ASTEP South: An Antarctic Search for Transiting Planets around the celestial South pole


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Abstract: ASTEP South is the first phase of the ASTEP project that aims to determine the quality of Dome C as a site for future photometric searches for transiting exoplanets and discover extrasolar planets from the Concordia base in Antarctica. ASTEP South consists of a front-illuminated 4x4k CCD camera, a 10 cm refractor, and a simple mount in a thermalized enclosure. A double glass window is used to reduce temperature variations and its accompanying turbulence on the optical path. The telescope is fixed and observes a 4° x 4° field centered on the celestial South pole. With this design, A STEP South should be very stable and observe with low and constant airmass, both being important issues for photometric precision. We present the project, the noise budget, an analysis of test observations around the celestial North pole done in Calern as well as first observations from Concordia.

1) ASTEP South: aim and setup

ASTEP South aims to detect transiting planets from Dome C, Antarctica. The 3 month continuous night as well as a very dry atmosphere should yield to an improvement of the photometric precision when compared to other sites. The instrument is completely fixed and points towards the celestial South pole continuously, so that stars turn around the CCD every ~24 hours. The instrument was set up at the Concordia base in January-February 2008. ASTEP South is now observing and delivering its first data.

2) Simple model

We perform an analytical model to evaluate the planet radius that can be detected with ASTEP South. Simulated field at the celestial South pole from the Besançon model are used. We consider that a planet is detected if the flux variation is at least 3 times the photon noise. From the star radius, we obtain the minimum planet radius that can be detected. As shown in fig. 4, in a 1°x1° field, a planet with a radius of 1.5 RJup can be detected for roughly 500 stars. For our 3.8°x3.8°, this number grows to 7000 and possibly to detect planets.

3) Numerical study

Simphot is a photometric simulator that aims to reproduce each step of a survey, from the observation to the final lightcurves. The starting point is the flux from target and background stars. Atmospheric elements such a seeing variations and sky background are added. A CCD transmission matrix is then simulated as well as instrumental noise including jitter and Point Spread Function variations onto the CCD. Aperture photometry and comparison with a reference star are then performed on simulated images. Lightcurves and photometric precision for each target star are then obtained.

Conclusion: ASTEP South is the first transit survey from Dome C, Antarctica. The instrument inside its thermalized box is currently observing towards the celestial South pole. A simple analytical model show that the observed field contains enough star to allow transit detection with our 10 cm refractor. Simulation made with Simphot show a rms noise close to the photon noise for stars of magnitude 12 or less, and a noise level better than 10 mmag for stars of magnitude 14 or less. This first campaign should allow us to test this new observing method, to qualify the Dome C for photometric precision and possibly to detect planets.

References:
- Fressin et al. EAS 14, 2005