Unveiling Iodine-Calibrated RV Spectroscopy

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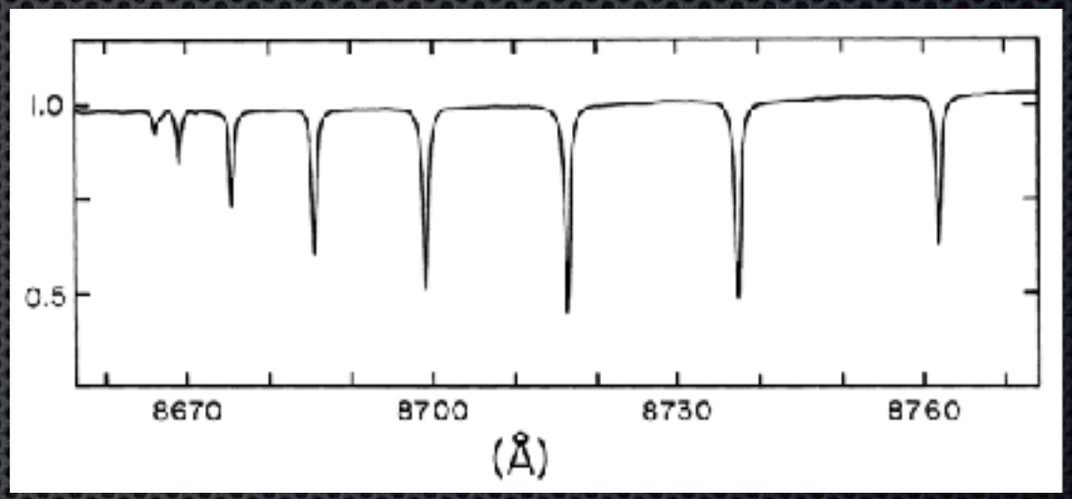
Background

Iodine cells for RVs

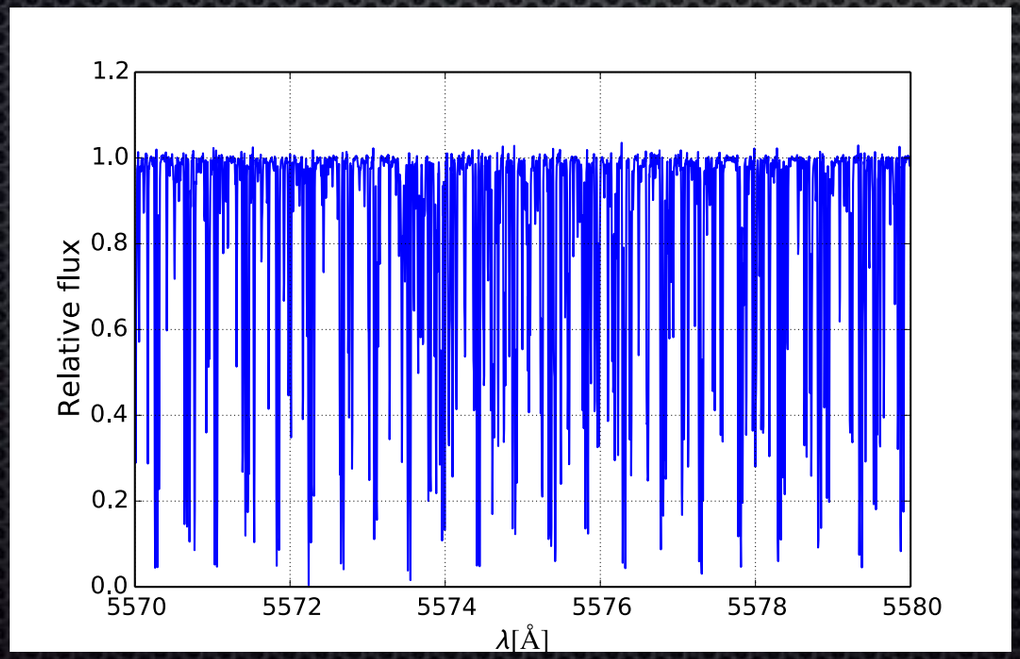


- **Campbell & Walker (1979)**
  - HF Gas, ~10 m/s
  - “seven of 15 stars there is a ‘possible’ or ‘probable’ companion in the range ~1-9 Mj”

Background

Iodine cells for RVs

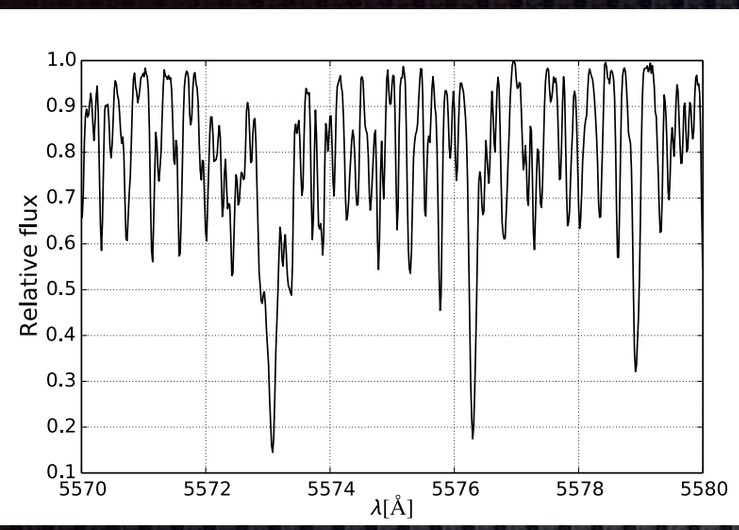
- **Libbrecht (1988), Cochran & Hatzes (1990), Marcy & Butler (1992)**
- Iodine gas, ~3 m/s

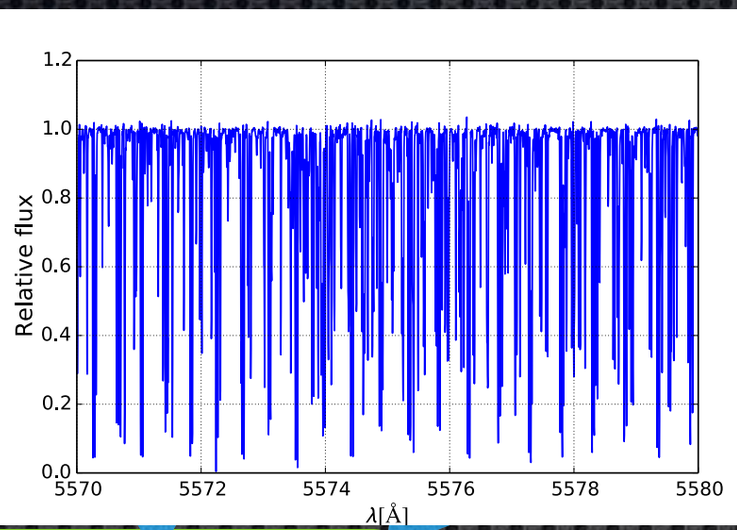


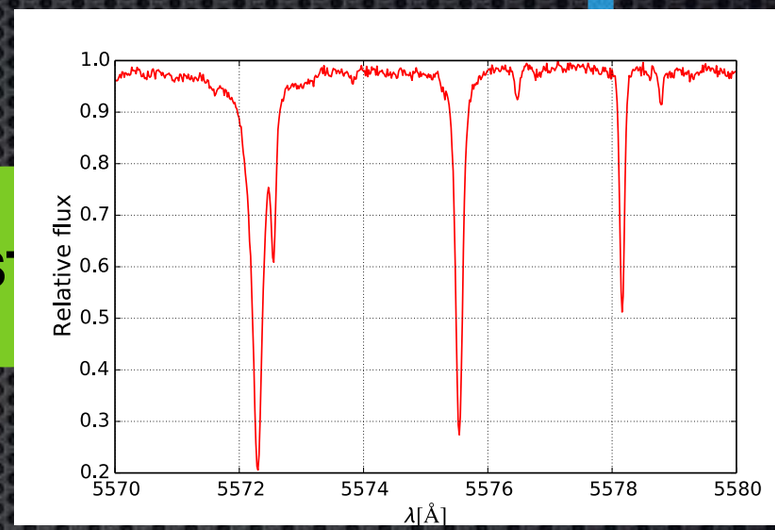
Wright 2016

Iodine Doppler Pipeline

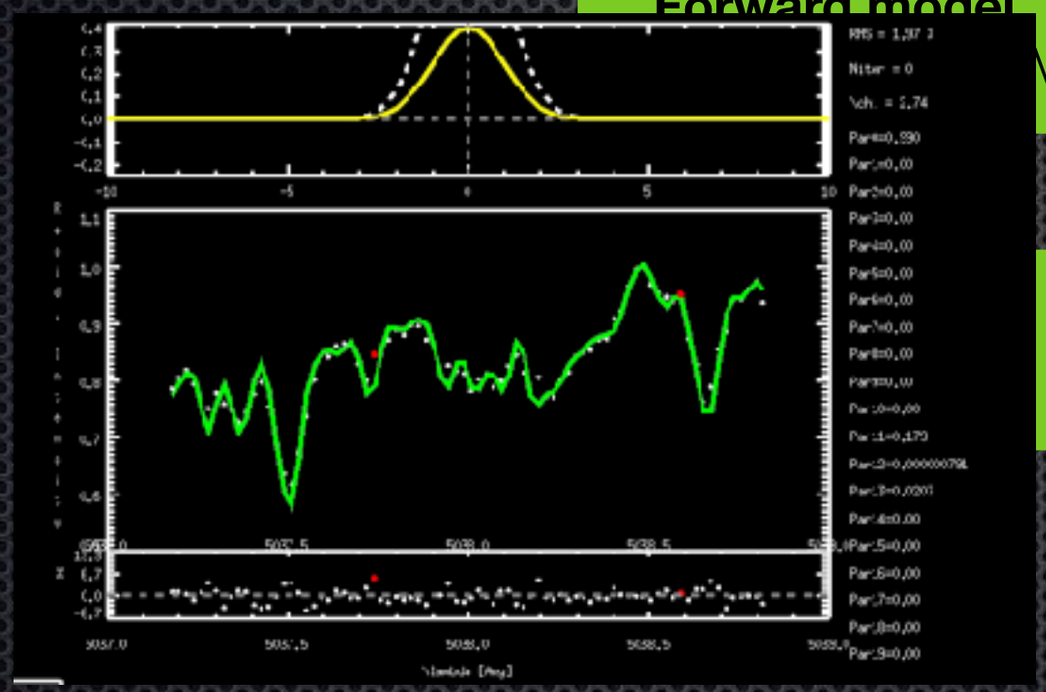
iodine-free
template

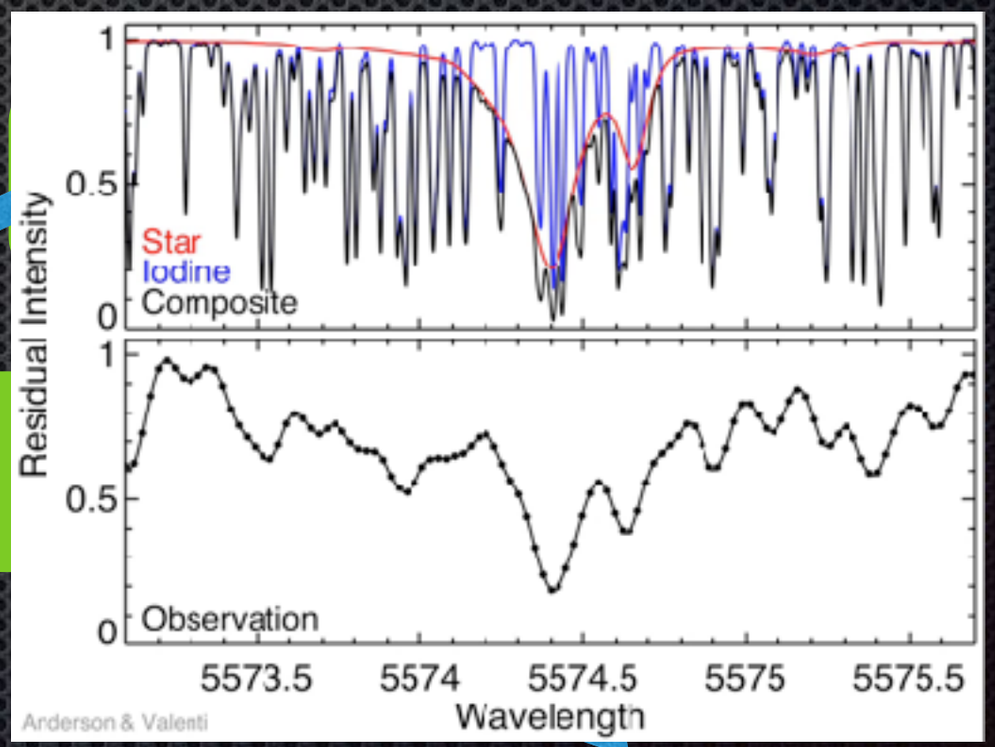






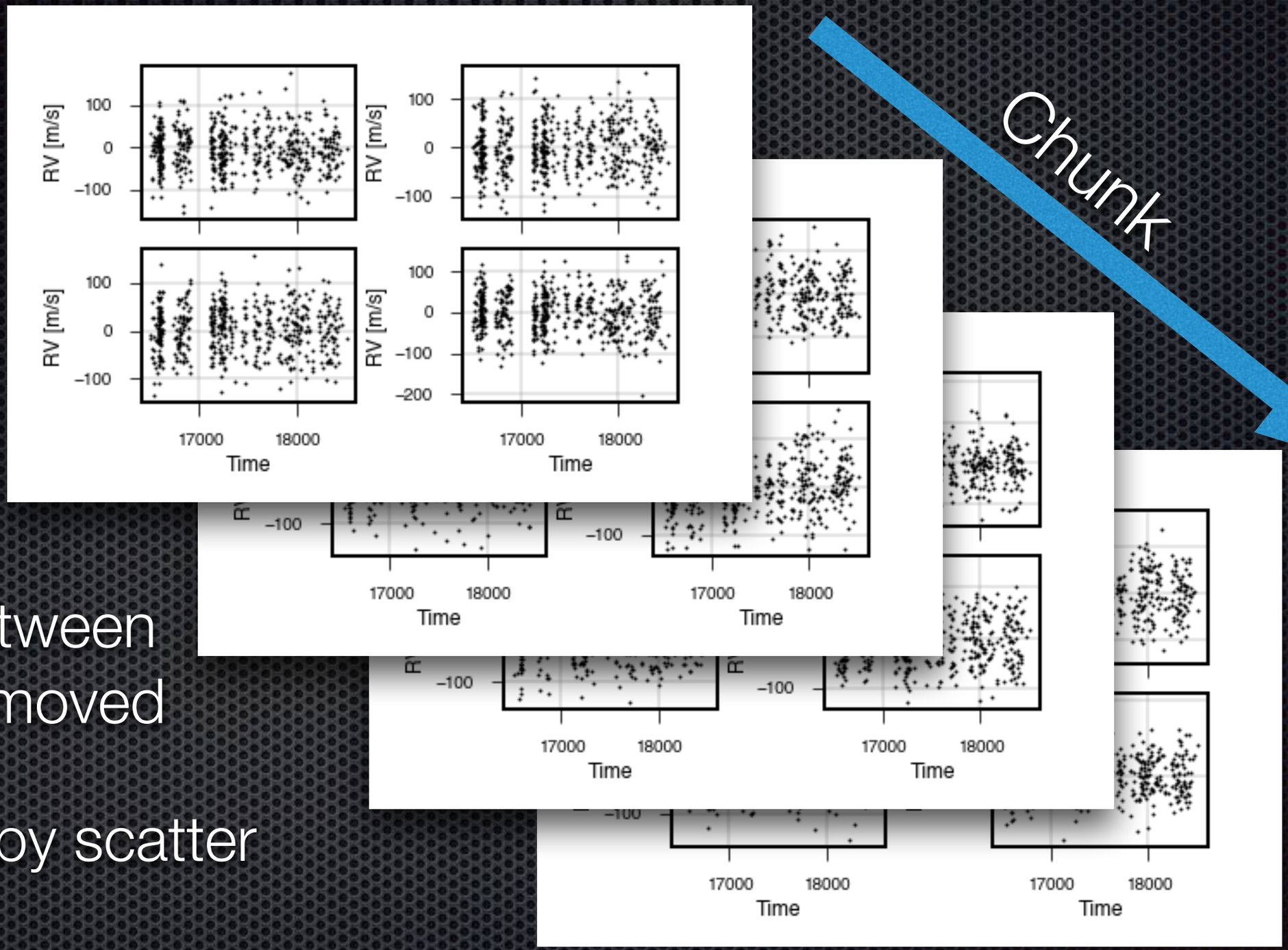
Forward model





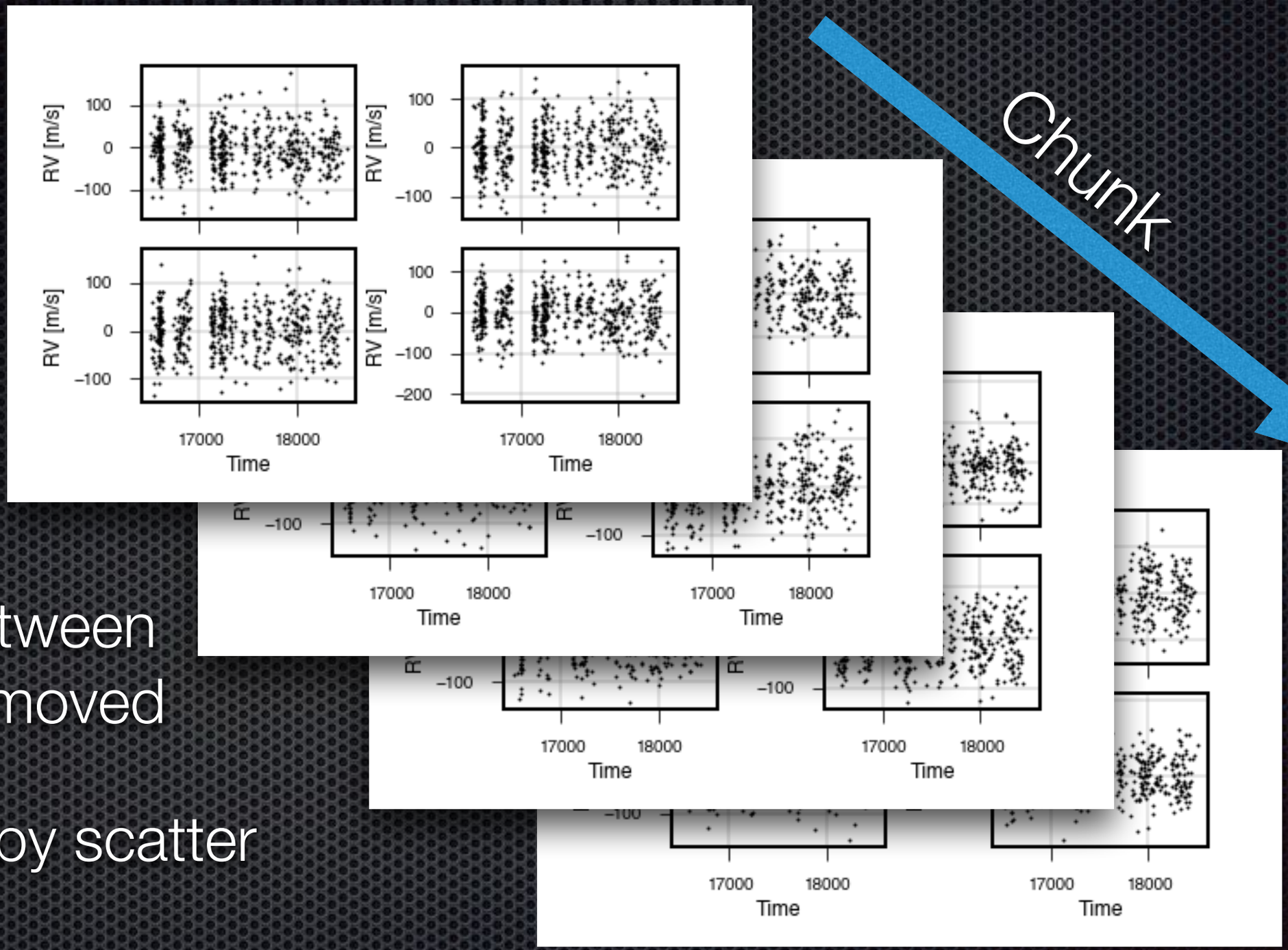
RV time series

Chunk Combination



- Offsets between chunks removed
- Weighted by scatter
- Keep only 98% ‘best’ chunks

Chunk Combination



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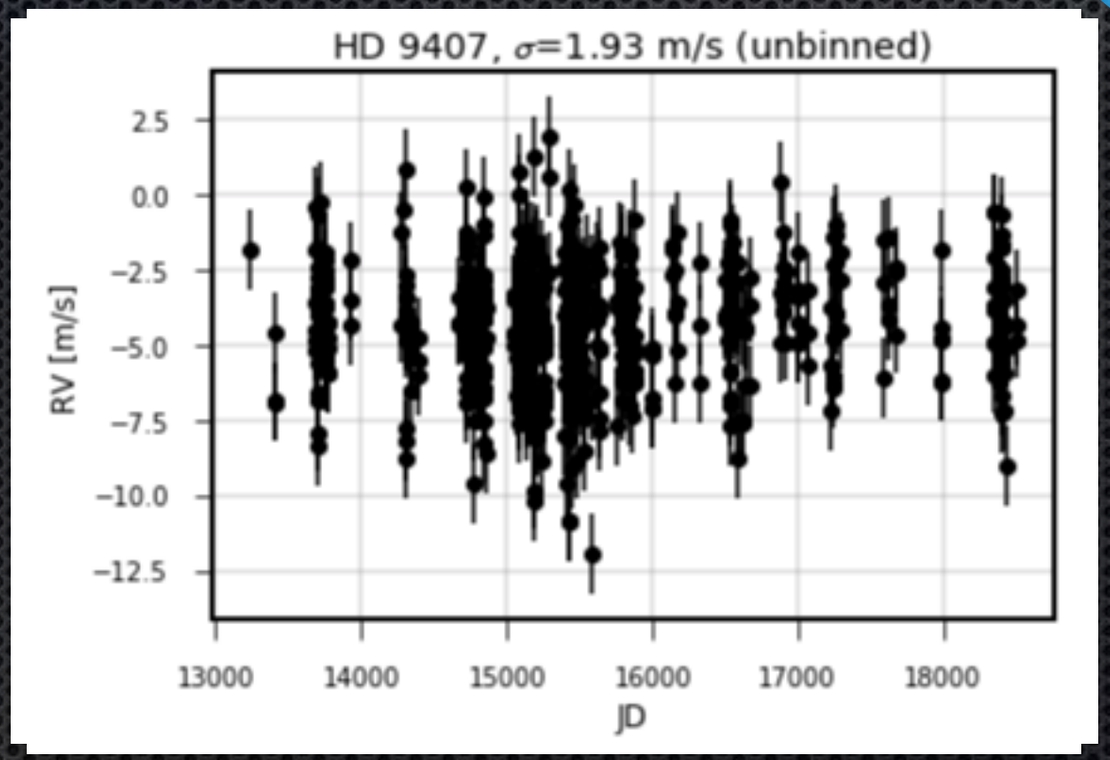
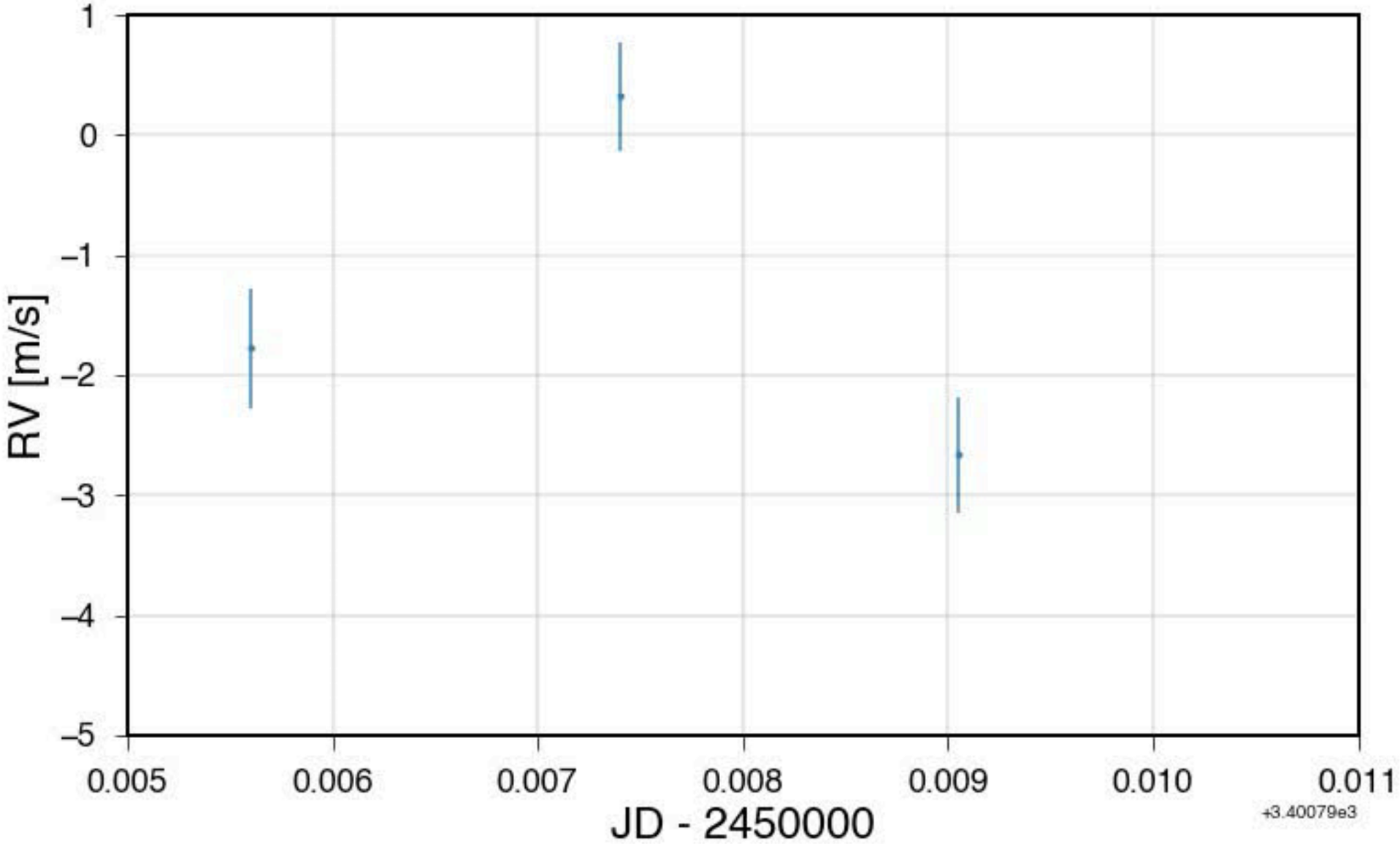


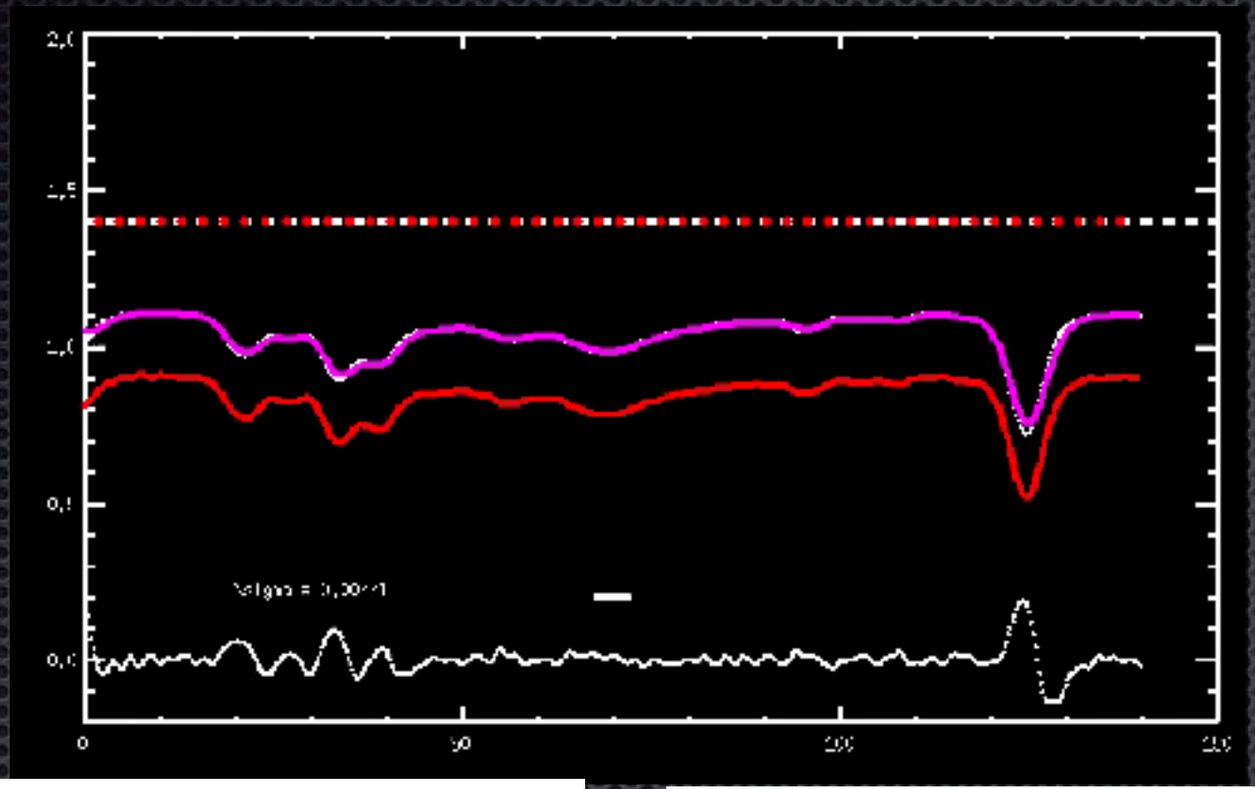
Chunk

- Offsets between chunks removed
- Weighted by scatter
- Keep only XX% ‘best’ chunks

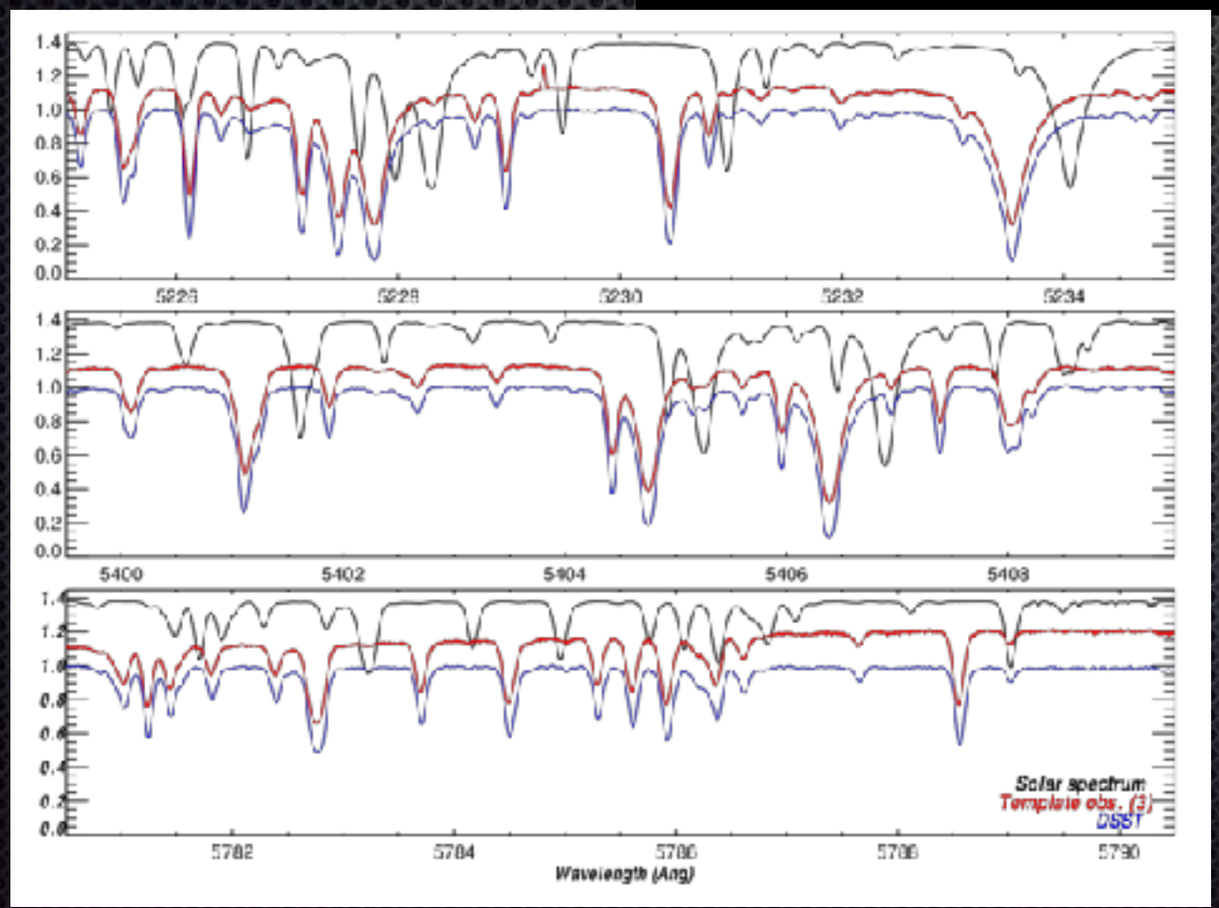
Velocities change with time



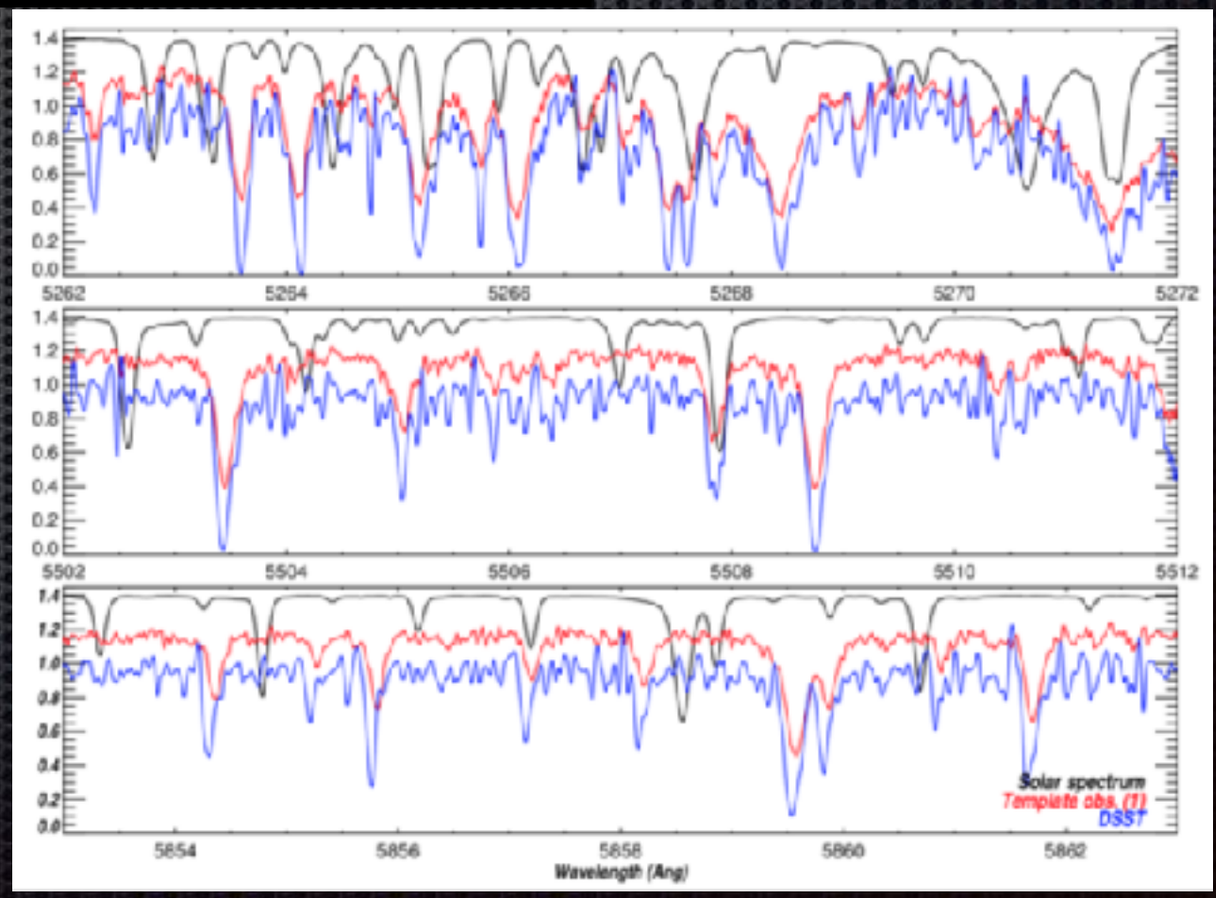
Template deconvolution



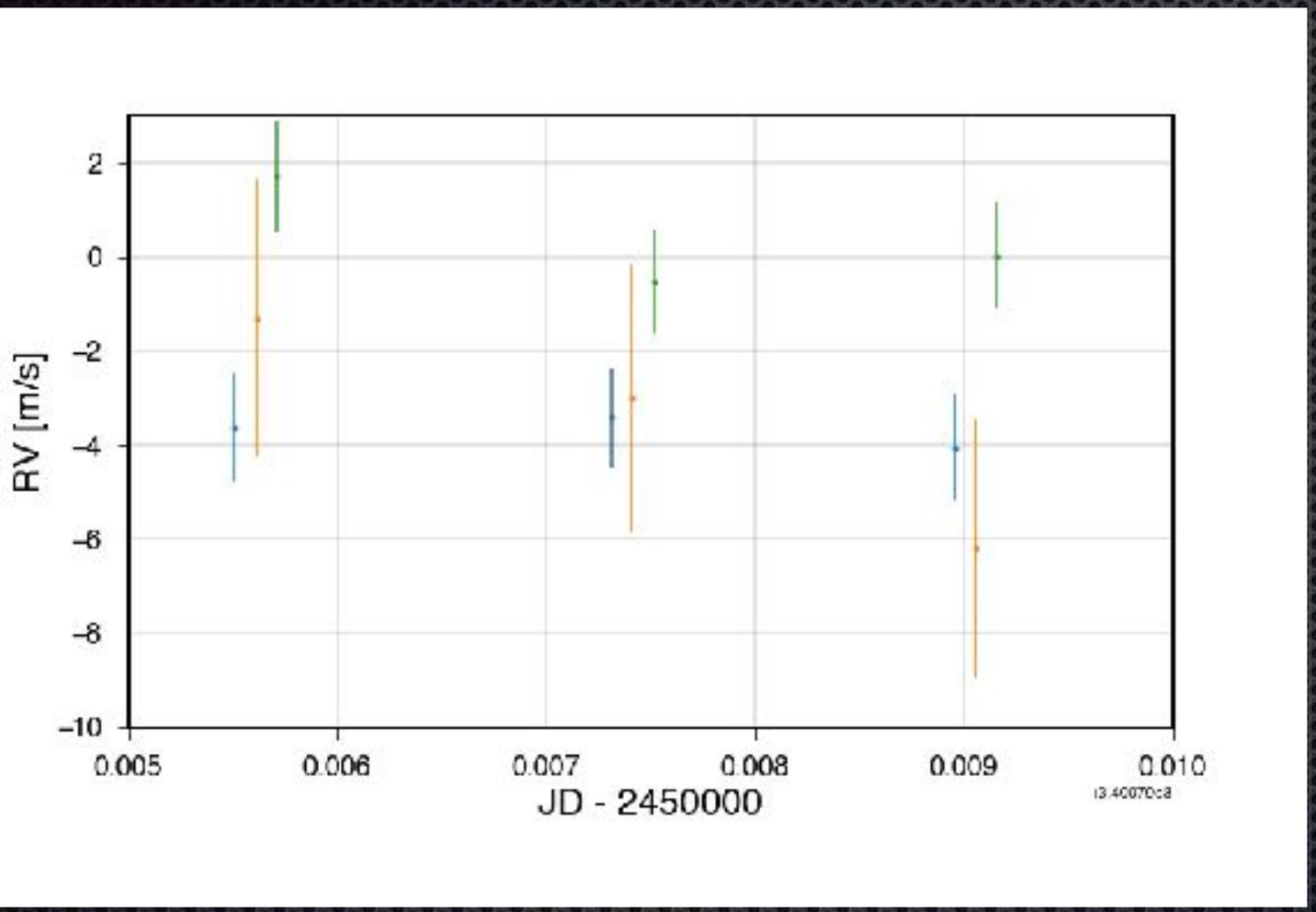
Good

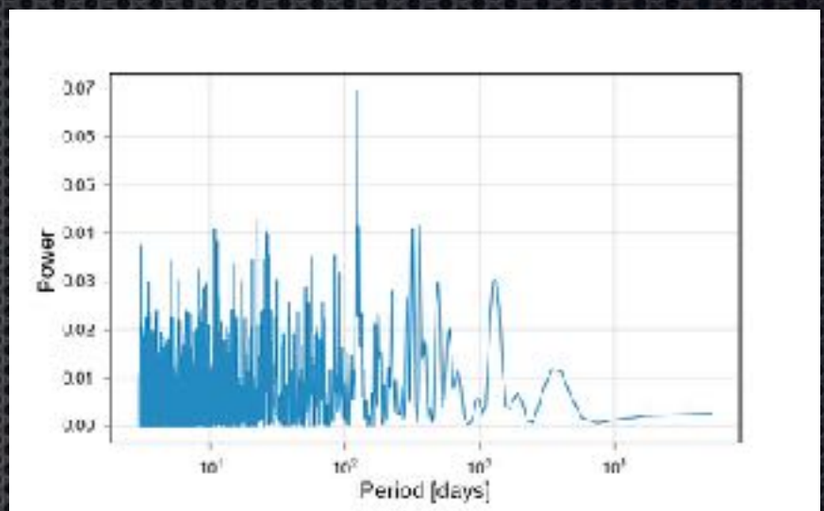


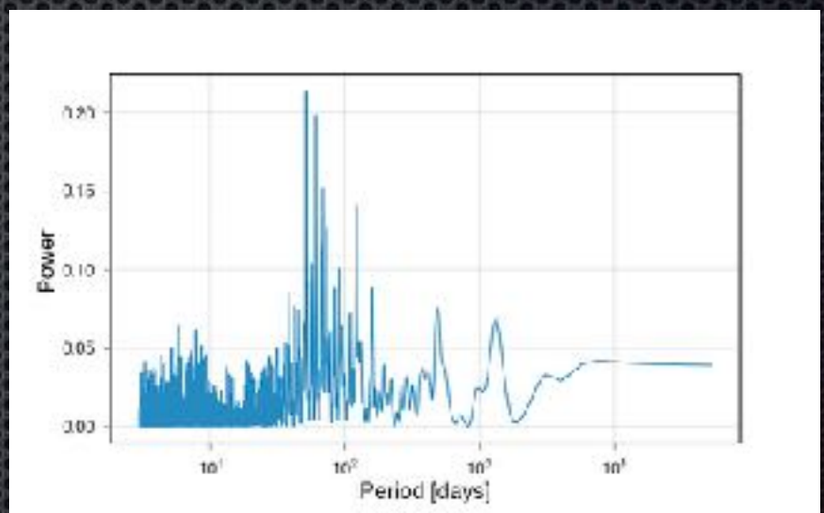
Less Good

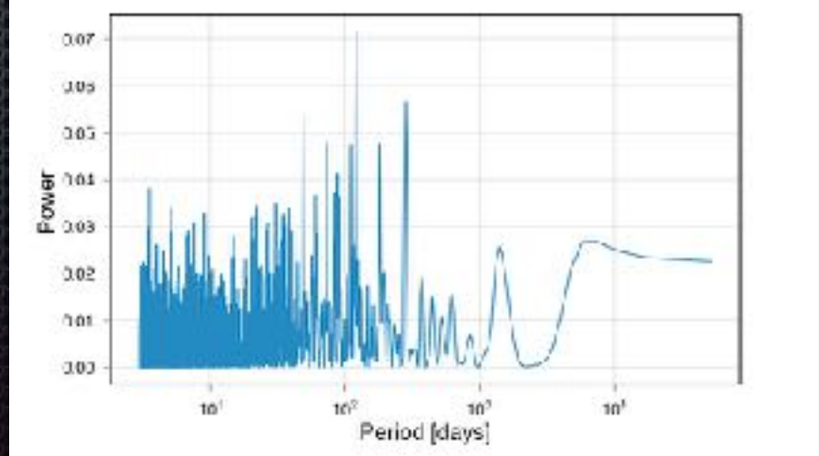


Velocities change with templates



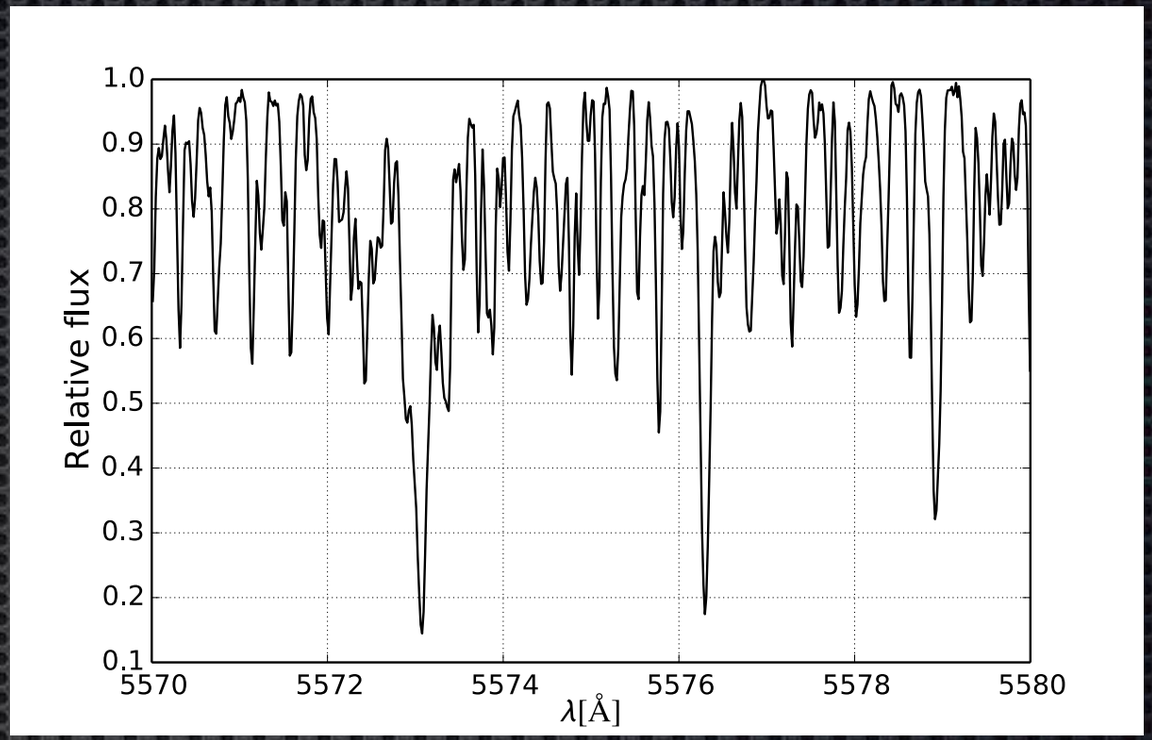


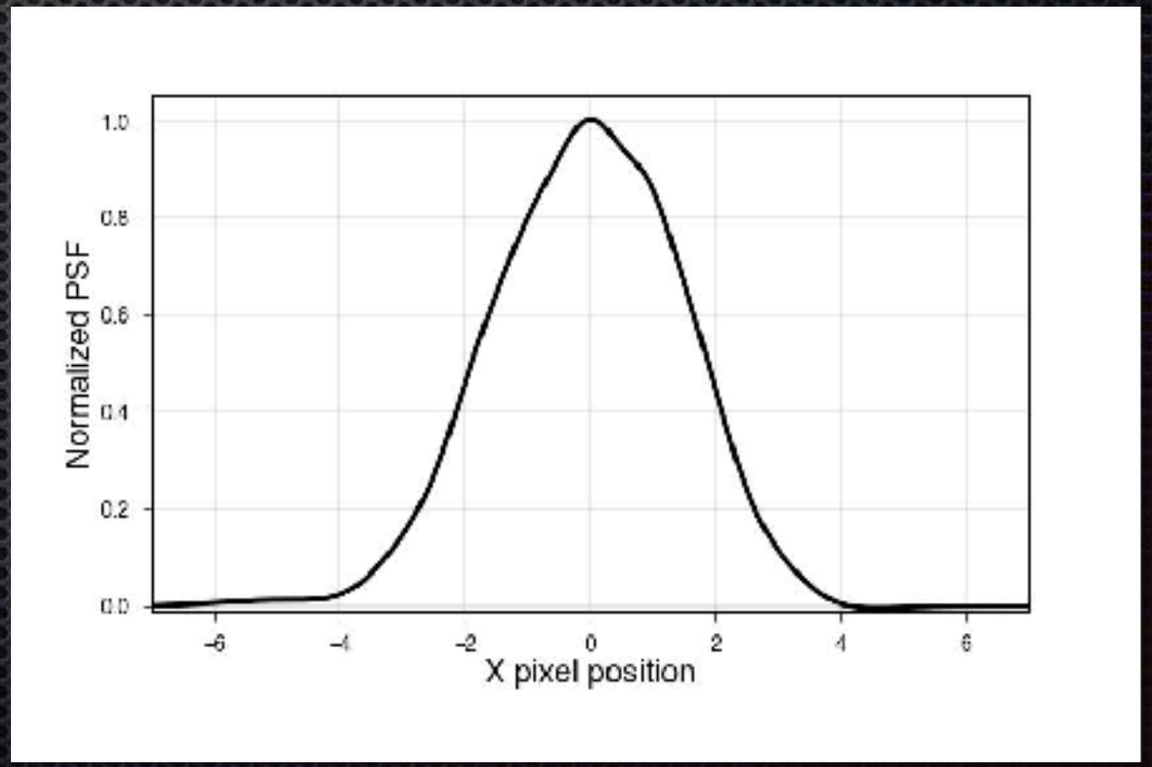




Disadvantages

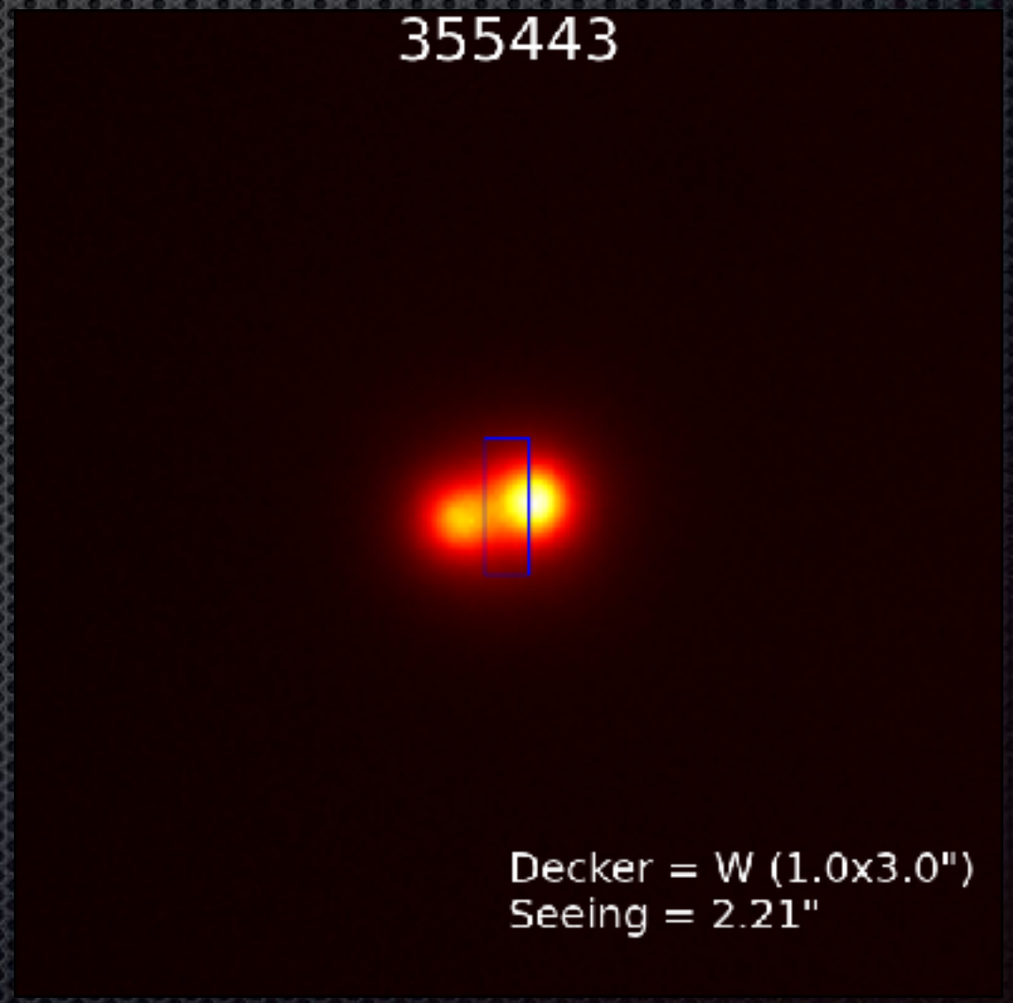
- High SNR required
  - ~800 chunks x 15 free parameters = ~12000 free parameters
- Iodine absorbs ~half the light
- Prevents some ancillary science
- Can’t measure RVs for moderate or rapid rotators
- Line profile variations do not track stellar activity





Why Are we still using Iodine?

- Magical
  - Extraordinarily insensitive to: LSF, environment, etc.
- Low(er) risk
- Easier path to ~3 m/s



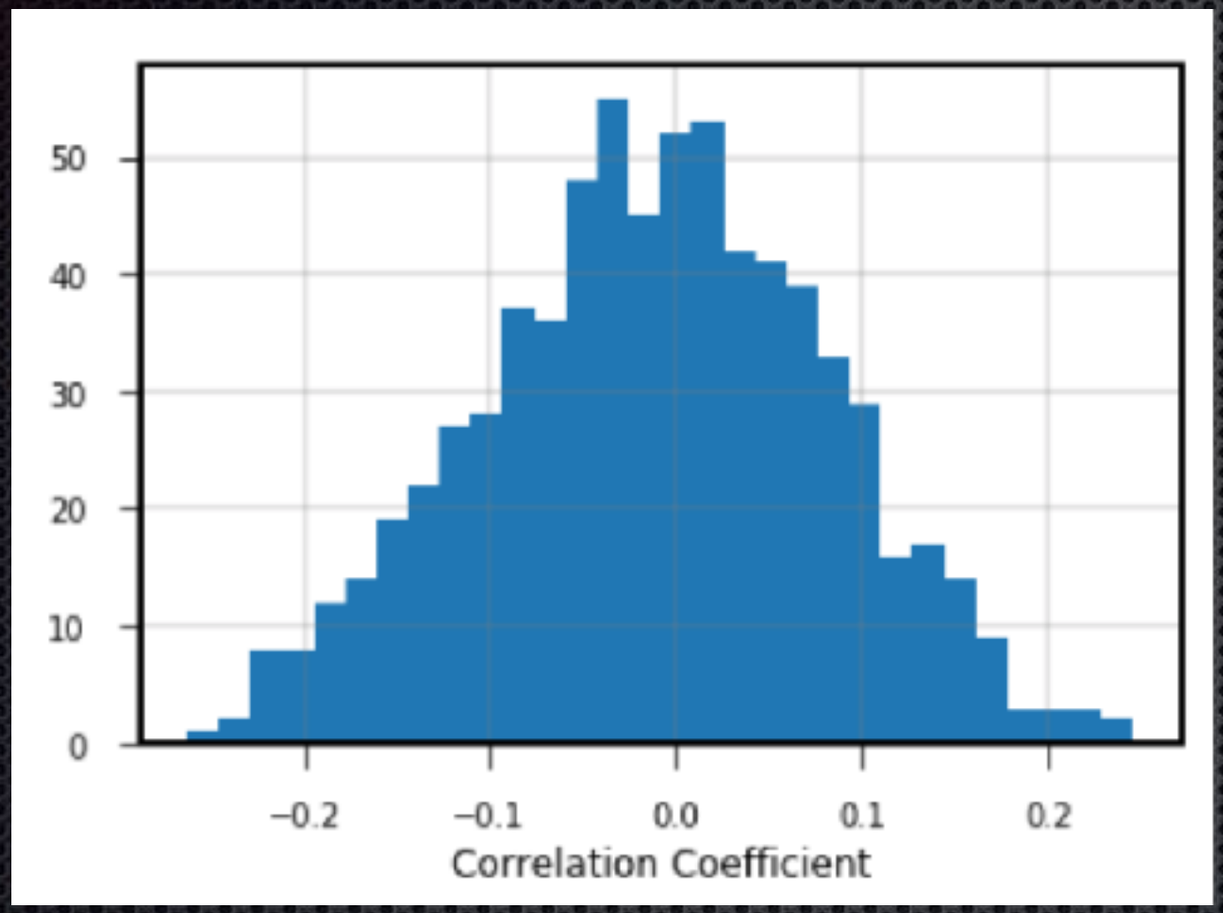
Role for Iodine in the Future

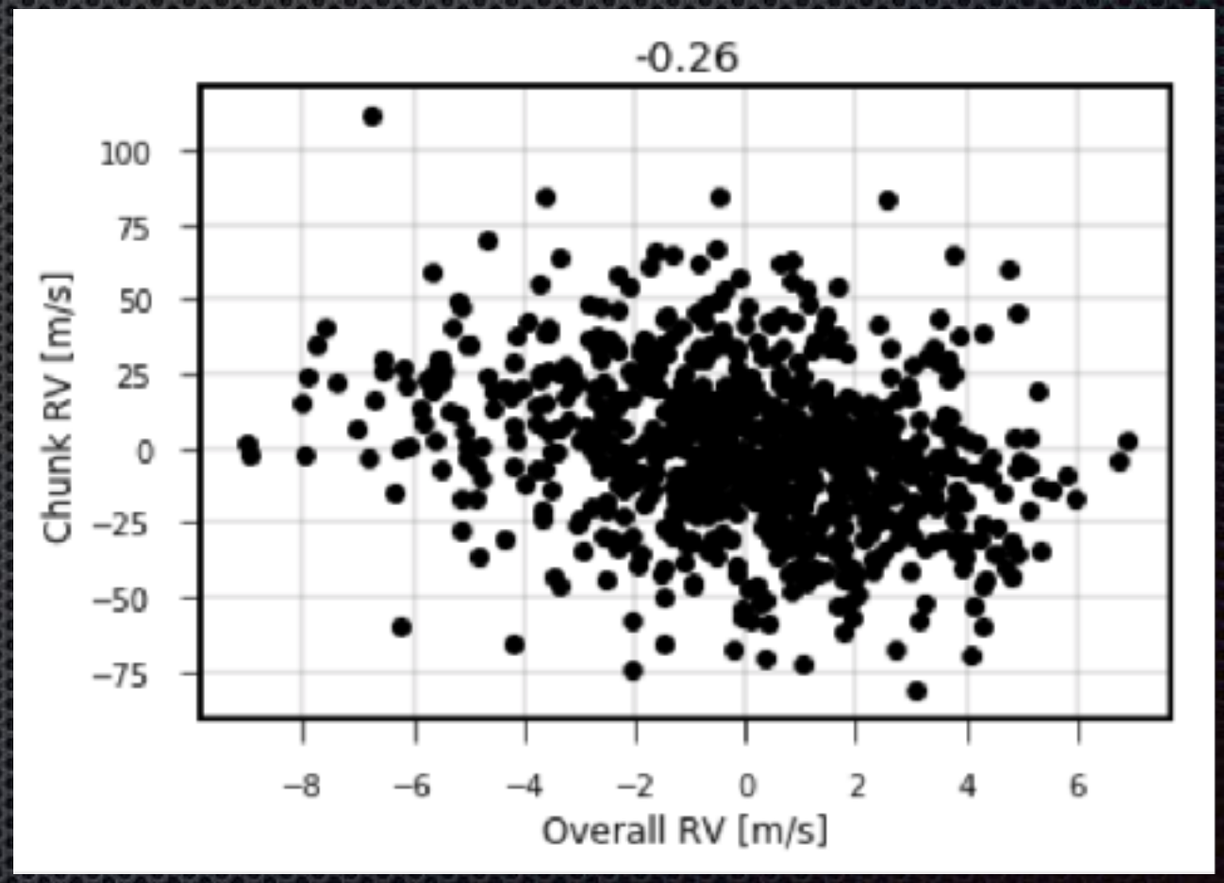
- Cheap(er), dedicated RV facilities
  - E.g. APF, MINERVA
- Worldwide networks
  - Continuous coverage
  - E.g. SONG
- Continuation of existing datasets

Credit: Laurie Hatch

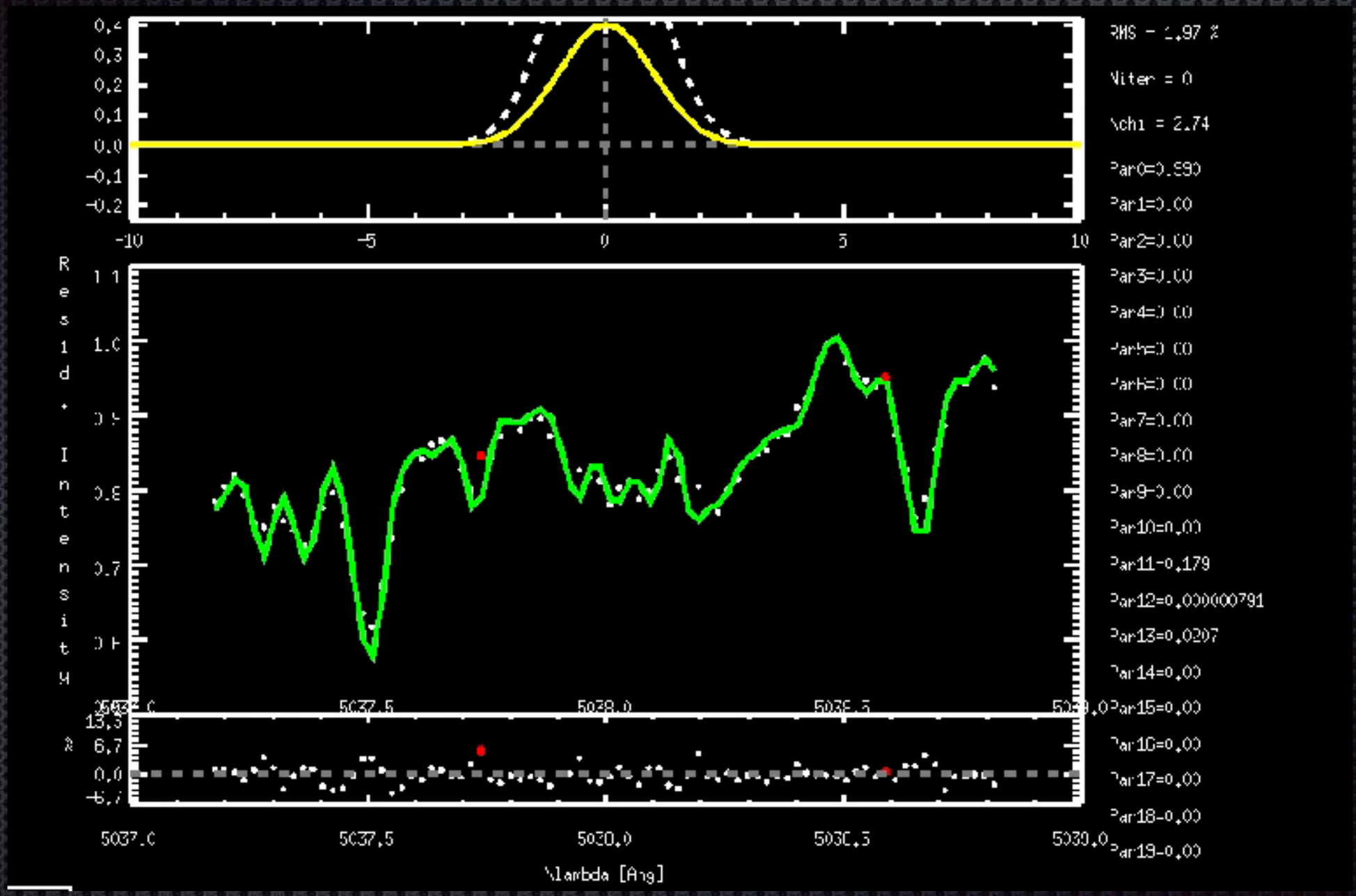
Backup Slides

Line by line analysis





Forward Modeling



$$I_{obs}(\lambda) = k[T_{I2}(\lambda) \cdot I_S(\lambda + \Delta\lambda)] \otimes PSF$$

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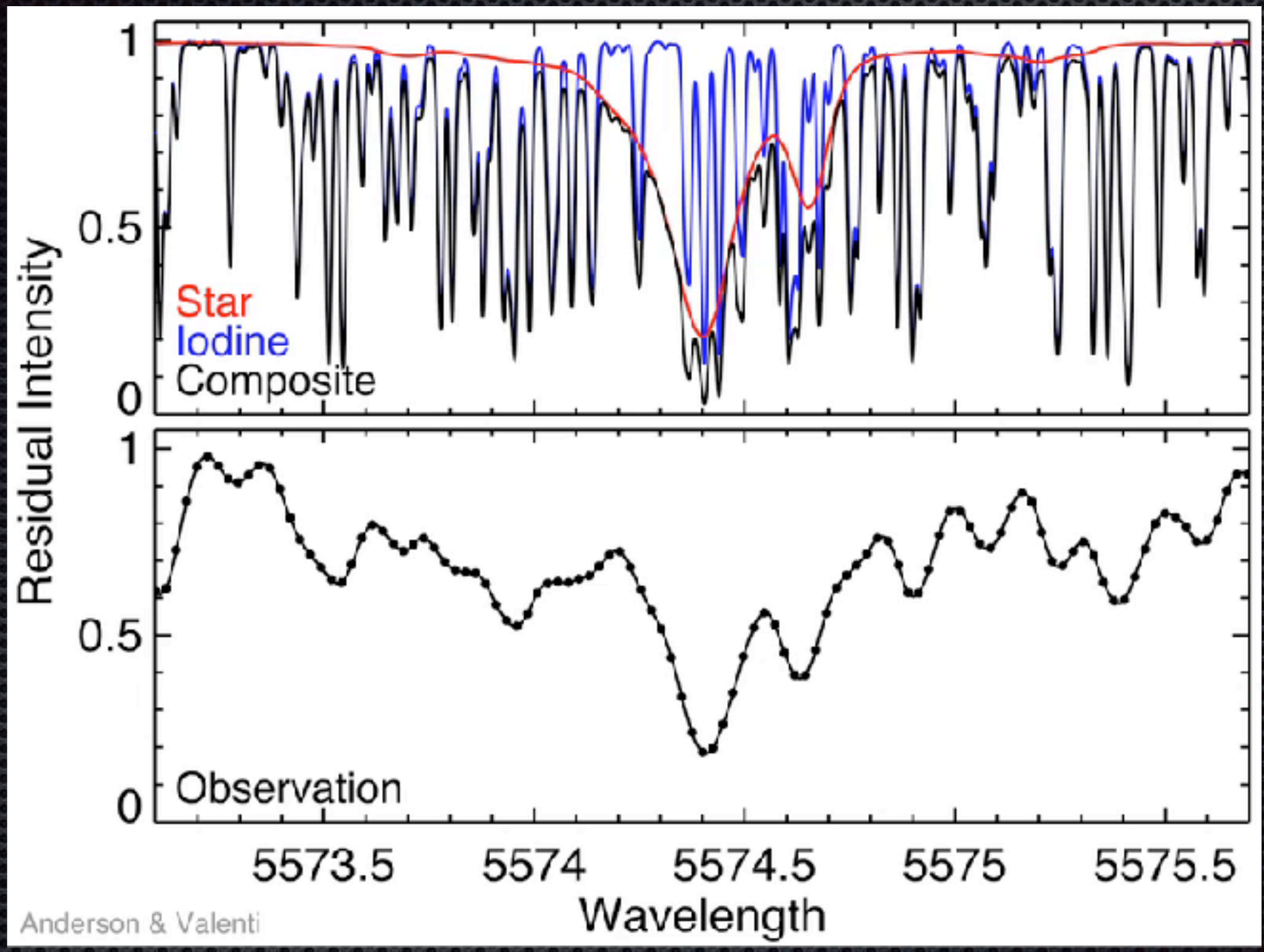

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