

Table of Content

1	Introduction	1
1.1	26 years of exoplanet discoveries	1
1.2	Transiting Exoplanet Survey Satellite	6
1.3	The Neptune Desert	10
1.4	Detection Methods	13
1.4.1	Radial Velocities	13
1.4.2	Transits	18
1.5	Signal Search	21
1.5.1	Lomb-Scargle Periodogram	21
1.5.2	Posterior Samplings and Signal Detection	22
1.5.3	MCMC, Metropolis and DRAM algorithms	23
1.6	Stellar Activity	25
1.7	Stars in the sample	27
1.8	Thesis Outline	28
2	Difficulties disentangling weak Doppler signals from stellar activity	29
2.1	HD 26965 - Stellar properties	29
2.2	Spectroscopic Observations	33
2.2.1	HIRES Observations	33
2.2.2	PFS Observations	34
2.2.3	CHIRON Observations	34
2.2.4	HARPS Observations	35
2.3	Periodogram Analysis	37
2.4	Bayesian Analysis	37
2.4.1	Model Selection	41
2.4.2	Signal injection	44
2.5	Stellar Activity and RV correlations	47
2.6	Testing variability and stability of the period and amplitude	47
2.7	ASAS Photometry	52
2.8	Mount Wilson HK measurements	52
3	Iodine-free spectra for high-resolution spectrographs	59
3.1	The iodine cell method for precise radial velocity measurements	59
3.1.1	Fundamentals of Iodine Observations	60
3.1.2	Determining the LSF, wavelength solution and Doppler shift	62

3.2	Iodine-free spectra derivation	66
3.2.1	PFS	67
3.2.2	HIRES	67
3.2.3	UCLES	70
3.3	Results	70
3.4	Direct Applications and Future Work	82
4	A short-period Neptune orbiting the G-type star TOI-132	83
4.1	Photometry	83
4.1.1	<i>TESS</i> Photometry	83
4.1.2	Ground-based time-series photometry	84
4.2	HARPS Spectroscopic Follow-up	87
4.3	Stellar Parameters	89
4.4	Speckle Imaging	94
4.5	ASAS Photometry	97
4.6	Joint Analysis	97
4.7	TTV Analysis	102
4.8	Discussion	106
5	A 55-day period dense Neptune transiting the bright star HD 95338	108
5.1	Spectroscopic Observations	108
5.1.1	PFS	109
5.1.2	HARPS	109
5.2	Stellar Parameters	114
5.3	Detection from Radial Velocities	117
5.3.1	Posterior Samplings and Signal Detection	117
5.4	Stellar Activity and RV correlations	125
5.5	Photometry	125
5.5.1	<i>TESS</i> Photometry	125
5.5.2	ASAS Photometry	130
5.6	Joint Analysis	134
5.7	Additional Signals	137
5.8	Discussion	137
6	Summary and conclusions	140
	Bibliography	143