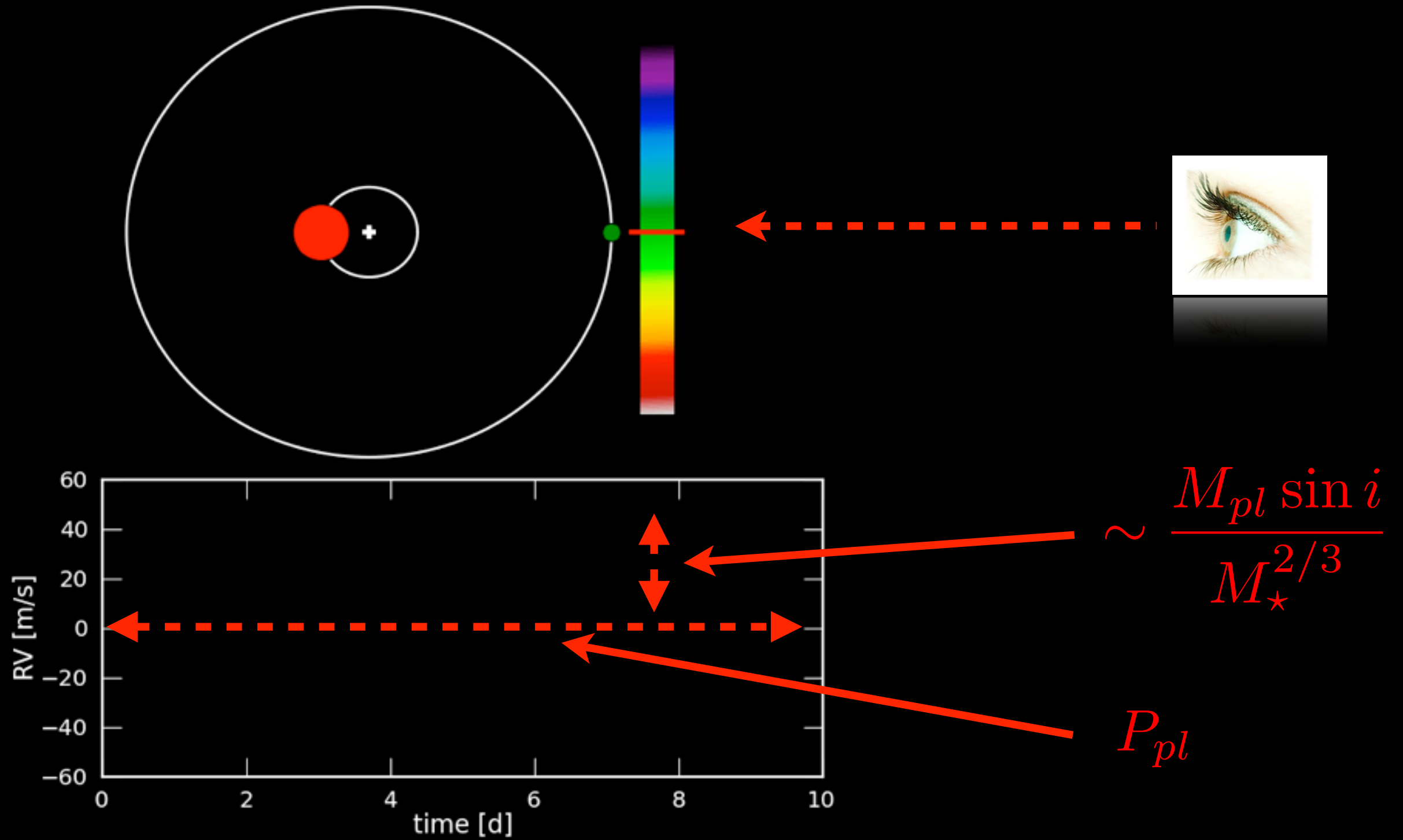


The Past, Present and Future of Doppler Planet Searches

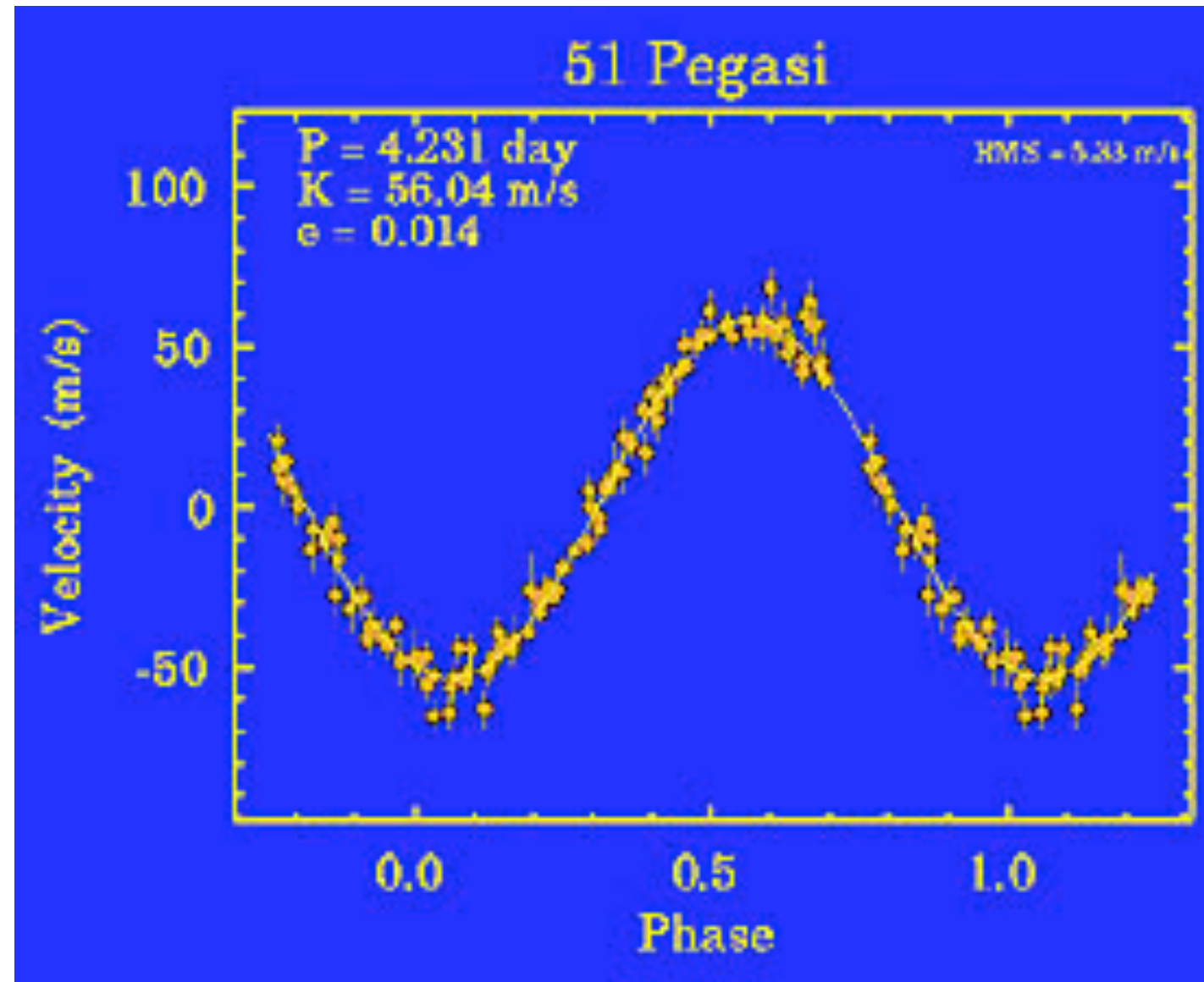
Debra Fischer
Yale University

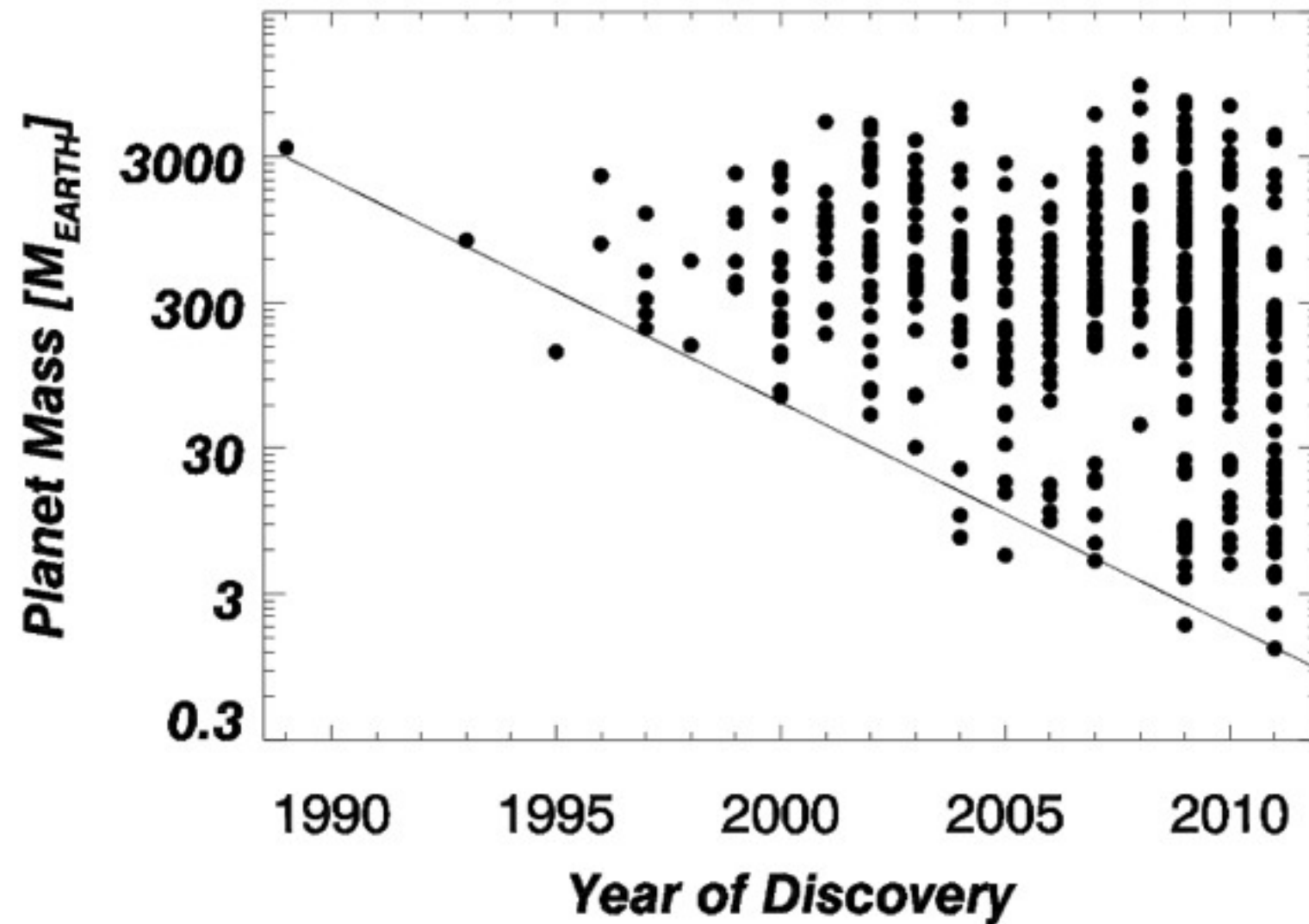


animation credit: Xavier Dumusque

51 Peg:

- line profile variations, e.g., on-radial oscillations?
- face-on orbits?

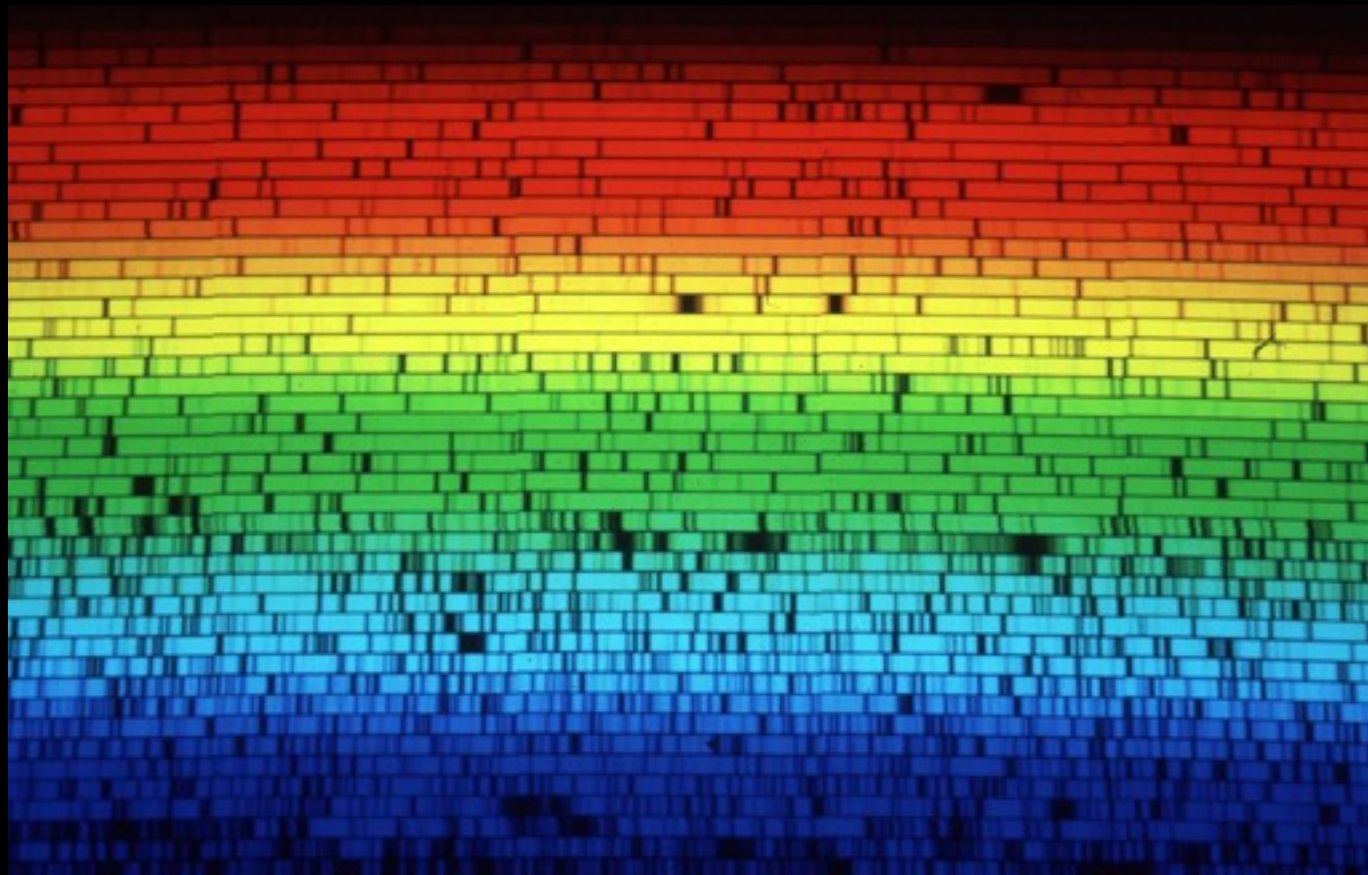




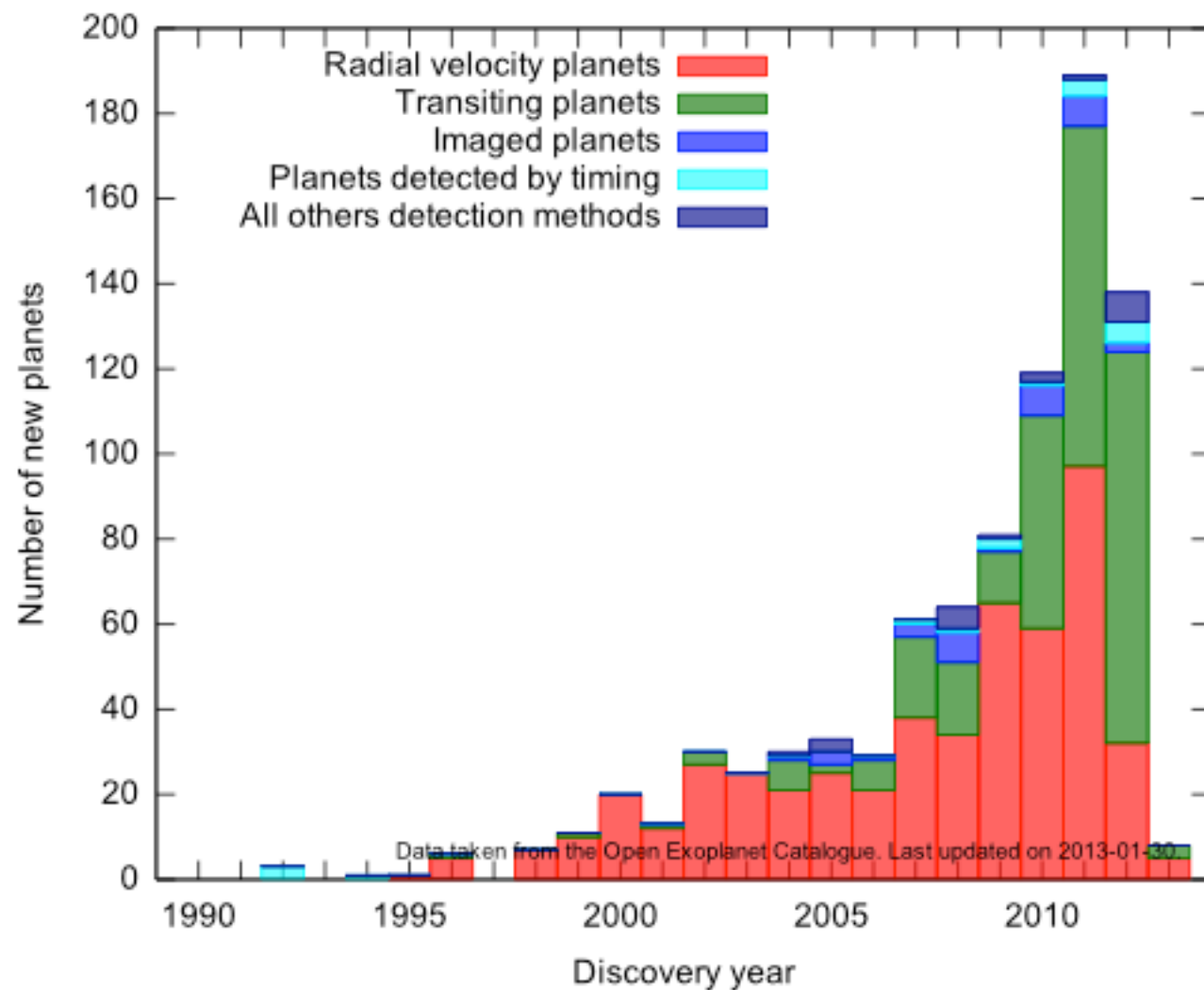
The RV technique has a history of steady detection of smaller and smaller mass planets.

However, each improvement in detectability was enabled by technology breakthroughs

2010 Decadal Survey: *“Our view of the universe has changed dramatically. Hundreds of planets of startling diversity have been discovered orbiting distant suns.”*



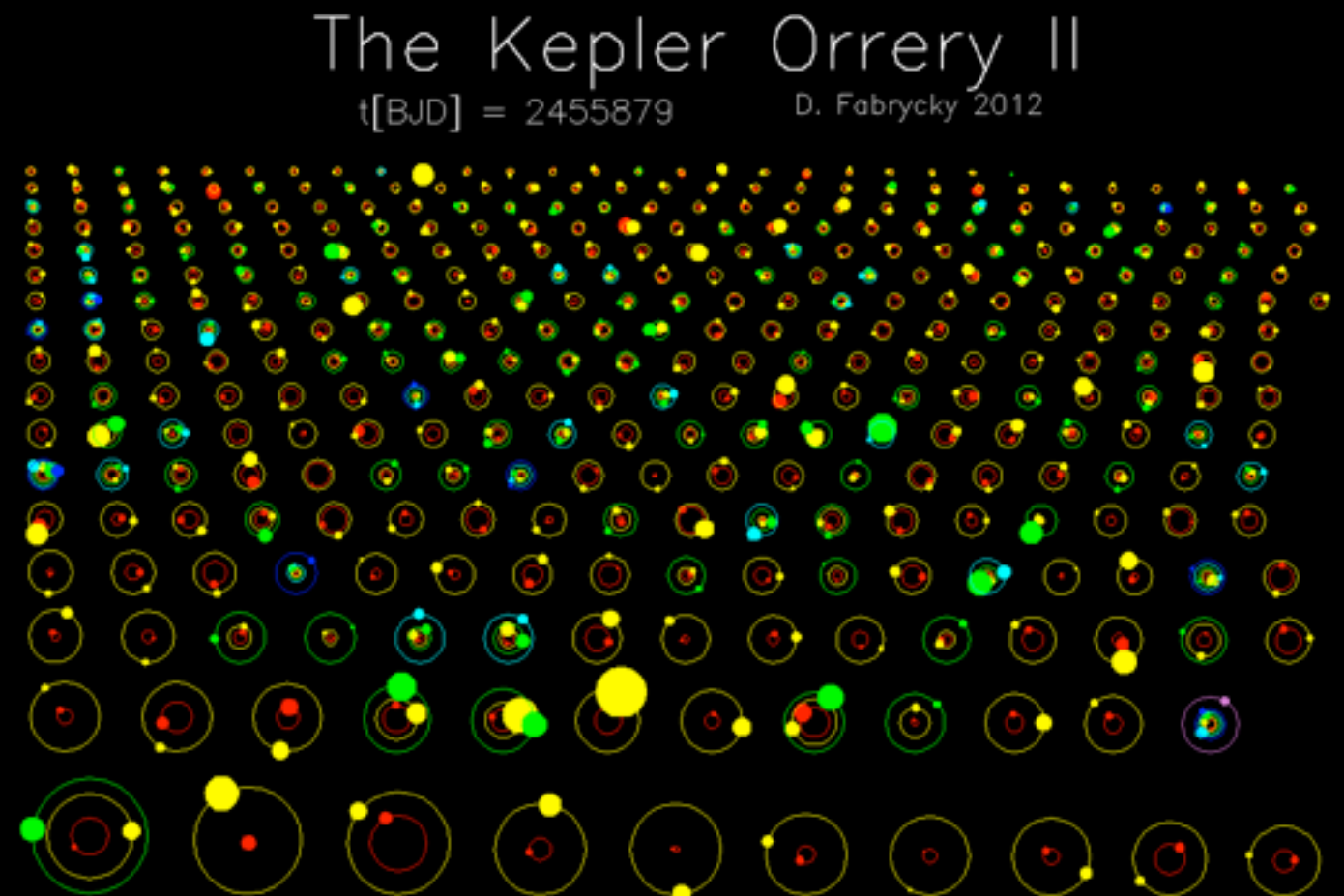
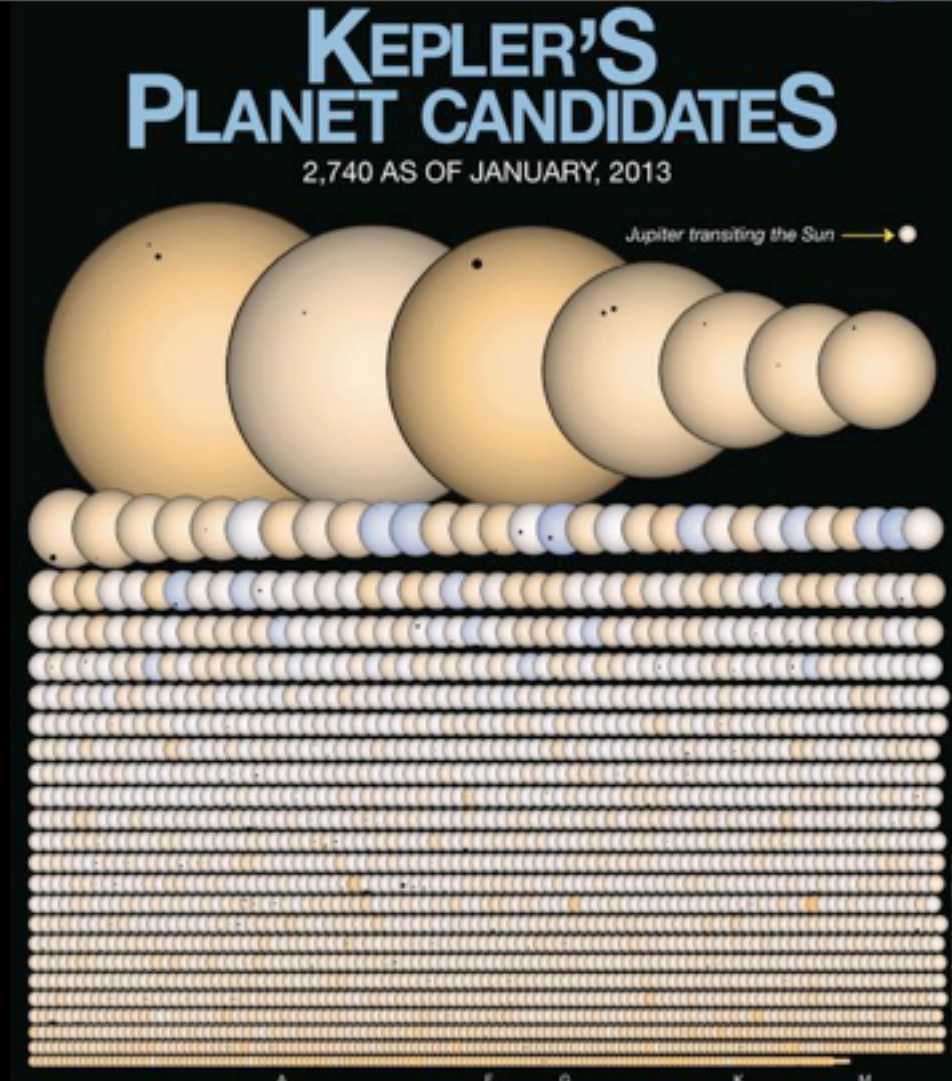
*Recommended technology development to improve
Doppler precision to 10 cm/s.*



courtesy Hanno Rein

Turn over in RV detections:

- in part bookkeeping b/c of significant followup effort with Kepler
- In part a slow down in advances in instrumentation for exoplanet searches

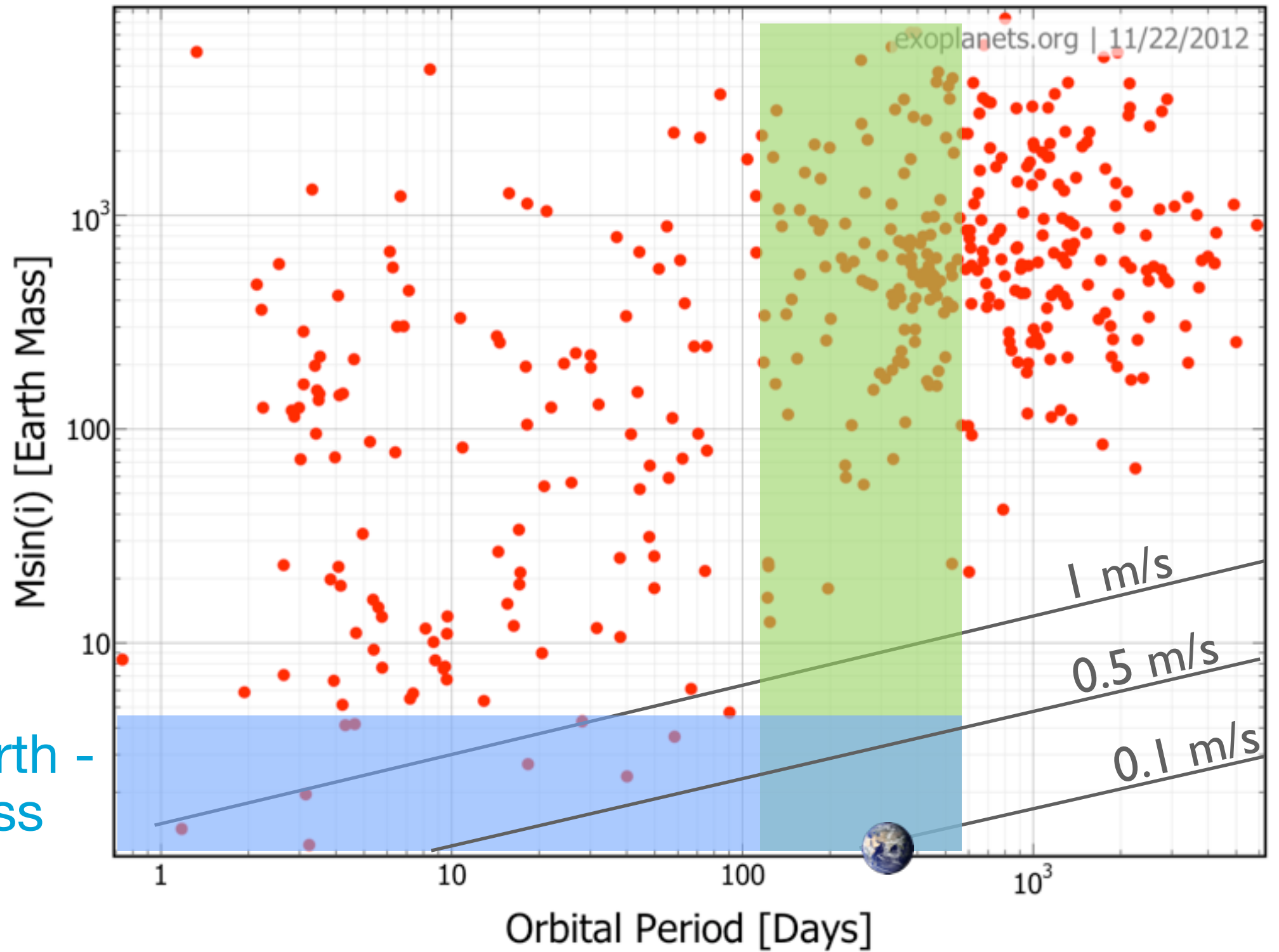


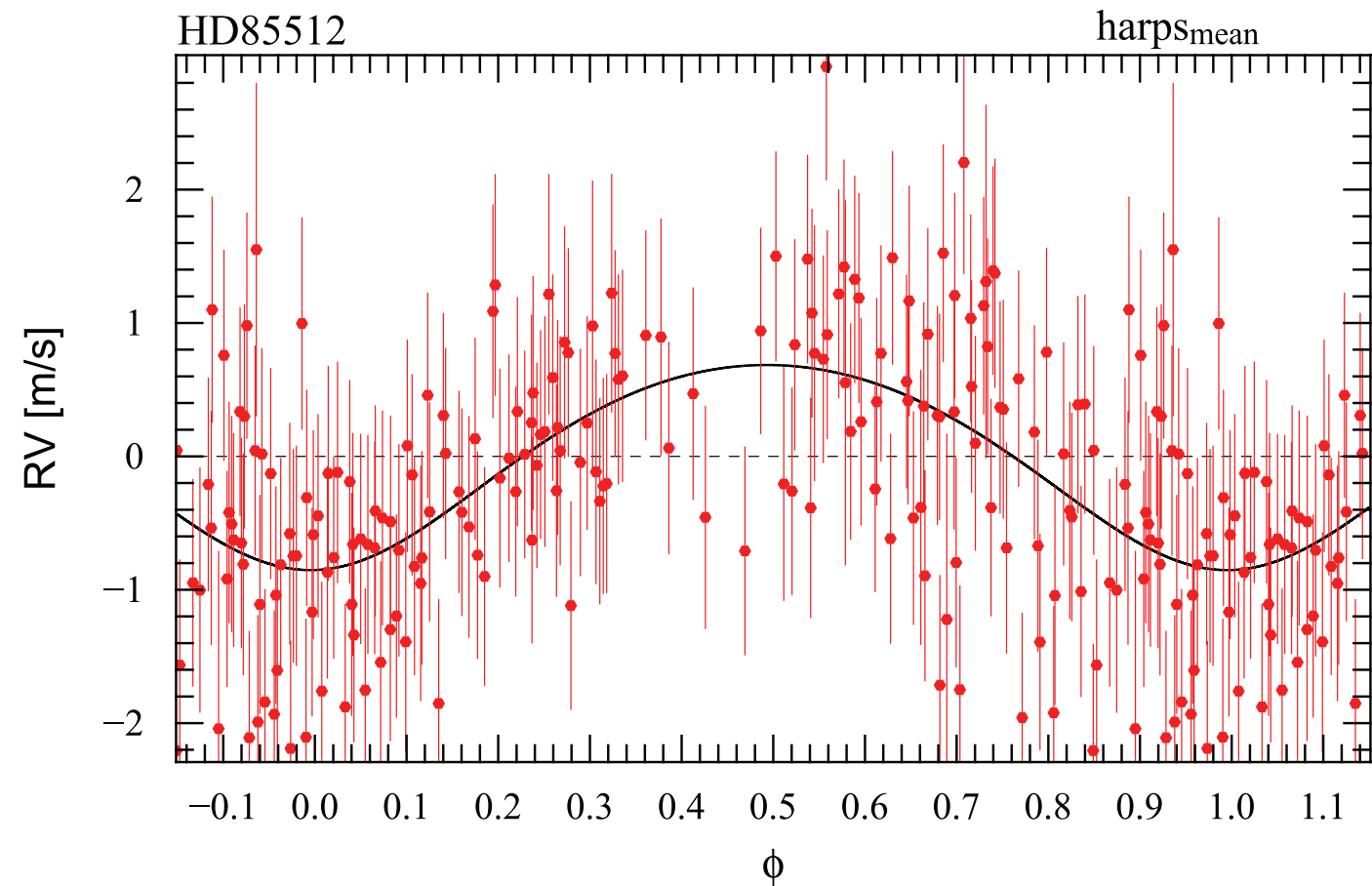
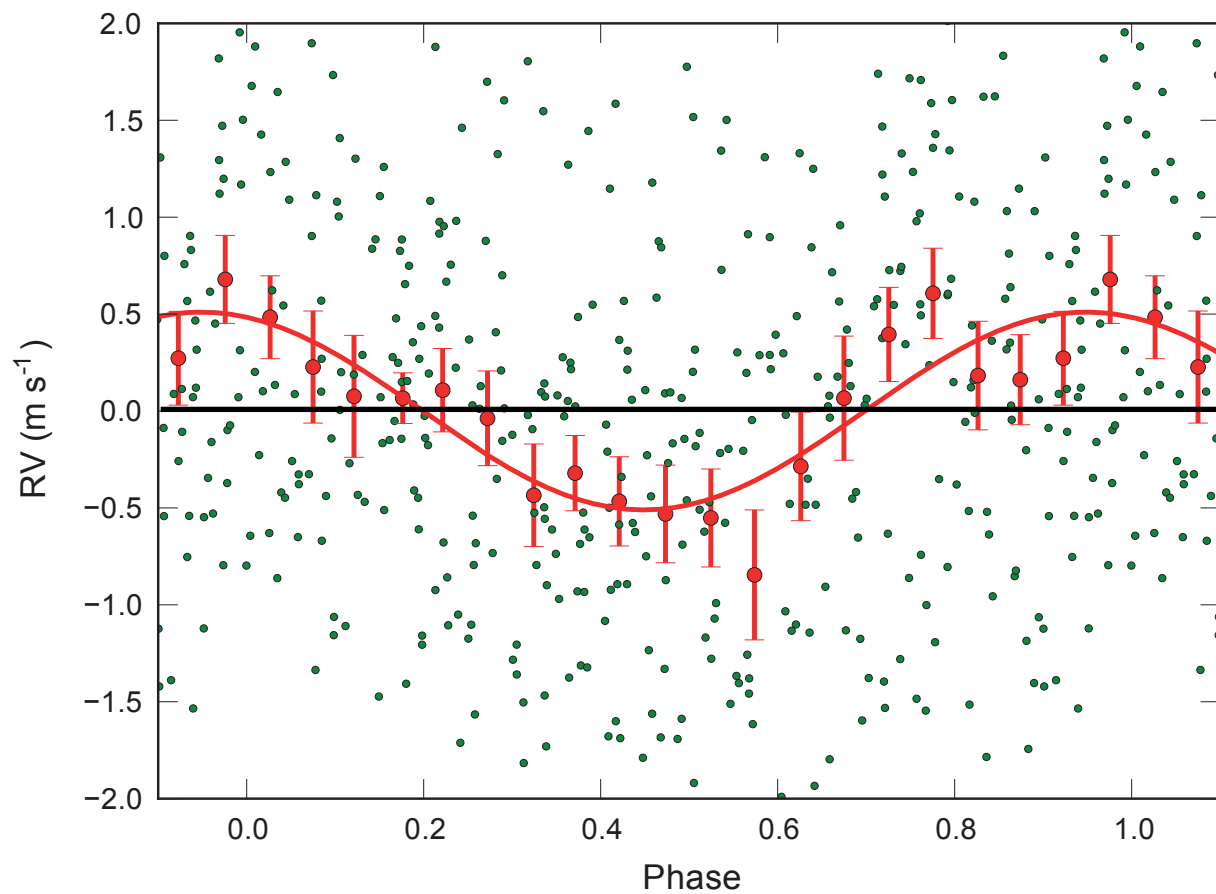
“Practically all Sun-like stars have planets”

- ~17% have planets 0.8 - 1.25 with $P < 85$ days
- ~50% have planets 1.25 - 4 times the mass of the Earth
- 10% have larger (up to Neptune-size) planets with $P < 400d$

Habitable
zone

Super Earth -
Earth mass





*Most low mass exoplanet detections have come from HARPS.
Are the ESO astronomers content with this status quo?*

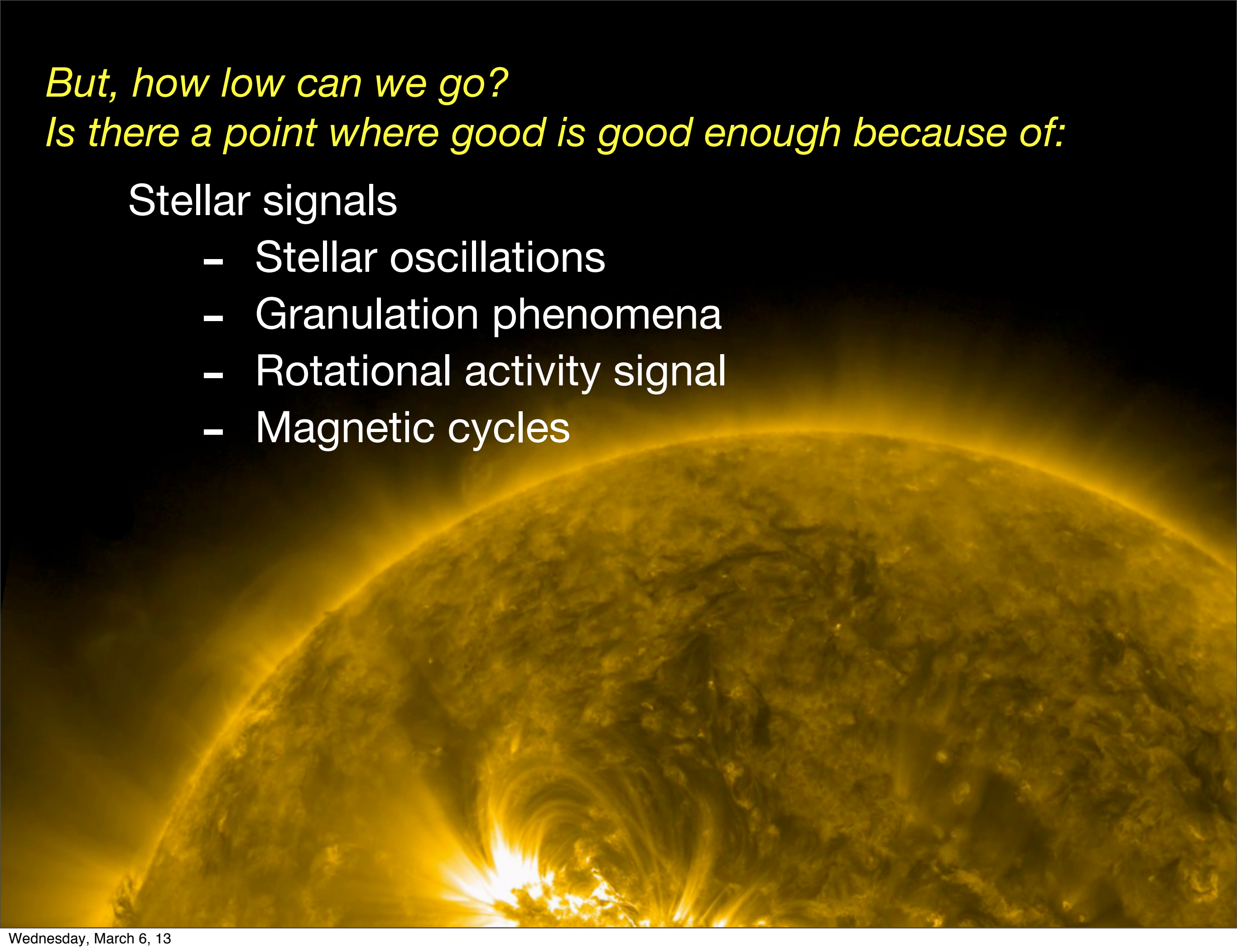
ESPRESSO on the VLT will aim for 10 cm s^{-1} precision

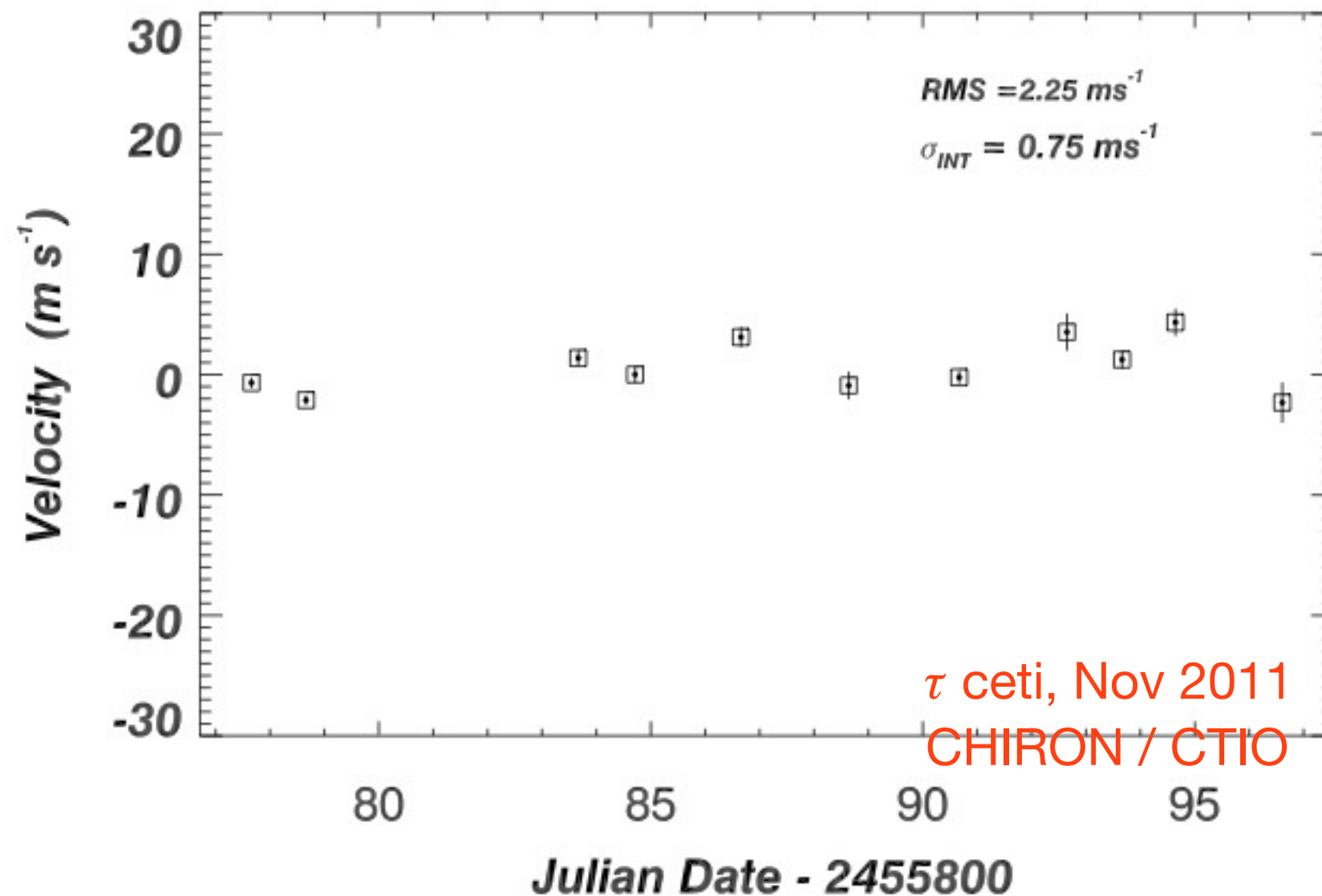
But, how low can we go?

Is there a point where good is good enough because of:

Stellar signals

- Stellar oscillations
- Granulation phenomena
- Rotational activity signal
- Magnetic cycles

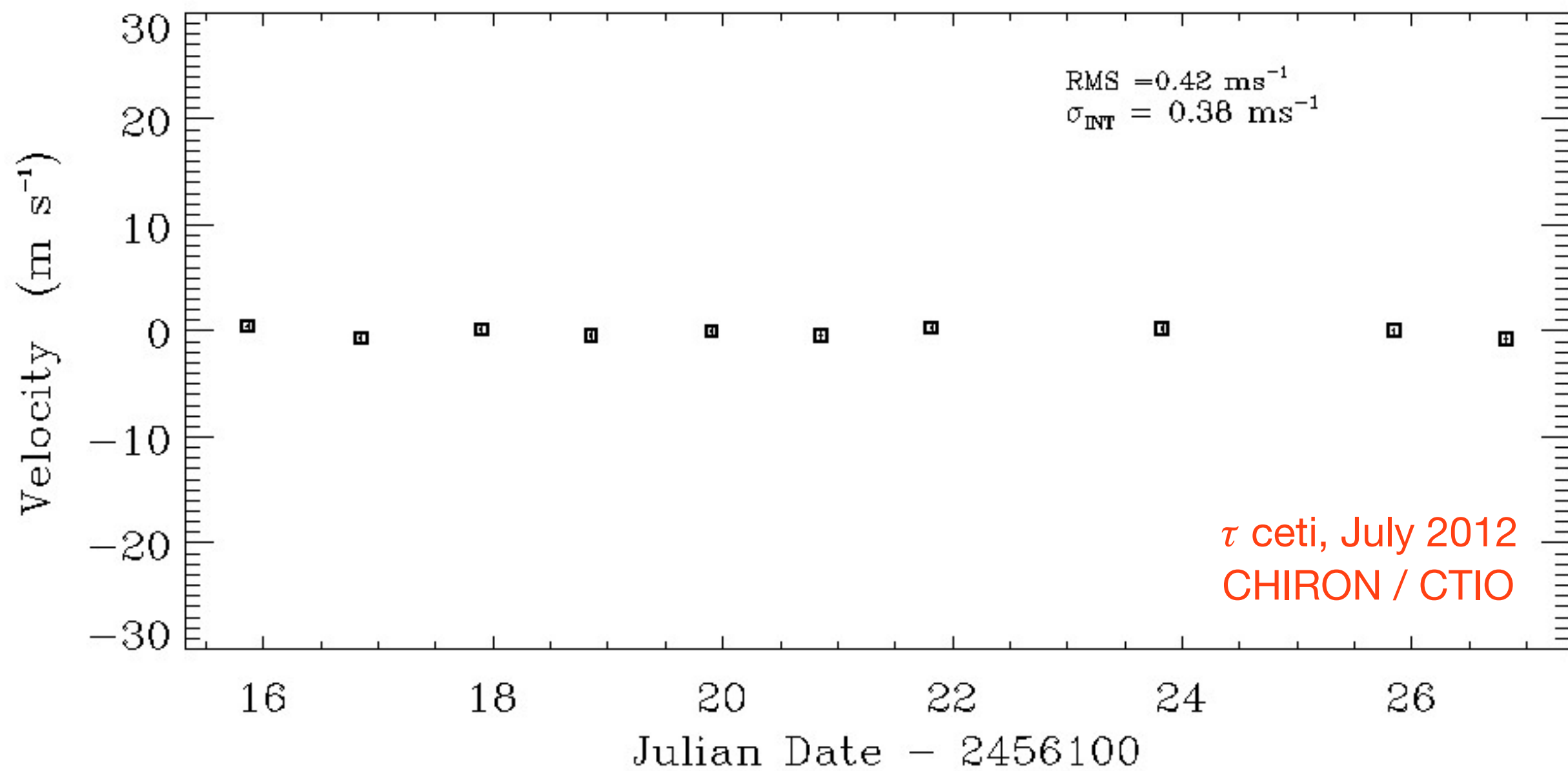




PI's: Fischer / Tokovinin

Instrumental precision vs. instrument stability

Upgrade planned: echelle in vacuum enclosure, exposure meter, better temperature control, octagonal fiber light injection



PI's: Fischer / Tokovinin
Upgrade completed.

What is needed to reach extreme precision?

- *engineering (stability)*
- *coupling of light to the spectrograph (fibers)*
- *wavelength calibration (etalons, frequency combs?)*
- *stellar signals (“noise”)*

Classical spectrographs?

Radically new designs: solid state, photonics

What are the exoplanet parameters needed for interdisciplinary (planetary + astrophysics) advances?

- mass
- distance from host star (orbital period)
- radius
- chemical composition

Extreme precision radial velocities will be one critical tool for detection, confirmation and follow-up support of space missions.

Uniquely gives planet mass (plate tectonics, internal structure)