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Searching For Planetary Systems Using Bayesian Analysis

To answer fundamental questions and determine large-scale properties of planets in our galaxy, a large population free of observational biases is required. Therefore, a high-throughput, multi-object, radial velocity instrument has been built based upon the ET instrument developed by Jian Ge and collaborators (Ge 2002, van Eyken et al. 2004). The new instrument, called the W.M. Keck Exoplanet Tracker, has already demonstrated multi-object capability, while the ET prototype instrument has detected its first new extrasolar planet (Ge et al., 2005 AAS). Current plans are to use the Keck ET instrument with the Sloan telescope to perform an All-Sky Survey for Extrasolar Planets (ASEPS) from 2008-2020, with the capability of detecting tens of thousands of new planets, compared with the ~ 170 currently known. A three-month test run begins in March 2006.

However, coupled with a form of statistics known as Bayesian statistics, it is possible to do even more. I intend to develop Bayesian analysis software that will detect the “hidden” presence of additional planets within the radial velocity signatures measured by the Keck ET. The method has already been used to discover a second planet’s signature in HD 208487 (Gregory 2005, preprint). Use of the software with ASEPS will allow us in theory to perform an All-Sky Survey for Extrasolar Planetary Systems.

In addition, Bayesian inference can be used to determine precisely when to follow-up targets so that the maximum amount of information is obtained. I intend to create software that will predict the best time to perform follow-up on ASEPS’ planet candidates, drastically improving the efficiency of our search and increasing the number of discovered planets. In addition, the Bayesian software can reduce false detections and reduce biases towards short-period planets inherent in radial velocity surveys. In all these ways, Bayesian software can dramatically increase the number of planets discovered by ASEPS and therefore increase the population of known extrasolar planets from which scientific studies are performed.