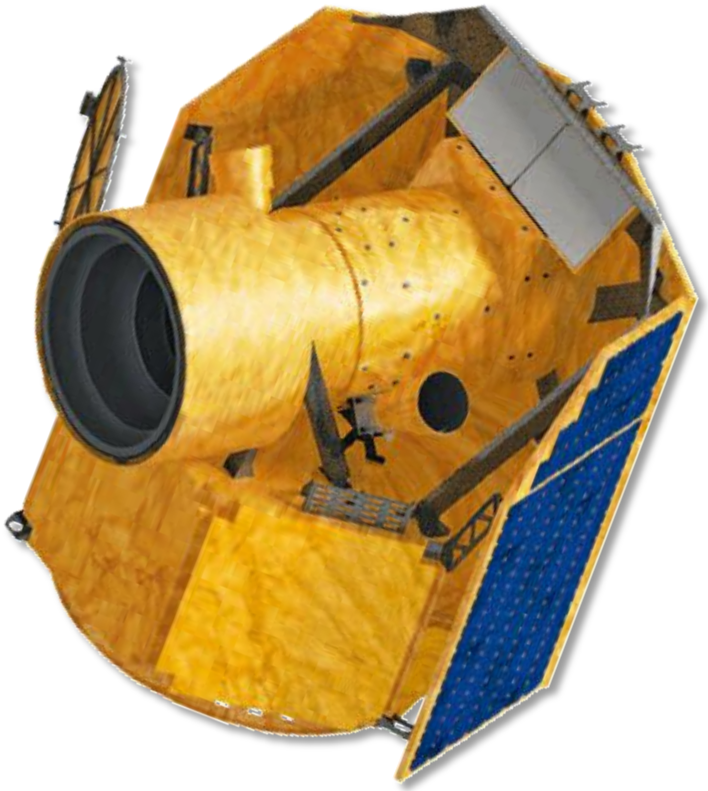
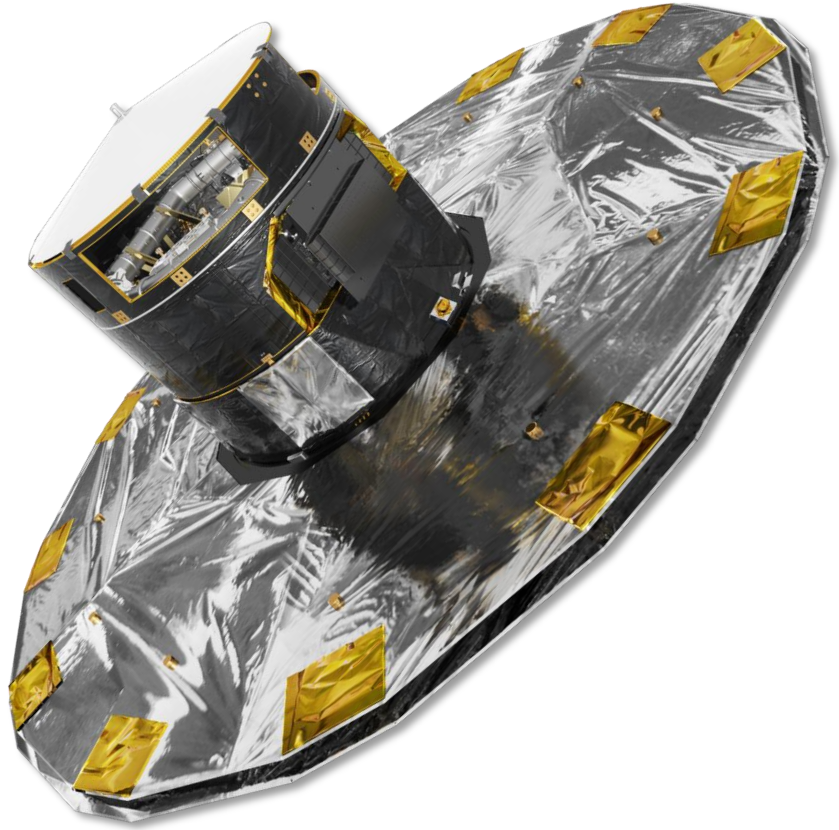
The GAIA/CHEOPS synergy





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and the CHEOPS A1 working group

Introduction

- GAIA is the most accurate (~10 μas) astrometric survey ever; it was launched in 2013 and is performing well (though some technical issues)
- Final catalog is expected in ≥2022, with a few intermediate releases starting from 2016
- **What planets (or planetary candidates) can GAIA provide to CHEOPS?** This was investigated within the CHEOPS A1 WG, designed to 1) build an overview of available targets, 2) monitor present and future planet-search surveys, 3) establishing selection criteria for CHEOPS, 4) and proposing strategies to build the target list.

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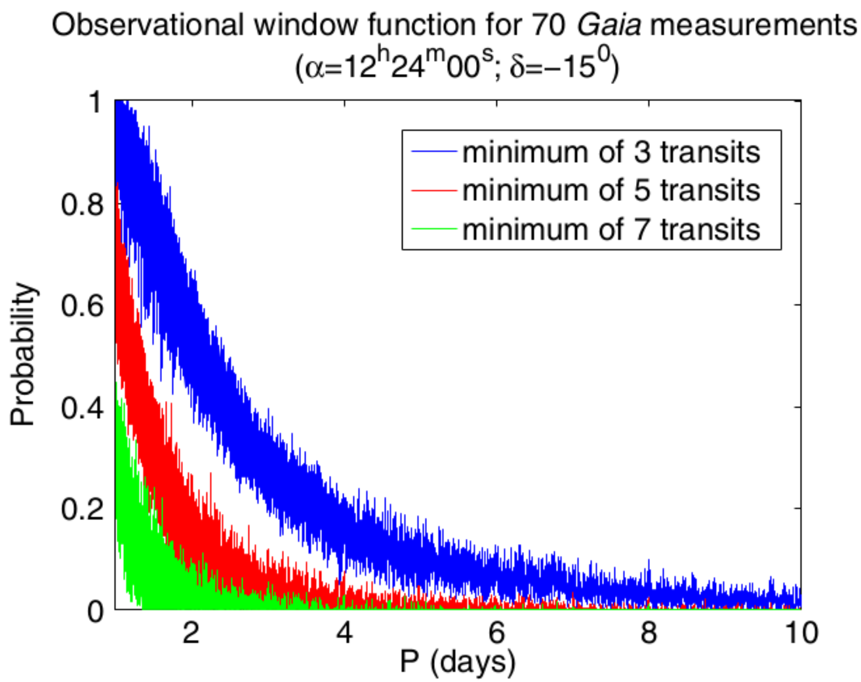
We started reviewing some recent works about the GAIA planet yield:

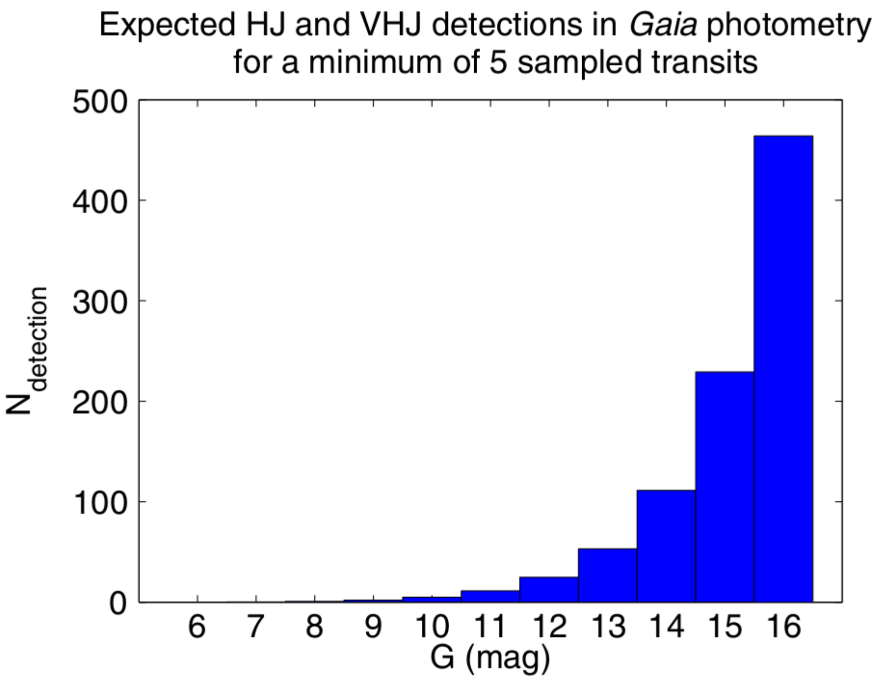
- Casertano+ 2008, A&A 482, 699. "*Double-blind test program for astrometric planet detection with GAIA*"
- Perryman+ 2014, Apj 797, 14. "*Astrometric Exoplanet Detection with GAIA*"
- Dzigan & Zucker 2012, ApJ 753, 1. "*Detection of Transiting Jovian Exoplanets by GAIA Photometry*"
- Sozzetti+ 2014, MNRAS 437, 497, "*Astrometric detection of giant planets around nearby M dwarfs: the GAIA potential*"
- Lucy 2014, A&A 571, 86. "*Analysing weak orbital signals in GAIA data*"
- Sahlmann+ 2015, MNRAS 447, 287. "*GAIA's potential for the discovery of circumbinary planets*"

"Photometric" planets

Challenges of GAIA planets discovered by photometry:

- GAIA's photometric detection of transiting planets will be limited by precision (1 mmag) and especially by the sparse sampling of the scanning law (Dzigan & Zucker 2012)
- Nearly all those planets will be VHJ (P < 3 d); only ~40 of them will be robustly detected and bright enough for CHEOPS (G < 12).





“Astrometric” planets

Challenges of GAIA planets discovered by astrometry:

- the **astrometric method** is biased towards massive, cool planets hosted by low-mass, nearby stars
- the **transit probability** is p ~ R*/a (1/300 for an Earth twin) → strongly biased towards short-period planets
- as for the **FGK dwarfs**, GAIA should discover 20,000 planets, of which 25-40 transiting (Perryman+ 2014); only ~2 will be brighter than G<12
- as for the **M dwarfs**, ~10 transiting systems with accurate orbit determination (Δi < 2°) are expected (Sozzetti+ 2013); but they are expected to be hosted by very late and faint stars (G>14)

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CHEOPS follow-up of planets astrometrically detected by GAIA is challenging:

▸ Best-fit orbital parameters such as *P* and *i* can be affected by ~a few % errors even in the best case: ephemeris and transit geometry very uncertain. Realistic transit window up to ~20% of the orbital phase! (Perryman+ 2015)

▸ ambiguity over inferior vs. superior conjunction (intrinsic to the astrometric method): both must be monitored → 2x window → 40% of the phase!

▸ most detections will be transit of long-period (a>1 AU) giants: deep (>0.01 mag) and long (>12h) transits. Ground-based coordinated follow-up more suited?

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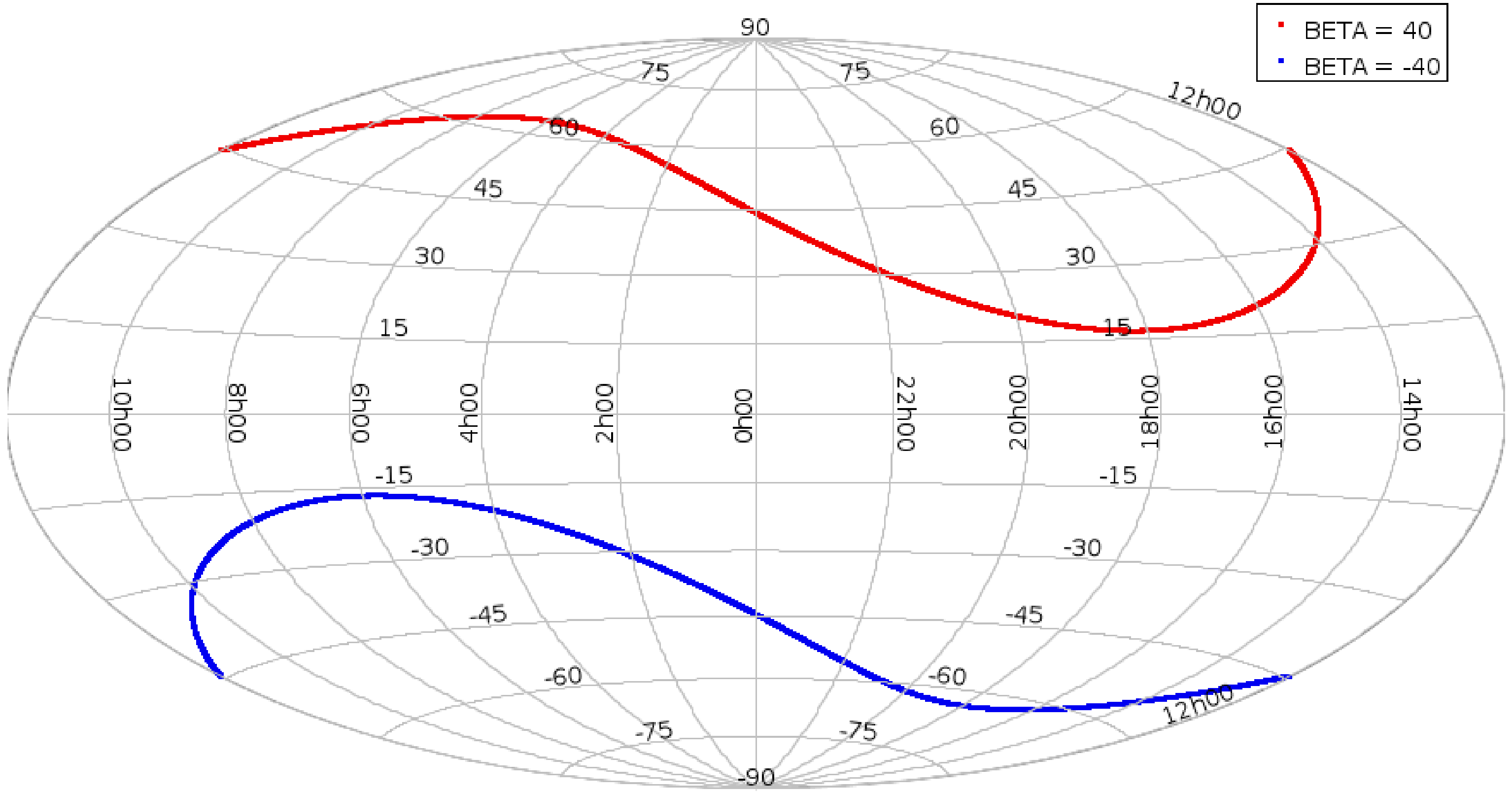
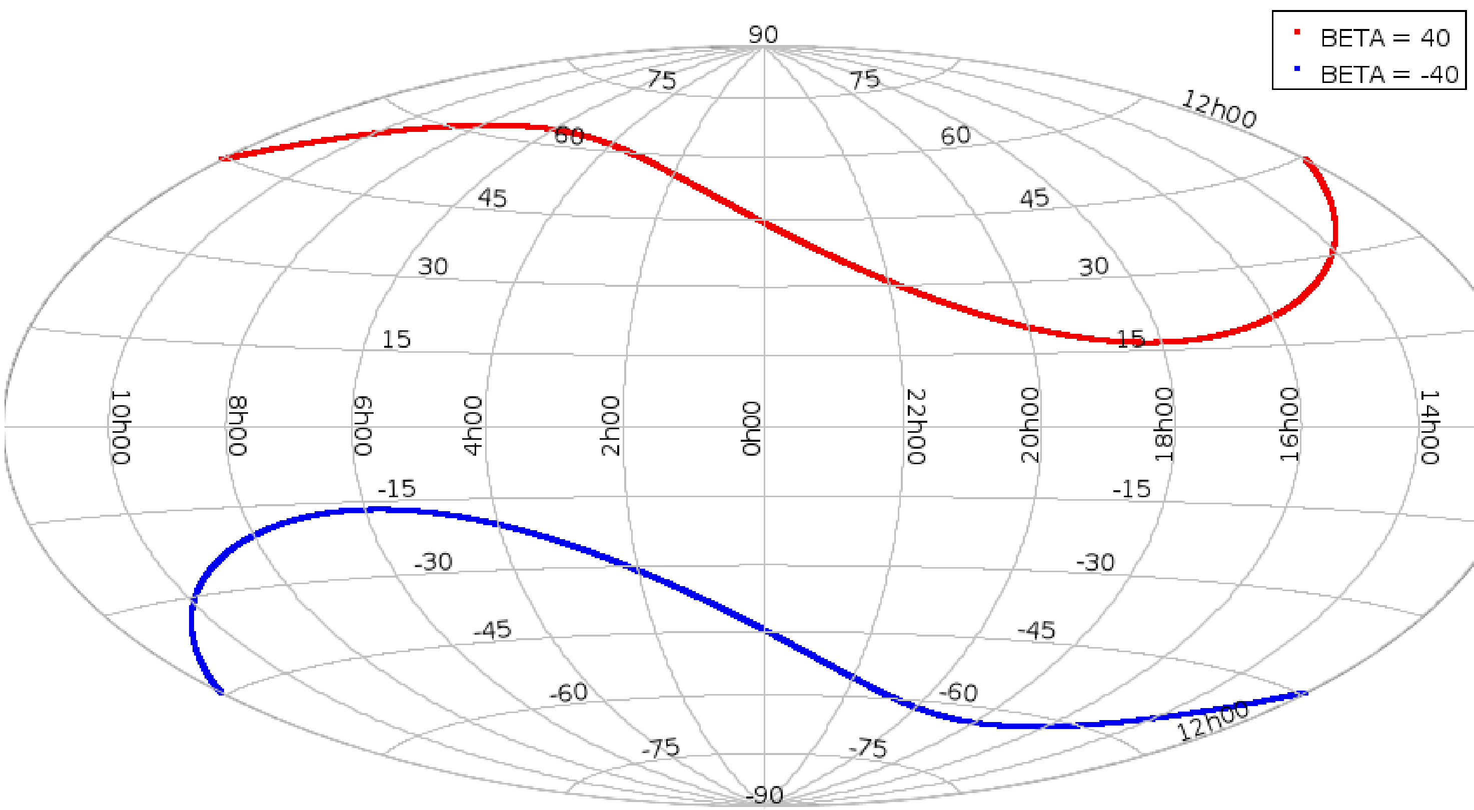
The GAIA scanning law predicts a maximum of N~140 transits at ecliptic latitude β~45, decreasing to N~65 on the ecliptic, and N~78 at the poles. The β~45 parallel is mostly at high declinations, i.e., difficult to be accessed by CHEOPS.



The GAIA/CHEOPS synergy

GAIA planets discovered through photometry will be strongly biased towards β~45°, because S/N scales with √(N); but "astrometric" planets will be limited by the temporal baseline, so ~isotropically distributed (Perryman+ 2014)



Conclusions

- Transiting planets provided by GAIA through photometry will be a few tens of VHJ (~1 Rjup, P < 3 d, G < 12). Most of them, however, will be at high declinations
- Planets discovered by GAIA trough astrometry will be essentially giant planets on large orbits, hosted by relatively faint stars. Only a handful of them will be transiting and bright enough for CHEOPS (G < 12), and detecting their transits will be very time-expensive
- **While GAIA will be an extremely powerful tool to better characterize the CHEOPS targets, its impact as target provider will be very limited on a few lucky cases**