SPOTTING BLUE PLANETS AROUND SPOTTED RED STARS

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Goal: Find habitable planets with radial velocity

What we're looking for

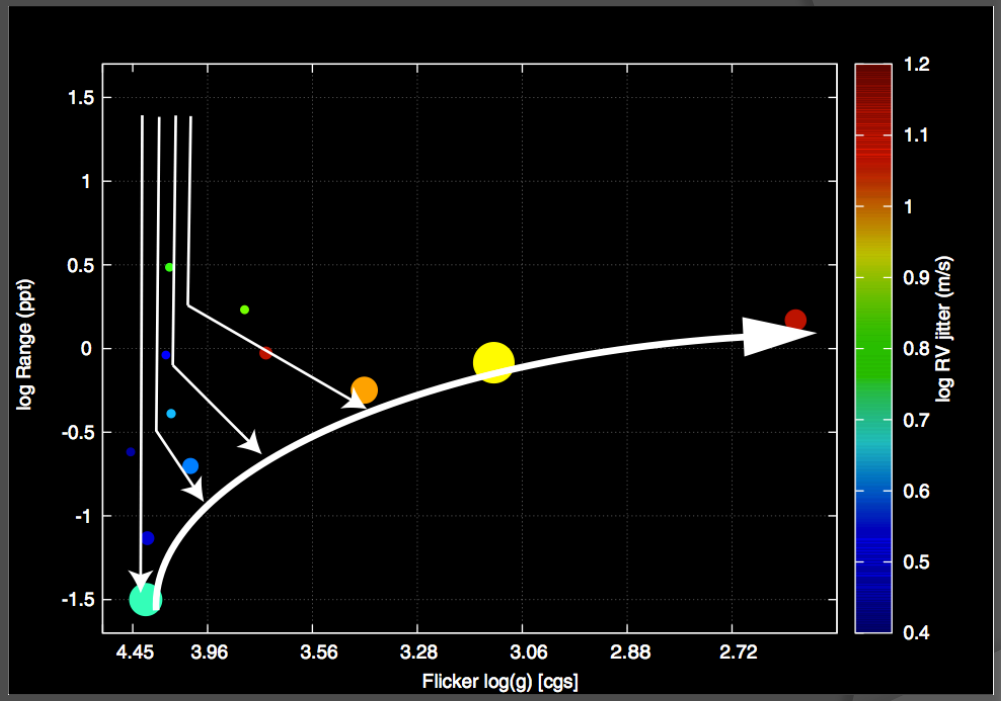
- Terrestrial planets are ≤5 M_{earth} (Weiss & Marcy 2014, Rogers 2015)
- Habitable-zone RV amplitudes of:
  - 30-150 cm/s (M dwarf)
  - 10-30 cm/s (FGK)

What we're using

- HPF (100 cm/s for M dwarfs)
- WIYN EPDS (50-10 cm/s for FGK)
- ESPRESSO (10 cm/s for FGK)

The problem: stellar activity

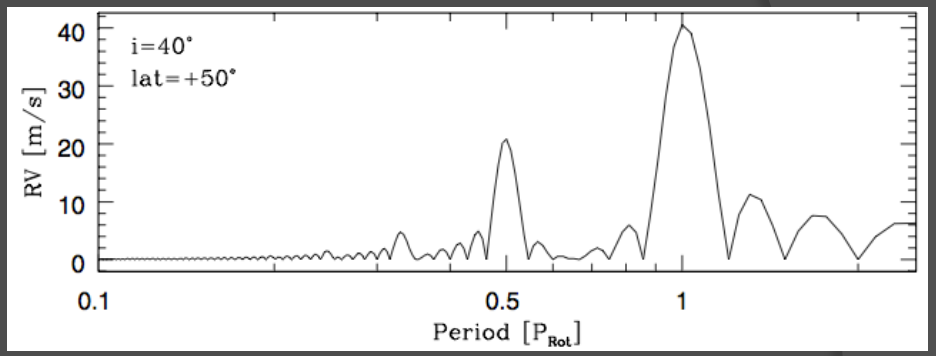
- FGK stars: *quietest* stars have RV "jitter" ~3 m/s.
- M stars: activity creates false-positive "planet" signals at 2-3 m/s (e.g. Robertson+ 2014).
- There are no "quiet" stars below 1 m/s!



Flicker and jitter values from Bastien+ 2014

The M dwarf challenge

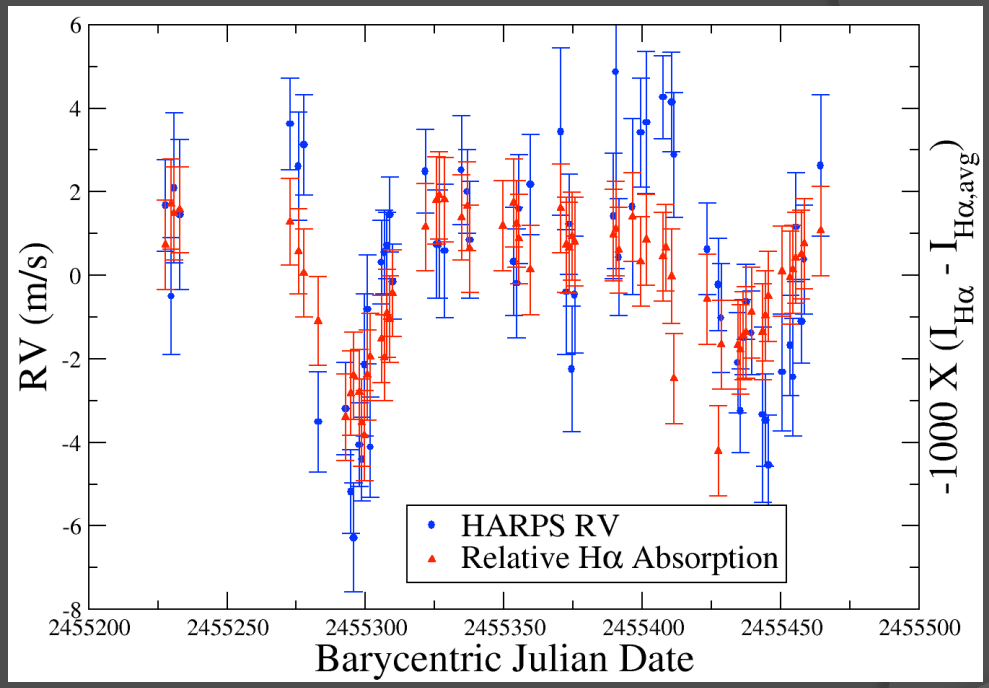
- Sun-as-model paradigm breaks down (e.g. αΩ dynamo, tracers).
- ~100-day rotation periods → harmonics in HZ.
- *Required for HPF!



Power spectrum of starspot signal (Boisse+ 2011).

Lessons learned

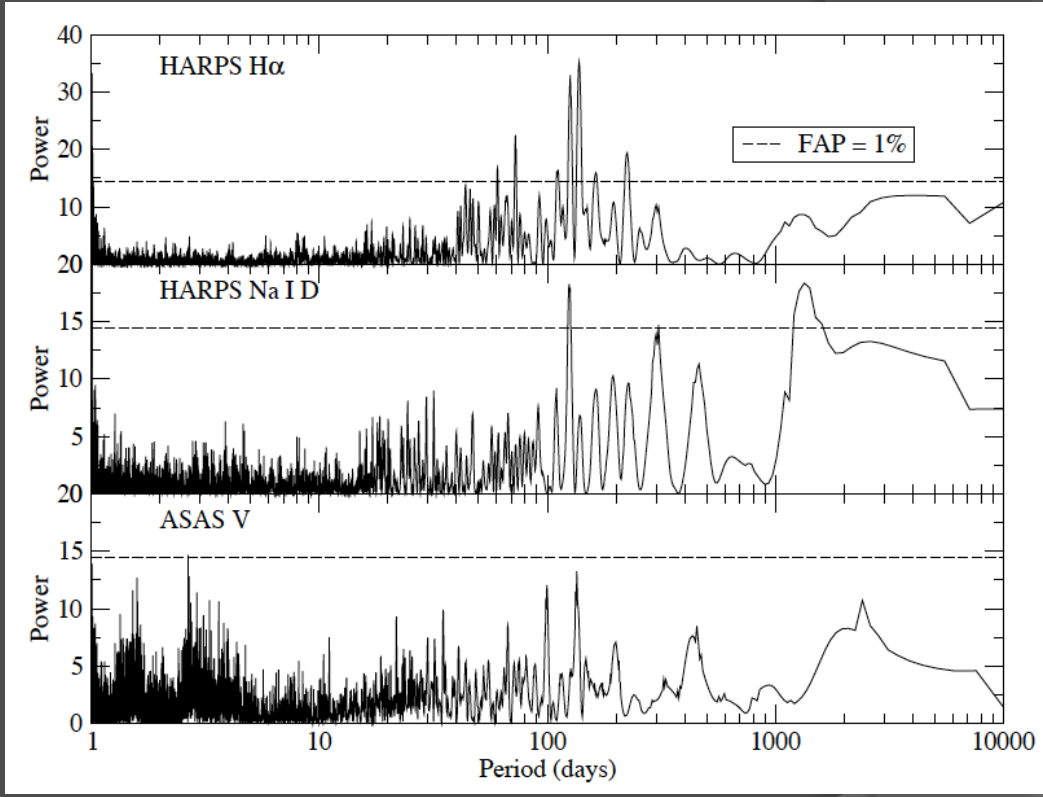
- The power of red spectral activity tracers! H-alpha, sodium D, especially.
- Boisse et al. were right: stellar rotation makes “fake” HZ planets (Robertson+ 2014, Robertson & Mahadevan 2014)



The activity signal formerly known as Gliese 581d

Lessons learned

- Starspots? Doesn't look like it in photometry.
- Appears to be common in old M dwarfs.
- Magnetic suppression of convection? See Kürster+ 2003 (Barnard's star).



Power spectra of stellar activity indices for Gliese 581

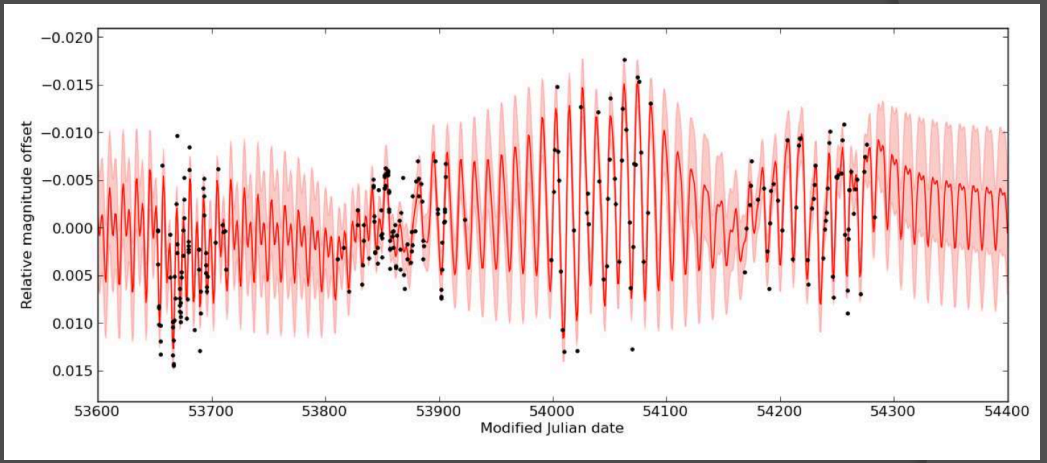
Looking forward

- HPF survey targets later, potentially younger M stars.
- Near-IR necessitates new activity tracers.
- Want to find planets!

A flare on CN Leo, seen by the NIR sodium doublet

Looking forward

- Want to incorporate spectroscopy, photometry, RV in multiparametric planet/activity modeling.
- Gaussian Processes: successful in modeling photometric variability in *Kepler* targets



Gaussian Process model of photometric variability on HD 189733 (Roberts+ 2013)

Conclusions

- Continued exploration of activity-driven RV variability essential for discovery, characterization of Earthlike planets.
- M dwarfs present unique challenges and interesting results.
- Early results show planets *can* be distinguished from astrophysical noise!