New Target Stars and Radial Velocity Discoveries of Hot Rocky Exoplanets

Supervision team: Professor Carole Haswell, Dr John Barnes and Dr Joanna Barstow

External supervisor: Dr Joe Llama (Lowell Observatory)

Lead contact: Professor Carole Haswell

Description:

The Dispersed Matter Planet Project (DMPP) uses signatures of absorption by circumstellar gas to identify the probable host stars of key exoplanets for study in the coming era of exoplanetology. We identified 39 bright, nearby target stars and are executing a state-of-the-art programme of high cadence, high precision radial velocity RV observations to detect rocky exoplanets in short period orbits around them. Our first three planetary systems are DMPP-1: a compact multiplanet system, with multiple super-Earth planets orbiting a bright nearby star; DMPP-2, the joint first RV discovery of a planet orbiting a strongly pulsating star; DMPP-3 which is a ~500d eccentric binary star system hosting a circum-primary super-Earth. The last of these presents formidable challenges to our current planet formation models. Because the stars were identified by the signatures of absorbing gas ablated from the close-in planets, these systems are amenable to transmission spectroscopy which can reveal the planet composition. Furthermore, angular momentum considerations suggest these planets have a high probability of transiting. Thus, potentially, our planet discoveries will yield planet masses, radii and compositions, all with small uncertainty ranges. This paves the way for comparative exogeology.

The 39 DMPP target stars were selected using the log R'_{HK} metric to identify stars shrouded by absorbing circumstellar gas. One strand of the work for this PhD project will be to extend the DMPP supersample by exploiting thousands more archival log R'_{HK} measurements. This work will combine stellar astrophysics with data science techniques to identify the stars which probably host hot rocky planets in edge-on orbits.

The second work strand will be the observation and analysis of radial velocity planet searches on the existing DMPP targets and new targets identified by the student. This will be as part of the DMPP collaboration, which involves a handful of people and is led by Haswell at the OU.

If the Covid-19 restrictions lift, the work is likely to include opportunities to travel to observatories, including the facilities of the European Southern Observatory in Chile, the South African Astronomical Observatory in the western Roggeveld Mountains in the Karoo, South Africa and Lowell Observatory in Arizona, USA.

The student(s) will be expected to lead-author papers announcing planet discoveries and present results at national and international exoplanet conferences.

Continued

References:

1. **Haswell, Carole A.**, Staab, Daniel, **Barnes, John R.**, Anglada-Escudé, Guillem, Fossati, Luca, Jenkins, James S., Norton, A.J., Doherty, J., Cooper, J. '*Dispersed Matter Planet Project discoveries of ablating planets orbiting nearby bright stars'* 2019, Nature Astronomy, 4, 408 doi:10.1038/s41550-019-0973-y.
2. Staab, Daniel, **Haswell, Carole A.**, **Barnes, John R.**, Anglada-Escudé, Guillem, Fossati, Luca, Doherty, James P.J., Cooper, Joseph, Jenkins, James S., Díaz, Matías, Soto, Maritza G. *'A compact multi-planet system around a bright nearby star from the Dispersed Matter Planet Project'* 2019, Nature Astronomy, 4, 399 doi:10.1038/s41550-019-0974-x.
3. **Barnes, John R., Haswell, Carole A.**, Staab, Daniel, Anglada-Escudé, Guillem, Fossati, Luca, Doherty, J.P.J., Cooper, J., Jenkins, James S., Díaz, M.R., Soto, M.G., Peña Rojas, P.A. *'An ablating super-Earth in an eccentric binary from the Dispersed Matter Planet Project'*

names in bold are supervisors, underlined names are former PhD students in Haswell's group

Qualifications required:

Degree in physics, astrophysics or closely-related subject at 2:1 MPhys or better.
Programming experience is highly desirable.
Interest in and background knowledge of exoplanetary research is desirable.