Exoplanetary transits

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The era of exoplanets

Detections Per Year

Radial Velocity
Transits
Microlensing
Imaging
Timing Variations
Orbital Brightness
Modulation
Astrometry
Transiting planets: the basics

Probability? \( \approx \frac{R_\star}{a} \)
- \( \approx 0.5\% \) for Earth+Sun, \( 0.1\% \) for Jupiter+Sun
- \( \approx 10\% \) for a ‘hot’ planet (\( P < 5 \text{d} \))

Brightness drop? \( \approx \left(\frac{R_p}{R_\star}\right)^2 \)
- \( \approx 1\% \) for Jupiter+Sun
- \( \approx 100\text{ppm} \) for Earth+Sun

Detection methods?
- High-precision photometric survey of thousands of stars
- High-precision photometric monitoring of RV planets

Credits: Cook (2007); Jehin (2010); NASA (2011); Cortner (2011); Winn (2010); Johnson (2008);
Transiting planets: treasures in the sky

Phase curve (heat transfer, albedo, rotation...), Trojan search, planet mass...

Whole orbit

Emission spectrum – planet disk resolution – eccentricity...

occultation

Planet radius – obliquity –
Limb absorption spectrum – inclination – stellar density – spots – limb-darkening – satellite – rings...

transit

Planet – planet interactions

Dynamic – structure – atmosphere

No need for ultra high resolution/contrast imaging

Credits: Deming & Seager (2009)
Transiting planets: mass-radius plot

Mass-radius plot of transiting planets and their host stars

Credits: TEPCat/J. Southworth
Our projects
1. Search for transits of nearby exoplanets detected by RVs

From the ground

OFXB (2007)

TRAPPIST (2010 to now)

From space

Spitzer (2009 to now)

CHEOPS (from 2018)
1. Search for transits of nearby exoplanets detected by RVs

GJ436b @ 10pc

Gillon et al. (2007)

GJ3470b @ 30pc

Bonfils et al. (2012)

55 Cnc b @ 12pc

Demory et al. (2011)

HD219134b and c @ 6.5pc

Motalebi et al. (2016); Gillon et al. (2017)
2. Follow-up of candidates found by wide-field transit surveys

WASP

Kepler/K2

MEarth

From 2018: TESS
Example: follow-up of a WASP candidate with TRAPPIST

**WASP**
- Pixel scale = 13.7"
- Typical precision ~ 1%

**TRAPPIST**
- Pixel scale = 0.65"
- Typical precision ~0.1%

Example: a blend, but an interesting one; this is an highly irradiated planet, WASP-64 (Gillon et al. 2013)
3. Search for transiting terrestrial planets around nearby ultracool dwarfs
Southern hemisphere:
TRAPPIST-South (Chile)

Northern hemisphere:
TRAPPIST-North (Morocco)

SSO – Paranal (Chile) – 4 x 1m telescopes

SNO – Tenerife – ? x 1m telescopes
4. Detailed characterization of known transiting planets

- Radial velocities
- High-precision transit photometry
- Transit transmission spectroscopy
- Occultation emission spectroscopy
- Phase curve
- Occultation mapping
- Host star characterization
- Transit timing variations
4. Detailed characterization of known transiting planets

Demory, Gillon et al. (2017)
Our team
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