Solar RV Noise is Lower in the NIR: An FF' Application to Spectral Irradiance Data

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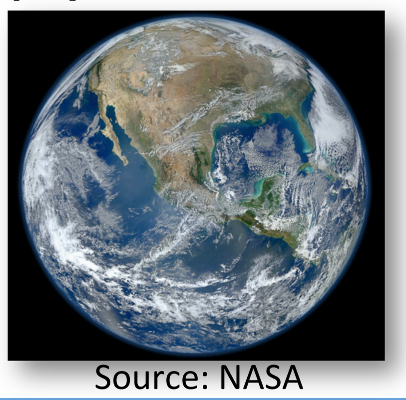
Stellar Noise: Drowning out exoplanet signals

The search for an Earth twin is proceeding in earnest. However, the fundamental limitation on the detection of low mass exoplanets is no longer instrumental but also astrophysical in nature.

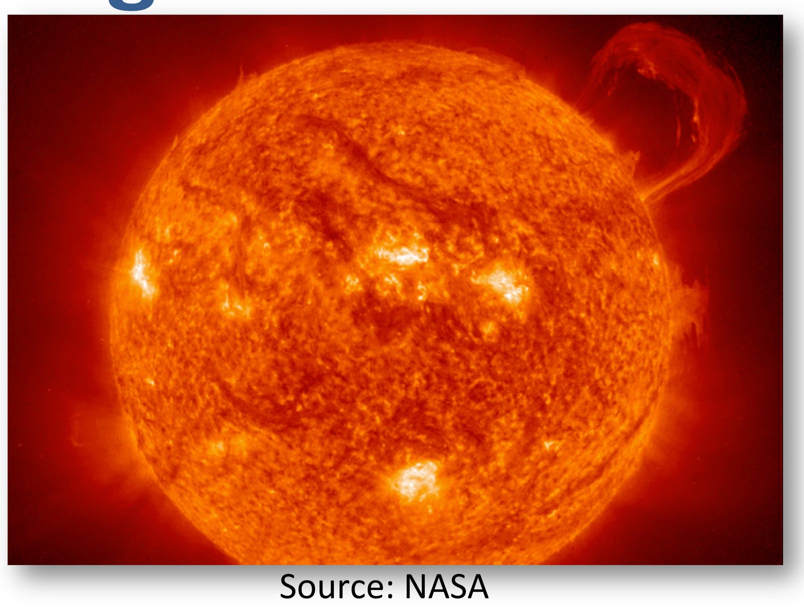


Source: NASA

Astrophysical noise sources include:

- Starspots
- Stellar Cycles
- Stellar Flares
- Stellar Granulation
- Faculae/regions inhibiting convection

These have been studied first and foremost on the Sun and can be observed photometrically and kinematically.



Source: NASA

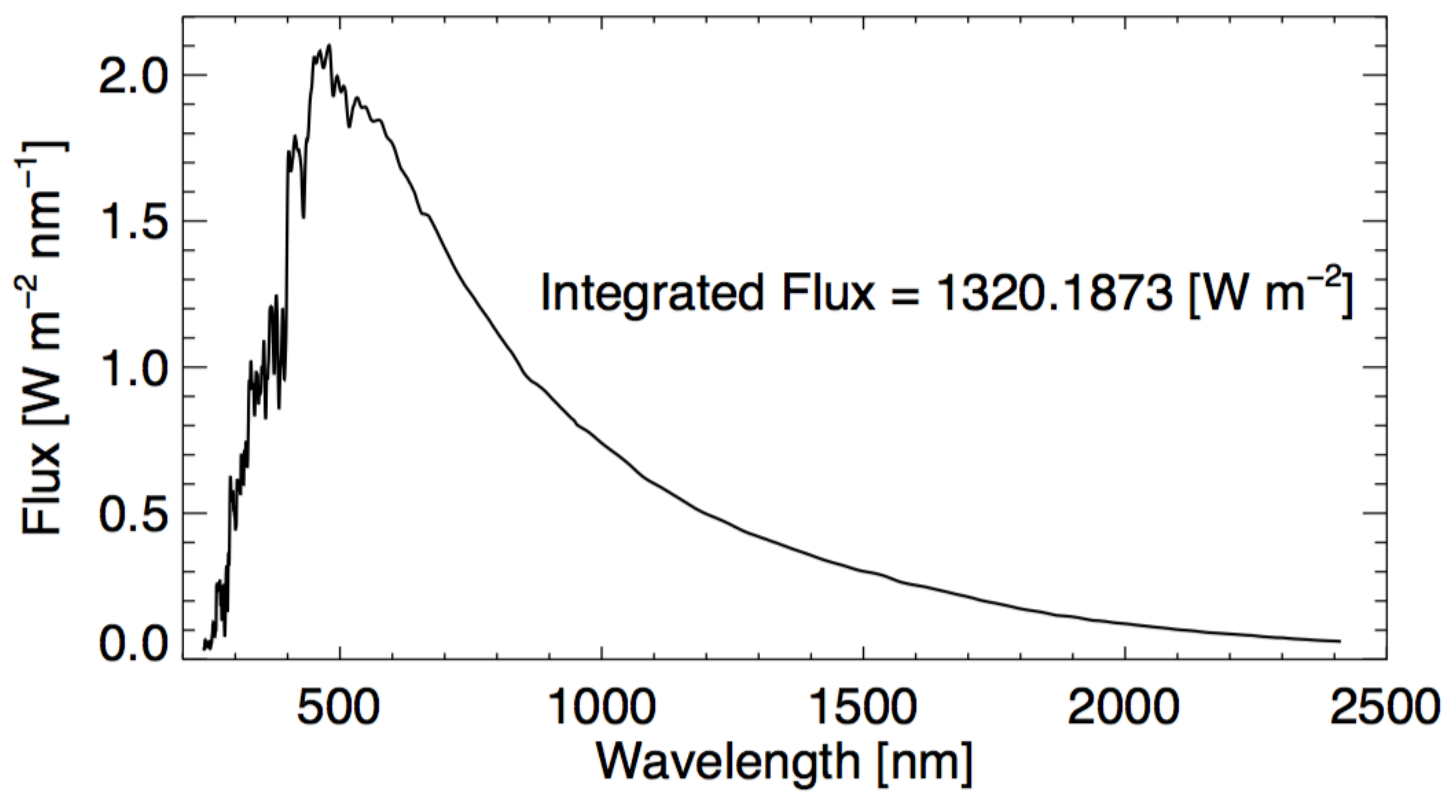
Motivation:
The recent flurry of habitable zone, low mass planets which have been called into question or discounted due to stellar noise shows that we need a better understanding of stellar activity.

Goal:
We aimed to estimate **solar** RV noise as a function of wavelength and time.

Tuning the Aerial: Can the noise be reduced?

Observations:
The SOlar Radiation & Climate Experiment (SORCE) observed total and spectral solar irradiance (TSI, SSI) over 8 years.

Source: LASP



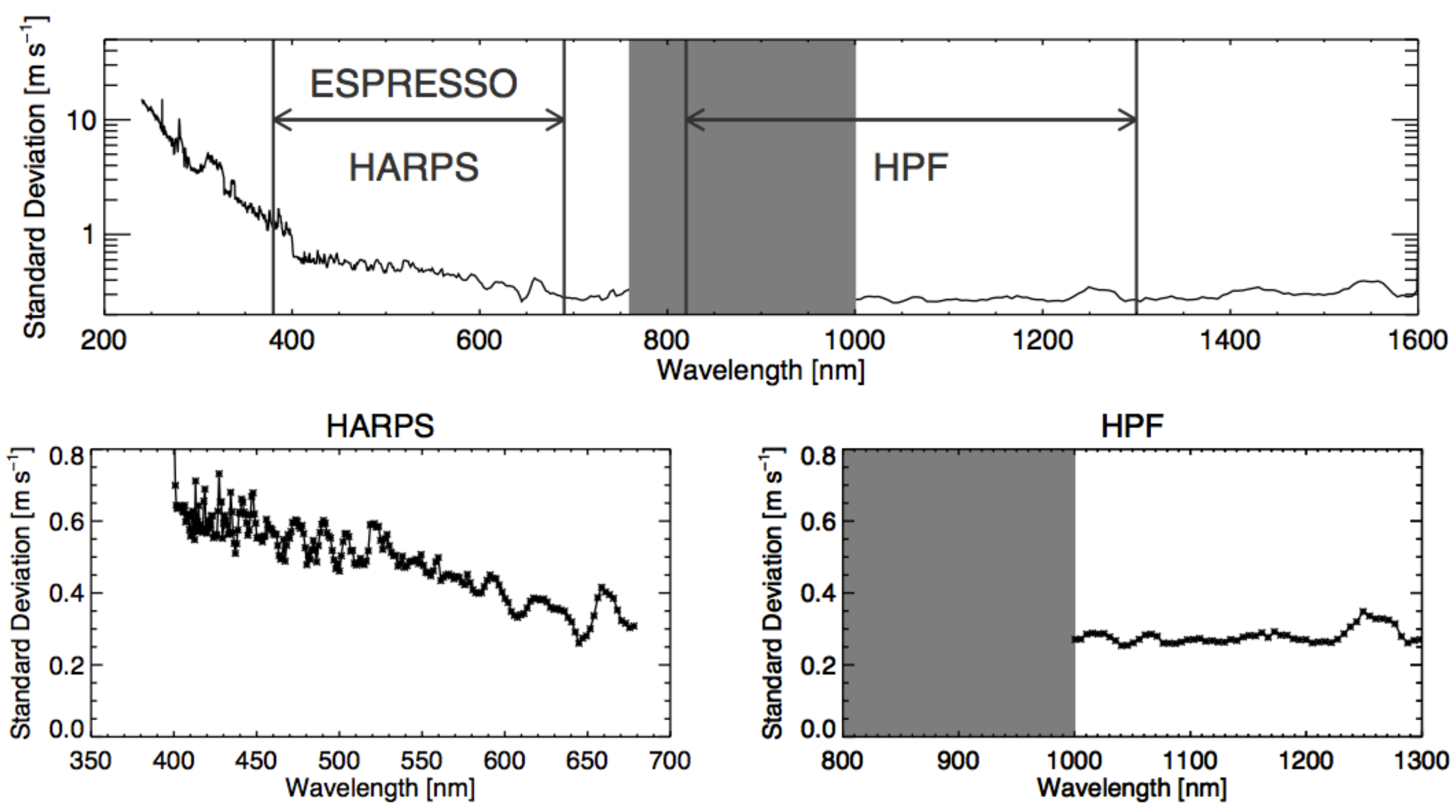
SSI as measured by SORCE for 2006 Jan 29 (Marchwinski et al.).

Methods:
We applied the FF' method (Aigrain et al. 2012), which uses a simplified spot model to estimate RV variations from photometric observations, to the SORCE data. This allowed us to compare the RV variation with time and wavelength.

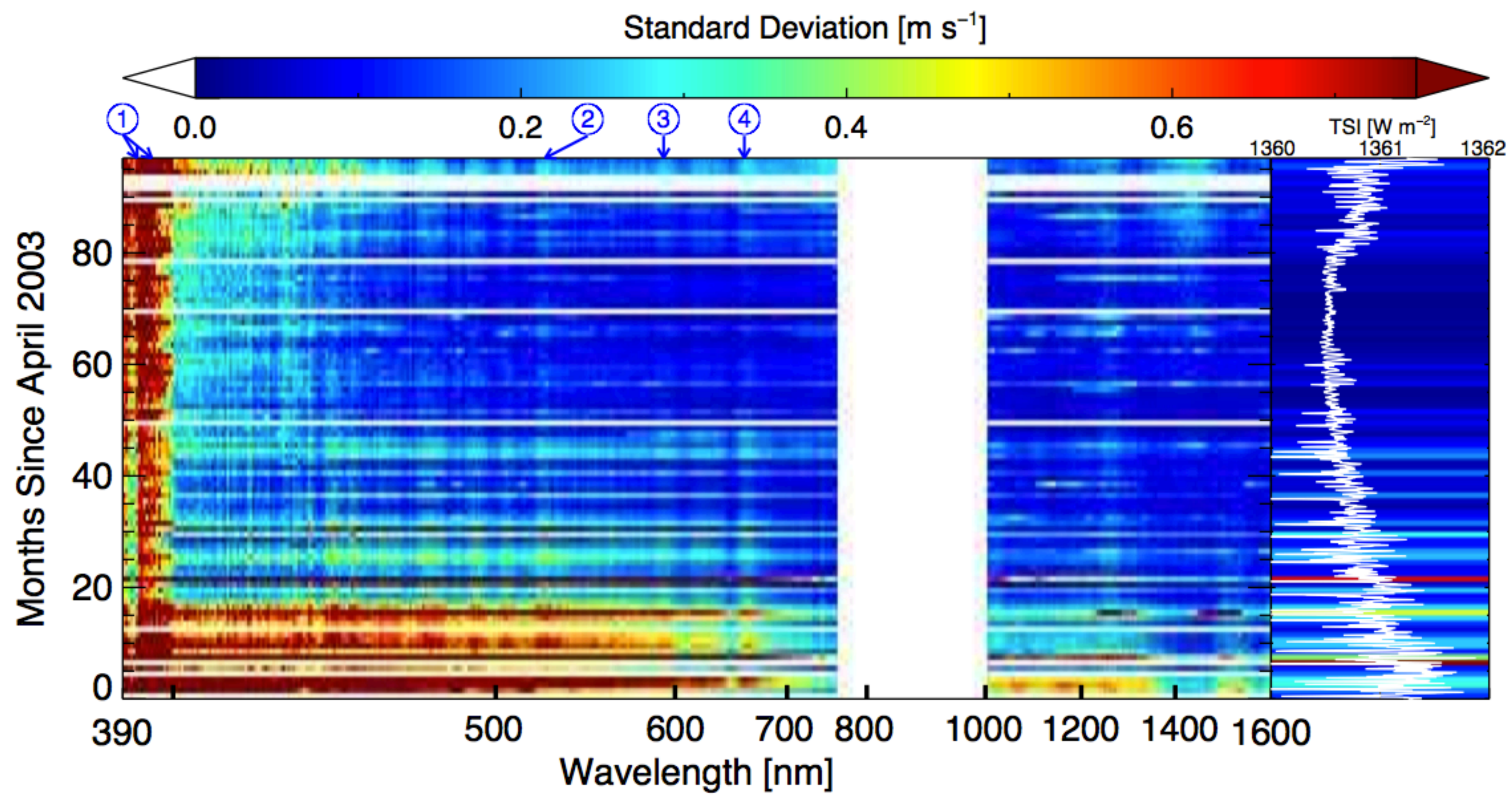
The NIR shows Lower Variation

ΔRVs were calculated over the entire 8 year span from the SSI as a function of wavelength. Below is the standard deviation of these ΔRVs as a function of wavelength. The RV variations are lower in the NIR by up to a factor of ~4. In the NIR there is little variation with wavelength, while in the optical the variations decrease with increasing wavelength (Greyed out region contains detector effects).

Additionally, the NIR shows consistently lower RV variation with time (right), with the optical only approaching the NIR during solar minimum. Numbers identify spectral activity indicators.



Standard deviation of estimated ΔRV (Marchwinski et al. under review). Labels indicate actual/expected wavelength coverage, not actual data.



Monthly standard deviation of estimated ΔRV versus wavelength and time. TSI plotted on right (Marchwinski et al. under review).

Conclusion:
We conclude that the new, NIR, planet-hunting spectrographs being built, such as HPF, could unambiguously observe the RV signals of low mass planets around bright, nearby, solar-type stars due to the reduction in stellar noise. This may be independent of or in support of traditional optical RV surveys.

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References: Aigrain, S. et al. 2012, MNRAS, 419, 3147 Marchwinski, R. et al. 2014, ApJ, submitted