres, G., et al. 2012, AJ, 144, 19
Bakos, G. Á., Hartman, J. D., Bhatti, W., et al. 2015a, AJ, 149, 149
Bakos, G. Á., Penev, K., Bayliss, D., et al. 2015b, ApJ, 813, 111
Bakos, G. Á., Hartman, J. D., Bhatti, W., et al. 2021, AJ, 162, 7
Ballard, S., Christiansen, J. L., Charbonneau, D., et al. 2011, ApJ, 732, 41
Baluev, R. V., Sokov, E. N., Shaidulin, V. S., et al. 2015, MNRAS, 450, 3101
Baluev, R. V., Sokov, E. N., Hoyer, S., et al. 2020, MNRAS, 496, L11
Barbieri, M., Alonso, R., Desidera, S., et al. 2009, A&A, 503, 601
Barkaoui, K., Burdanov, A., Hellier, C., et al. 2019, AJ, 157, 43
Barros, S. C. C., Boue, G., Gibson, N. P., et al. 2013, MNRAS, 430, 3032
Barros, S. C. C., Pollacco, D. L., Gibson, N. P., et al. 2012, MNRAS, 419, 1248
Barros, S. C. C., Faedi, F., Collier Cameron, A., et al. 2011, A&A, 525, A54
Barros, S. C. C., Brown, D. J. A., Hébrard, G., et al. 2016, A&A, 593, A113
Barstow, J. K., Aigrain, S., Irwin, P. G. J., & Sing, D. K. 2017, ApJ, 834, 50
Bayliss, D., Zhou, G., Penev, K., et al. 2013, AJ, 146, 113
Bayliss, D., Hartman, J. D., Zhou, G., et al. 2018a, AJ, 155, 119
Bayliss, D., Gillen, E., Eigmüller, P., et al. 2018b, MNRAS, 475, 4467
Bean, J. L., Désert, J.-M., Seifahrt, A., et al. 2013, ApJ, 771, 108

Bean, J. L., & Seifahrt, A. 2008, A&A, 487, L25
Beatty, T. G., Madhusudhan, N., Pogge, R., et al. 2017a, AJ, 154, 242
Beatty, T. G., Marley, M. S., Gaudi, B. S., et al. 2019, AJ, 158, 166
Beatty, T. G., Pepper, J., Siverd, R. J., et al. 2012, ApJL, 756, L39
Beatty, T. G., Collins, K. A., Fortney, J., et al. 2014, ApJ, 783, 112
Beatty, T. G., Stevens, D. J., Collins, K. A., et al. 2017b, AJ, 154, 25
Beatty, T. G., Wong, I., Fetherolf, T., et al. 2020, AJ, 160, 211
Beaulieu, J.-P., Tinetti, G., Kipping, D. M., et al. 2011, ApJ, 731, 16
Beck, P., Robson, L., Gallaway, M., Jones, H. R. A., & Campbell, D. 2019, PASP, 131, 084402
Becker, A. C., Kundurthy, P., Agol, E., et al. 2013, ApJL, 764, L17
Beky, B., Bakos, G. Á., Hartman, J., et al. 2011, ApJ, 734, 109
Bell, T. J., Dang, L., Cowan, N. B., et al. 2021, MNRAS, 504, 3316
Benneke, B., Werner, M., Petigura, E., et al. 2017, ApJ, 834, 187
Bento, J., Schmidt, B., Hartman, J. D., et al. 2017, MNRAS, 468, 835
Bento, J., Hartman, J. D., Bakos, G. Á., et al. 2018, MNRAS, 477, 3406
Benz, W., Broeg, C., Fortier, A., et al. 2021, ExA, 51, 109
Berta, Z. K., Charbonneau, D., Bean, J., et al. 2011, ApJ, 736, 12
Berta, Z. K., Charbonneau, D., Désert, J.-M., et al. 2012, ApJ, 747, 35
Berta-Thompson, Z. K., Irwin, J., Charbonneau, D., et al. 2015, Natur, 527, 204
Biddle, L. I., Pearson, K. A., Crossfield, I. J. M., et al. 2014, MNRAS, 443, 1810
Bieryla, A., Hartman, J. D., Bakos, G. Á., et al. 2014, AJ, 147, 84
Bieryla, A., Collins, K., Beatty, T. G., et al. 2015, AJ, 150, 12
Blecic, J., Harrington, J., Madhusudhan, N., et al. 2013, ApJ, 779, 5
Boisse, I., Hartman, J. D., Bakos, G. Á., et al. 2013, A&A, 558, A86
Bonfanti, A., Delrez, L., Hooton, M. J., et al. 2021, A&A, 646, A157
Bonfils, X., Gillon, M., Udry, S., et al. 2012, A&A, 546, A27
Borucki, W. J., Koch, D. G., Basri, G., et al. 2011, ApJ, 736, 19
Bouchy, F., Hebb, L., Skillen, I., et al. 2010, A&A, 519, A98
Bouma, L. G., Winn, J. N., Howard, A. W., et al. 2020a, ApJL, 893, L29
Bouma, L. G., Winn, J. N., Baxter, C., et al. 2019, AJ, 157, 217
Bouma, L. G., Hartman, J. D., Brahm, R., et al. 2020b, AJ, 160, 239
Bourrier, V., Lecavelier des Etangs, A., Hébrard, G., et al. 2015, A&A, 579, A55
Bourrier, V., Kitzmann, D., Kuntzer, T., et al. 2020, A&A, 637, A36
Brahm, R., Jordán, A., Hartman, J. D., et al. 2015, AJ, 150, 33
Brahm, R., Jordán, A., Bakos, G. Á., et al. 2016a, AJ, 151, 89
Brahm, R., Jones, M., Espinoza, N., et al. 2016b, PASP, 128, 124402
Brahm, R., Hartman, J. D., Jordán, A., et al. 2018a, AJ, 155, 112
Brahm, R., Espinoza, N., Jordán, A., et al. 2018b, MNRAS, 477, 2572
Brahm, R., Nielsen, L. D., Wittenmyer, R. A., et al. 2020, AJ, 160, 235
Brown, D. J. A., Anderson, D. R., Doyle, A. P., et al. 2014, arXiv:1412.7761
Brown, D. J. A., Triaud, A. H. M. J., Doyle, A. P., et al. 2017, MNRAS, 464, 810
Bruno, G., Lewis, N. K., Stevenson, K. B., et al. 2018a, AJ, 155, 55
Bruno, G., Lewis, N. K., Stevenson, K. B., et al. 2018b, AJ, 156, 124
Bryan, M. L., Alsubai, K. A., Latham, D. W., et al. 2012, ApJ, 750, 84
Buchhave, L. A., Bakos, G. Á., Hartman, J. D., et al. 2010, ApJ, 720, 1118
Buchhave, L. A., Bakos, G. Á., Hartman, J. D., et al. 2011, ApJ, 733, 116
Burdanov, A., Benni, P., Sokov, E., et al. 2018, PASP, 130, 074401
Burke, C. J., McCullough, P. R., Valenti, J. A., et al. 2007, ApJ, 671, 2115
Burke, C. J., McCullough, P. R., Valenti, J. A., et al. 2008, ApJ, 686, 1331
Burke, C. J., McCullough, P. R., Bergeron, L. E., et al. 2010, ApJ, 719, 1796
Burt, J. A., Nielsen, L. D., Quinn, S. N., et al. 2020, AJ, 160, 153
Cañas, C. I., Stefansson, G., Monson, A. J., et al. 2019, ApJL, 877, L29
Cabot, S. H. C., Bello-Arufe, A., Mendonça, J. M., et al. 2021, AJ, 162, 218
Cáceres, C., Ivanov, V. D., Minniti, D., et al. 2009, A&A, 507, 481
Cáceres, C., Kabath, P., Hoyer, S., et al. 2014, A&A, 565, A7
Carleo, I., Gandolfi, D., Barragán, O., et al. 2020, AJ, 160, 114
Carter, J. A., Winn, J. N., Gilliland, R., & Holman, M. J. 2009, ApJ, 696, 241
Casasayas-Barris, N., Pallé, E., Yan, F., et al. 2019, A&A, 628, A9
Chakraborty, A., Roy, A., Sharma, R., et al. 2018, AJ, 156, 3
Chan, T., Ingemyr, M., Winn, J. N., et al. 2011, AJ, 141, 179
Changeat, Q., Edwards, B., Al-Refaie, A. F., et al. 2020, AJ, 160, 260
Charbonneau, D., Winn, J. N., Everett, M. E., et al. 2007, ApJ, 658, 1322
Charbonneau, D., Winn, J. N., Latham, D. W., et al. 2006, ApJ, 636, 445
Charbonneau, D., Berta, Z. K., Irwin, J., et al. 2009, Natur, 462, 891
Chavero, C., de la Reza, R., Domingos, R. C., et al. 2010, A&A, 517, A40
Chen, G., Casasayas-Barris, N., Pallé, E., et al. 2020, A&A, 642, A54
Chen, G., Pallé, E., Nortmann, L., et al. 2017, A&A, 600, L11
Chen, G., Pallé, E., Parviainen, H., Murgas, F., & Yan, F. 2021, ApJL, 913, L16
Chen, G., van Boekel, R., Wang, H., et al. 2014, A&A, 563, A40
Chen, G., Pallé, E., Welbanks, L., et al. 2018, A&A, 616, A145
Christian, D. J., Gibson, N. P., Simpson, E. K., et al. 2009, MNRAS, 392, 1585
Christiansen, J. L., Ballard, S., Charbonneau, D., et al. 2010, ApJ, 710, 97
Christiansen, J. L., Ballard, S., Charbonneau, D., et al. 2011, ApJ, 726, 94
Ciardi, D. R., Crossfield, I. J. M., Feinstein, A. D., et al. 2018, AJ, 155, 10
Ciceri, S., Mancini, L., Southworth, J., et al. 2013, A&A, 557, A30
Ciceri, S., Mancini, L., Southworth, J., et al. 2015, A&A, 577, A54
Ciceri, S., Mancini, L., Southworth, J., et al. 2016, MNRAS, 456, 990
Cloutier, R., Eastman, J. D., Rodriguez, J. E., et al. 2020, AJ, 160, 3
Cochran, W. D., Fabrycky, D. C., Torres, G., et al. 2011, ApJS, 197, 7
Cointepas, M., Almenara, J. M., Bonfils, X., et al. 2021, A&A, 650, A145
Cameron, A. C., Bouchy, F., Hébrard, G., et al. 2007, MNRAS, 375, 951
Collins, K. A., Kielkopf, J. F., & Stassun, K. G. 2017, AJ, 153, 78
Collins, K. A., Eastman, J. D., Beatty, T. G., et al. 2014, AJ, 147, 39
Colón, K. D., Ford, E. B., Lee, B., Mahadevan, S., & Blake, C. H. 2010, MNRAS, 408, 1494
Cortés-Zuleta, P., Rojo, P., Wang, S., et al. 2020, A&A, 636, A98
Covino, E., Esposito, M., Barbieri, M., et al. 2013, A&A, 554, A28
Crossfield, I. J. M., Ciardi, D. R., Petigura, E. A., et al. 2016, ApJS, 226, 7
Crossfield, I. J. M., Ciardi, D. R., Isaacson, H., et al. 2017, AJ, 153, 255
Crossfield, I. J. M., Waalkes, W., Newton, E. R., et al. 2019, ApJL, 883, L16
Crouzet, N., McCullough, P. R., Long, D., et al. 2017, AJ, 153, 94
Crouzet, N., Healy, B. F., Hebrard, G., et al. 2020, AJ, 159, 44
Daban, J.-B., Gouvret, C., Guillot, T., et al. 2010, Proc. SPIE, 7733, 77334T
Dai, F., Winn, J. N., Albrecht, S., et al. 2016, ApJ, 823, 115
Dai, Q., Shin, E., Smith, C., et al. 2018, Open and inclusive collaboration in science: A framework, OECD Science, Technology and Industry Working Papers, 2018/07,(Paris: OECD Publishing), doi:10.1787/2dbff737-en
Dalba, P. A., Gupta, A. F., Rodriguez, J. E., et al. 2020, AJ, 159, 241
Damasso, M., Esposito, M., Nascimbeni, V., et al. 2015a, A&A, 581, L6
Damasso, M., Biazzo, K., Bonomo, A. S., et al. 2015b, A&A, 575, A111
David, T. J., Crossfield, I. J. M., Benneke, B., et al. 2018a, AJ, 155, 222
David, T. J., Mamajek, E. E., Vanderburg, A., et al. 2018b, AJ, 156, 302
Davis, A. B., Wang, S., Jones, M., et al. 2020, AJ, 160, 229
Daylan, T., Pinglé, K., Wright, J., et al. 2021, AJ, 161, 85
de Leon, J. P., Livingston, J., Endl, M., et al. 2021, MNRAS, 508, 195
de Val-Borro, M., Bakos, G. Á., Brahm, R., et al. 2016, AJ, 152, 161
Delrez, L., Van Grootel, V., Anderson, D. R., et al. 2014, A&A, 563, A143
Delrez, L., Santerne, A., Almenara, J.-M., et al. 2016, MNRAS, 458, 4025
Delrez, L., Madhusudhan, N., Lendl, M., et al. 2018, MNRAS, 474, 2334
Demangeon, O. D. S., Faedi, F., Hebrard, G., et al. 2018, A&A, 610, A63
Demangeon, O. D. S., Zapatero Osorio, M. R., Alibert, Y., et al. 2021, A&A, 653, A41
Deming, D., Wilkins, A., McCullough, P., et al. 2013, ApJ, 774, 95
Demory, B.-O., Gillon, M., Deming, D., et al. 2011, A&A, 533, A114
Demory, B.-O., Pozuelos, F. J., Gómez Maqueo Chew, Y., et al. 2020, A&A, 642, A49
Dittmann, J. A., Close, L. M., Scuderi, L. J., & Morris, M. D. 2010, ApJ, 717, 235
Dittmann, J. A., Close, L. M., Scuderi, L. J., Turner, J., & Stephenson, P. C. 2012, NewA, 17, 438
Dittmann, J. A., Irwin, J. M., Charbonneau, D., et al. 2017, Natur, 544, 333
Dorval, P., Talens, G. J. J., Otten, G. P. P. L., et al. 2020, A&A, 635, A60
Dragomir, D., Benneke, B., Pearson, K. A., et al. 2015, ApJ, 814, 102
Dragomir, D., Kane, S. R., Pilyavsky, G., et al. 2011, AJ, 142, 115
Dragomir, D., Matthews, J. M., Eastman, J. D., et al. 2013, ApJL, 772, L2
Dreizler, S., Crossfield, I. J. M., Kossakowski, D., et al. 2020, A&A, 644, A127
Dressing, C. D., Vanderburg, A., Schlieder, J. E., et al. 2017, AJ, 154, 207
Dunham, E. W., Borucki, W. J., Koch, D. G., et al. 2010, ApJL, 713, L136
Eastman, J. D., Beatty, T. G., Siverd, R. J., et al. 2016, AJ, 151, 45
Edwards, B., & Tinetti, G. 2022, AJ, 164, 15
Edwards, B., Rice, M., Zingales, T., et al. 2019, ExA, 47, 29
Edwards, B., Changeat, Q., Yip, K. H., et al. 2021a, MNRAS, 504, 5671
Edwards, B., Changeat, Q., Mori, M., et al. 2021b, AJ, 161, 44
Ehrenreich, D., Lovis, C., Allart, R., et al. 2020, Natur, 580, 597
Eibe, M. T., Cuesta, L., Ullán, A., Pérez-Verde, A., & Navas, J. 2012, MNRAS, 423, 1381
Eigmüller, P., Gandolfi, D., Persson, C. M., et al. 2017, AJ, 153, 130
Endl, M., Caldwell, D. A., Barclay, T., et al. 2014, ApJ, 795, 151
Enoch, B., Cameron, A. C., Anderson, D. R., et al. 2011a, MNRAS, 410, 1631
Enoch, B., Anderson, D. R., Barros, S. C. C., et al. 2011b, AJ, 142, 86
Espinoza, N., Bayliss, D., Hartman, J. D., et al. 2016, AJ, 152, 108
Espinoza, N., Rabus, M., Brahm, R., et al. 2017, MNRAS, 471, 4374
Espinoza, N., Rackham, B. V., Jordán, A., et al. 2019a, MNRAS, 482, 2065
Espinoza, N., Hartman, J. D., Bakos, G. Á., et al. 2019b, AJ, 158, 63
Esposito, M., Covino, E., Desidera, S., et al. 2017, A&A, 601, A53

Esposito, M., Armstrong, D. J., Gandolfi, D., et al. 2019, A&A, 623, A165
Esteves, L. J., Mooij, E. J. W. D., & Jayawardhana, R. 2015, ApJ, 804, 150
European Commission 2016, Open Innovation, Open Science, Open to the World: A Vision for Europe, https://digital-strategy.ec.europa.eu/en/library/open-innovation-open-science-open-world, doi:10.2777/061652
Evans, D. F., Southworth, J., & Smalley, B. 2016, ApJL, 833, L19
Evans, T. M., Sing, D. K., Goyal, J. M., et al. 2018, AJ, 156, 283
Faedi, F., Barros, S. C. C., Anderson, D. R., et al. 2011, A&A, 531, A40
Faedi, F., Pollacco, D., Barros, S. C. C., et al. 2013, A&A, 551, A73
Faigler, S., Tal-Or, L., Mazeh, T., Latham, D. W., & Buchhave, L. A. 2013, ApJ, 771, 26
Fischer, P. D., Knutson, H. A., Sing, D. K., et al. 2016, ApJ, 827, 19
Foreman-Mackey, D., Hogg, D. W., Lang, D., & Goodman, J. 2013, PASP, 125, 306
Fortney, J. J., Demory, B.-O., Désert, J.-M., et al. 2011, ApJS, 197, 9
Fraine, J. D., Deming, D., Gillon, M., et al. 2013, ApJ, 765, 127
Fressin, F., Guillot, T., Bouchy, F., et al. 2005, in EAS Publications Ser. 14, Dome C Astronomy and Astrophysics Meeting, ed. M. Giard, F. Casoli, & F. Paletou (Les Ulis: EDP Sciences), 309
Fukui, A., Narita, N., Tristram, P. J., et al. 2011, PASJ, 63, 287
Fukui, A., Narita, N., Kurosaki, K., et al. 2013, ApJ, 770, 95
Fukui, A., Kawashima, Y., Ikoma, M., et al. 2014, ApJ, 790, 108
Fukui, A., Narita, N., Kawashima, Y., et al. 2016, ApJ, 819, 27
Fulton, B. J., Shporer, A., Winn, J. N., et al. 2011, AJ, 142, 84
Fulton, B. J., Collins, K. A., Gaudi, B. S., et al. 2015, ApJ, 810, 30
Gan, T., Lin, Z., Wang, S. X., et al. 2022, MNRAS, 511, 83
Gandolfi, D., Hébrard, G., Alonso, R., et al. 2010, A&A, 524, A55
Gandolfi, D., Barragán, O., Livingston, J. H., et al. 2018, A&A, 619, L10
Garhart, E., Deming, D., Mandell, A., et al. 2020, AJ, 159, 137
Gaudi, B. S., Stassun, K. G., Collins, K. A., et al. 2017, Natur, 546, 514
Gibson, N. P., Aigrain, S., Barstow, J. K., et al. 2013a, MNRAS, 428, 3680
Gibson, N. P., Aigrain, S., Barstow, J. K., et al. 2013b, MNRAS, 436, 2974
Gibson, N. P., Pollacco, D., Simpson, E. K., et al. 2008, A&A, 492, 603
Gibson, N. P., Pollacco, D., Simpson, E. K., et al. 2009, ApJ, 700, 1078
Gibson, N. P., Pollacco, D. L., Barros, S., et al. 2010, MNRAS, 401, 1917
Gilbert, E. A., Barclay, T., Schlieder, J. E., et al. 2020, AJ, 160, 116
Giles, H. A. C., Bayliss, D., Espinoza, N., et al. 2018, MNRAS, 475, 1809
Gillon, M., Triaud, A. H. M. J., Mayor, M., et al. 2008, A&A, 485, 871
Gillon, M., Demory, B. O., Barman, T., et al. 2007a, A&A, 471, L51
Gillon, M., Pont, F., Demory, B. O., et al. 2007b, A&A, 472, L13
Gillon, M., Anderson, D. R., Triaud, A. H. M. J., et al. 2009a, A&A, 501, 785
Gillon, M., Smalley, B., Hebb, L., et al. 2009b, A&A, 496, 259
Gillon, M., Doyle, A. P., Lendl, M., et al. 2011, A&A, 533, A88
Gillon, M., Triaud, A. H. M. J., Fortney, J. J., et al. 2012, A&A, 542, A4
Gillon, M., Anderson, D. R., Collier-Cameron, A., et al. 2013, A&A, 552, A82
Gillon, M., Anderson, D. R., Collier-Cameron, A., et al. 2014, A&A, 562, L3
Gillon, M., Demory, B.-O., Van Grootel, V., et al. 2017, NatAs, 1, 0056
Gómez Maqueo Chew, Y., Faedi, F., Pollacco, D., et al. 2013, A&A, 559, A36
Granata, V., Nascimbeni, V., Piotto, G., et al. 2014, AN, 335, 797
Grunblatt, S. K., Huber, D., Gaidos, E., et al. 2017, AJ, 154, 254
Grziwa, S., Gandolfi, D., Csizmadia, S., et al. 2016, AJ, 152, 132
Guenther, E. W., Díaz, R. F., Gazzano, J.-C., et al. 2012, A&A, 537, A136
Guilluy, G., Gressier, A., Wright, S., et al. 2021, AJ, 161, 19
Günther, M. N., Pozuelos, F. J., Dittmann, J. A., et al. 2019, NatAs, 3, 1099
Guo, X., Crossfield, I. J. M., Dragomir, D., et al. 2020, AJ, 159, 239
Harpsøe, K. B. W., Hardis, S., Hinse, T. C., et al. 2013, A&A, 549, A10
Harris, C. R., Millman, K. J., van der Walt, S. J., et al. 2020, Natur, 585, 357
Hartman, J. D., Bakos, G. Á., Torres, G., et al. 2009, ApJ, 706, 785
Hartman, J. D., Bakos, G. Á., Sato, B., et al. 2011a, ApJ, 726, 52
Hartman, J. D., Bakos, G. Á., Kipping, D. M., et al. 2011b, ApJ, 728, 138
Hartman, J. D., Bakos, G. Á., Torres, G., et al. 2011c, ApJ, 742, 59
Hartman, J. D., Bakos, G. Á., Béky, B., et al. 2012, AJ, 144, 139
Hartman, J. D., Bakos, G. Á., Torres, G., et al. 2014, AJ, 147, 128
Hartman, J. D., Bhatti, W., Bakos, G. Á., et al. 2015a, AJ, 150, 168
Hartman, J. D., Bakos, G. Á., Buchhave, L. A., et al. 2015b, AJ, 150, 197
Hartman, J. D., Bayliss, D., Brahm, R., et al. 2015c, AJ, 149, 166
Hartman, J. D., Bakos, G. Á., Bhatti, W., et al. 2016, AJ, 152, 182
Hartman, J. D., Bakos, G. Á., Bayliss, D., et al. 2019, AJ, 157, 55
Hartman, J. D., Jordán, A., Bayliss, D., et al. 2020, AJ, 159, 173
Haswell, C. A., Fossati, L., Ayres, T., et al. 2012, ApJ, 760, 79
Hay, K. L., Collier-Cameron, A., Doyle, A. P., et al. 2016, MNRAS, 463, 3276
Hebb, L., Collier-Cameron, A., Loeillet, B., et al. 2009, ApJ, 693, 1920
Hebb, L., Collier-Cameron, A., Triaud, A. H. M. J., et al. 2010, ApJ, 708, 224
Hébrard, G., Bouchy, F., Pont, F., et al. 2008, A&A, 488, 763
Hébrard, G., Collier Cameron, A., Brown, D. J. A., et al. 2013, A&A, 549, A134
Hedges, C., Saunders, N., Barentsen, G., et al. 2019, ApJL, 880, L5
Hedges, C., Hughes, A., Zhou, G., et al. 2021, AJ, 162, 54
Hellier, C., Anderson, D. R., Collier Cameron, A., et al. 2009a, Natur, 460, 1098
Hellier, C., Anderson, D. R., Gillon, M., et al. 2009b, ApJL, 690, L89
Hellier, C., Anderson, D. R., Collier Cameron, A., et al. 2010, ApJL, 723, L60
Hellier, C., Anderson, D. R., Collier Cameron, A., et al. 2011, A&A, 535, L7
Hellier, C., Anderson, D. R., Collier Cameron, A., et al. 2012, MNRAS, 426, 739
Hellier, C., Anderson, D. R., Cameron, A. C., et al. 2014, MNRAS, 440, 1982
Hellier, C., Anderson, D. R., Collier Cameron, A., et al. 2015, AJ, 150, 18
Hellier, C., Anderson, D. R., Collier Cameron, A., et al. 2017, MNRAS, 465, 3693
Hellier, C., Anderson, D. R., Bouchy, F., et al. 2019a, MNRAS, 482, 1379
Hellier, C., Anderson, D. R., Triaud, A. H. M. J., et al. 2019b, MNRAS, 488, 3067
Hellier, C., Anderson, D. R., Barkaoui, K., et al. 2019c, MNRAS, 490, 1479
Henning, T., Mancini, L., Sarkis, P., et al. 2018, AJ, 155, 79
Hinse, T. C., Han, W., Yoon, J.-N., et al. 2015, JASS, 32, 21
Hirano, T., Nowak, G., Kuzuhara, M., et al. 2016, ApJ, 825, 53
Hirano, T., Dai, F., Livingston, J. H., et al. 2018, AJ, 155, 124
Hobson, M. J., Brahm, R., Jordán, A., et al. 2021, AJ, 161, 235
Holczer, T., Mazeh, T., Nachmani, G., et al. 2016, ApJS, 225, 9
Holman, M. J., Winn, J. N., Latham, D. W., et al. 2006, ApJ, 652, 1715
Holman, M. J., Winn, J. N., Latham, D. W., et al. 2007, ApJ, 664, 1185
Howard, A. W., Johnson, J. A., Marcy, G. W., et al. 2011, ApJ, 730, 10
Howard, A. W., Bakos, G. Á., Hartman, J., et al. 2012, ApJ, 749, 134
Howell, S. B., Sobeck, C., Haas, M., et al. 2014, PASP, 126, 398
Hoyer, S., Pallé, E., Dragomir, D., & Murgas, F. 2016, AJ, 151, 137
Hoyer, S., Rojo, P., & López-Morales, M. 2012, ApJ, 748, 22
Hoyer, S., López-Morales, M., Rojo, P., et al. 2013, MNRAS, 434, 46
Hrudkova, M., Skillen, I., Benn, C. R., et al. 2010, MNRAS, 403, 2111
Huang, C. X., Hartman, J. D., Bakos, G. Á., et al. 2015a, AJ, 150, 85
Huang, C. X., Quinn, S. N., Vanderburg, A., et al. 2020, ApJL, 892, L7
Huang, X., Bakos, G., & Hartman, J. 2015b, IAUGA, 29, 2159630
Huitson, C. M., Désert, J.-M., Bean, J. L., et al. 2017, AJ, 154, 95
Huitson, C. M., Sing, D. K., Pont, F., et al. 2013, MNRAS, 434, 3252
Hunter, J. D. 2007, CSE, 9, 90
Irwin, J., Charbonneau, D., Nutzman, P., et al. 2008, ApJ, 681, 636
Ivshina, E. S., & Winn, J. N. 2022, ApJS, 259, 62
Jenkins, J. S., Díaz, M. R., Kurtovic, N. T., et al. 2020, NatAs, 4, 1148
Jiang, I.-G., Lai, C.-Y., Savushkin, A., et al. 2016, AJ, 151, 17
Johns, D., Reed, P. A., Rodriguez, J. E., et al. 2019, AJ, 158, 78
Johns-Krull, C. M., McCullough, P. R., Burke, C. J., et al. 2008, ApJ, 677, 657
Johnson, J. A., Winn, J. N., Albrecht, S., et al. 2009a, PASP, 121, 1104
Johnson, J. A., Winn, J. N., Cabrera, N. E., & Carter, J. A. 2009b, ApJL, 692, L100
Johnson, J. A., Winn, J. N., Narita, N., et al. 2008, ApJ, 686, 649
Johnson, J. A., Winn, J. N., Bakos, G. Á., et al. 2011, ApJ, 735, 24
Johnson, M. C., Gandolfi, D., Fridlund, M., et al. 2016, AJ, 151, 171
Johnson, M. C., Dai, F., Justesen, A. B., et al. 2018a, MNRAS, 481, 596
Johnson, M. C., Rodriguez, J. E., Zhou, G., et al. 2018b, AJ, 155, 100
Jones, M. I., Brahm, R., Espinoza, N., et al. 2018, A&A, 613, A76
Jones, M. I., Brahm, R., Espinoza, N., et al. 2019, A&A, 625, A16
Jordán, A., Brahm, R., Bakos, G. Á., et al. 2014, AJ, 148, 29
Jordán, A., Brahm, R., Espinoza, N., et al. 2020, AJ, 159, 145
Joshi, Y. C., Pollacco, D., Cameron, A. C., et al. 2009, MNRAS, 392, 1532
Juncher, D., Buchhave, L. A., Hartman, J. D., et al. 2015, PASP, 127, 851
Kain, I. J., Newton, E. R., Dittmann, J. A., et al. 2020, AJ, 159, 83
Kammer, J. A., Knutson, H. A., Line, M. R., et al. 2015, ApJ, 810, 118
Kanodia, S., Cañas, C. I., Stefansson, G., et al. 2020, ApJ, 899, 29
Khandelwal, A., Chaturvedi, P., Chakraborty, A., et al. 2022, MNRAS, 509, 3339
Kipping, D., Nesvorný, D., Hartman, J., et al. 2019, MNRAS, 486, 4980
Kipping, D. M., Bakos, G. Á., Hartman, J., et al. 2010, ApJ, 725, 2017
Kipping, D. M., Hartman, J., Bakos, G. Á., et al. 2011, AJ, 142, 95
Kirk, J., López-Morales, M., Wheatley, P. J., et al. 2019, AJ, 158, 144
Kirk, J., Wheatley, P. J., Louden, T., et al. 2017, MNRAS, 468, 3907
Kirk, J., Wheatley, P. J., Louden, T., et al. 2016, MNRAS, 463, 2922
Kirk, J., Wheatley, P. J., Louden, T., et al. 2018, MNRAS, 474, 876
Kirk, J., Rackham, B. V., MacDonald, R. J., et al. 2021, AJ, 162, 34
Kjurkchieva, D., Dimitrov, D., & Ibryamov, S. 2016, BlgAJ, 24, 101
Knutson, H. A., Benneke, B., Deming, D., & Homeier, D. 2014a, Natur, 505, 66
Knutson, H. A., Charbonneau, D., Cowan, N. B., et al. 2009, ApJ, 703, 769
Knutson, H. A., Madhusudhan, N., Cowan, N. B., et al. 2011, ApJ, 735, 27

Knutson, H. A., Lewis, N., Fortney, J. J., et al. 2012, ApJ, 754, 22
Knutson, H. A., Dragomir, D., Kreidberg, L., et al. 2014b, ApJ, 794, 155
Koch, D. G., Borucki, W. J., Basri, G., et al. 2010a, ApJL, 713, L79
Koch, D. G., Borucki, W. J., Rowe, J. F., et al. 2010b, ApJL, 713, L131
Kokori, A., Tsiaras, A., Edwards, B., et al. 2021, ExA, 53, 547
Kokori, A., Tsiaras, A., Edwards, B., et al. 2022, ApJS, 258, 40
Korth, J., Csizmadia, S., Gandolfi, D., et al. 2019, MNRAS, 482, 1807
Kossakowski, D., Espinoza, N., Brahm, R., et al. 2019, MNRAS, 490, 1094
Kossakowski, D., Kemmer, J., Bluhm, P., et al. 2021, A&A, 656, A124
Kostov, V. B., Schlieder, J. E., Barclay, T., et al. 2019, AJ, 158, 32
Kovács, G., Bakos, G. Á., Torres, G., et al. 2007, ApJL, 670, L41
Kovács, G., Bakos, G. Á., Hartman, J. D., et al. 2010, ApJ, 724, 866
Kozłowski, S. K., Sybilski, P. W., Konacki, M., et al. 2017, PASP, 129, 105001
Kreidberg, L., Line, M. R., Bean, J. L., et al. 2015, ApJ, 814, 66
Kuhn, R. B., Rodriguez, J. E., Collins, K. A., et al. 2016, MNRAS, 459, 4281
Kundurthy, P., Becker, A. C., Agol, E., Barnes, R., & Williams, B. 2013, ApJ, 764, 8
Lacedelli, G., Malavolta, L., Borsato, L., et al. 2021, MNRAS, 501, 4148
Lam, K. W. F., Faedi, F., Brown, D. J. A., et al. 2017, A&A, 599, A3
Latham, D. W., Bakos, G. Á., Torres, G., et al. 2009, ApJ, 704, 1107
Latham, D. W., Borucki, W. J., Koch, D. G., et al. 2010, ApJL, 713, L140
Lee, J. W., Youn, J.-H., Kim, S.-L., Lee, C.-U., & Hinse, T. C. 2012, AJ, 143, 95
Lendl, M., Cubillos, P. E., Hagelberg, J., et al. 2017a, A&A, 606, A18
Lendl, M., Gillon, M., Queloz, D., et al. 2013, A&A, 552, A2
Lendl, M., Anderson, D. R., Collier-Cameron, A., et al. 2012, A&A, 544, A72
Lendl, M., Triaud, A. H. M. J., Anderson, D. R., et al. 2014, A&A, 568, A81
Lendl, M., Delrez, L., Gillon, M., et al. 2016, A&A, 587, A67
Lendl, M., Ehrenreich, D., Turner, O. D., et al. 2017b, A&A, 603, L5
Lendl, M., Anderson, D. R., Bonfanti, A., et al. 2019, MNRAS, 482, 301
Lewis, N. K., Knutson, H. A., Showman, A. P., et al. 2013, ApJ, 766, 95
Lillo-Box, J., Barrado, D., Santos, N. C., et al. 2015, A&A, 577, A105
Lindor, B. M., Hartman, J. D., Bakos, G. Á., et al. 2021, AJ, 161, 64
Line, M. R., Knutson, H., Deming, D., Wilkins, A., & Desert, J.-M. 2013, ApJ, 778, 183
Lister, T. A., Anderson, D. R., Gillon, M., et al. 2009, ApJ, 703, 752
Louden, T., Wheatley, P. J., Irwin, P. G. J., Kirk, J., & Skillen, I. 2017, MNRAS, 470, 742
Lund, M. B., Rodriguez, J. E., Zhou, G., et al. 2017, AJ, 154, 194
Luque, R., Pallé, E., Kossakowski, D., et al. 2019, A&A, 628, A39
Luque, R., Serrano, L. M., Molaverdikhani, K., et al. 2021, A&A, 645, A41
Maciejewski, G. 2020, AcA, 70, 181
Maciejewski, G., Errmann, R., Raetz, S., et al. 2011a, A&A, 528, A65
Maciejewski, G., Raetz, S., Nettelmann, N., et al. 2011b, A&A, 535, A7
Maciejewski, G., Dimitrov, D., Neuhäuser, R., et al. 2010, MNRAS, 407, 2625
Maciejewski, G., Dimitrov, D., Neuhäuser, R., et al. 2011c, MNRAS, 411, 1204
Maciejewski, G., Dimitrov, D., Seeliger, M., et al. 2013a, A&A, 551, A108
Maciejewski, G., Niedzielski, A., Wolszczan, A., et al. 2013b, AJ, 146, 147
Maciejewski, G., Ohlert, J., Dimitrov, D., et al. 2014, AcA, 64, 11
Maciejewski, G., Fernández, M., Aceituno, F. J., et al. 2015, A&A, 577, A109
Maciejewski, G., Dimitrov, D., Fernández, M., et al. 2016a, A&A, 588, L6
Maciejewski, G., Dimitrov, D., Mancini, L., et al. 2016b, AcA, 66, 55
Maciejewski, G., Fernández, M., Aceituno, F., et al. 2018, AcA, 68, 371
Mallonn, M., Juvan-Beaulieu, I., Sedaghati, E., et al. 2019a, RNAAS, 3, 123
Mallonn, M., & Strassmeier, K. G. 2016, A&A, 590, A100
Mallonn, M., Nascimbeni, V., Weingrill, J., et al. 2015a, A&A, 583, A138
Mallonn, M., von Essen, C., Weingrill, J., et al. 2015b, A&A, 580, A60
Mallonn, M., von Essen, C., Herrero, E., et al. 2019b, A&A, 622, A81
Mancini, L., Giordano, M., Mollière, P., et al. 2016a, MNRAS, 461, 1053
Mancini, L., Kemmer, J., Southworth, J., et al. 2016b, MNRAS, 459, 1393
Mancini, L., Ciceri, S., Chen, G., et al. 2013a, MNRAS, 436, 2
Mancini, L., Southworth, J., Ciceri, S., et al. 2013b, A&A, 551, A11
Mancini, L., Nikolov, N., Southworth, J., et al. 2013c, MNRAS, 430, 2932
Mancini, L., Southworth, J., Ciceri, S., et al. 2014a, MNRAS, 443, 2391
Mancini, L., Southworth, J., Ciceri, S., et al. 2014b, A&A, 568, A127
Mancini, L., Southworth, J., Ciceri, S., et al. 2014c, A&A, 562, A126
Mancini, L., Hartman, J. D., Penev, K., et al. 2015a, A&A, 580, A63
Mancini, L., Esposito, M., Covino, E., et al. 2015b, A&A, 579, A136
Mancini, L., Southworth, J., Raia, G., et al. 2017, MNRAS, 465, 843
Mancini, L., Esposito, M., Covino, E., et al. 2018, A&A, 613, A41
Mancini, L., Southworth, J., Mollière, P., et al. 2019, MNRAS, 485, 5168
Mancini, L., Sarkis, P., Henning, T., et al. 2020, A&A, 633, A30
Mandushev, G., O'Donovan, F. T., Charbonneau, D., et al. 2007, ApJL, 667, L195
Mandushev, G., Quinn, S. N., Buchhave, L. A., et al. 2011, ApJ, 741, 114
Mann, A. W., Gaidos, E., Mace, G. N., et al. 2016, ApJ, 818, 46
Mann, A. W., Johnson, M. C., Vanderburg, A., et al. 2020, AJ, 160, 179
Mannaday, V. K., Thakur, P., Jiang, I.-G., et al. 2020, AJ, 160, 47
Mansfield, M., Bean, J. L., Stevenson, K. B., et al. 2020, ApJL, 888, L15
Martin, D. V., El-Badry, K., Hodžić, V. K., et al. 2021, MNRAS, 507, 4132
Masuda, K. 2017, AJ, 154, 64
Masuda, K., Hirano, T., Taruya, A., Nagasawa, M., & Suto, Y. 2013, ApJ, 778, 185
Maxted, P. F. L., Anderson, D. R., Gillon, M., et al. 2010a, AJ, 140, 2007
Maxted, P. F. L., Anderson, D. R., Collier Cameron, A., et al. 2010b, PASP, 122, 1465
Maxted, P. F. L., Anderson, D. R., Collier Cameron, A., et al. 2011, PASP, 123, 547
Maxted, P. F. L., Anderson, D. R., Collier Cameron, A., et al. 2013a, PASP, 125, 48
Maxted, P. F. L., Anderson, D. R., Doyle, A. P., et al. 2013b, MNRAS, 428, 2645
Maxted, P. F. L., Anderson, D. R., Collier Cameron, A., et al. 2016, A&A, 591, A55
Maxted, P. F. L., Ehrenreich, D., Wilson, T. G., et al. 2022, MNRAS, 514, 77
Mayo, A. W., Vanderburg, A., Latham, D. W., et al. 2018, AJ, 155, 136
McCullough, P. R., Stys, J. E., Valenti, J. A., et al. 2006, ApJ, 648, 1228
McCullough, P. R., Burke, C. J., Valenti, J. A., et al. 2008, arXiv:0805.2921
McLeod, K. K., Rodriguez, J. E., Oelkers, R. J., et al. 2017, AJ, 153, 263
Mékarnia, D., Guillot, T., Rivet, J.-P., et al. 2016, MNRAS, 463, 45
Ment, K., Dittmann, J. A., Astudillo-Defru, N., et al. 2019, AJ, 157, 32
Miller-Ricci, E., Rowe, J. F., Sasselov, D., et al. 2008, ApJ, 682, 586
Mislis, D., Schröter, S., Schmitt, J. H. M. M., Cordes, O., & Reif, K. 2010, A&A, 510, A107
Mislis, D., Mancini, L., Tregloan-Reed, J., et al. 2015, MNRAS, 448, 2617
Mohler-Fischer, M., Mancini, L., Hartman, J. D., et al. 2013, A&A, 558, A55
Montalto, M., Gregorio, J., Boué, G., et al. 2012, MNRAS, 427, 2757
Montalto, M., Malavolta, L., Gregorio, J., et al. 2022, MNRAS, 509, 2908
Morello, G., Claret, A., Martin-Lagarde, M., et al. 2020, AJ, 159, 75
Morello, G., Waldmann, I. P., Tinetti, G., et al. 2014, ApJ, 786, 22
Morton, T. D., Bryson, S. T., Coughlin, J. L., et al. 2016, ApJ, 822, 86
Motalebi, F., Udry, S., Gillon, M., et al. 2015, A&A, 584, A72
Moutou, C., Almenara, J. M., Hébrard, G., et al. 2021, A&A, 653, A147
Močnik, T., Hellier, C., Anderson, D. R., Clark, B. J. M., & Southworth, J. 2017a, MNRAS, 469, 1622
Močnik, T., Southworth, J., & Hellier, C. 2017b, MNRAS, 471, 394
Močnik, T., Anderson, D. R., Brown, D. J. A., et al. 2016, PASP, 128, 124403
Moyano, M., Almeida, L. A., von Essen, C., Jablonski, F., & Pereira, M. G. 2017, MNRAS, 471, 650
Mugnai, L. V., Modirrousta-Galian, D., Edwards, B., et al. 2021, AJ, 161, 284
Murgas, F., Chen, G., Nortmann, L., Palle, E., & Nowak, G. 2020, A&A, 641, A158
Murgas, F., Chen, G., Pallé, E., Nortmann, L., & Nowak, G. 2019, A&A, 622, A172
Murgas, F., Pallé, E., Parviainen, H., et al. 2017, A&A, 605, A114
Murgas, F., Palle, E., Zapatero Osorio, M. R., et al. 2014, A&A, 563, A41
Murgas, F., Astudillo-Defru, N., Bonfils, X., et al. 2021, A&A, 653, A60
Narita, N., Hirano, T., Sanchis-Ojeda, R., et al. 2010, PASJ, 62, L61
Narita, N., Sato, B., Ohshima, O., & Winn, J. N. 2008, PASJ, 60, L1
Narita, N., Enya, K., Sato, B., et al. 2007, PASJ, 59, 763
Narita, N., Hirano, T., Fukui, A., et al. 2015, ApJ, 815, 47
Nascimbeni, V., Piotto, G., Bedin, L. R., & Damasso, M. 2011a, A&A, 527, A85
Nascimbeni, V., Piotto, G., Bedin, L. R., et al. 2011b, A&A, 532, A24
Nascimbeni, V., Piotto, G., Pagano, I., et al. 2013a, A&A, 559, A32
Nascimbeni, V., Cunial, A., Murabito, S., et al. 2013b, A&A, 549, A30
Neveu-VanMalle, M., Queloz, D., Anderson, D. R., et al. 2014, A&A, 572, A49
Neveu-VanMalle, M., Queloz, D., Anderson, D. R., et al. 2016, A&A, 586, A93
Newton, E. R., Mann, A. W., Kraus, A. L., et al. 2021, AJ, 161, 65
Nielsen, L. D., Bouchy, F., Turner, O. D., et al. 2019, MNRAS, 489, 2478
Nielsen, L. D., Brahm, R., Bouchy, F., et al. 2020a, A&A, 639, A76
Nielsen, L. D., Gandolfi, D., Armstrong, D. J., et al. 2020b, MNRAS, 492, 5399
Nikolov, N., Chen, G., Fortney, J. J., et al. 2013, A&A, 553, A26
Nikolov, N., Sing, D. K., Pont, F., et al. 2014, MNRAS, 437, 46
Nikolov, N., Sing, D. K., Burrows, A. S., et al. 2015, MNRAS, 447, 463
Nikolov, N., Sing, D. K., Fortney, J. J., et al. 2018, Natur, 557, 526
Niraula, P., Redfield, S., Dai, F., et al. 2017, AJ, 154, 266

Noyes, R. W., Bakos, G. Á., Torres, G., et al. 2008, ApJL, 673, L79
Nutzman, P., Charbonneau, D., Winn, J. N., et al. 2009, ApJ, 692, 229
Nutzman, P., Gilliland, R. L., McCullough, P. R., et al. 2011, ApJ, 726, 3
Oberst, T. E., Rodriguez, J. E., Colon, K. D., et al. 2017, AJ, 153, 97
O'Donovan, F. T., Charbonneau, D., Mandushev, G., et al. 2006, ApJL, 651, L61
O'Donovan, F. T., Charbonneau, D., Bakos, G. Á., et al. 2007, ApJL, 663, L37
Osborn, A., Armstrong, D. J., Cale, B., et al. 2021a, MNRAS, 507, 2782
Osborn, H. P., Armstrong, D. J., Adibekyan, V., et al. 2021b, MNRAS, 502, 4842
Öztürk, O., & Erdem, A. 2019, MNRAS, 486, 2290
Pál, A., Sárneczky, K., Szabó, G. M., et al. 2011, MNRAS, 413, L43
Pál, A., Bakos, G. Á., Torres, G., et al. 2008, ApJ, 680, 1450
Pál, A., Bakos, G. Á., Fernandez, J., et al. 2009, ApJ, 700, 783
Pál, A., Bakos, G. Á., Torres, G., et al. 2010, MNRAS, 401, 2665
Palle, E., Chen, G., Prieto-Arranz, J., et al. 2017, A&A, 602, L15
Parviainen, H., Pallé, E., Nortmann, L., et al. 2016, A&A, 585, A114
Patra, K. C., Winn, J. N., Holman, M. J., et al. 2017, AJ, 154, 4
Patra, K. C., Winn, J. N., Holman, M. J., et al. 2020, AJ, 159, 150
Pearson, K. A., Turner, J. D., & Sagan, T. G. 2014, NewA, 27, 102
Penev, K., Bakos, G. Á., Bayliss, D., et al. 2013, AJ, 145, 5
Pepper, J., Siverd, R. J., Beatty, T. G., et al. 2013, ApJ, 773, 64
Pepper, J., Rodriguez, J. E., Collins, K. A., et al. 2017, AJ, 153, 215
Petigura, E. A., Livingston, J., Batygin, K., et al. 2020, AJ, 159, 2
Petrucci, R., Jofré, E., Ferrero, L. V., et al. 2018, MNRAS, 473, 5126
Petrucci, R., Jofré, E., Gómez Maqueo Chew, Y., et al. 2020, MNRAS, 491, 1243
Petrucci, R., Jofré, E., Melita, M., Gómez, M., & Mauas, P. 2015, MNRAS, 446, 1389
Petrucci, R., Jofré, E., Schwartz, M., et al. 2013, ApJL, 779, L23
Pluriel, W., Whiteford, N., Edwards, B., et al. 2020, AJ, 160, 112
Poddaný, S., Brát, L., & Pejcha, O. 2010, NewA, 15, 297
Pollacco, D., Skillen, I., Collier Cameron, A., et al. 2008, MNRAS, 385, 1576
Püsküllü, Ç., Soydugan, F., Erdem, A., & Budding, E. 2017, NewA, 55, 39
Queloz, D., Anderson, D., Collier Cameron, A., et al. 2010, A&A, 517, L1
Quinn, S. N., Bakos, G. Á., Hartman, J., et al. 2012, ApJ, 745, 80
Quinn, S. N., Becker, J. C., Rodriguez, J. E., et al. 2019, AJ, 158, 177
Rabus, M., Deeg, H. J., Alonso, R., Belmonte, J. A., & Almenara, J. M. 2009, A&A, 508, 1011
Rabus, M., Jordán, A., Hartman, J. D., et al. 2016, AJ, 152, 88
Raetz, S., Mugrauer, M., Schmidt, T. O. B., et al. 2009a, AN, 330, 475
Raetz, S., Mugrauer, M., Schmidt, T. O. B., et al. 2009b, AN, 330, 459
Raetz, S., Maciejewski, G., Seeliger, M., et al. 2015, MNRAS, 451, 4139
Raynard, L., Goad, M. R., Gillen, E., et al. 2018, MNRAS, 481, 4960
Ribas, I., Font-Ribera, A., & Beaulieu, J.-P. 2008, ApJL, 677, L59
Rice, K., Malavolta, L., Mayo, A., et al. 2019, MNRAS, 484, 3731
Ricker, G. R., Winn, J. N., Vanderspek, R., et al. 2014, Proc. SPIE, 9143, 914320
Rodriguez, J. E., Vanderburg, A., Eastman, J. D., et al. 2018a, AJ, 155, 72
Rodriguez, J. E., Colón, K. D., Stassun, K. G., et al. 2016, AJ, 151, 138
Rodriguez, J. E., Becker, J. C., Eastman, J. D., et al. 2018b, AJ, 156, 245
Rodriguez, J. E., Eastman, J. D., Zhou, G., et al. 2019a, AJ, 158, 197
Rodriguez, J. E., Quinn, S. N., Huang, C. X., et al. 2019b, AJ, 157, 191
Rodriguez, J. E., Vanderburg, A., Zieba, S., et al. 2020, AJ, 160, 117
Rodriguez, J. E., Quinn, S. N., Zhou, G., et al. 2021, AJ, 161, 194
Sada, P. V., & Ramón-Fox, F. G. 2016, PASP, 128, 024402
Sada, P. V., Deming, D., Jennings, D. E., et al. 2012, PASP, 124, 212
Saha, S., Chakrabarty, A., & Sengupta, S. 2021, AJ, 162, 18
Salisbury, M. A., Kolb, U. C., Norton, A. J., & Haswell, C. A. 2021, NewA, 83, 101477
Sanchis-Ojeda, R., Winn, J. N., Holman, M. J., et al. 2011, ApJ, 733, 127
Santerne, A., Bonomo, A. S., Hébrard, G., et al. 2011, A&A, 536, A70
Santerne, A., Hébrard, G., Lillo-Box, J., et al. 2016, ApJ, 824, 55
Sariya, D. P., Jiang, I.-G., Su, L.-H., et al. 2021, RAA, 21, 097
Sato, B., Hartman, J. D., Bakos, G. Á., et al. 2012, PASJ, 64, 97
Schanche, N., Hébrard, G., Collier Cameron, A., et al. 2020, MNRAS, 499, 428
Sedaghati, E., Boffin, H. M. J., Jeřabková, T., et al. 2016, A&A, 596, A47
Seeliger, M., Dimitrov, D., Kjurkchieva, D., et al. 2014, MNRAS, 441, 304
Seeliger, M., Kitze, M., Errmann, R., et al. 2015, MNRAS, 451, 4060
Shporer, A., Mazeh, T., Pont, F., et al. 2009a, ApJ, 694, 1559
Shporer, A., Tamuz, O., Zucker, S., & Mazeh, T. 2007, MNRAS, 376, 1296
Shporer, A., Bakos, G. Á., Bouchy, F., et al. 2009b, ApJ, 690, 1393
Shporer, A., Zhou, G., Fulton, B. J., et al. 2017, AJ, 154, 188
Shporer, A., Wong, I., Huang, C. X., et al. 2019, AJ, 157, 178
Shporer, A., Collins, K. A., Astudillo-Defru, N., et al. 2020, ApJL, 890, L7
Simpson, E. K., Faedi, F., Barros, S. C. C., et al. 2011, AJ, 141, 8
Sing, D. K., Lecavelier des Etangs, A., Fortney, J. J., et al. 2013, MNRAS, 436, 2956
Sing, D. K., Wakeford, H. R., Showman, A. P., et al. 2015, MNRAS, 446, 2428
Sinukoff, E., Howard, A. W., Petigura, E. A., et al. 2016, ApJ, 827, 78
Siverd, R. J., Beatty, T. G., Pepper, J., et al. 2012, ApJ, 761, 123
Siverd, R. J., Collins, K. A., Zhou, G., et al. 2018, AJ, 155, 35
Skaf, N., Bieger, M. F., Edwards, B., et al. 2020, AJ, 160, 109
Skillen, I., Pollacco, D., Collier Cameron, A., et al. 2009, A&A, 502, 391
Smalley, B., Anderson, D. R., Collier Cameron, A., et al. 2010, A&A, 520, A56
Smalley, B., Anderson, D. R., Collier Cameron, A., et al. 2011, A&A, 526, A130
Smalley, B., Anderson, D. R., Collier-Cameron, A., et al. 2012, A&A, 547, A61
Smith, A. M. S. 2015, AcA, 65, 117
Smith, A. M. S., Anderson, D. R., Collier Cameron, A., et al. 2012, AJ, 143, 81
Smith, A. M. S., Anderson, D. R., Bouchy, F., et al. 2013, A&A, 552, A120
Smith, A. M. S., Anderson, D. R., Armstrong, D. J., et al. 2014, A&A, 570, A64
Smith, A. M. S., Csizmadia, S., Gandolfi, D., et al. 2019, AcA, 69, 135
Sokov, E. N., Sokova, I. A., Dyachenko, V. V., et al. 2018, MNRAS, 480, 291
Soto, M. G., Díaz, M. R., Jenkins, J. S., et al. 2018, MNRAS, 478, 5356
Southworth, J., Bruni, I., Mancini, L., & Gregorio, J. 2012a, MNRAS, 420, 2580
Southworth, J., & Evans, D. F. 2016, MNRAS, 463, 37
Southworth, J., Mancini, L., Madhusudhan, N., et al. 2017, AJ, 153, 191
Southworth, J., Mancini, L., Maxted, P. F. L., et al. 2012b, MNRAS, 422, 3099
Southworth, J., Tregloan-Reed, J., Pinhas, A., et al. 2018, MNRAS, 481, 4261
Southworth, J., Hinse, T. C., Burgdorf, M. J., et al. 2009, MNRAS, 399, 287
Southworth, J., Mancini, L., Novati, S. C., et al. 2010, MNRAS, 408, 1680
Southworth, J., Dominik, M., Jørgensen, U. G., et al. 2011, A&A, 527, A8
Southworth, J., Hinse, T. C., Dominik, M., et al. 2012c, MNRAS, 426, 1338
Southworth, J., Mancini, L., Browne, P., et al. 2013, MNRAS, 434, 1300
Southworth, J., Hinse, T. C., Burgdorf, M., et al. 2014, MNRAS, 444, 776
Southworth, J., Mancini, L., Tregloan-Reed, J., et al. 2015a, MNRAS, 454, 3094
Southworth, J., Mancini, L., Ciceri, S., et al. 2015b, MNRAS, 447, 711
Southworth, J., Tregloan-Reed, J., Andersen, M. I., et al. 2016, MNRAS, 457, 4205
Southworth, J., Dominik, M., Jørgensen, U. G., et al. 2019, MNRAS, 490, 4230
Sozzetti, A., Torres, G., Charbonneau, D., et al. 2009, ApJ, 691, 1145
Sozzetti, A., Bonomo, A. S., Biazzo, K., et al. 2015, A&A, 575, L15
Sozzetti, A., Damasso, M., Bonomo, A. S., et al. 2021, A&A, 648, A75
Spake, J. J., Brown, D. J. A., Doyle, A. P., et al. 2016, PASP, 128, 024401
Spyratos, P., Nikolov, N., Southworth, J., et al. 2021, MNRAS, 506, 2853
Stefansson, G., Mahadevan, S., Hebb, L., et al. 2017, ApJ, 848, 9
Stefansson, G., Cañas, C., Wisniewski, J., et al. 2020, AJ, 159, 100
Stevens, D. J., Collins, K. A., Gaudi, B. S., et al. 2017, AJ, 153, 178
Stevenson, K. B., Bean, J. L., Seifahrt, A., et al. 2014, AJ, 147, 161
Stevenson, K. B., Bean, J. L., Seifahrt, A., et al. 2016, ApJ, 817, 141
Stevenson, K. B., Harrington, J., Fortney, J. J., et al. 2012, ApJ, 754, 136
Street, R. A., Simpson, E., Barros, S. C. C., et al. 2010, ApJ, 720, 337
Su, L.-H., Jiang, I.-G., Sariya, D. P., et al. 2021, AJ, 161, 108
Sulis, S., Dragomir, D., Lendl, M., et al. 2019, A&A, 631, A129
Sun, L., Gu, S., Wang, X., et al. 2017, AJ, 153, 28
Sun, L.-L., Gu, S.-H., Wang, X.-B., et al. 2015, RAA, 15, 117
Zhao, S., Jiang-hui, J., & Yao, D. 2018, ChA&A, 42, 101
Temple, L. Y., Hellier, C., Albrow, M. D., et al. 2017, MNRAS, 471, 2743
Temple, L. Y., Hellier, C., Almleaky, Y., et al. 2018, MNRAS, 480, 5307
Temple, L. Y., Hellier, C., Anderson, D. R., et al. 2019a, MNRAS, 490, 2467
Temple, L. Y., Hellier, C., Almleaky, Y., et al. 2019b, AJ, 157, 141
Teske, J., Díaz, M. R., Luque, R., et al. 2020, AJ, 160, 96
Tinetti, G., Drossart, P., Eccleston, P., et al. 2018, ExA, 46, 135
Todorov, K. O., Deming, D., Knutson, H. A., et al. 2012, ApJ, 746, 111
Torres, G., Winn, J. N., & Holman, M. J. 2008, ApJ, 677, 1324
Torres, G., Bakos, G. Á., Kovács, G., et al. 2007, ApJL, 666, L121
Torres, G., Bakos, G. Á., Hartman, J., et al. 2010, ApJ, 715, 458
Tregloan-Reed, J., Southworth, J., & Tappert, C. 2013, MNRAS, 428, 3671
Tregloan-Reed, J., Southworth, J., Burgdorf, M., et al. 2015, MNRAS, 450, 1760
Tregloan-Reed, J., Southworth, J., Mancini, L., et al. 2018, MNRAS, 474, 5485
Triaud, A. H. M. J., Queloz, D., Hellier, C., et al. 2011, A&A, 531, A24

Triaud, A. H. M. J., Anderson, D. R., Collier Cameron, A., et al. 2013, A&A, 551, A80
Triaud, A. H. M. J., Gillon, M., Ehrenreich, D., et al. 2015, MNRAS, 450, 2279
Triaud, A. H. M. J., Neveu-VanMalle, M., Lendl, M., et al. 2017, MNRAS, 467, 1714
Tripathi, A., Winn, J. N., Johnson, J. A., et al. 2010, ApJ, 715, 421
Tsiaras, A., Waldmann, I. P., Rocchetto, M., et al. 2016, pylightcurve: Exoplanet lightcurve model, Astrophysics Source Code Library, ascl:1612.018
Tsiaras, A., Waldmann, I. P., Zingales, T., et al. 2018, AJ, 155, 156
Turner, J. D., Smart, B. M., Hardegree-Ullman, K. K., et al. 2013, MNRAS, 428, 678
Turner, J. D., Pearson, K. A., Biddle, L. I., et al. 2016a, MNRAS, 459, 789
Turner, J. D., Leiter, R. M., Biddle, L. I., et al. 2017, MNRAS, 472, 3871
Turner, O. D., Anderson, D. R., Collier Cameron, A., et al. 2016b, PASP, 128, 064401
Turner, O. D., Anderson, D. R., Barkaoui, K., et al. 2019, MNRAS, 485, 5790
Van Eylen, V., Dai, F., Mathur, S., et al. 2018, MNRAS, 478, 4866
Van Grootel, V., Gillon, M., Valencia, D., et al. 2014, ApJ, 786, 2
Vanderburg, A., Becker, J. C., Buchhave, L. A., et al. 2017, AJ, 154, 237
Vanderspek, R., Huang, C. X., Vanderburg, A., et al. 2019, ApJL, 871, L24
Villanueva, S., Eastman, J. D., & Gaudi, B. S. 2016, ApJ, 820, 87
Vines, J. I., Jenkins, J. S., Acton, J. S., et al. 2019, MNRAS, 489, 4125
Virtanen, P., Gommers, R., Oliphant, T. E., et al. 2020, NatMe, 17, 261
von Essen, C., Schröter, S., Agol, E., & Schmitt, J. H. M. M. 2013, A&A, 555, A92
von Essen, C., Wedemeyer, S., Sosa, M. S., et al. 2019, A&A, 628, A116
Wakeford, H. R., Sing, D. K., Kataria, T., et al. 2017, Sci, 356, 628
Wakeford, H. R., Sing, D. K., Stevenson, K. B., et al. 2020, AJ, 159, 204
Wang, J., Xie, J.-W., Barclay, T., & Fischer, D. A. 2014a, ApJ, 783, 4
Wang, S., Wang, X.-Y., Wang, Y.-H., et al. 2018a, AJ, 156, 181
Wang, S., Jones, M., Shporer, A., et al. 2019a, AJ, 157, 51
Wang, X.-B., Gu, S.-H., Cameron, A. C., et al. 2013, RAA, 13, 593
Wang, X.-b., Gu, S.-h., Collier Cameron, A., et al. 2014b, AJ, 147, 92
Wang, X.-Y., Wang, S., Hinse, T. C., et al. 2018b, PASP, 130, 064401
Wang, X.-Y., Wang, Y.-H., Wang, S., et al. 2021, ApJS, 255, 15
Wang, Y.-H., Wang, S., Liu, H.-G., et al. 2017, AJ, 154, 49
Wang, Y.-H., Wang, S., Hinse, T. C., et al. 2019b, AJ, 157, 82
Weaver, I. C., López-Morales, M., Espinoza, N., et al. 2020, AJ, 159, 13
Weinberg, N. N., Sun, M., Arras, P., & Essick, R. 2017, ApJL, 849, L11
Weiss, L. M., Marcy, G. W., Rowe, J. F., et al. 2013, ApJ, 768, 14
West, R. G., Collier Cameron, A., Hebb, L., et al. 2009a, A&A, 502, 395
West, R. G., Anderson, D. R., Gillon, M., et al. 2009b, AJ, 137, 4834
West, R. G., Hellier, C., Almenara, J.-M., et al. 2016, A&A, 585, A126
Wilkins, A. N., Delrez, L., Barker, A. J., et al. 2017, ApJL, 836, L24
Wilson, D. M., Gillon, M., Hellier, C., et al. 2008, ApJL, 675, L113
Winn, J. N., Henry, G. W., Torres, G., & Holman, M. J. 2008a, ApJ, 675, 1531
Winn, J. N., Holman, M. J., & Roussanova, A. 2007a, ApJ, 657, 1098
Winn, J. N., Johnson, J. A., Albrecht, S., et al. 2009a, ApJL, 703, L99
Winn, J. N., Holman, M. J., Bakos, G. Á., et al. 2007b, AJ, 134, 1707
Winn, J. N., Holman, M. J., Torres, G., et al. 2008b, ApJ, 683, 1076
Winn, J. N., Holman, M. J., Henry, G. W., et al. 2009b, ApJ, 693, 794
Winn, J. N., Johnson, J. A., Fabrycky, D., et al. 2009c, ApJ, 700, 302
Winn, J. N., Matthews, J. M., Dawson, R. I., et al. 2011a, ApJL, 737, L18
Winn, J. N., Howard, A. W., Johnson, J. A., et al. 2011b, AJ, 141, 63
Winters, J. G., Medina, A. A., Irwin, J. M., et al. 2019, AJ, 158, 152
Wong, I., Knutson, H. A., Cowan, N. B., et al. 2014, ApJ, 794, 134
Wong, I., Knutson, H. A., Lewis, N. K., et al. 2015, ApJ, 811, 122
Wong, I., Knutson, H. A., Kataria, T., et al. 2016, ApJ, 823, 122
Wyttenbach, A., Lovis, C., Ehrenreich, D., et al. 2017, A&A, 602, A36
Yan, F., Espinoza, N., Molaverdikhani, K., et al. 2020, A&A, 642, A98
Yee, S. W., Winn, J. N., Knutson, H. A., et al. 2020, ApJL, 888, L5
Yip, K. H., Changeat, Q., Edwards, B., et al. 2021, AJ, 161, 4
Yu, L., Zhou, G., Rodriguez, J. E., et al. 2018a, AJ, 156, 250
Yu, L., Rodriguez, J. E., Eastman, J. D., et al. 2018b, AJ, 156, 127
Yu, L., Crossfield, I. J. M., Schlieder, J. E., et al. 2018c, AJ, 156, 22
Zellem, R. T., Pearson, K. A., Blaser, E., et al. 2020, PASP, 132, 054401
Zhao, M., O'Rourke, J. G., Wright, J. T., et al. 2014, ApJ, 796, 115
Zhou, G., Bayliss, D., Penev, K., et al. 2014, AJ, 147, 144
Zhou, G., Rodriguez, J. E., Collins, K. A., et al. 2016, AJ, 152, 136
Zhou, G., Bakos, G. Á., Hartman, J. D., et al. 2017, AJ, 153, 211
Zhou, G., Huang, C. X., Bakos, G. Á., et al. 2019a, AJ, 158, 141
Zhou, G., Bakos, G. Á., Bayliss, D., et al. 2019b, AJ, 157, 31