Is there a planet in my data?
Sagan Summer Workshop 2016

Analyzing radial velocity data affected by stellar activity signals

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1) What happens if a planet with the same amplitude is moved at shorter periods? Try with a period of 2.2 days with the same amplitude. What do you think, is it easier or more difficult to detect? Is it possible to detect an Earth twin at very short period? If yes, can you detect smaller signals? If no, what types of signal can you detect? You can first see if the signal appears in the periodogram to give a first guess, and then use the GP modeling.

2) What happens if a planet with the same amplitude is moved at longer periods? Try with a period of 100 days with the same amplitude. What do you think, is it easier or more difficult to detect? Is it possible to detect an Earth twin with a period of 100 days? If yes, can you detect smaller signals? If no, what type of signal can you detect at this period? You can first see if the signal appears in the periodogram to give a first guess, and then use the GP modelling.

3) What happens if you change the stellar inclination? Is the activity RV signal more or less important? You can first try with one active region using SOAP 2.0, and then model the activity for a star like the Sun inclined with an angle of 45 degrees. Is it therefore more difficult or easier to detect planets? Do you prefer to observe equator-on stars, or pole on stars for planet detection? If you have time, give an example using the GP regression and fitting a planetary signal.

4) What happens if you increase the rotation period of the star? Is the activity RV signal increasing or decreasing? You can first try with one active region using SOAP 2.0, and then model the activity for a star like the Sun with an rotational period of 40 days. Is the effect of spots bigger than the effect of plages? Do you know why? How change the correlations between RVs and the other parameters (BIS SPAN, FWHM, photometry)? Do you prefer a star that is rotating slower to detect exoplanets?

5) What happens if you decrease the rotation period of the star? Is the activity RV signal increasing or decreasing? You can first try with one active region using SOAP 2.0, and then model the activity for a star like the Sun with a rotational period of 5 days. Is the effect of spots bigger than the effect of plages? Do you know why? How change the correlations between RVs and the other parameters (BIS SPAN, FWHM, photometry)? Do you prefer a star that is rotating faster to detect exoplanets?

6) What happens if you decrease the difference between the spot temperature and the quiet photosphere? Is the activity RV signal larger or smaller? You can first try with one spot using SOAP 2.0, and then model the activity for a star like the Sun with a difference in spot temperature of 100 K (fix the rotation period to 5 days). How the effect of spots is sensitive to this change? Can you detect smaller planetary signals that when comparing with an activity model of the Sun? Do you think it is therefore better to observe G dwarfs or M dwarfs to look for small planets? Why (think about the Planck energy distribution)?

7) What happens if you keep the same period but you increase of decrease the amplitude of the planet. Is it more difficult to detect smaller amplitude planetary signals, or large amplitude ones? Using the RV data set used in the example and GP modeling, try to find for which amplitude you can confidently detect an exoplanet with a period of 10 days?

8) Change the number of RV observations (change the “half_data” parameter to int(len(time)/4.), int(len(time)/3.) and int(len(time))). Is it more difficult or easier to detect the same exoplanet? Try for different number of measurement to detect what is the smallest planetary signal you can detect and try to see how this evolves? Is this following a Gaussian distribution (~sqrt(Nmeas.)) or not? Do you know why? The computational time for “half_data”= int(len(time)) can be long, so do it at the end if you have time.