



 Cerro Calán
 Observatorio Astronómico Nacional

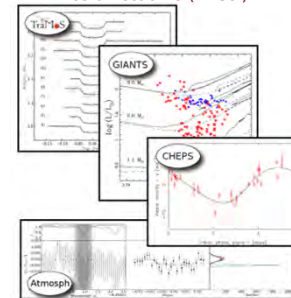


Exoplanet Research at Universidad de Chile

Patricio Rojo
 Prof. Astronomy Department
 U. Chile

Ground-based Exoplanets at U. Chile

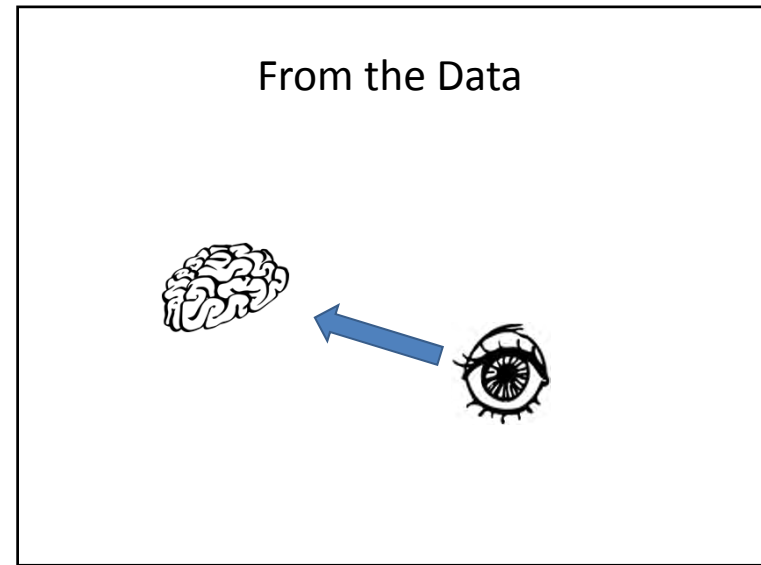
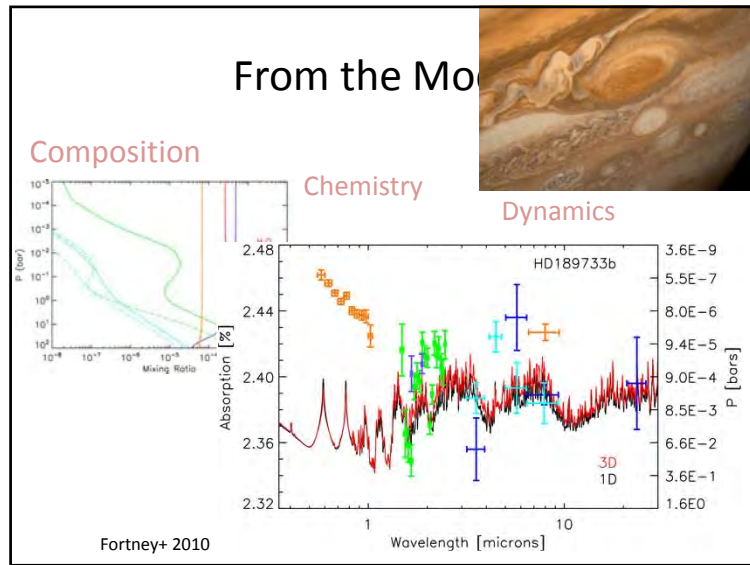
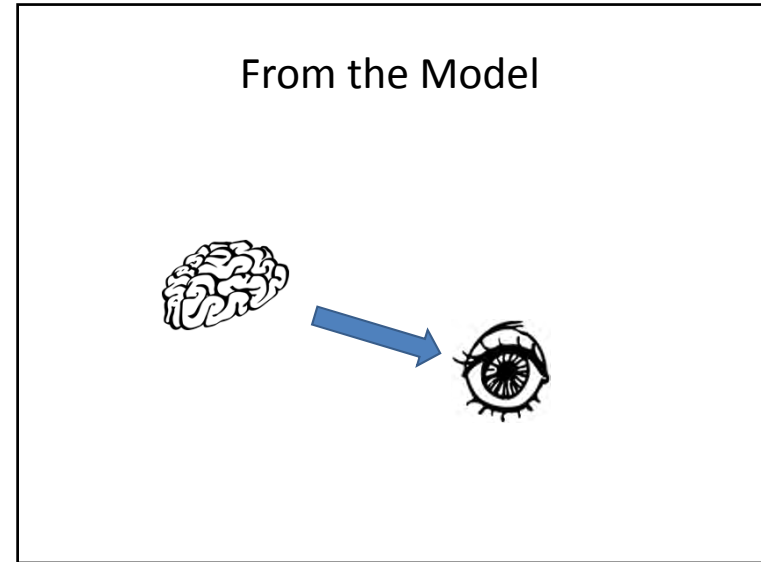
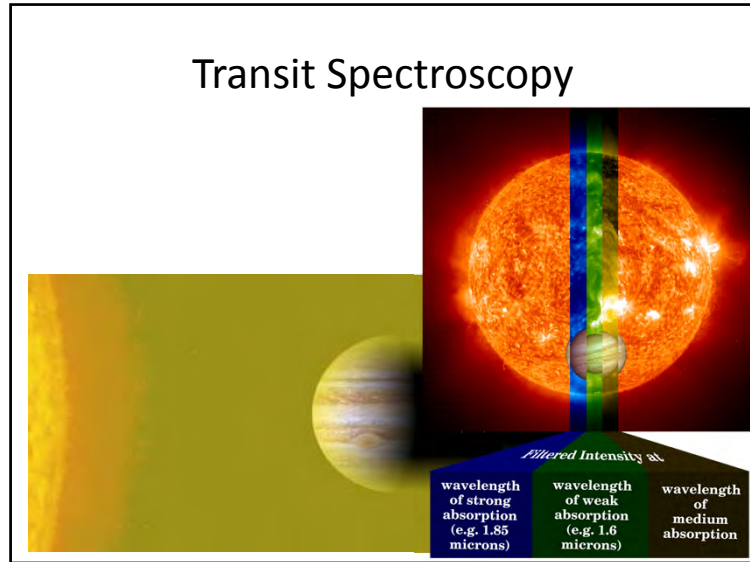
- Exoatmospheres
 - Optical Transmission Spectroscopy
 - Nicola Astudillo (M.Sc.)
- Surveys
 - Calan-Hertfordshire Exoplanet Survey (CHEPS)
 - James Jenkins (PostDoc)
 - H.R.A. Jones (Hertfordshire)
 - Red Giants Search
 - Matias Jones (Ph.D.)
 - TraMoS
 - Sergio Hoyer (Ph.D.)

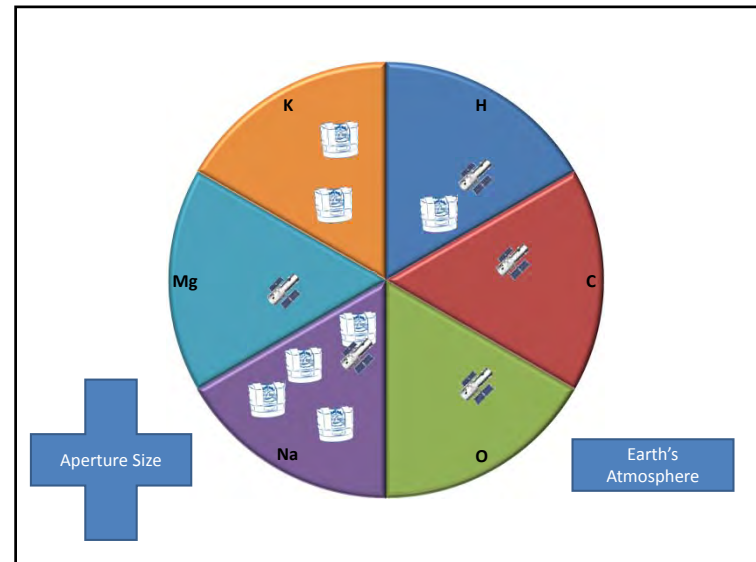
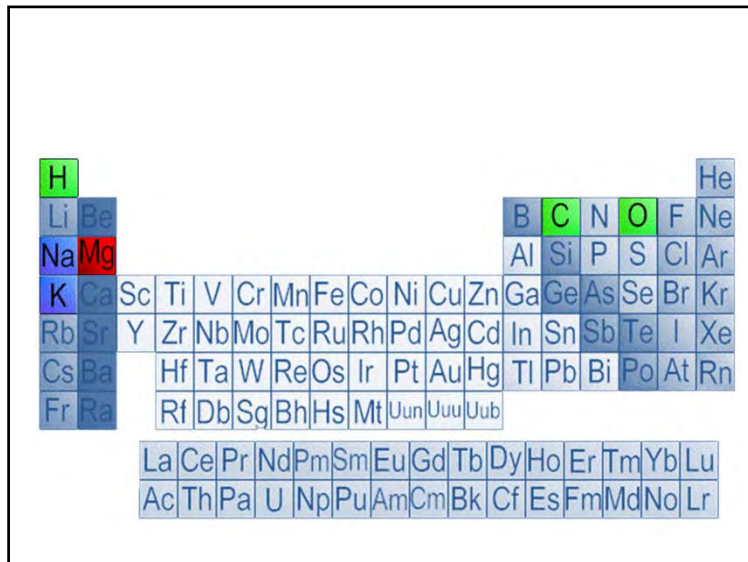
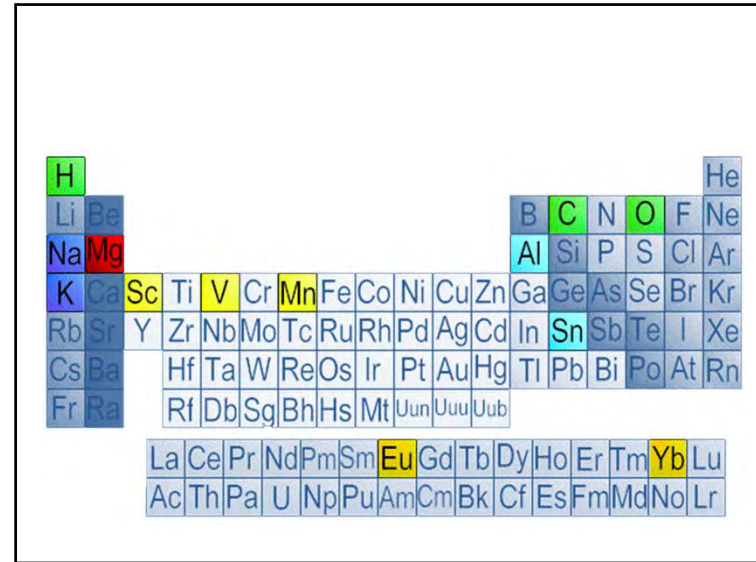
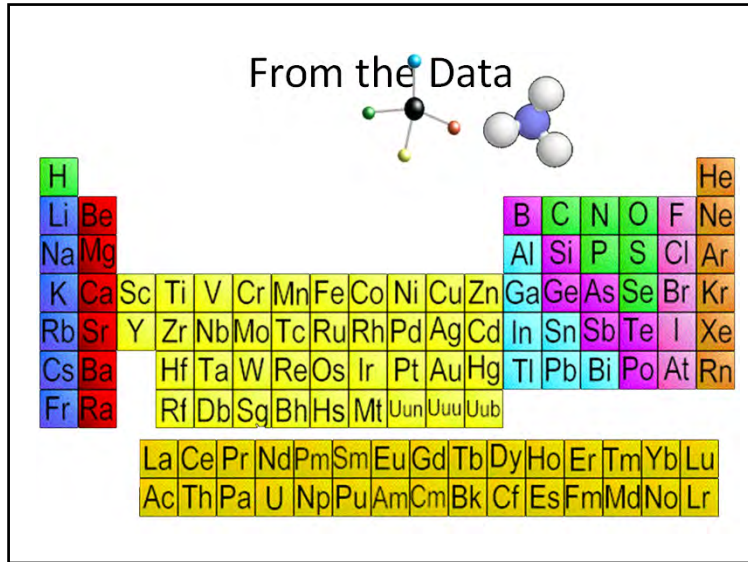


Ground-based Exoplanets at U. Chile

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- | | |
|--|---|
| <ul style="list-style-type: none"> ▪ P. Kabath (ESO) ▪ V. Ivanov (ESO) ▪ C. Cáceres (UV) ▪ J. Barnes (Herts) ▪ D. Pinfield (Herts) ▪ M. Tuomi (Herts) ▪ M.T. Ruiz (UChile) ▪ H.Y. Pavlenko (Torun) ▪ C. Migaszewsky (Torun) ▪ H. Goddziewsky (Torun) | <ul style="list-style-type: none"> ▪ A. Jordán (PUC) ▪ M. López-Morales (Harvard) ▪ C. Melo (ESO) ▪ F. Murgas (IAC) ▪ D. Crooker (UChile) ▪ E. Servajean (UChile) ▪ F. Concha (UChile) ▪ R. Ramírez (UChile) ▪ J. Parada (UConcepción) ▪ P. Bluhm (UConcepción) |
|--|---|

EXOATMOSPHERES



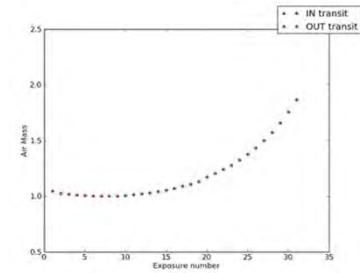


HD209458b again

- Astudillo & Rojo 2013, A&A accepted

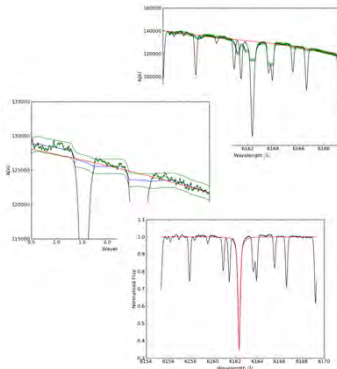
The Data

- HDS @ Subaru
 - Online archive (Snellen+ 2008)
- 5418 to 6814 Angstroms
 - 22 orders
- $R \sim 45,000$
- 18 in- & 11 out-of-transit frames
- Non-linearity correction
 - Permitted Na detection
- No reference star

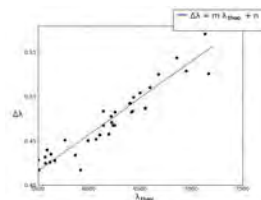


Data preparation pipeline

- Normalization

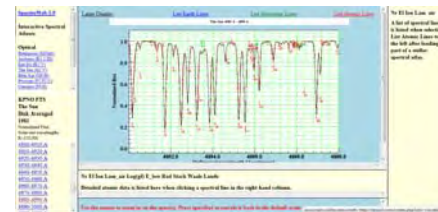


- Doppler shift



The Database

- Spectroweb
 - Line info + type identification (Telluric / Molecular / Atomic)



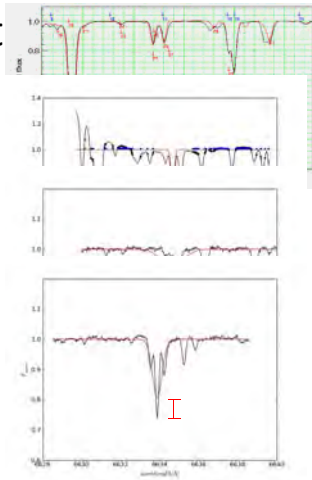
Transit

- Selection criteria
 - Strong solar lines (>10%)
 - Non-crowded zones
 - Symmetric lines
 - Blends

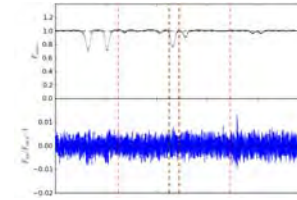
2297 -> 454 lines

– log(gf) > -0.2

29 lines

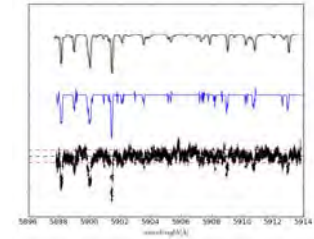


- Recentering

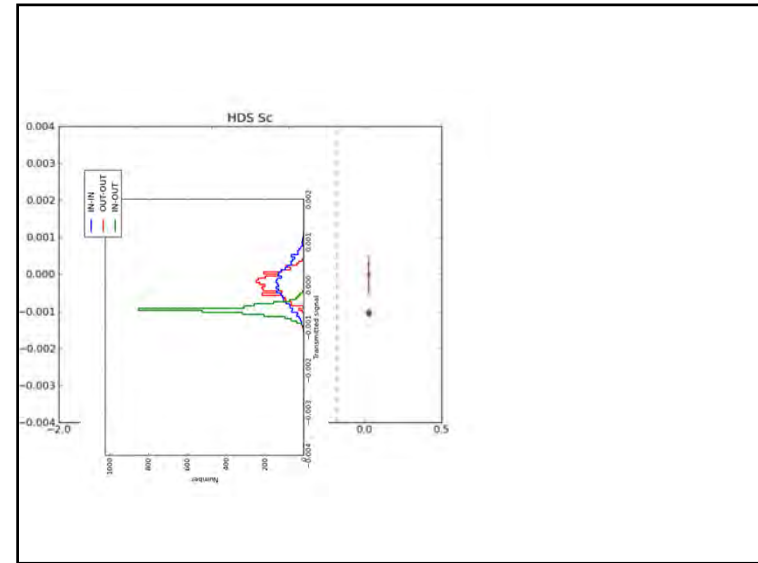
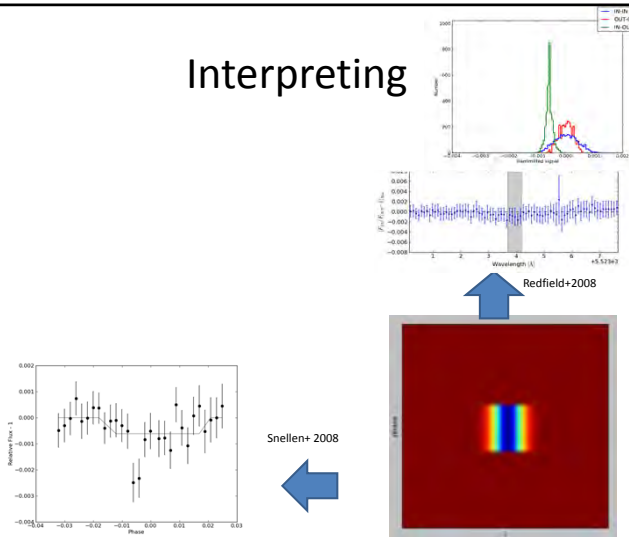


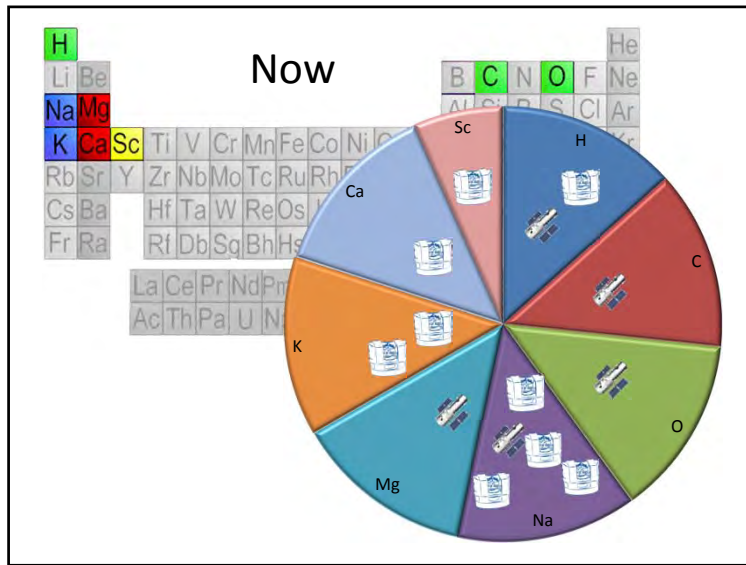
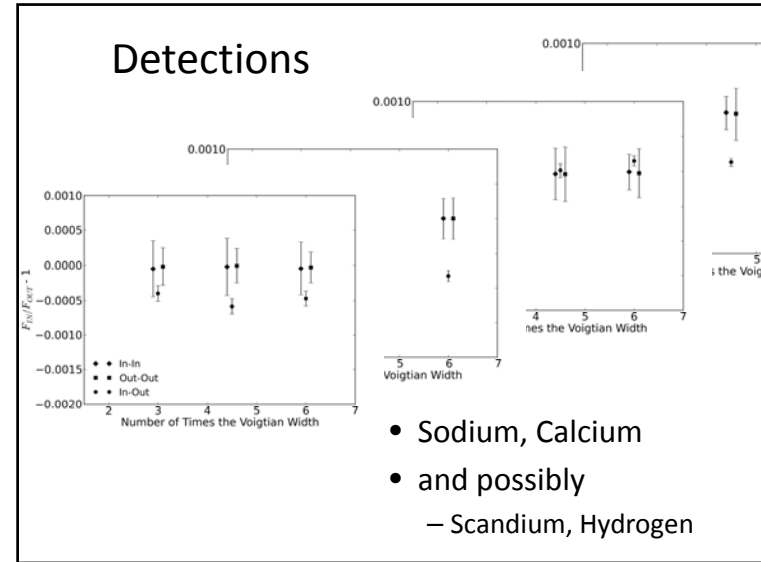
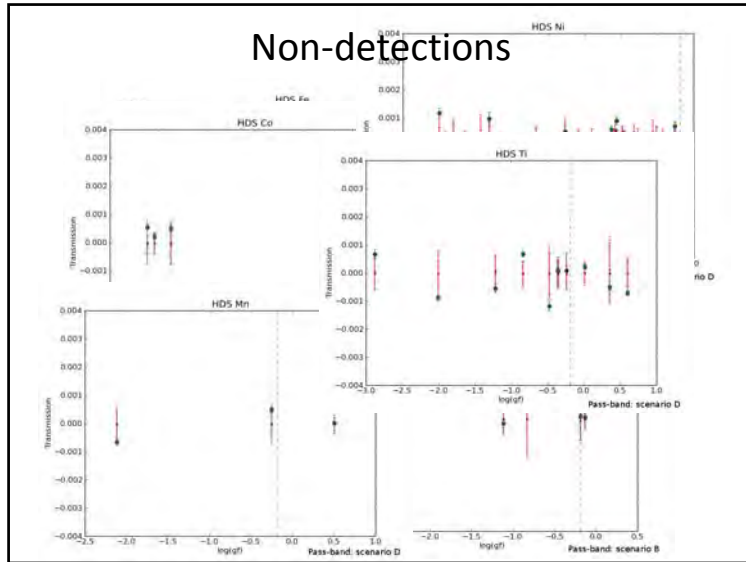
- Telluric correction

$$- I_0 = I_{\star} e^{-nks}$$



Interpreting





Exoatmosferas

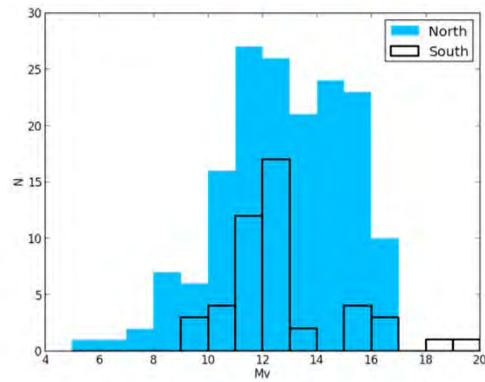
- New automated analysis, telluric corrections
- First Detection of Calcium and possibly Scandium on HD209458b
 - Gas phase consistent
 - Ca was expected to be condensed out

EXOPLANET SURVEYS

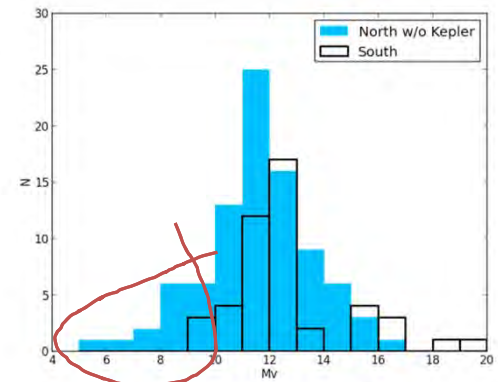
CHEPS

- Calan-Hertfordshire Extrasolar Planet Search
- Main Sequence Radial Velocity Survey

CHEPS



CHEPS



CHEPS

- 220+ southern metal-rich stars
 - FGK
 - 58pc+
 - $V \geq 7.5$
 - removed known

A Venn diagram with five overlapping circles representing different astronomical surveys: CHEPS (top), AAPS (right), Magellan (left), Swiss (center), and HARPS-GTO (bottom). The circles overlap significantly, indicating shared stars between multiple surveys.

CHEPS

- Radial Velocity Search
 - Coralie @ Euler
 - ~ 50 nights from 2010
 - Own pipeline!
 - HARPS @ 3.6m
 - 400+ hrs

Expected Yield
22 new planets
3 bright transiting

CHEPS

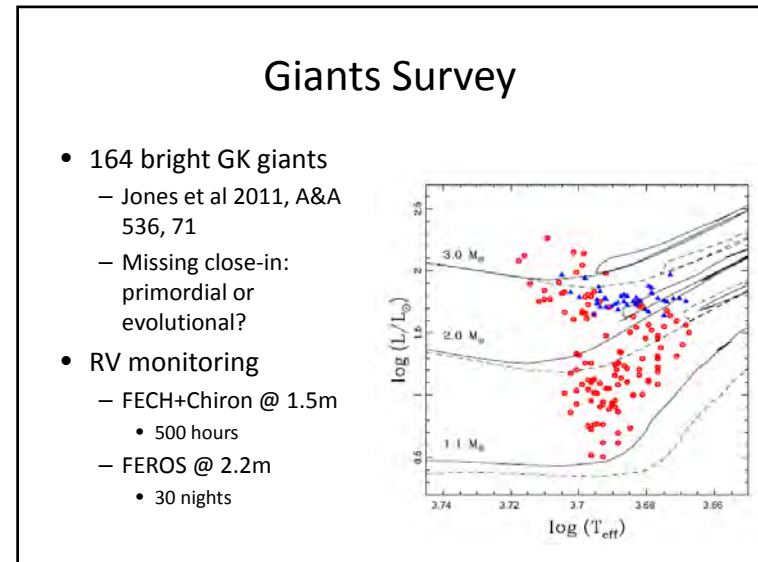
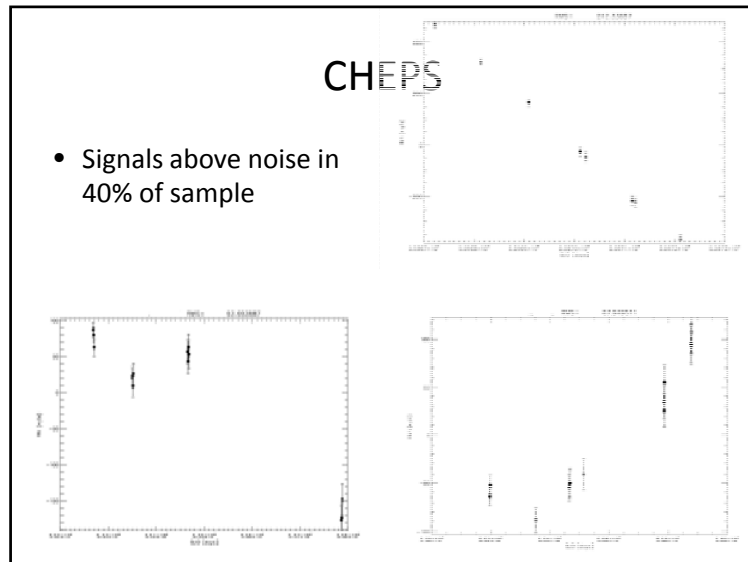
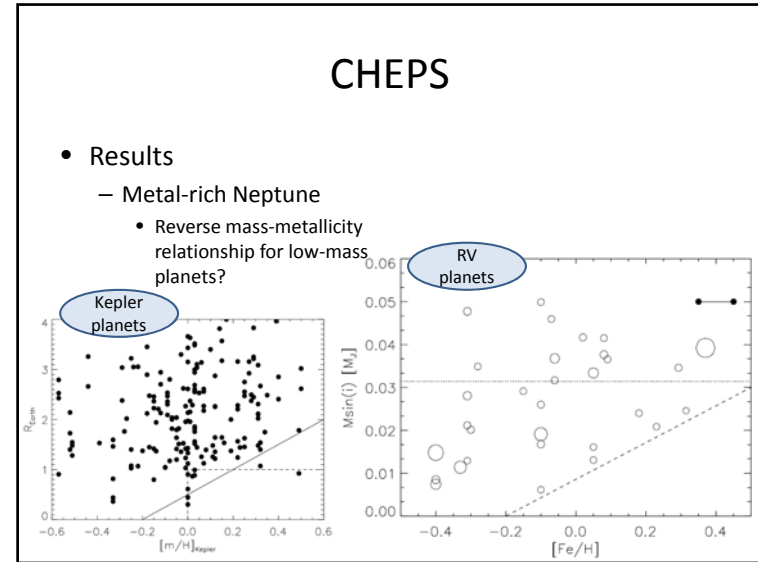
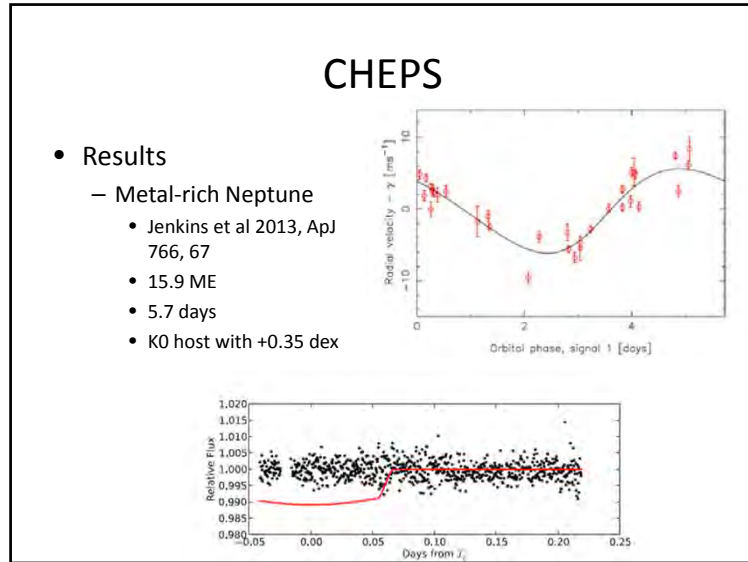
- Results
 - Catalog
 - Jenkins et al 2011, A&A 531, A8
 - 850 stars

Three histograms showing the frequency distribution of velocity components: U (km/s), V (km/s), and W (km/s). The U component ranges from -200 to 100 km/s, V from -150 to 100 km/s, and W from -100 to 100 km/s. A separate plot shows Normalised Frequency vs $\log R_{\odot}$ with a peak around -5.0.

CHEPS

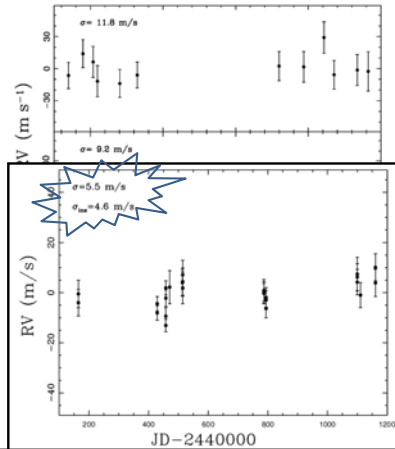
- Results
 - Brown Dwarf
 - Jenkins et al 2012, MNRAS 398, 911
 - 1.35 AU
 - $e=0.63$
 - G3 host with +0.29 dex

Three vertically stacked plots (a, b, c) showing radial velocity data over time (JD-2,450,000 [days]). Plot (a) shows the radial velocity V_r [km s⁻¹] with a blue sinusoidal fit. Plot (b) shows O-C residuals [m s⁻¹] with data points and error bars. Plot (c) shows O-C residuals [m s⁻¹] with data points and error bars.

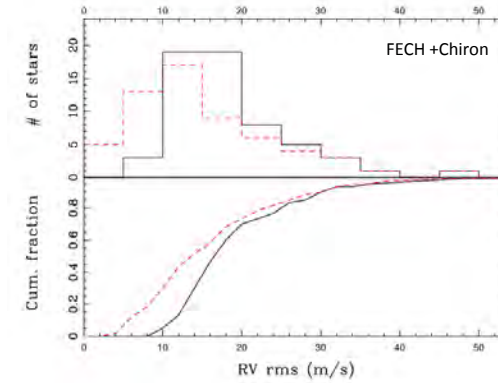


Giants Survey

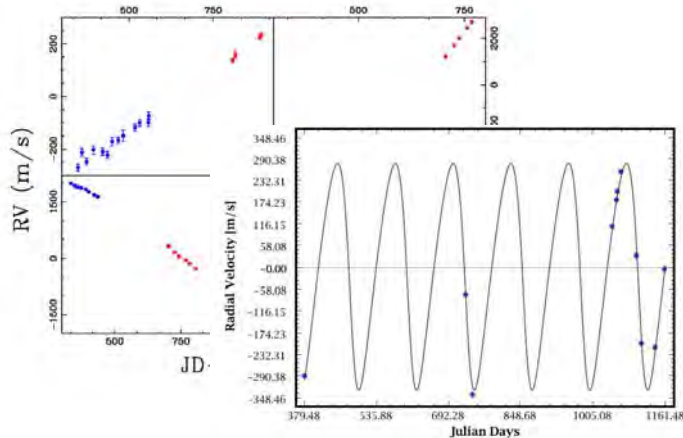
- 164 bright GK giants
 - Jones et al 2011, A&A 536, 71
 - Missing close-in: primordial or evolutionary?
- RV monitoring
 - FECH+Chiron @ 1.5m
 - 500 hours
 - FEROS @ 2.2m
 - 30 nights



Giants Survey



Giants Survey



Signal Processing “Anillo” Center

- Multi-disciplinary center
- Rich SP toolbox from communications
 - Voice recognition
- Applications to
 - Mining
 - Volcanology
 - Astronomy
 - RV searches
 - Exo-atmospheric characterization

2013 - 2015



- Transit Monitoring from the South



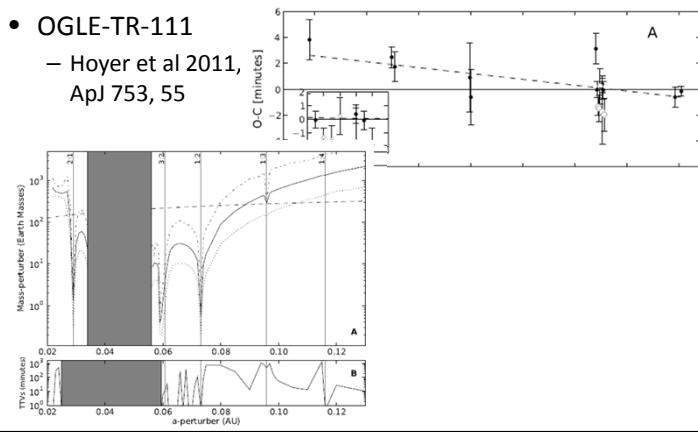
- Search for Transit Timing Variations (2008)

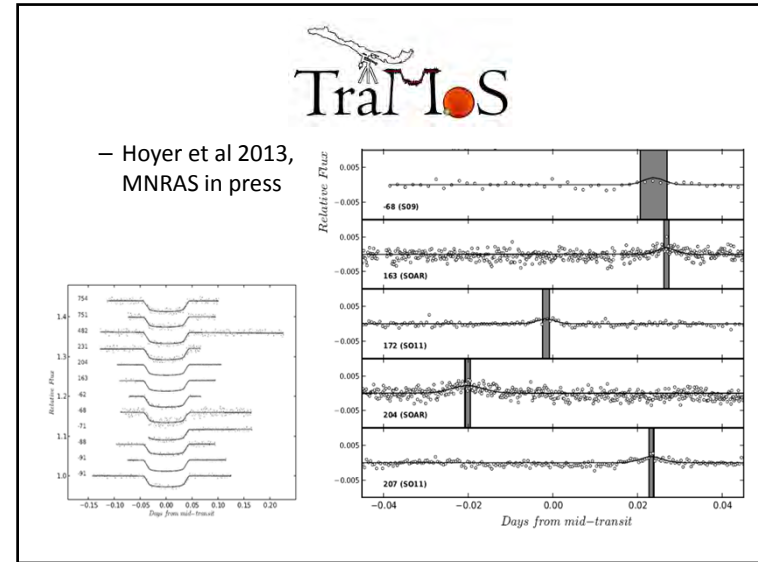
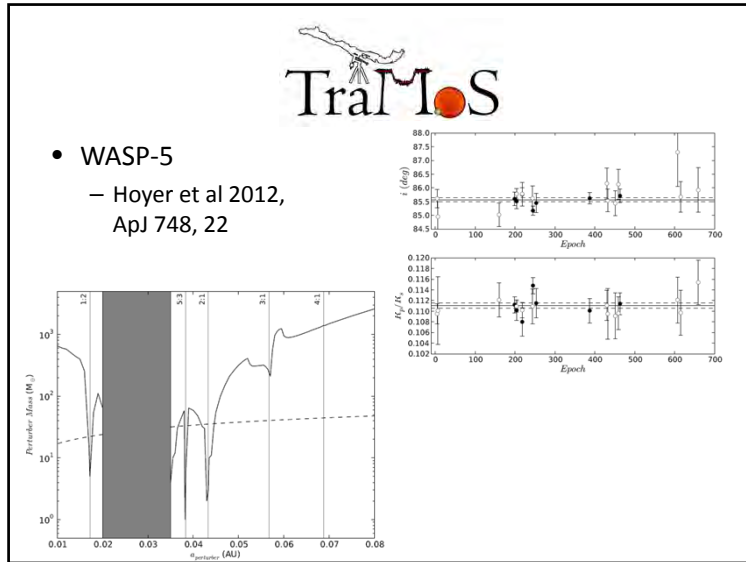


- Search for Transit Variations
 - Timing
 - Shape
 - Spots
- Until today
 - ~ 80 transits
 - 22+ planets



- OGLE-TR-111
 - Hoyer et al 2011, ApJ 753, 55





Conclusions

- Exoatmospheric characterization
- CHEPS
- Giants Survey
- TraMOS
- New atmospheric detections
- Surveys are reaching maturity
- Robust pipelines
- Have obtained/secured observing time
- Have detected new planets
- ... stay tuned