
Alexis Brandeker
Stockholm University
CHEOPS
CHARACTERIZING EXOPLANET SATELLITE
esa

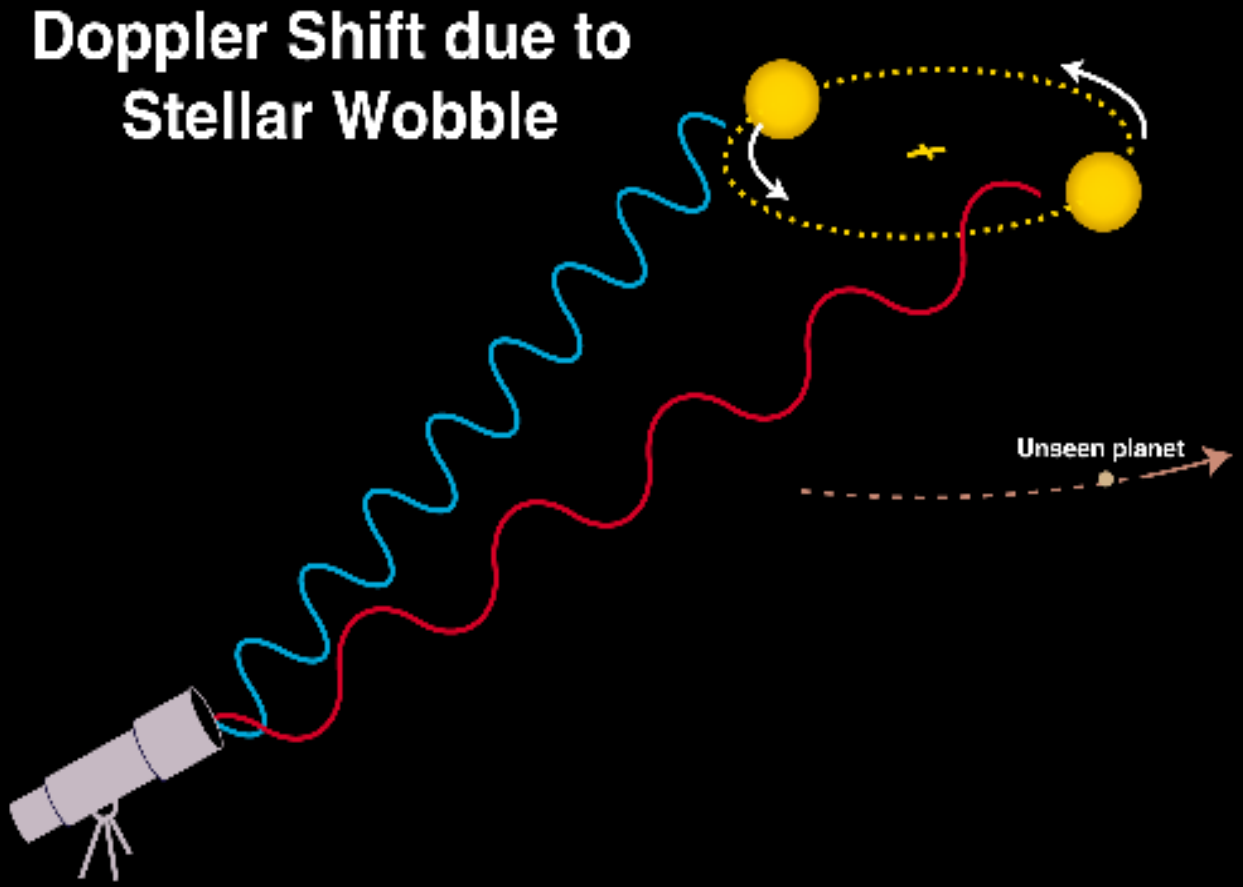
ESA small mission requirements

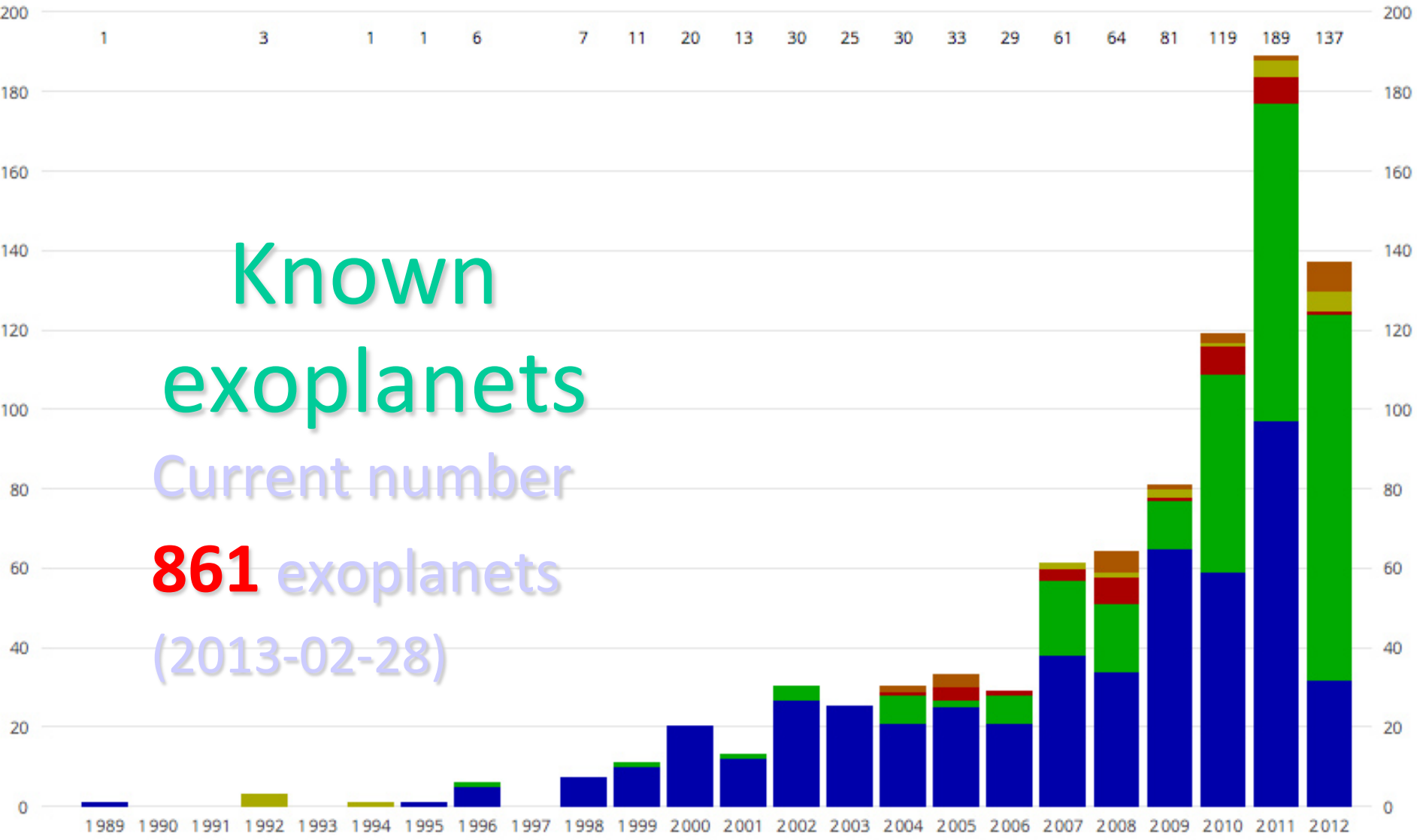
- Science
  - top rated science in any area of space science
- Cost
  - total cost < 150 M€
  - cost to ESA: not to exceed 50 M€
- Schedule
  - developed and launched within 4 years

call issued	March 3, 2012
proposal due	June 15, 2012
mission selection	October 19, 2012
mission adoption	Nov 2013/ Feb 2014
launch	2017

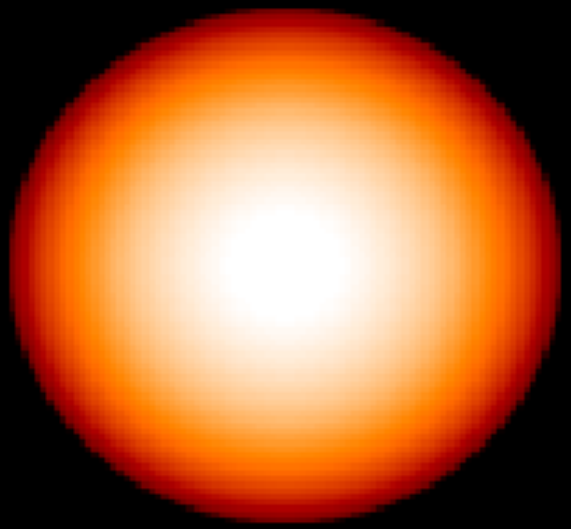
Country	Institutes	Contacts
CH	University of Bern (project lead) University of Geneva Swiss Space Center (EPFL) ETH-Z	Willy Benz, Nicolas Thomas Didier Queloz Anton Ivanov Michael Meyer
Austria	Institut für Weltraumforschung, Graz	Wolfgang Baumjohann
Belgium	Centre Spatial de Liège Université de Liège	Etienne Renotte Michaël Gillon
France	Laboratoire d'astrophysique de Marseille	Magali Deleuil
Hungary	Konkoly Observatory	Laszlo Kiss
Italy	Osservatorio Astrofisico di Catania – INAF Osservatorio Astronomico di Padova - INAF Università di Padova	Isabella Pagano Roberto Ragazzoni Giampaolo Piotto
Portugal	Centro de Astrofisica da Universidade do Porto	Nuno C. Santos
Sweden	Onsala Space Observatory, Chalmers University Stockholm University	René Liseau Göran Olofsson
UK	University of Warwick	Don Pollaco

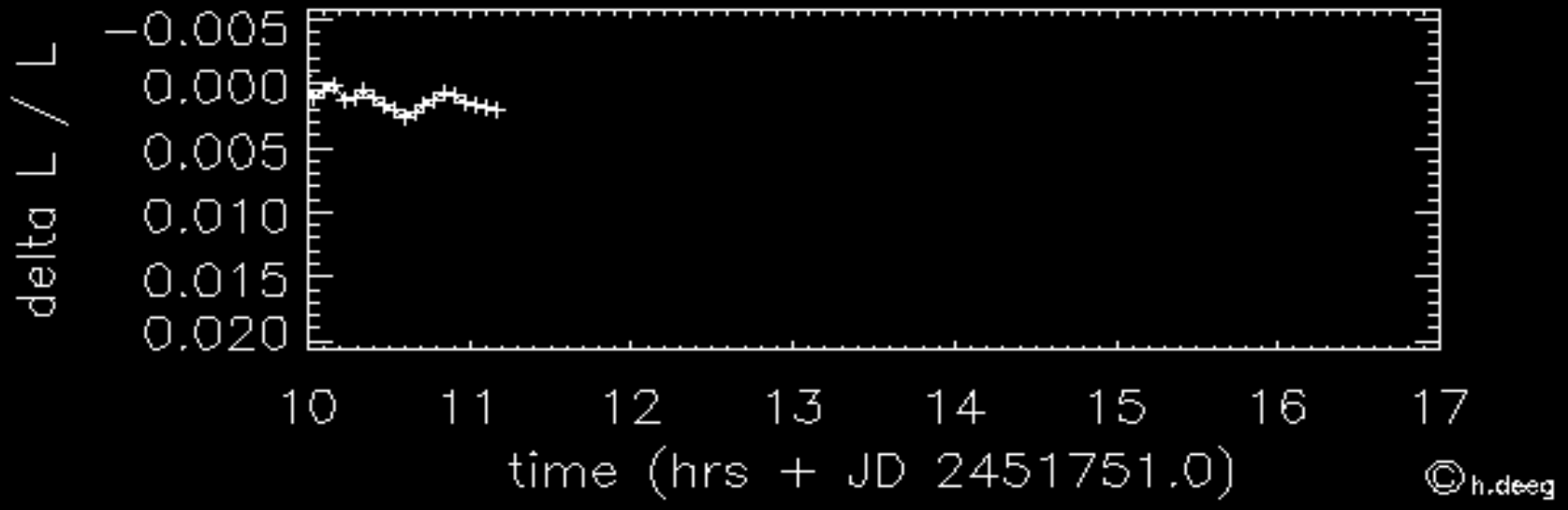
Radial velocity measurements



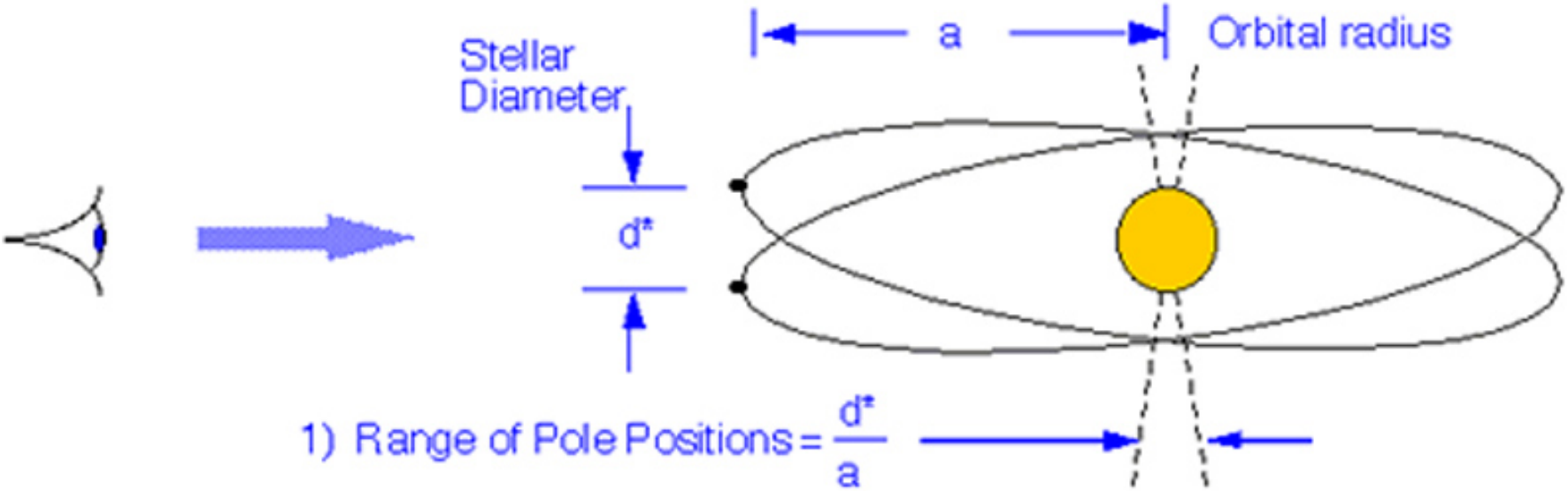

Known exoplanets
Current number
861 exoplanets
(2013-02-28)
1 3 1 1 6 7 11 20 13 30 25 30 33 29 61 64 81 119 189 137
0 20 40 60 80 100 120 140 160 180 200
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012

Exoplanet transit

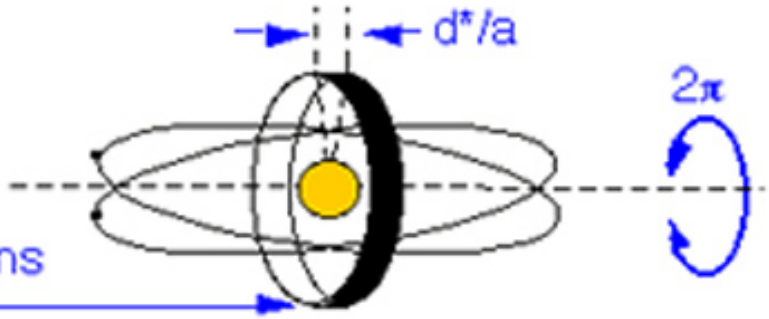




GEOMETRY FOR TRANSIT PROBABILITY



1) Range of Pole Positions = $\frac{d^*}{a}$

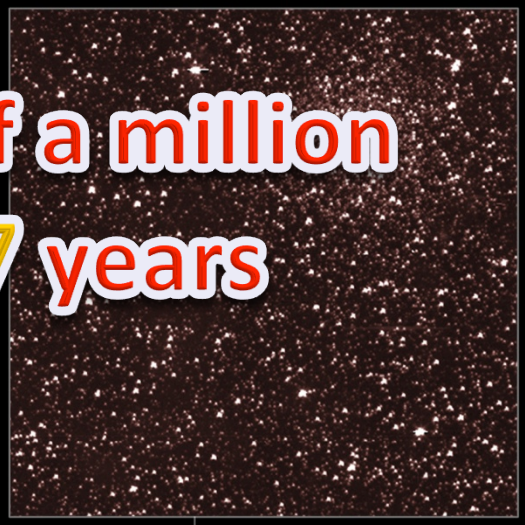


2) Solid angle of $2\pi d^*/a$
for all possible pole positions
for any given LOS
Note full sphere solid angle is 4π

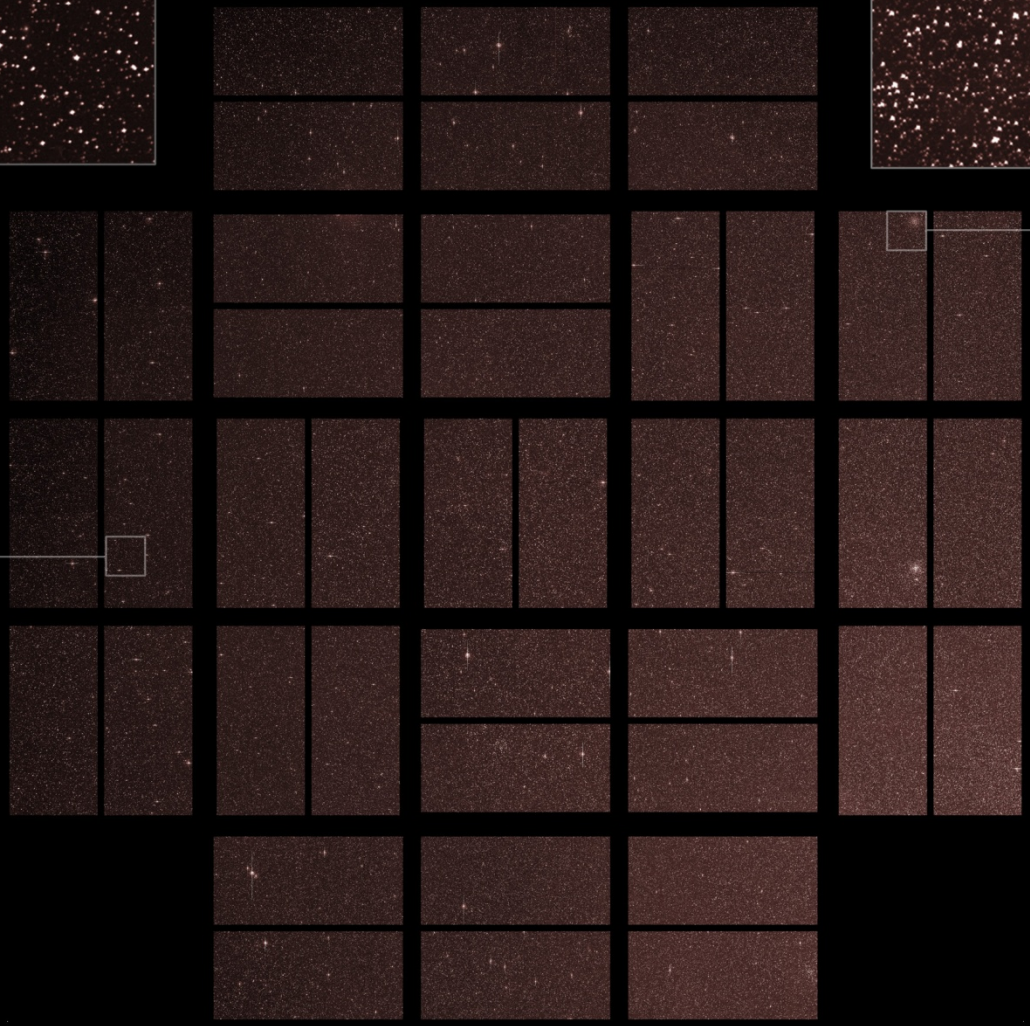
3) Geometric Transit Probability = $d^*/2a$

Kepler: 150 000 stars out of a million continuously under ~~3~~ 7 years

TrES-2

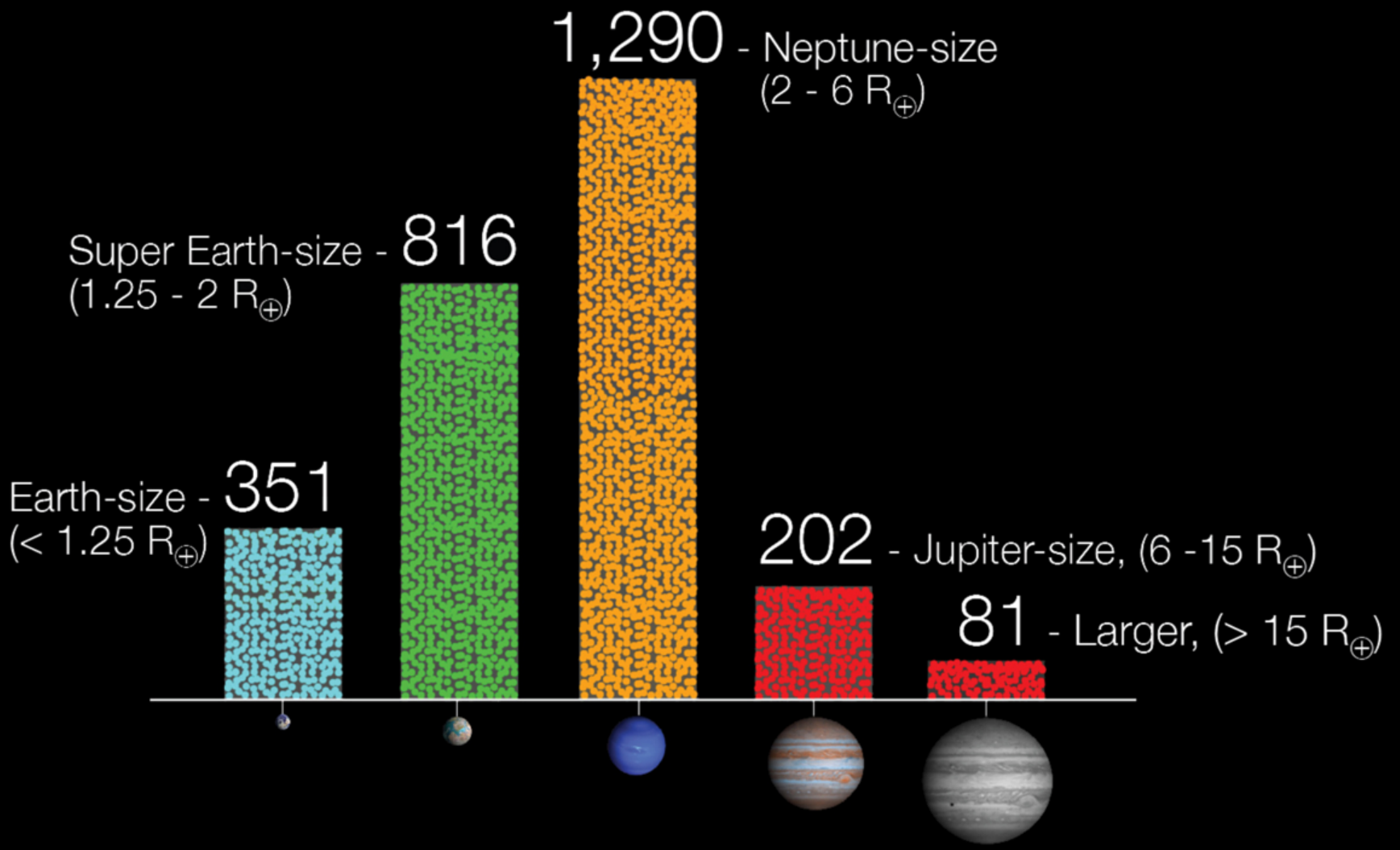


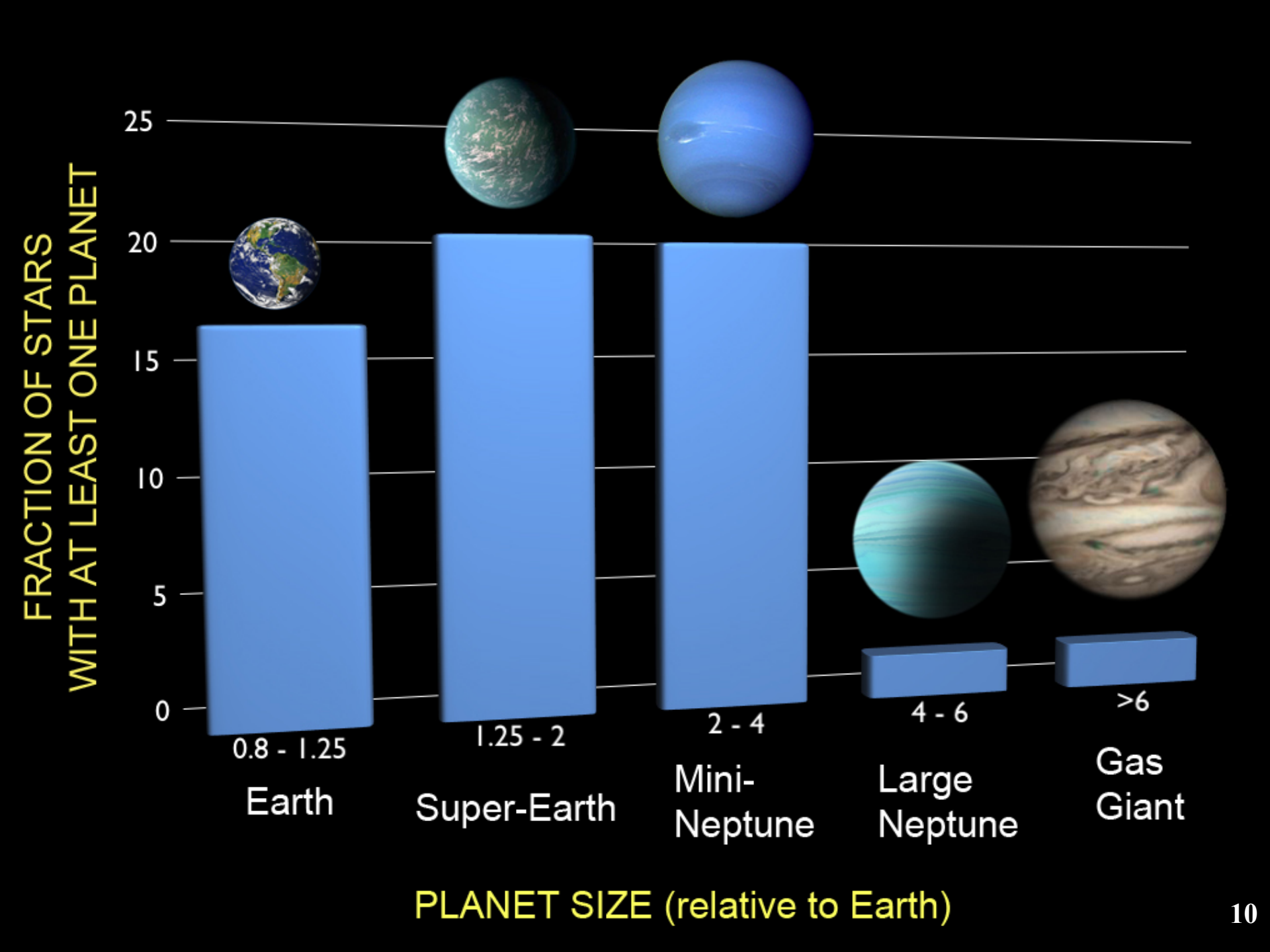
NGC 6791



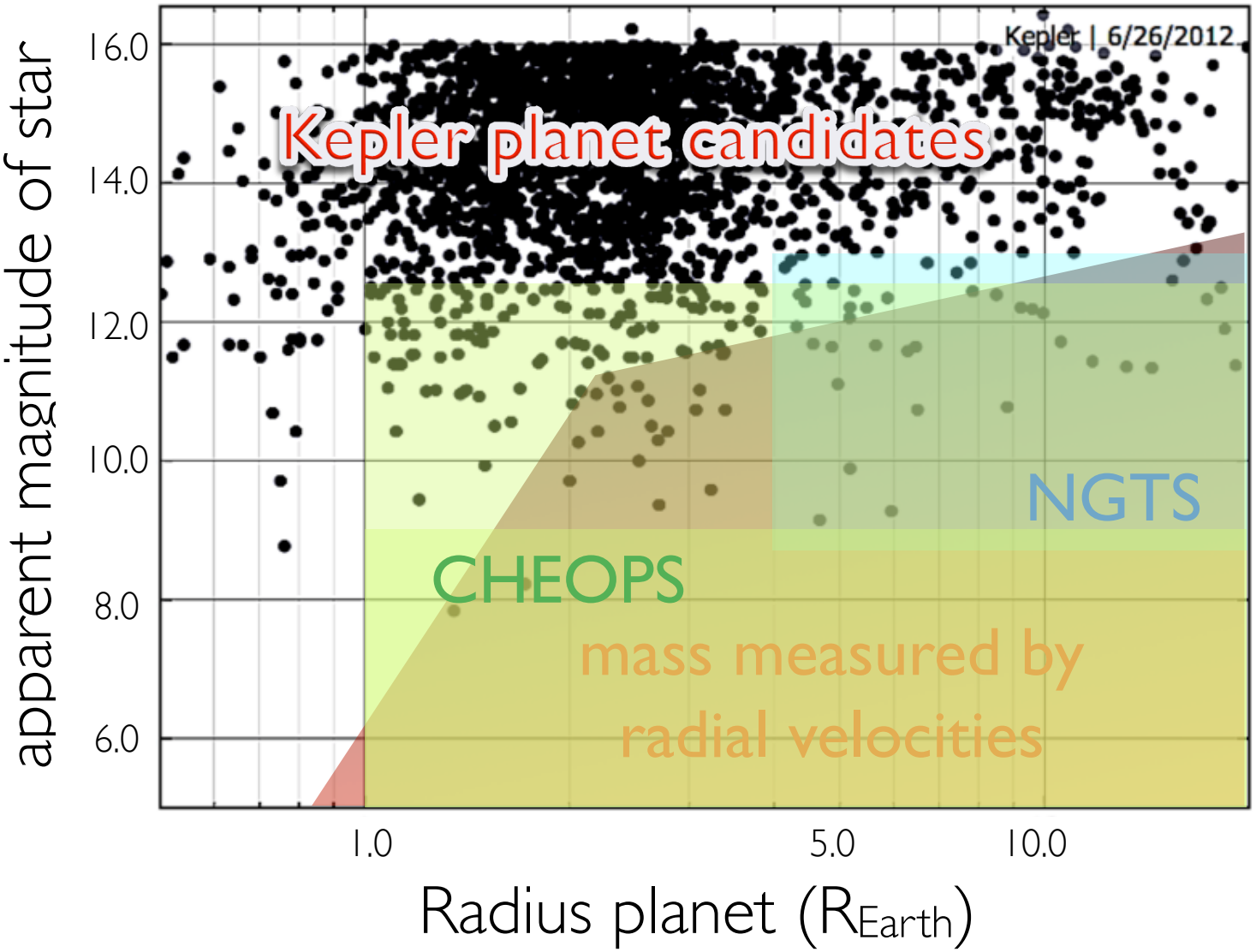
Sizes of Planet Candidates

As of January 7, 2013

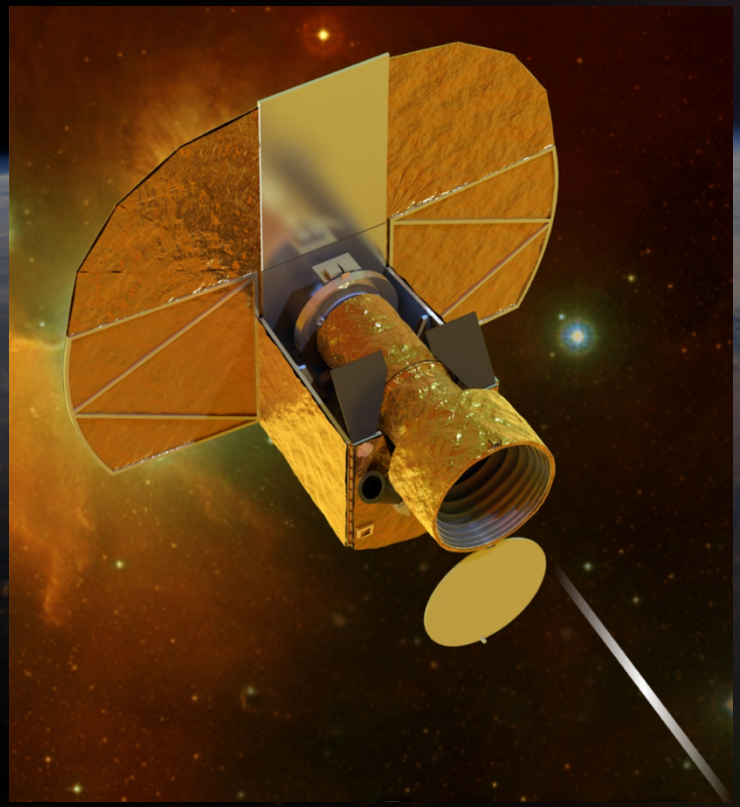



FRACTION OF STARS
WITH AT LEAST ONE PLANET
25
20
15
10
5
0
0.8 - 1.25
1.25 - 2
2 - 4
4 - 6
>6
Earth
Super-Earth
Mini-
Neptune
Large
Neptune
Gas
Giant
PLANET SIZE (relative to Earth)

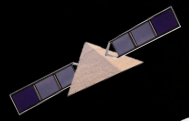
Targets: Bright stars



Cheops (2017)



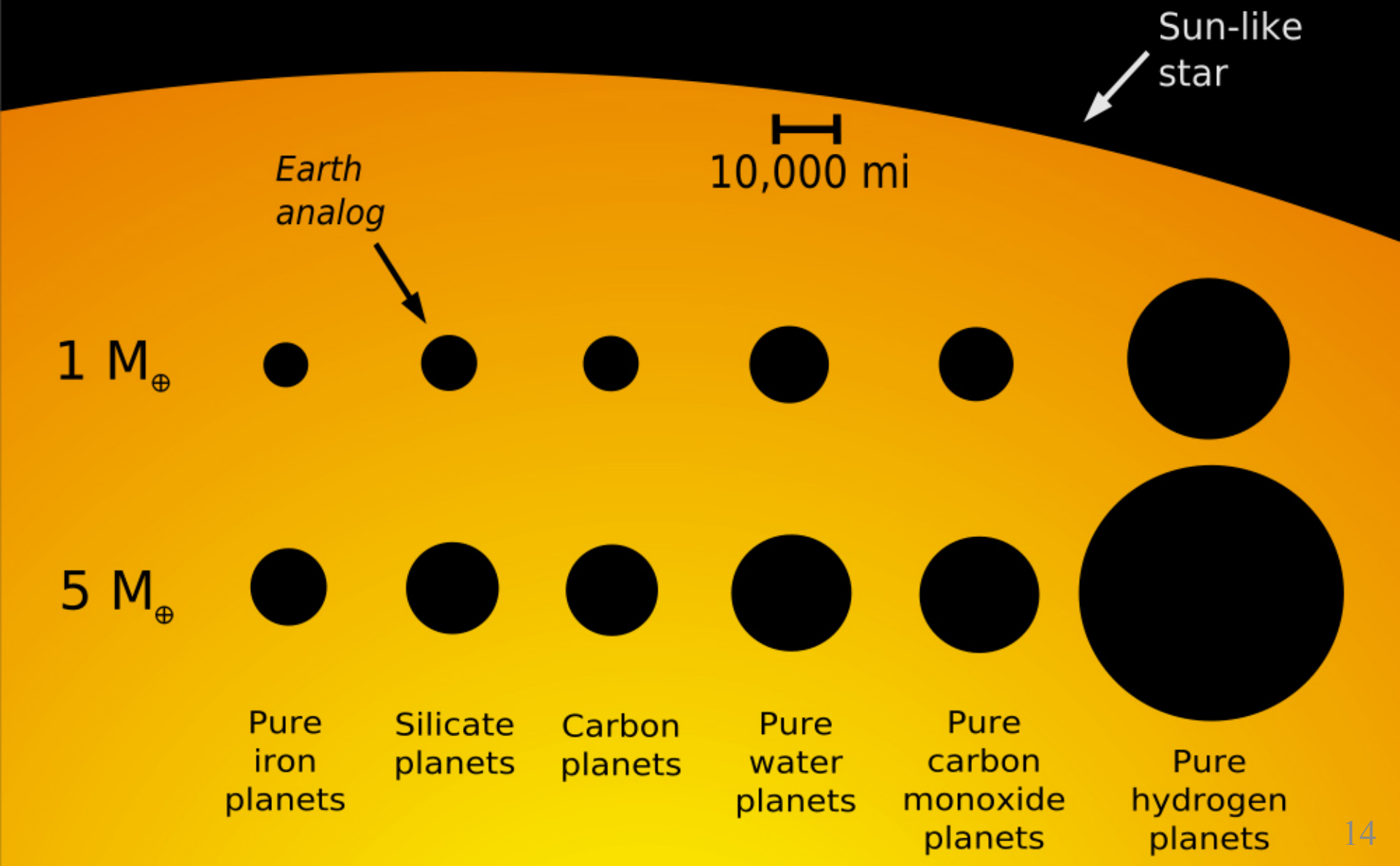
- Characterise planets (radii, composition)
- Small mirror (30 cm)
- Point (almost) anywhere: follow up RV discoveries



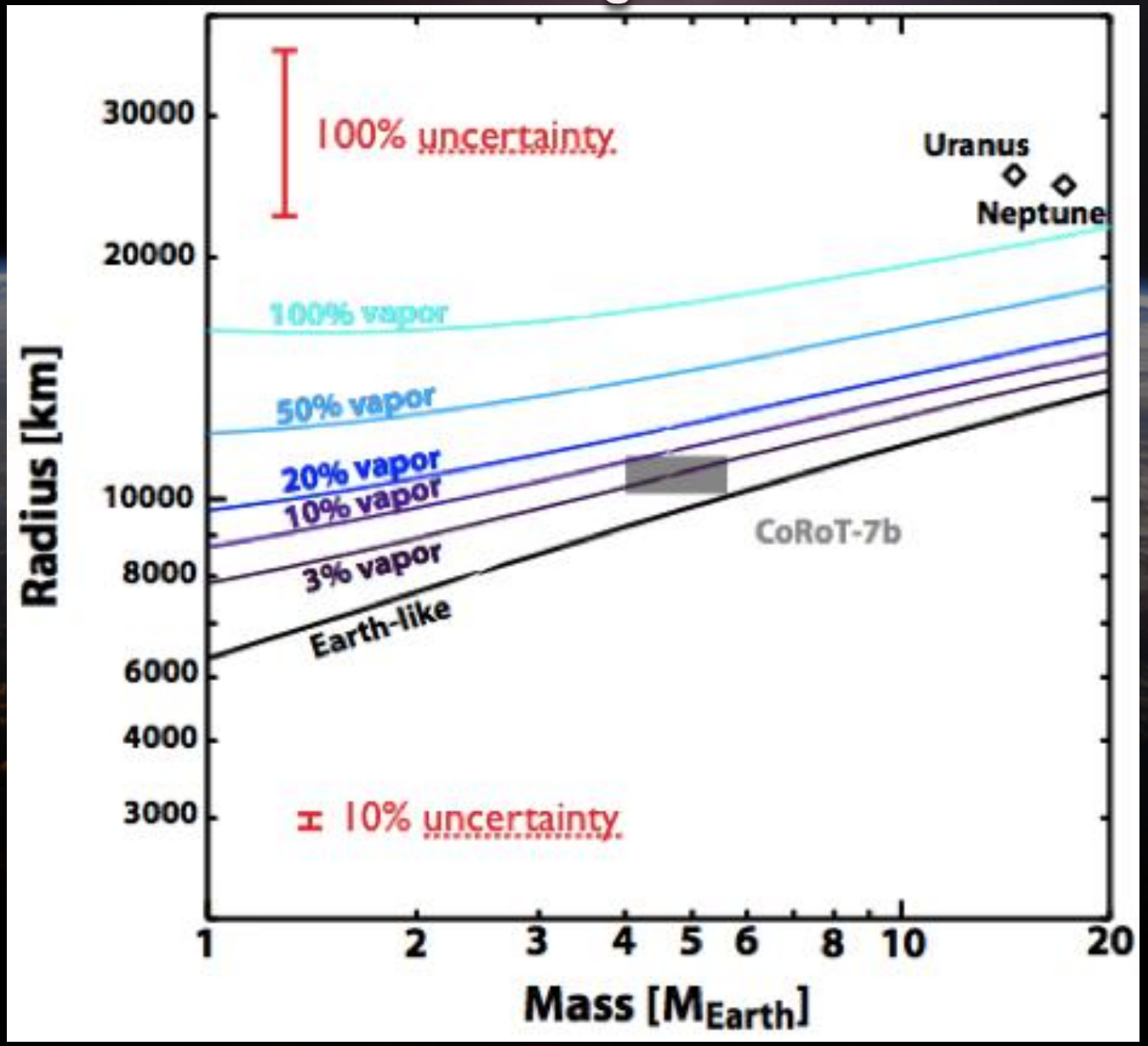
CHEOPS: Science Objectives

1. Mass-radius relation determination
2. Identification of planets with atmospheres
3. Constraints on planet migration paths
4. Energy transport in hot Jupiter atmospheres
5. Targets for future spectroscopic facilities
6. Variability study of astronomical sources

Predicted sizes of different kinds of planets



Cheops


100% uncertainty
Uranus
Neptune
100% vapor
50% vapor
20% vapor
10% vapor
3% vapor
Earth-like
CoRoT-7b
10% uncertainty
Radius [km]
30000
20000
10000
8000
6000
4000
3000
1
2
3
4
5
6
8
10
20
Mass [M_Earth]

Summary

Name	CHEOPS (CHaracterizing ExOPlanet Satellite)
Primary science goal	Measure the radius of planets transiting bright stars to 10% accuracy (Earth-like: 15 ppm)
Targets	Known exoplanet host stars with a V-magnitude < 12.5 anywhere on the sky
Wavelength	Visible range : 400 to 1100 nm
Telescope	30 cm effective aperture reflective on-axis telescope
Orbit	LEO sun-synchronous, LTAN 6am, 620-800 km
Lifetime	3.5 years
Type	s-class