Notes for Zu et al. "AN ALTERNATIVE APPROACH TO MEASURING REVERBERATION LAGS IN ACTIVE GALACTIC NUCLEI"

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1. ARTICLE

The physical ansatz for reverberation mapping is straightforward:

1. The continuum emission of the quasar shows (stochastic) variability that drives emission-line variations after a light travel-time delay.

2. The unobservable ionizing UV continuum that drives the emission lines is simply related to the observable satellite UV or optical continuum (i.e.,the pattern and phase of variations are closely correlated).

3. The light-travel time is the most important time scale; specifically, the local emission-line response time to continuum changes is assumed to be instantaneous and the dynamical time scale of the BLR is much larger than the light-travel time across it.

The relationship between the continuum and the emission line can be non-linear in nature, but the amplitude of variation on reverberation time scales is sufficiently small that the linear approximation seems to be justified.

first logaritmic priors are used for the τ_d and σ to determine the range of variability process parameters consistent with the continuum light curve. The logarithmic prior on τ_d essentially penalizes values that deviate from the median sampling intervals to avoid both unphysically large τ_d and a second class of solutions of $\tau_d \to 0$, when all data are completely uncorrelated and the model simply uses σ to broaden the uncertainties until obtaining an acceptable fit. Then we do the joint analysis of the continuum and the lines using Gaussian priors for τ_d and σ determined from the analysis of the continuum in isolation. In detail, we take the results of the MCMC analysis of the continuum and used uncorrelated priors on $\ln(\tau_d)$ and $\ln(\sigma)$ (which is conservative), where the prior for each variable was centered at the median value with the Gaussian width chosen to match the upper and lower 1σ confidence regions. The reason for using the continuum to define a stronger Gaussian prior on the process variable before carrying out the joint analysis is to eliminate the aforementioned second class of solutions of $\tau_d \to 0$ that could potentially bias our lag estimates. This secondary solution always exists at some level because of the finite temporal sampling. For modeling the continuums, we are only analyzing cases with significant variability, so this is not an issue for the individual light curves. However, in the joint analysis, if we fit the line and continuum light curves simultaneously at the wrong lag, the optimal solution will be to let $\tau_d \to 0$ since there are then no correlations between data points. Physically, it made more sense to consider only the ranges for the process variables τ_d and σ that were statistically consistent with the continuum variability.

The line flux relates closer to the continuum flux than for the magnitudes (relevant for torus?)

Chapter 4 describes how to get the line lags given the model equations and the different categories of lags obtained. Chapter 5 is about modelling correlated errors. Chapter 6 is about using multiple lines for extra data for the fit. Maybe this can be used with the torus filters? Needs similar transfer function/lags