Consider two lightcurves $x(t)$ and $y(t)$, where $x(t)$ is the driving lightcurve and $y(t)$ is the reprocessed lightcurve. If they are related by a linear impulse response, $g(\tau)$, then:

$$y(t) = \int_{-\infty}^{\infty} g(\tau)x(t-\tau)\mathrm{d}\tau \tag{1}$$

So, $y(t)$ is a delayed and blurred version of $x(t)$, with the amount of delay and blurring encoded in $g(\tau)$.

The power spectral density (PSD) of $x(t)$ is calculated from the Fourier transform of $x(t)$, which we denote $X(\nu)$. The PSD is $|X(\nu)|^2 = X^*(\nu)X(\nu)$, where the * denotes the complex conjugate. From the convolution theorem of Fourier transforms we can write:

$$Y(\nu) = G(\nu)X(\nu) \tag{2}$$

This means it is easy to relate the PSD of the reprocessed lightcurve to the PSD of the driving lightcurve and the impulse response function:

$$|Y(\nu)|^2 = |G(\nu)|^2|X(\nu)|^2 \tag{3}$$

The cross spectrum is defined as

$$C(\nu) = X^*(\nu)Y(\nu) \tag{4}$$

the phase, ϕ, of which gives the phase lag between X and Y at each Fourier frequency, ν. This can be converted to a time lag through:

$$\tau(\nu) = \frac{\phi(\nu)}{2\pi\nu} \tag{5}$$

Since $Y(\nu) = G(\nu)X(\nu)$, the cross spectrum can be written as:

$$C(\nu) = X^*(\nu)G(\nu)X(\nu) = G(\nu)|X(\nu)|^2 \tag{6}$$

thus, for a given impulse response function, one can trivially predict the time lags as a function of frequency, $\tau(\nu)$, by calculating the phase of $G(\nu)$, and the frequency dependence of the lags directly relates to the shape of the response function.