A principled Bayesian workflow for planet detection

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The detection of exoplanets with precise radial velocities is a well-studied statistical problem. A Bayesian approach, providing estimates for the posterior distributions of orbital parameters of interest, is now ubiquitous. However, the model comparison aspect of this approach, which is essential when claiming a planet detection or measuring its significance, is less well understood. Even if the Bayesian marginal likelihood (or evidence) is used, it is still often interpreted on a rather arbitrary and unjustified scale. Other detection criteria exist, but they can lead to significant biases in the detected planetary parameters. In other words, there is no principled approach to making decisions based on RV datasets.

In this talk, I will detail our efforts to develop a model for planet detection in RVs that has a straightforward and well-justified statistical interpretation and that is less sensitive to arbitrary changes in the assumed prior information. The approach frames the detection into a parameter estimation and classification problem and is easily implemented in practice. In applications to real and simulated data, we can recover known planet detections with interpretable (and intuitive) levels of significance. This model, and the more general Bayesian workflow it rests upon, holds promise to guide us in making the right decisions when it comes to detecting exoplanets.