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Towards a More General Method for Filling Gaps in Time Series

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Abstract. The need for a proper interpolation method for data coming from space missions like CoRoT is emphasized. A new gap-filling method is introduced which is based on auto-regressive moving average interpolation (ARMA) models. The method is tested on light curves from stars observed by the CoRoT satellite, filling the gaps caused by the South Atlantic Anomaly.

Keywords. methods: data analysis, stars: oscillations

1. Introduction

Recent space missions like CoRoT (Baglin *et al.* 2006) and Kepler (Borucki *et al.* 2010) provide photometric data with very high duty cycle and unprecedented resolution. However, the light curves always have some invalid flux measurements owing to operational procedures such as (among others) mask changes or reorientation of the satellite, or (as in the case of CoRoT) the impact of energetic particles when the satellite passes through the South Atlantic Anomaly. Those gaps produce aliases in the frequency spectra, and a gap-filling procedure is normally applied to avoid such aliases. The most commonly used one is linear interpolation, which is very simple but very unrealistic. It is the interpolation used for CoRoT data.

We have developed a new gap-filling technique (ARMA) based on auto-regressive moving average models, as a means of avoiding the errors introduced by linear interpolation methods. Our technique models the data points around the gaps by auto-regressive processes and interpolates the gaps with a forward-backward predictor, thence yielding a corrected light curve with regular sampling.

In this contribution we apply our gap-filling technique to the CoRoT light curves of two stars, HD 51193 and HD 172189.

2. Results

The first case is the Be star HD 51193 (Gutirrez et al. 2007) observed in the LRa02 target field (see Fig. 1). Between the two vertical dashed lines the improvement of the ARMA interpolation (crosses) is compared to the linear interpolation (dots).

In the right panel of Fig. 1 the grey peaks appearing on the right-hand side are produced by the spectral window caused by the gaps. In the ARMA-interpolated (black) spectra those peaks have disappeared. About 1.5% of the power spread over those peaks is thus recovered.

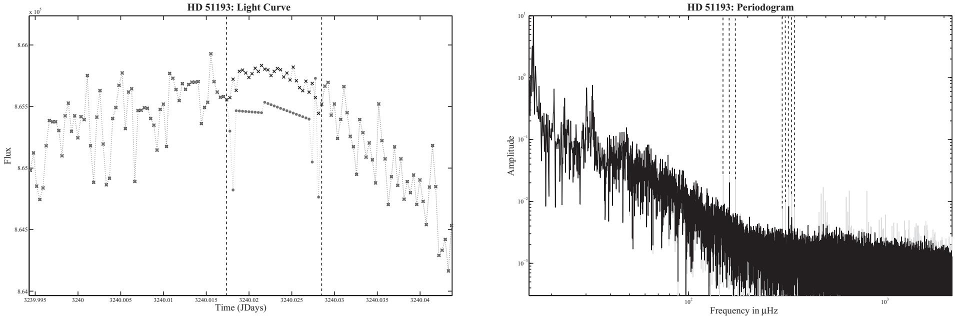

Figure 1. Left: a section of the HD 51193 light curve. Between the two vertical lines the dots represent linear interpolation and crosses the ARMA one. Right: a Scargle periodogram of the light curve. Linear interpolation is in grey and ARMA interpolation in black.

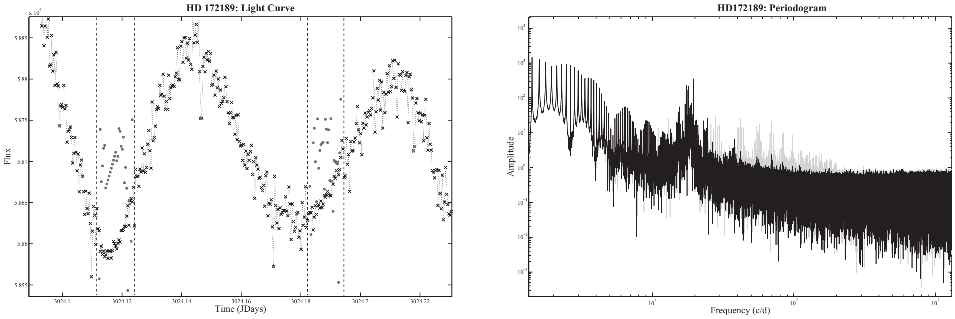

Figure 2. The same as Fig. 1, but for the star HD 172189.

The second case is the binary system HD 172189, (Martín-Ruiz et al. 2005) which shows classical δ Scuti pulsations (see Fig. 2). As the Figure shows, in this case the error introduced by linear interpolation is more pronounced and more critical. Again, the spectral window is removed much more efficiently with ARMA interpolation than with linear interpolation.

These two cases reveal the importance of introducing a reliable gap-filling process. Owing to the size of the gaps in CoRoT data, a greater improvement is expected in the case of δ Scuti stars.

A more detailed description of the method, together with further results, will be published shortly.

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