UNIVERSITY OF LEICESTER

Discovering and characterizing extra-solar planets with the Next Generation Transit Survey

• Participate in identifying new candidate transiting extra-solar planets from NGTS data. • Collect follow-up photometric transit light curves, plus spectroscopic and other data, to validate and confirm these planets. • Analyse, model and publish newly discovered planets, from short-period hot Neptunes to cold Jupiters in orbits of hundreds of days.	**Level**	PhD
	First Supervisor	Dr Matt Burleigh mrb1@le.ac.uk
	Second Supervisor	Dr Mike Goad
	Application Closing Date	See web page
	PhD Start date	September 2024

Project Details:

With over 5000 extra-solar planets now known, a complete census of exoplanetary types and systems is well underway, from hot Jupiters to cool rocky worlds. Transiting systems are key because a well-constrained orbital inclination allows for the precise determination of the mass, radius and thereby bulk composition of the transiting planet. A transiting planet can also potentially have its atmospheric composition investigated by space-based telescopes such as JWST and, at the end of this decade, ESA's Ariel mission. Today, the principle transiting exoplanet discovery machines are NASA's TESS satellite and, from the ground, the Next Generation Transit Survey (NGTS, ngtransits.org).

NGTS is located at Paranal, Chile and consists of a suite of twelve 20cm telescopes, with a total field of view of 96 square degrees. By achieving a photometric precision of about 0.1%, at the limit of what is achievable from the ground, NGTS is designed to detect the transits of Neptune, sub-Neptune and Super-Earth sized planets around stars brighter than about 15thmagnitude, as well as many new hot Jupiters, and increasingly, cooler planets in long period orbits up to several hundred days.

The original NGTS survey ran from 2015/16 to 2019/20. Among its discoveries was, at the time, the largest planet around a low mass M-dwarf star (NGTS-1b); a rare, hot Neptune-sized world in a very short period orbit of just over a day (NGTS-4b); multi-planet systems such as NGTS-11; and bloated hot Jupiters with significantly inflated atmospheres.

Beginning around 2019/20, NGTS switched its main focus to a number of other projects, including the discovery of transiting planets in much longer period orbits than had previously been possible. In particular, NGTS's telescopes are used to follow-up single transit events detected by the TESS mission. Since TESS typically observes a star for only 30 days or so, NGTS is ideal for long term monitoring to detect further transits and thereby determine the planets' true orbital periods. Unlike hot Jupiters, these "warm" and "cold" gas giants will have temperatures and atmospheres much more akin to Jupiter and Saturn in our own solar system, and will become key targets for future investigations with JWST and Ariel.

This PhD will focus on two main NGTS projects:

Over 40 NGTS planet discoveries from its surveys have been published or are currently being written up for publication. However, dozens more candidates still await follow-up photometric and radial velocity measurements to confirm their radii and masses. Meanwhile, some of the NGTS telescopes are still surveying the southern sky and more candidates are regularly identified through our partner initiatives such as the citizen science Planet Hunters

NGTS. In this project, you will help identify new candidate planets and obtain, reduce and analyze follow-up light curves with ground-based telescopes such as those at the South African Astronomical Observatory (SAAO). You will combine these data with radial velocity measurements from precision spectrographs such as Coralie and HARPs, and/or other datasets such as high resolution speckle imaging. You will analyse these datasets with suitable modelling codes, and lead papers to publish the results, validating, confirming and characterizing these new planets, and placing them in context.

You will also join NGTS's long period planet discovery team, analysing new single transit candidates from TESS together with follow-up NGTS transits and associated radial velocity data. Again, you will have the opportunity to publish some of these new discoveries. During this PhD, it is likely that new long period planet candidates will be added to NGTS's target list from other surveys such as ESA's GAIA satellite. This project is particularly important as we look forward to the launch of ESA's Plato mission in late 2026, which will reveal many more long period planets.

NGTS is very much a Team effort. You will participate in regular meetings with the local Leicester NGTS members, and in weekly online meetings with NGTS astronomers and PhD students from other universities. Once or twice a year you will also have the opportunity to join in-person NGTS consortium meetings, as well as the annual UK Exoplanet Meetings and other national and international conferences.
Candidates for this PhD should be enthusiastic to learn how to observe on large telescopes, potentially including travelling to SAAO and other observatories. Some knowledge of programming in python and other codes would be advantageous.

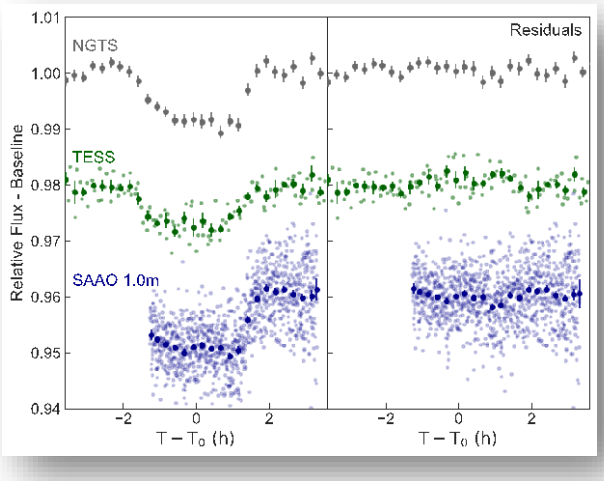
References:

"The Next Generation Transit Survey (NGTS)" – Wheatley et al. 2018, MNRAS, 475, 4476
https://arxiv.org/abs/1710.11100

"NGTS-4b: A sub-Neptune transiting in the desert" – West et al. 2019, MNRAS, 486, 5094
https://arxiv.org/abs/1809.00678

"NGTS 15b, 16b, 17b, and 18b: four hot Jupiters from the Next Generation Transit Survey" – Tilbrook et al. 2021, MNRAS, 504, 6018 http://arxiv.org/abs/2103.10302

"Two long-period transiting exoplanets on eccentric orbits: NGTS-20 b (TOI-5152 b) and TOI-5153 b" – Ulmer-Moll et al. 2022, A&A, 666, 46 https://arxiv.org/abs/2207.03911



Transit light curves of NGTS-17b, a hot Jupiter planet with a highly inflated atmosphere discovered by NGTS and published by ex-Leicester PhD student Rosie Tilbrook (2021, MNRAS, 504, 6018).

Further information on how to apply and funding can be found at
https://le.ac.uk/study/research-degrees/funded-opportunities/stfc