Photo-Reverberation Mapping

Tutorial #5

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The goal of this tutorial was to learn photo-reverberation mapping (photo-RM) methods and techniques, and to get introduce to tools that simulate active galactic nuclei (AGN) light-curves and perform photo-RM. And then, to apply these methods to real observational data.

Task 1

1. Simulating Light-Curves

In the `photRM.py` module, there are functions implemented to generate artificial AGN light curves. The `lc_two_bands` function generates them and returns light-curves that are ready for photo-RM. There are two main components for these light-curves [**?**, **?**]:

- The X band, which covers only the continuum. This one is generated with a Damped random walk (DRW) process , which is able to describe optical thermal emission of the accretion disk.
- The Y band, which covers emission lines and its surrounding continuum. It is modeled as described in [**?**, **?**]. The emission line response curve is obtained by convolving the X band light curve with a Gaussian kernel, which mean and standard deviation depend on the radius of the broad line region. Then this is summed up with another pure continuum curve with appropiate realistic weights.

I generated three pairs of light curves with $\log L = 43$, 44 and 45 $L_\odot$ respectively. They are 5000 data points long, have redshift $z = 0.1$, have an oscillatory signal with an amplitude of 0.14 magnitudes, noise of a factor of 0.00005, and a random time-lag. In Figures 1, 2 and 3, I plotted the first 1000 detections of these light-curves.

2. Estimating Time-Lags

Then, I estimated the time-lags of each pair of light-curves. I was using `PLIKE`, a Fortran code [**?**, **?**], but unfortunately I ran out of time to properly implement the few missing functions to run it. I

3. Gapped Light-Curves

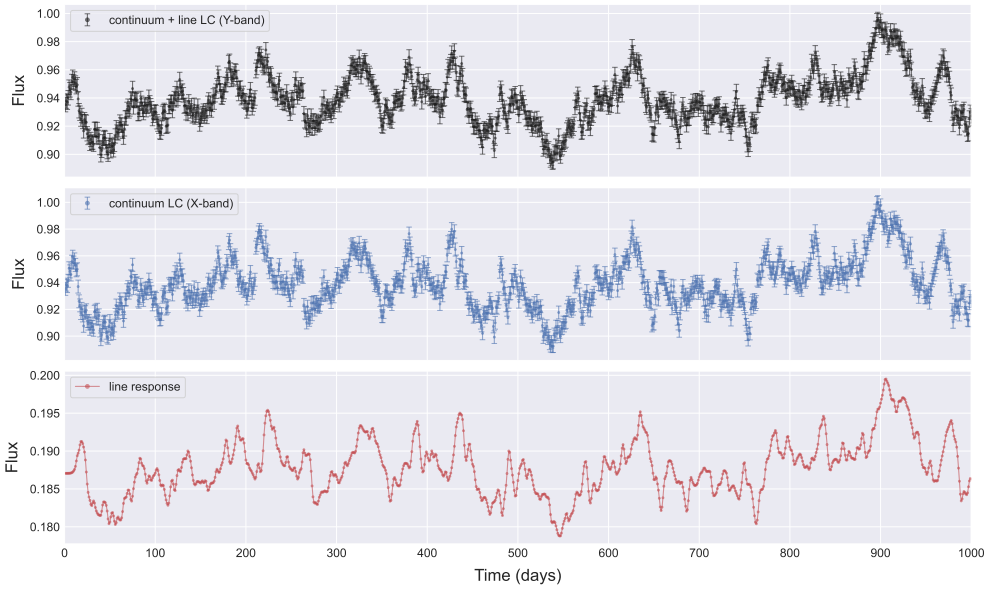

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Figure 1: Artificial light-curve of an AGN with $\log L = 43 L_{\odot}$

Task 2: NGC 4395

References

[1] H. Edri, S. E. Rafter, D. Chelouche, S. Kaspi, and E. Behar, "Broadband Photometric Reverberation Mapping of NGC 4395," , vol. 756, p. 73, Sept. 2012.

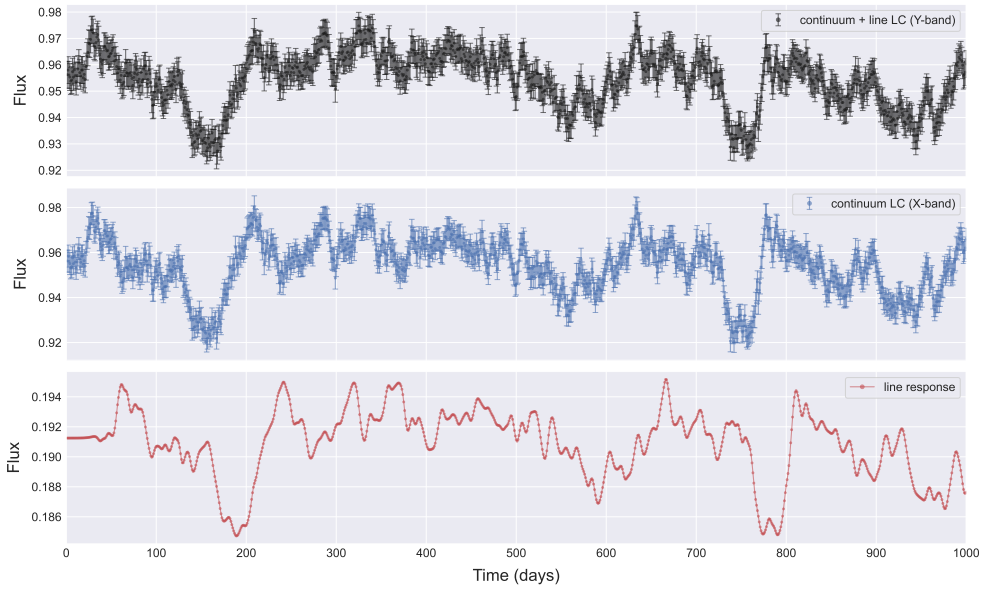

Figure 2: Artificial light-curve of an AGN with $\log L = 44 L_{\odot}$.

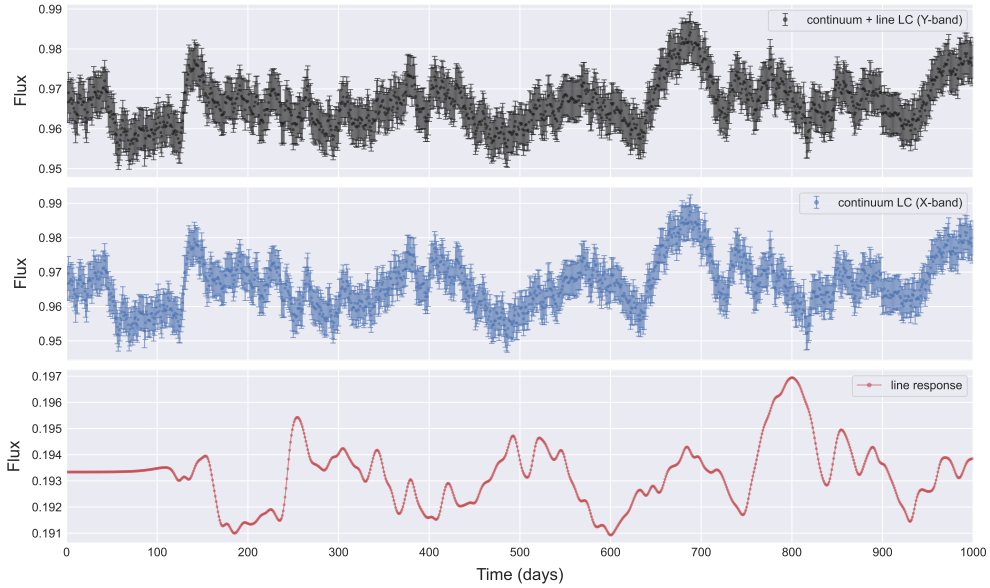

Figure 3: Artificial light-curve of an AGN with $\log L = 45 L_{\odot}$.

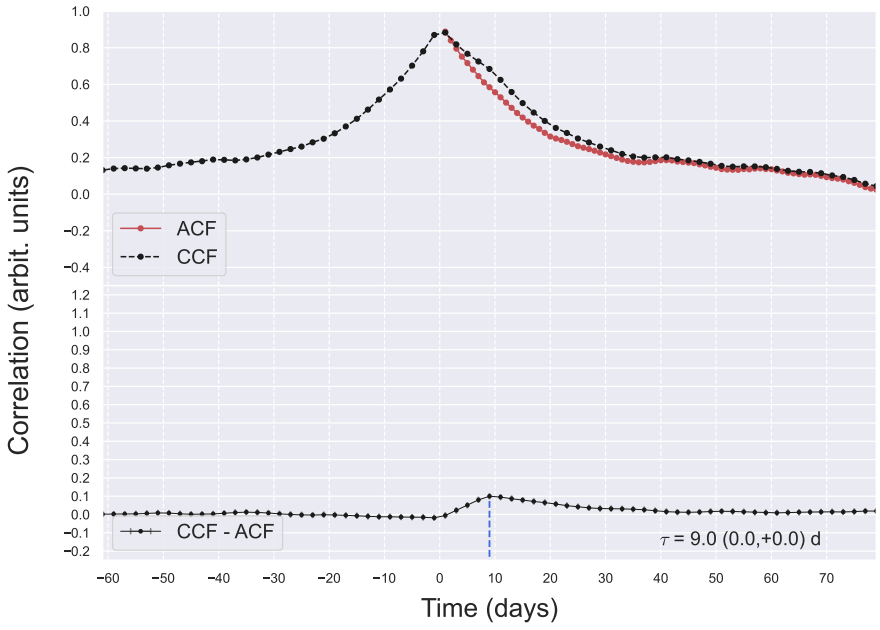

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Figure 4: CCF of the artificial light-curve with $\log L = 43 L_{\odot}$

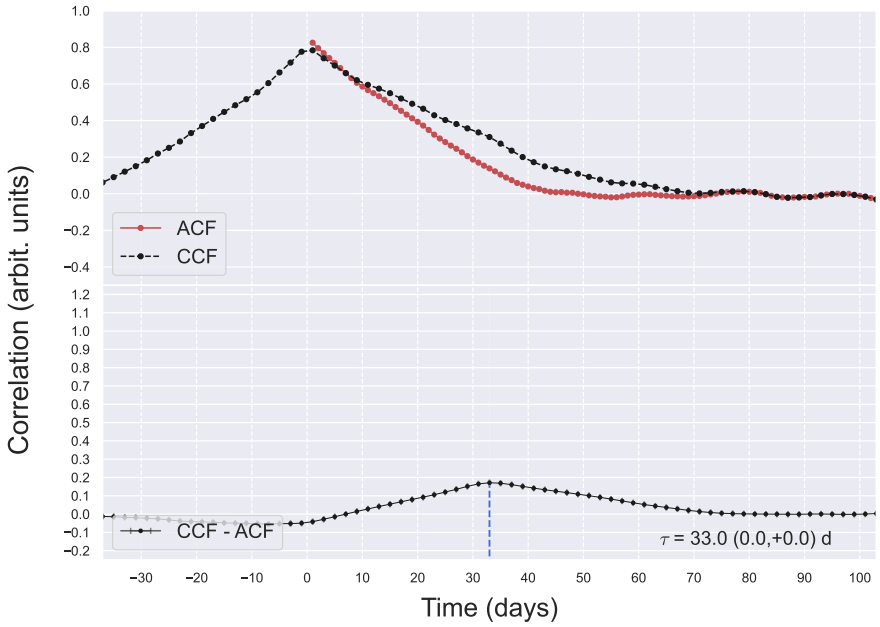

Figure 5: CCF of the artificial light-curve with $\log L = 44 L_{\odot}$.

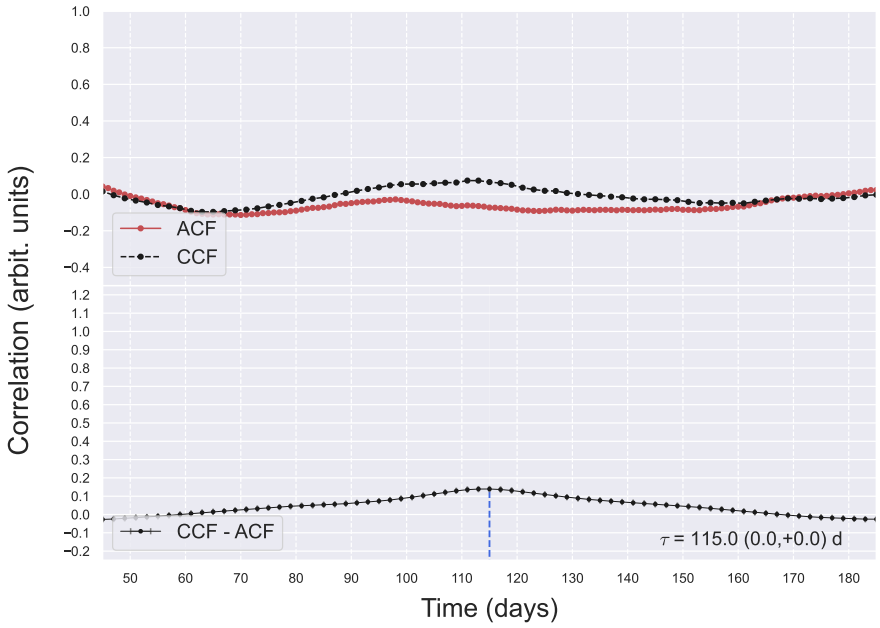

Figure 6: CCF of the artificial light-curve with $\log L = 45 L_{\odot}$.

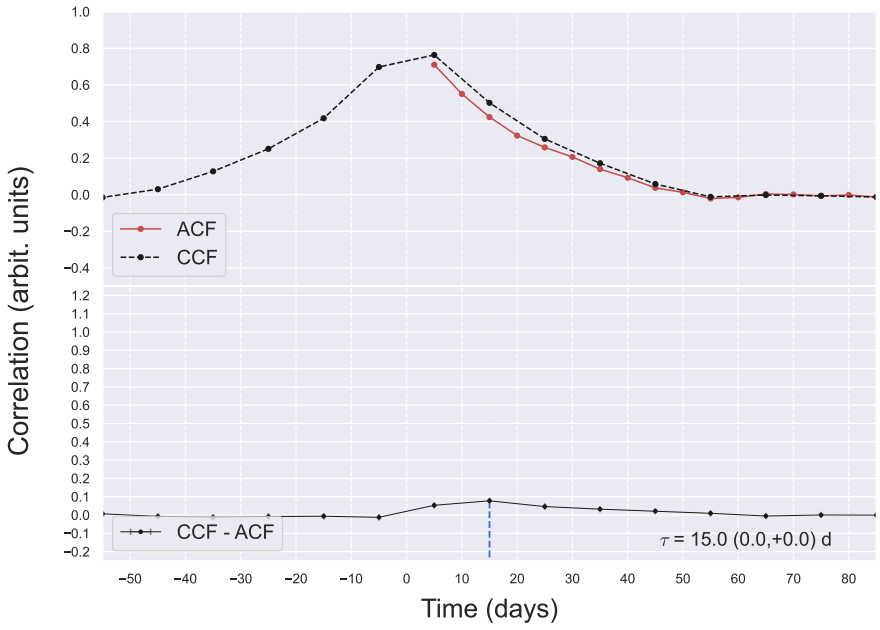

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Figure 7: CCF of the artificial light-curve with $\log L = 43 L_{\odot}$ with detections every five days.

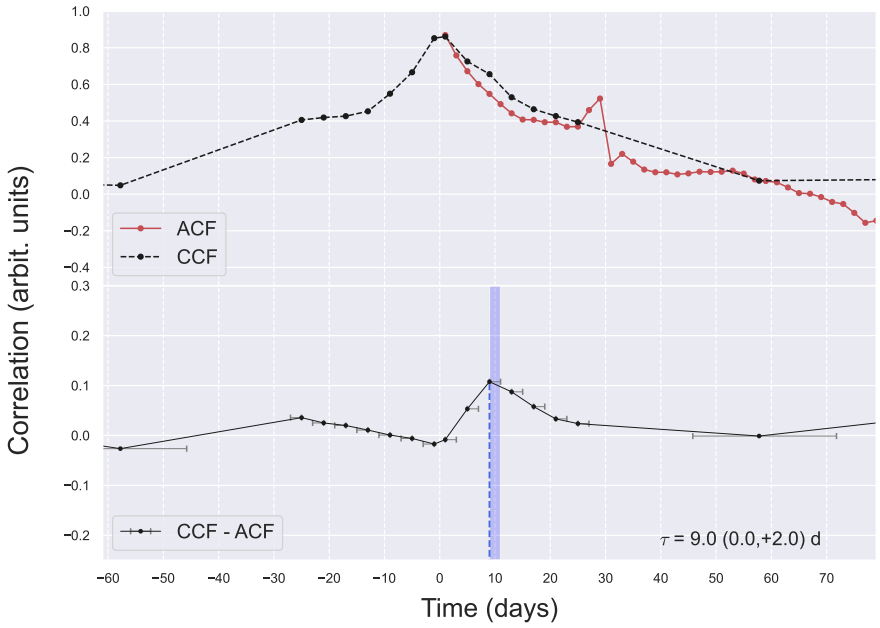

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Figure 8: CCF of the artificial light-curve with $\log L = 43 L_{\odot}$ with detections in a pattern of every day for one month and then a gap of a month.

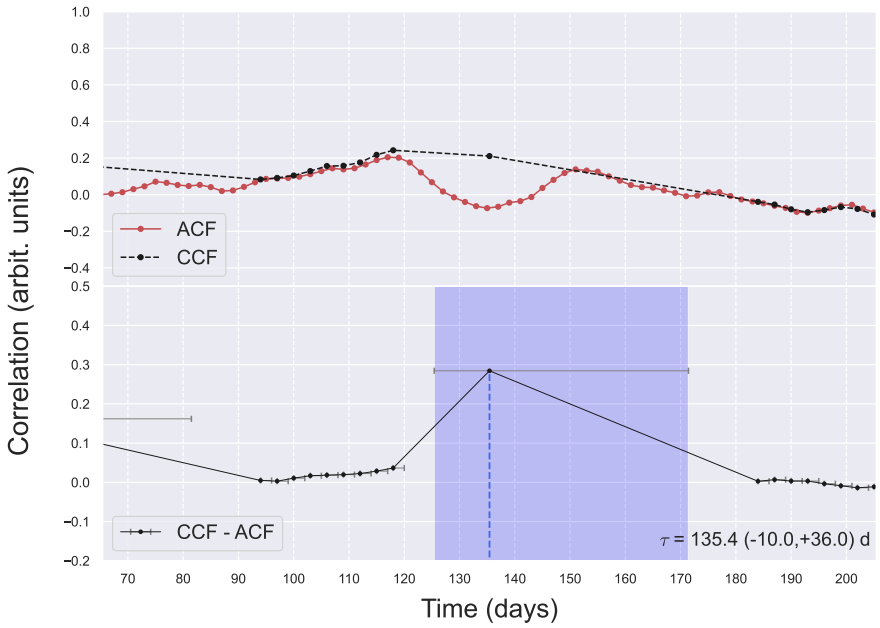

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Figure 9: CCF of the artificial light-curve with $\log L = 43 L_{\odot}$ with detections in a pattern of three month of observations every day, followed by six months of observations with a frequency of once per month and then a gap of three months.