Morello, Giuseppe

A blind method to detrend exoplanetary observations

Observations of exoplanetary transits are a powerful tool to investigate the nature of planets around other stars. Transits are revealed through periodic drops in the apparent stellar brightness, due to the interposition of a planet between the star and the observer. Multiwavelength observations can be used to characterize the atmospheres of exoplanets, through differences in the transit depths, typically at the level of one part in 10^4 in stellar flux for giant planets. Although this method has been successfully used to detect a list of molecules on several exoplanets, some controversial results are present in the literature. Instrumental systematics are often difficult to disentangle from the signal, and the use of different parameterizations of the systematics can affect the results. We present a blind source separation method, based on Independent Component Analysis (ICA) of individual pixel time series, to decorrelate the planetary signal without any prior instrument model or astrophysical information, hence ensuring a higher degree of objectivity. This method has been applied to a few Spitzer/IRAC light-curves of HD189733b and GJ436b, obtaining for the first time coherent and repeatable results over different epochs (Morello et al. 2014, ApJ, 786, 22, Morello et al. 2015, ApJ, 802, 117). The ability of ICA to disentangle the source signals from observations is not limited to photometric time series, but also to spectroscopic data (Waldmann et al. 2012, 2013, 2014), and images (Hyvarynen & Oja 2000, Neural Networks, 13, 411). We introduce here the ICA statistical technique, present its applications in exoplanetary science, and, in particular, the data detrending algorithm mentioned above (see also Morello 2015, ArXiv). We also report the results of its application to different observations, in addition to the already published ones. Finally, we discuss the possible advantages of implementing similar methods in other contexts, and future perspectives.