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2016-2017: ASTRO: Hierarchical Bayesian Modeling of Exoplanet Population

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Lecture: ***Signal Separation for Exoplanet Detection: A Diffusion Map Approach***

Speaker: David Stenning

Abstract:

An active area of research in modern astronomy is the detection of exoplanets---planets that orbit stars other than the Sun. A promising approach for discovering Earth-like exoplanets is the radial velocity method, which involves detecting the Doppler shift in a star's spectral lines resulting from the gravitational effects of an orbiting planet. However, the signal caused by a Doppler shift is often obscured by those resulting from stellar activity, such as dark spots rotating across the star's surface.

We aim to disentangle the Doppler shift signal present in stellar spectra from those of stellar activity, thereby improving the efficacy of the radial velocity method. We rely on synthetic spectra generated by the SOAP 2.0 code (Dumusque et al. 2014) to test various methodologies. In this talk, I will present some preliminary results on the use of diffusion maps (e.g. Coifman and Lafon, 2006; Lafron and Lee, 2006; Richards et al., 2009)---a nonlinear dimension reduction technique---as part of our overall procedure for distinguishing between Doppler shifts and stellar activity.

References:

Dumusque, X., Boisse, I., and Santos, N.C. (2014). SOAP 2.0: A Tool to Estimate the Photometric and Radial Velocity Variations Induced by Stellar Spots and Plages. The Astrophysical Journal, 796, 2.

Coifman, R.R. and Lafon, S. (2006). Diffusion maps. Applied and Computational Harmonic Analysis. 21: 5–30.

Lafon, S. and Lee, A.B. (2006). Diffusion Maps and Coarse-Graining: A Unified Framework for Dimensionality Reduction, Graph Partitioning, and Data Set Parameterization. IEEE Trans. Pattern Anal. Mach. Intell., vol. 28, pp. 1393-1403.

Richards, J.W., Freeman, P.E., Lee, A.B., and Schafer, C.M. (2009). Exploiting Low-Dimensional Structure in Astronomical Spectra. The Astrophysical Journal, 691, 32-42