Searching for long period transiting exoplanets with ASTEP South at Dome C, Antarctica

N. Crouzet[1], D. Mékarnia[2], T. Guillot[2], D. Bayliss[3], H. Deeg[4], E. Palle[4], L. Abe[2], A. Agabi[2], J.-P. Rivet[2], F.-X. Schmider[2], F. Murgas[4], M. Gillon[5], L. Delrez[6], E. Jehin[5], N. Espinoza[7]

[1] *European Space Agency / ESTEC, The Netherlands, nicolas.crouzet@esa.int;* [2] *Laboratoire Lagrange, Observatoire de la Côte d'Azur, CNRS, Nice, France;* [3] *University of Warwick, Coventry, UK;* [4] *Instituto de Astrofísica de Canarias, La Laguna, Tenerife, Spain;* [5] *Space sciences, Technologies and Astrophysics Research (STAR) Institute, Université de Liège, Belgium;* [6] *Cavendish Laboratory, University of Cambridge, UK;* [7] *Max-Planck-Institut für Astronomie, Heidelberg, Germany*

Abstract: Much of our understanding of gas giant exoplanets comes from the study of hot Jupiters. These planets are coupled to their host stars: the strong irradiation and tidal interactions impact their orbital and physical properties. In contrast, "cold Jupiters" (P > 30 days, a > 0.2 au) are largely decoupled from their host stars and those transiting bright stars provide ideal benchmarks to study this class of planets. The 4-month continuous night during the Antarctic winter combined with excellent weather conditions is favorable to the detection of such planets. We analyzed four winters of photometric data collected with the ASTEP South instrument at Dome C in Antarctica, identified transit candidates including at long periods, and conducted photometric follow-up with the 0.4m telescopes of the Las Cumbres Observatory Network of Telescopes.

1. ASTEP South

- **ASTEP** (Antarctica Search for Transiting Exoplanets) is a pilot project to detect and characterize exoplanets from Dome C and qualify this site for photometry in the visible (PI: T. Guillot, *Fressin+2005, Crouzet+2010, Mekarnia+2016, Crouzet+2018*).
- The **4-month continuous night during** the Antarctic winter combined with **excellent weather conditions** is favorable to the detection of periodic events including at long periods.
- ASTEP South is **a fixed 10 cm refractor** and a CCD camera in a thermalized enclosure installed at the French-Italian Concordia station, Dome C, Antarctica.
- We observed a 4°x4° field of view centered on the celestial South pole continuously during **four winters**.

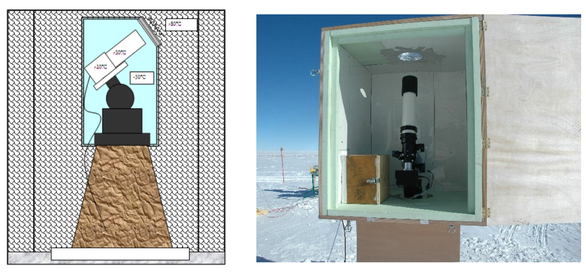
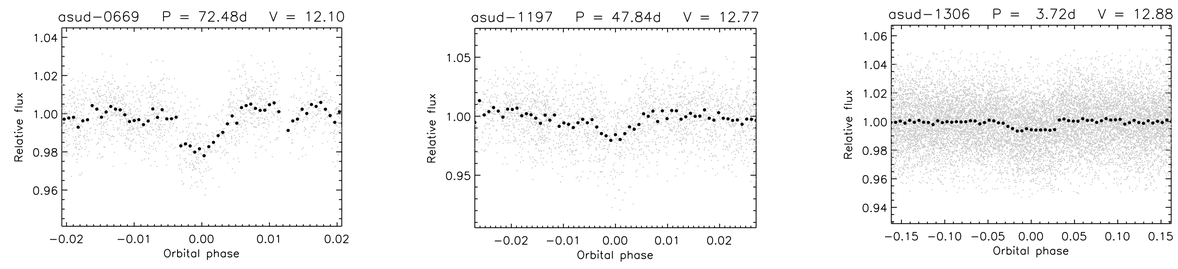


Figure 1. ASTEP South at the Concordia station, Dome C, Antarctica.

2. Transit candidates

- We built lightcurves for **6000 stars** with 6 < R mag < 15 and searched for periodic signals using the Box Least Square algorithm (BLS, *Kovacs+2002*).
- We identified **29 transit candidates**.
- Most of them are around **bright stars** and about half have a period **longer than 30 days**.



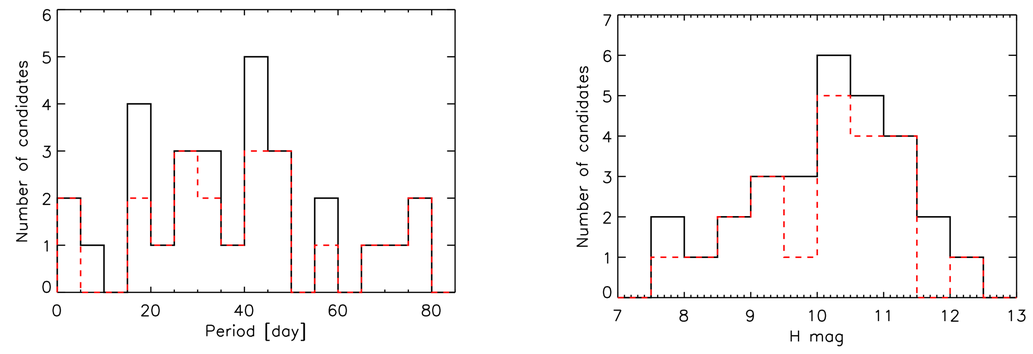


Figure 2. Top: Example of transit candidates. Bottom: Histograms of orbital periods (left) and host star H magnitude (right) for the initial set of candidates (black) and for those that are still valid (red).

3. Photometric follow-up

We conducted a photometric follow-up of these objects using the **0.4m telescopes** of the **Las Cumbres Observatory Network of Telescopes** (LCOGT) located at Siding Spring (Australia), Sutherland (South Africa), and Cerro Tololo (Chile). We find that:

- **7 have a confirmed signal**, including 2 stellar eclipsing binaries
- 7 can be rejected
- 15 need more observations

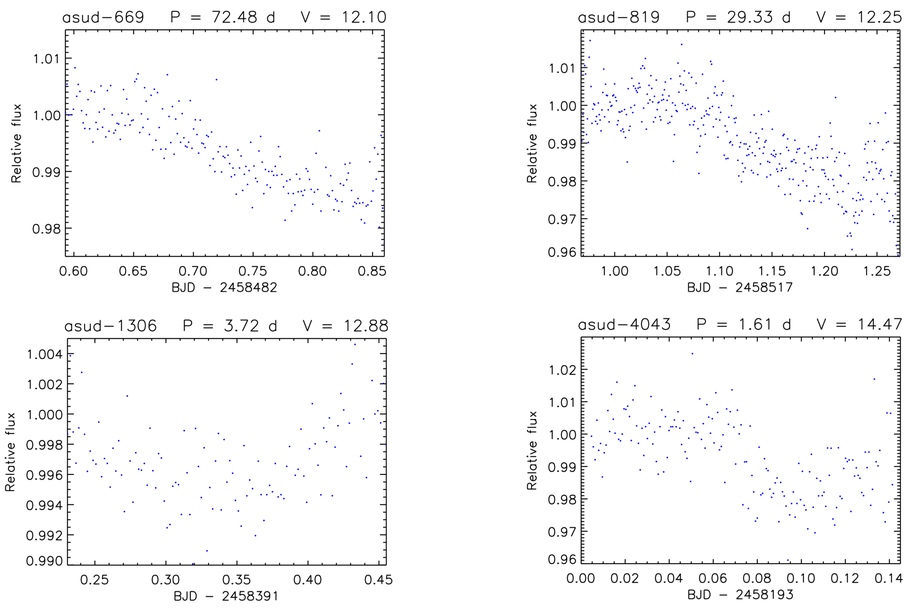


Figure 3. Lightcurves of four objects with a confirmed signal from LCOGT 0.4m telescopes.

4. Expected yield

- We expect to find **a few transiting "cold Jupiters" orbiting bright stars**, which will enable their characterization. Only a handle of such objects are known.
- If confirmed, these objects would expand the parameter space in the study of gas giant exoplanets.
- We also have two objects that could be hot Jupiters.

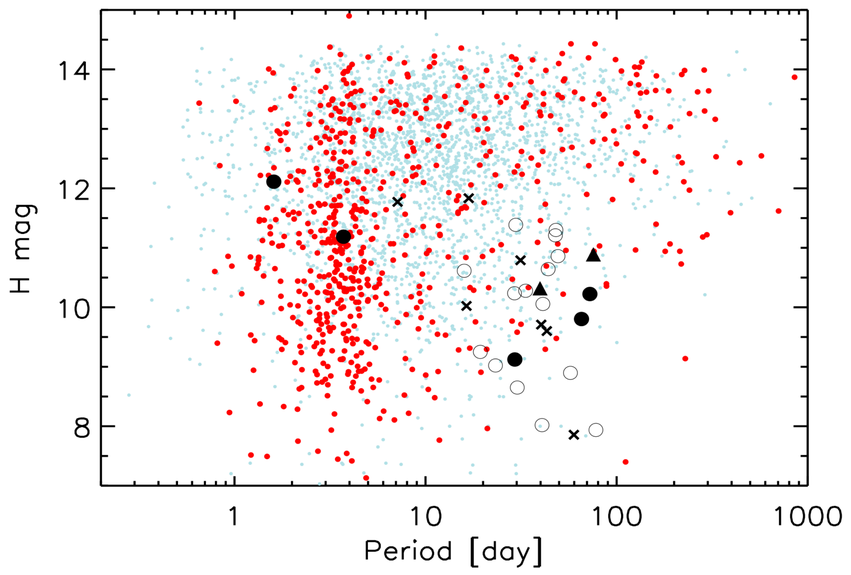


Figure 4. Orbital period as a function of stellar H magnitude for known transiting exoplanets and for our candidates. Giant planets (R > 0.35 R_{Jup}) are shown in red, smaller planets (R < 0.35 R_{Jup}) are shown in blue. Our candidates that are confirmed by photometric follow-up are shown as black filled circles, those that are eclipsing binaries as black filled triangles, those that need more observations as black open circles, and those that can be rejected as black crosses.

Conclusion: We identified 29 transit candidates in the 4-winter lightcurves obtained with ASTEP South at Dome C, Antarctica. The photometric follow-up is underway and we have confirmed the presence of a transit signal for several objects. The next step will be to obtain radial velocities and investigate their TESS lightcurves when they are available. This work should yield the discovery of a few transiting "cold Jupiters" suitable to atmospheric characterization and expand the parameter space in the study of gas giant exoplanets.

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