HOMEWORK 8
Gaussian Progress Regression

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Looking at Blazar Light-curve Periodicities with Gaussian Processes

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Abstract

Temporal analysis of blazar flux is a powerful tool to draw inferences about the emission processes and physics of these sources. In the most general case, the available light curves are irregularly sampled and influenced by gaps, and in addition are also affected by correlated noise, making their analysis complicated. Gaussian processes may offer a viable tool to assess the statistical significance of proposed periods in light curves characterized by any sampling and noise pattern. We infer the significance of the periods proposed in the literature for two well known blazars with multiple claims of possible year-long periodicity: PG 1553 + 113 and PKS 2155–304, in the high-energy and optical bands. Adding a periodic component to the modeling gives a better statistical description of the analyzed light curves. The improvement is rather solid for PG 1553 + 113, both at high energies and in the optical, while for PKS 2155–304 at high energies the improvement is not yet strong enough to allow cogent claims, and no evidence for periodicity emerged from the analysis in the optical. Modeling a light curve by means of Gaussian processes, in spite of being relatively computationally demanding, allows us to derive a wealth of information about the data under study and suggests an original analysis framework for light curves of astrophysical interest.

Unified Astronomy Thesaurus concepts: Blazars (164); Gaussian Processes regression (1930); Lomb-Scargle periodogram (1959); Time series analysis (1916); Astrostatistics techniques (1886); Period search (1211)

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Detecting the periodicity of highly irregularly sampled light curves with Gaussian processes: the case of SDSS J025214.67−002813.7

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ABSTRACT

Based on a 20-yr-long multiband observation of its light curve, it was conjectured that the quasar SDSS J025214.67−002813.7 has a periodicity of ∼4.4 yr. These observations were acquired at a highly irregular sampling rate and feature long intervals of missing data. In this setting, the inference over the light curve's spectral content requires, in addition to classic Fourier methods, a proper model of the probability distribution of the missing observations. In this article, we address the detection of the periodicity of a light curve from partial and irregularly sampled observations using Gaussian processes, a Bayesian non-parametric model for time series. This methodology allows us to evaluate the veracity of the claimed periodicity of the above-mentioned quasar and also to estimate its power spectral density. Our main contribution is the confirmation that considering periodic component definitely improves the modelling of the data, although being the source originally selected by a large sample of objects, the possibility that this is a chance result cannot be ruled out.

Key words: methods: statistical – quasars: individual: SDSS J025214.67−002813.7.