

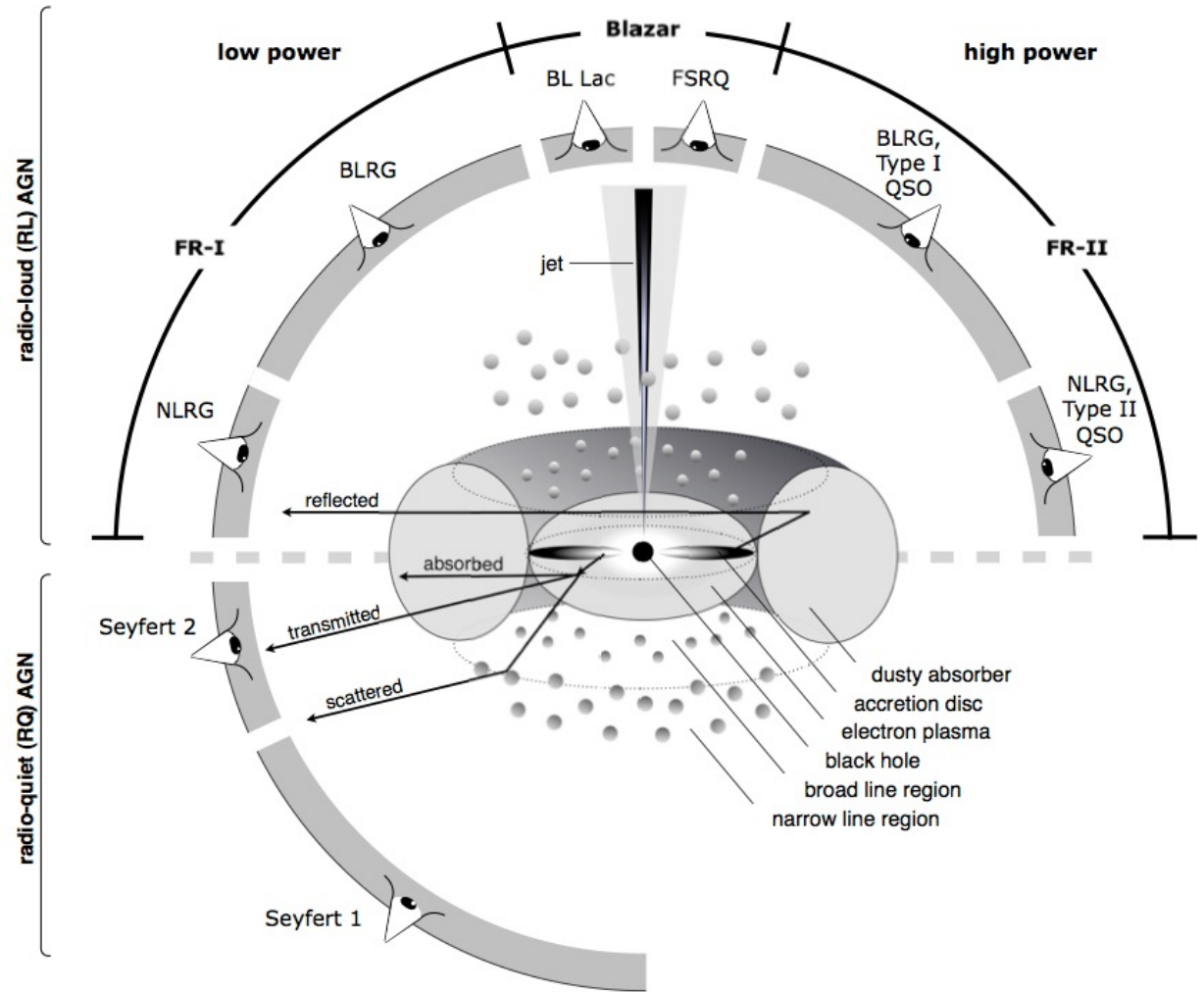
How to find correlations in blazar emission

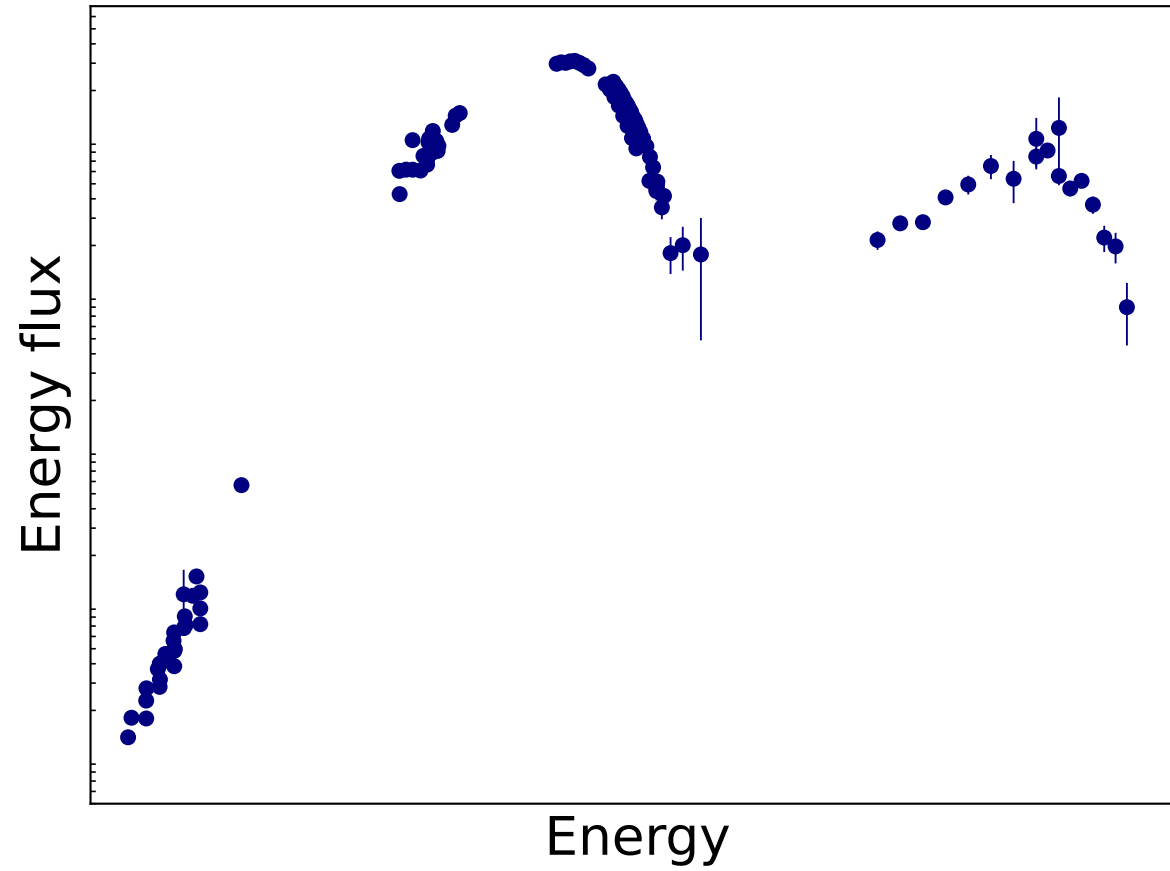
Felix Schmuckermaier

IMPRS Young Scientist Workshop - 22.11.23





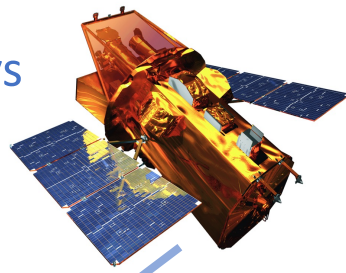




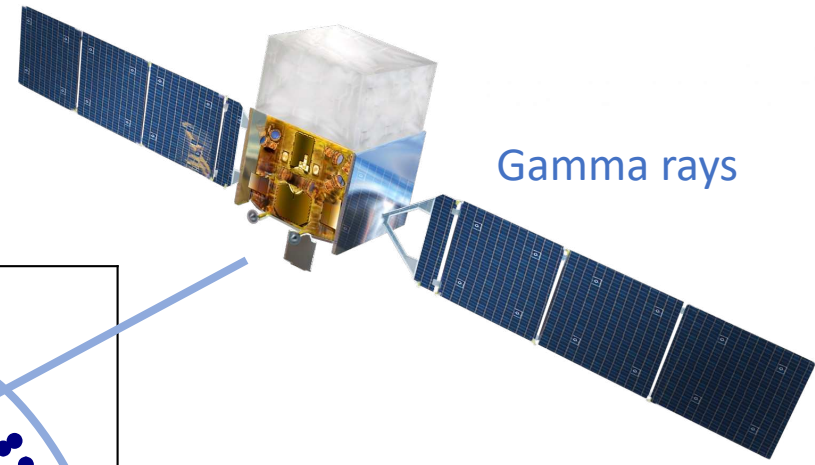
Optical



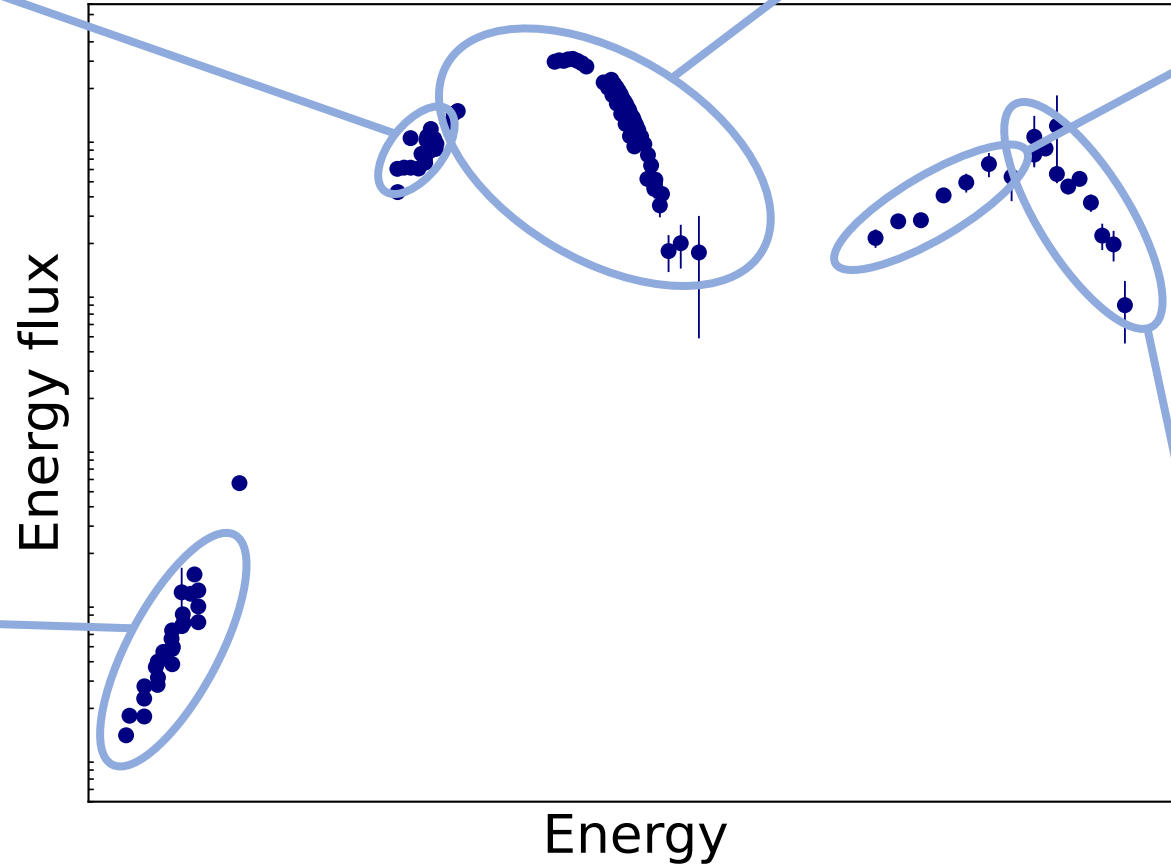
UV and X-rays



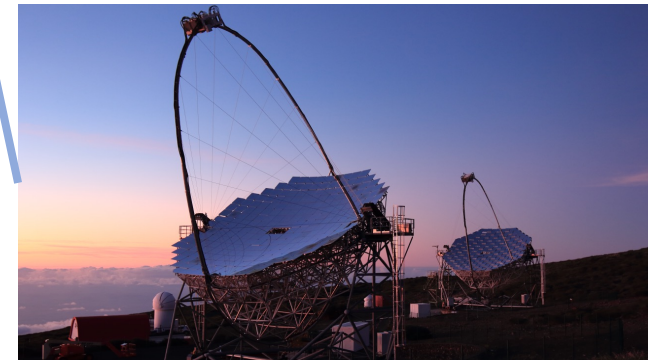
Gamma rays



Radio



Very high energy gamma rays

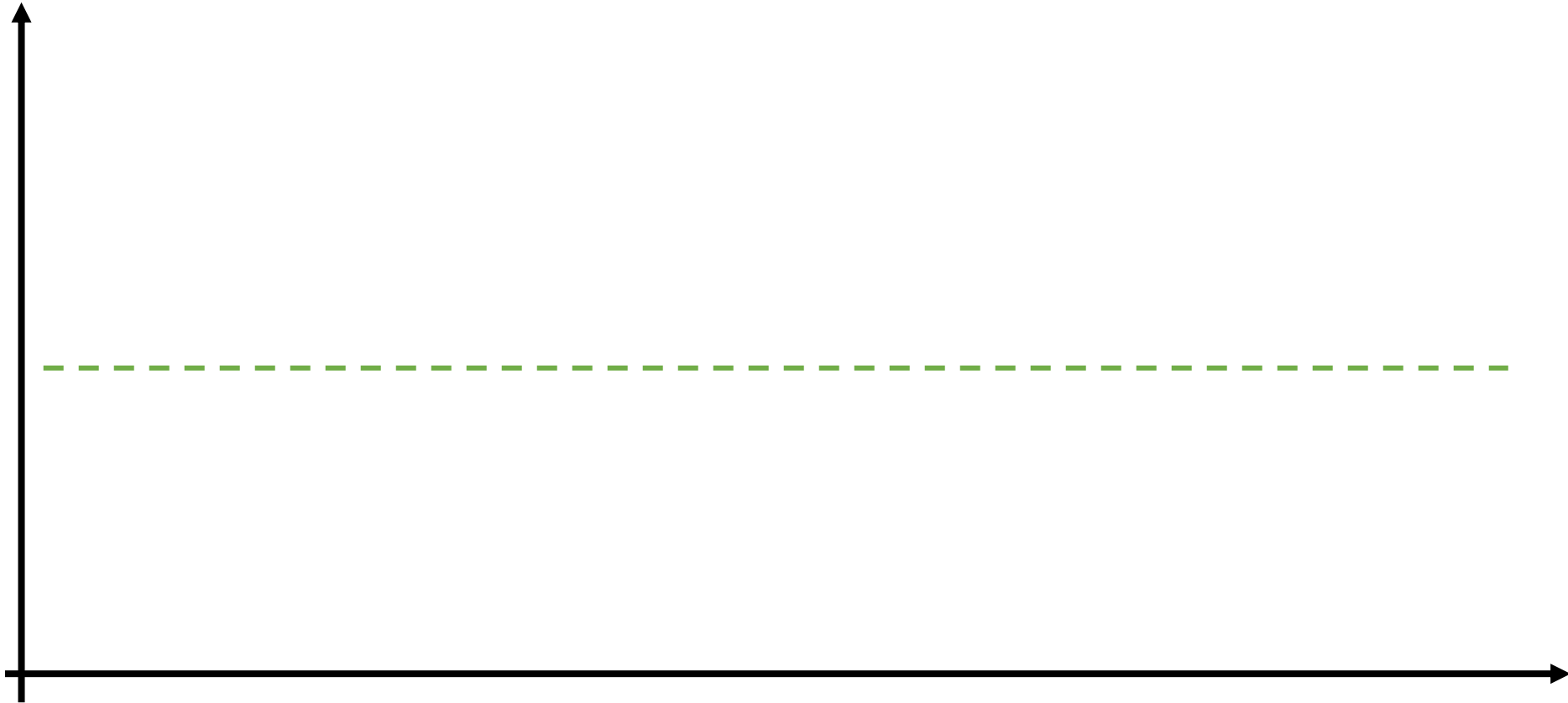


Flux



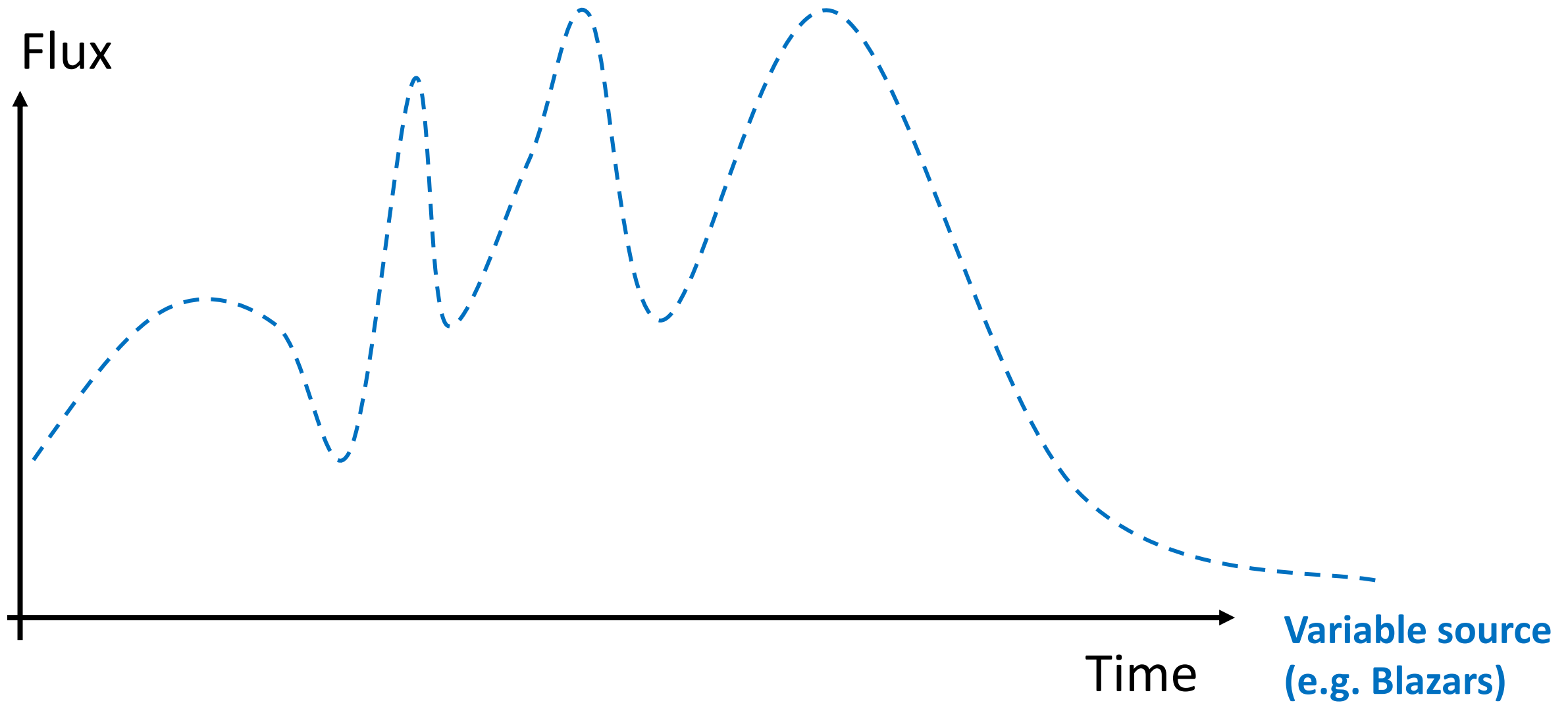
Time

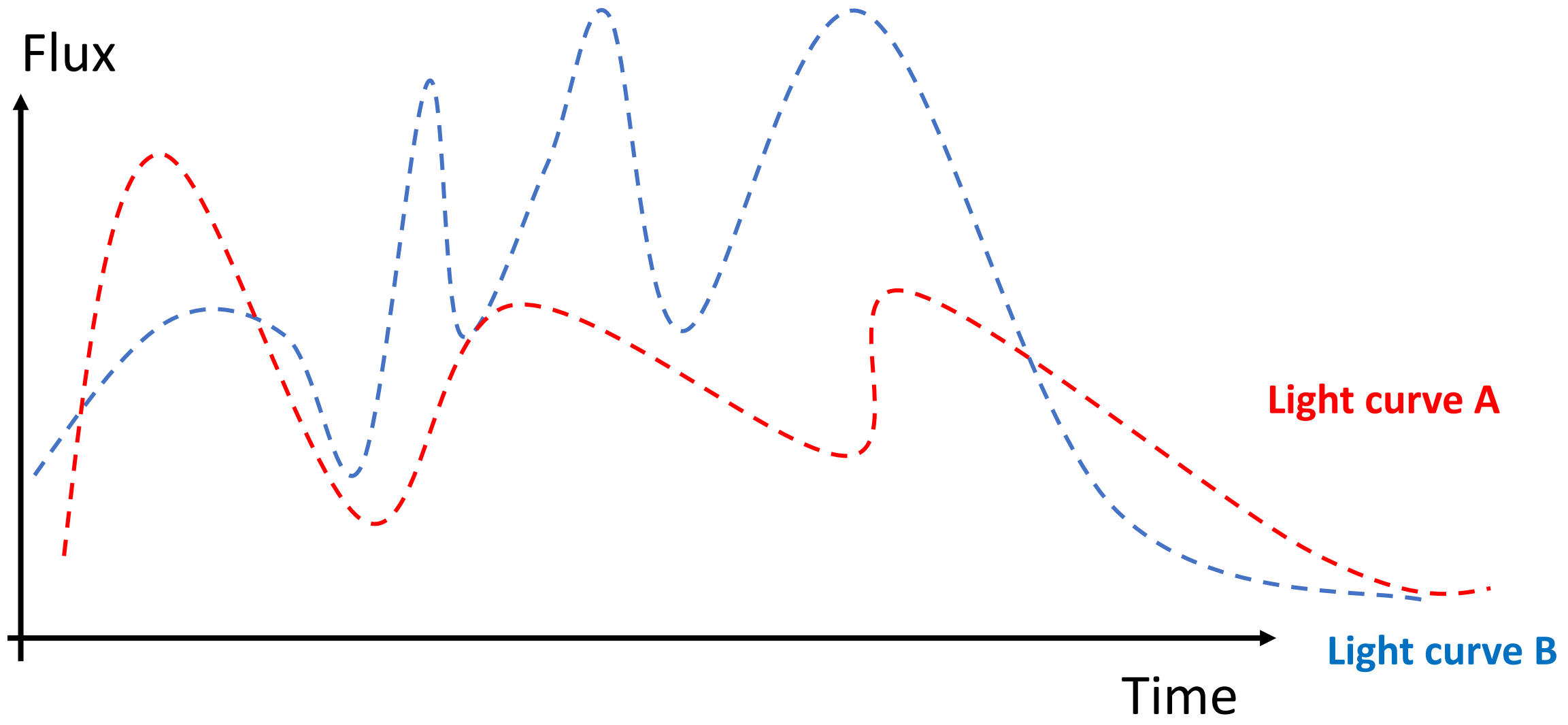
Flux

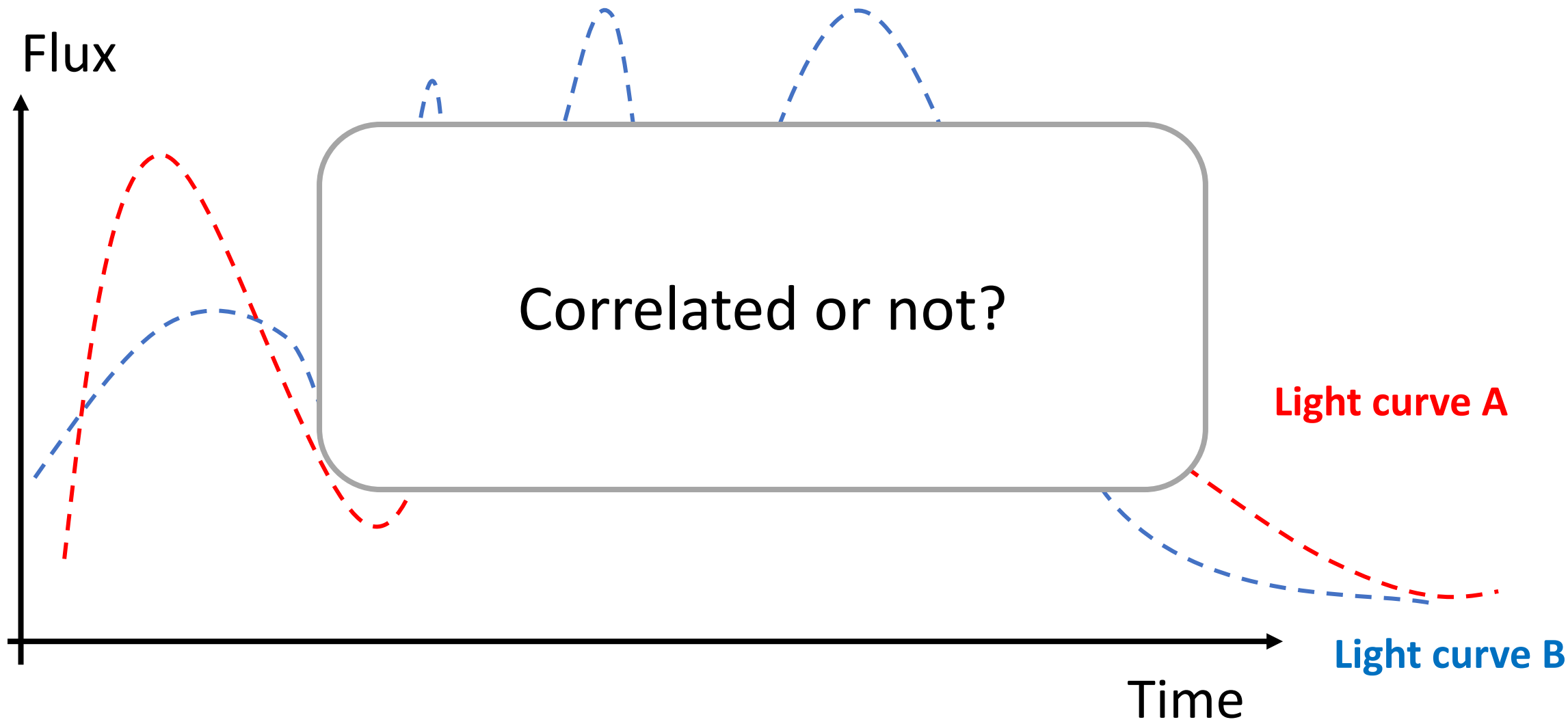


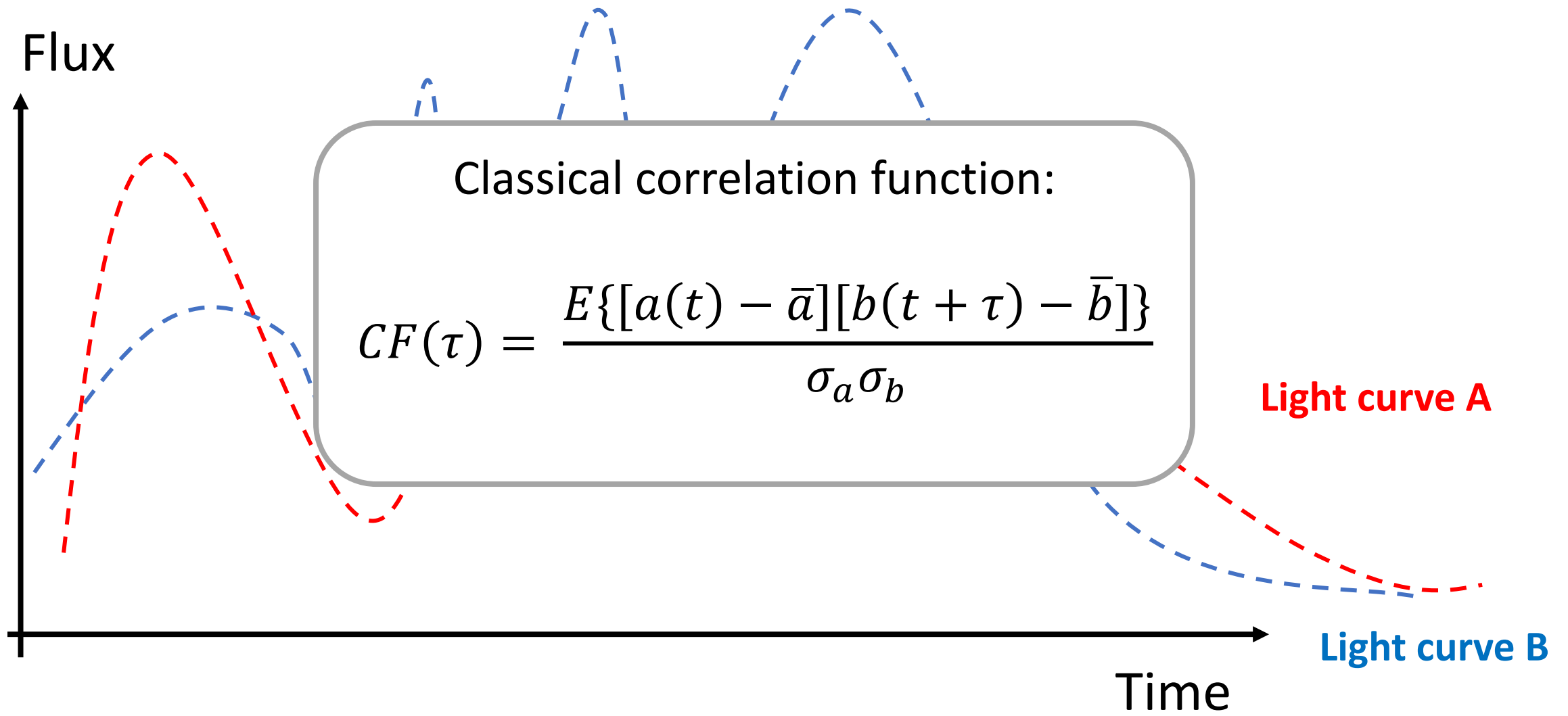
Stable source
(e.g. Crab)

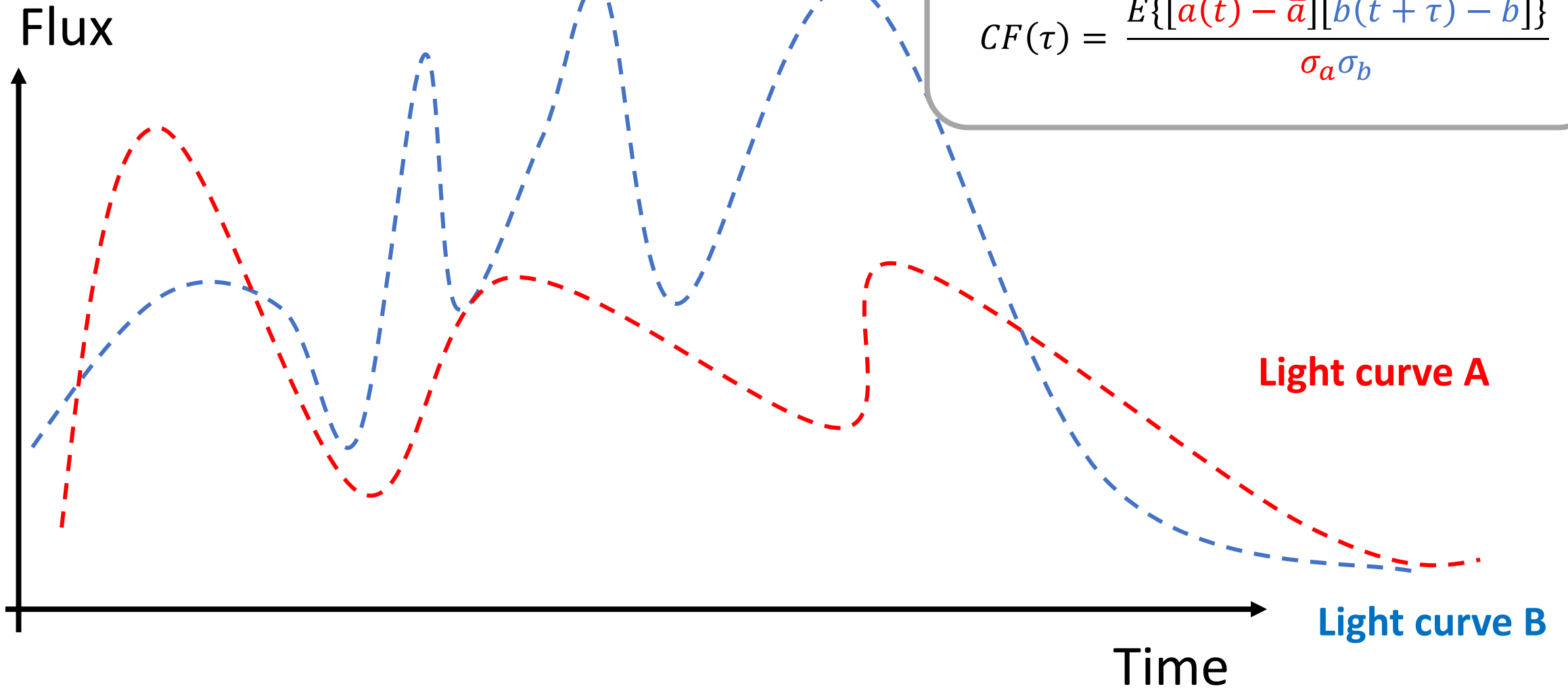
Time





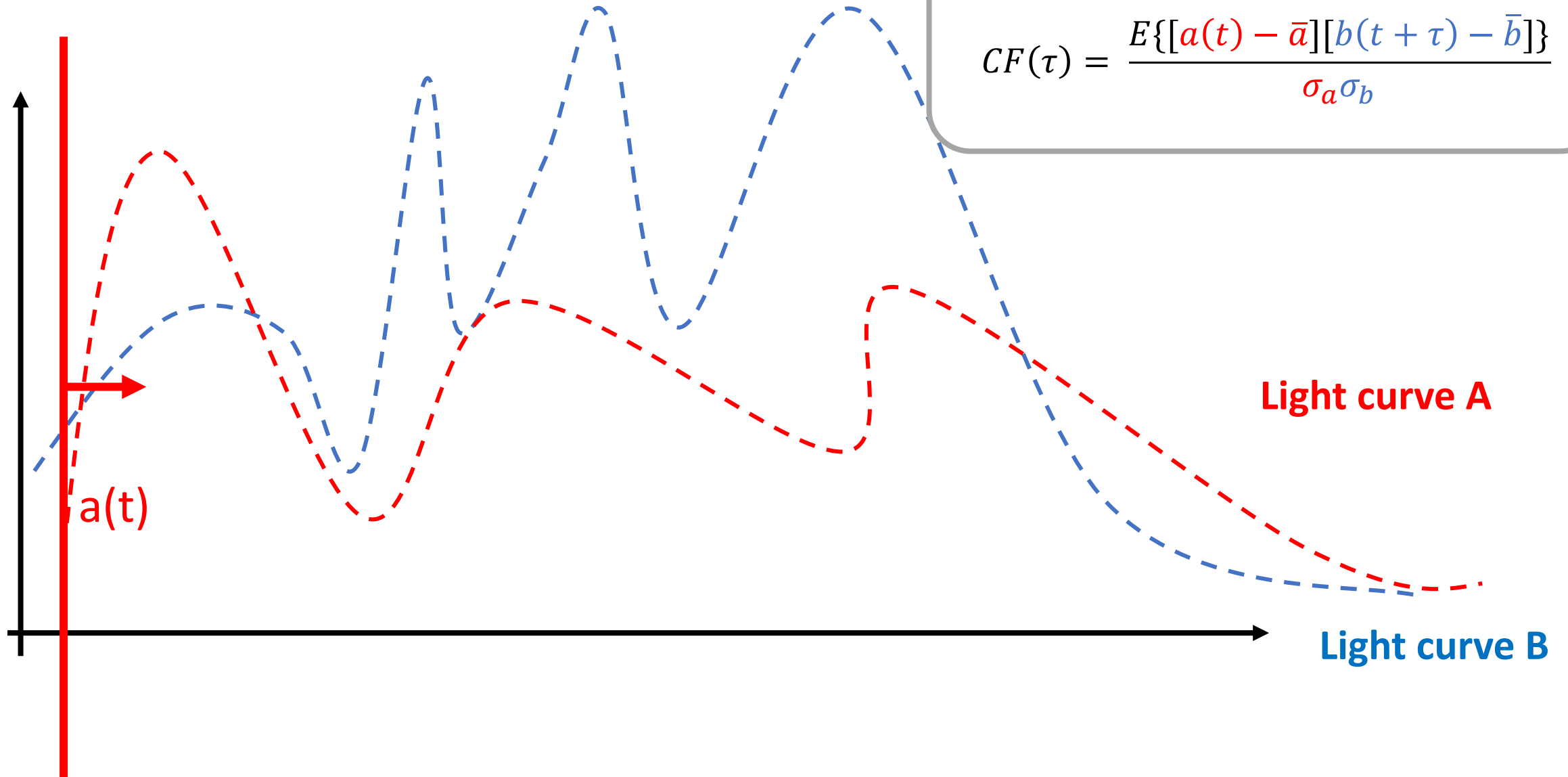






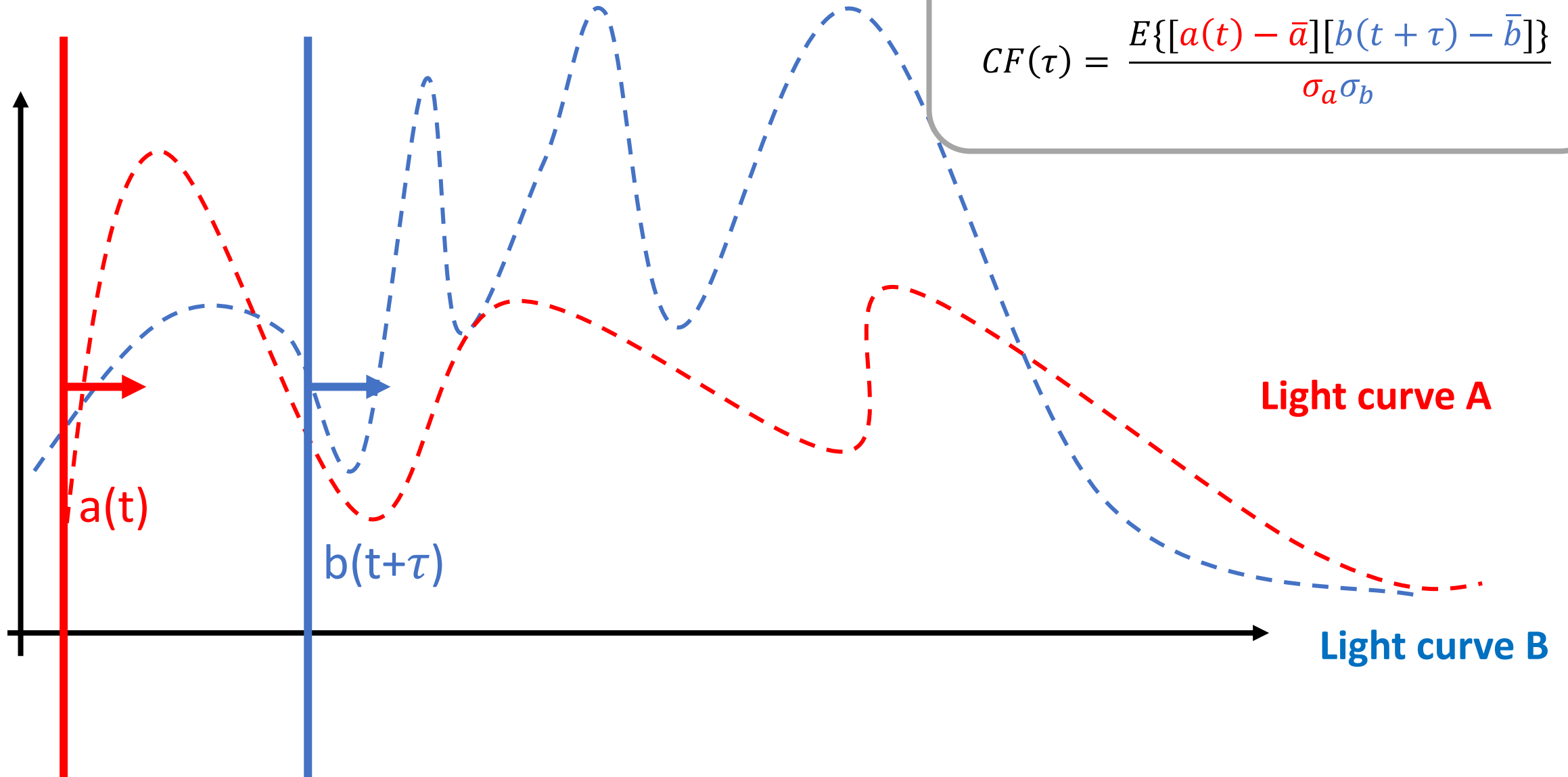
Classical correlation function:

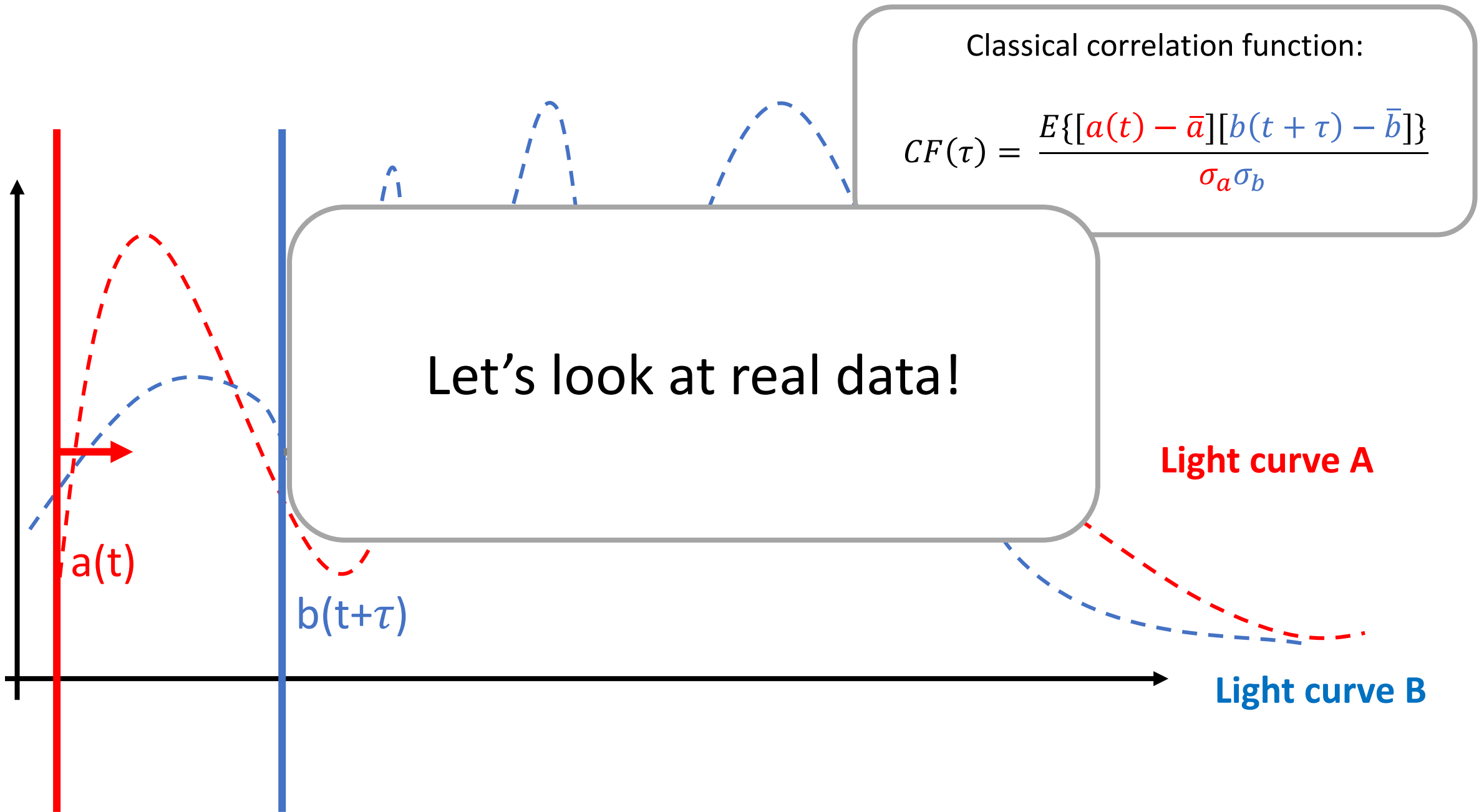
$$CF(\tau) = \frac{E\{[a(t) - \bar{a}][b(t + \tau) - \bar{b}]\}}{\sigma_a \sigma_b}$$

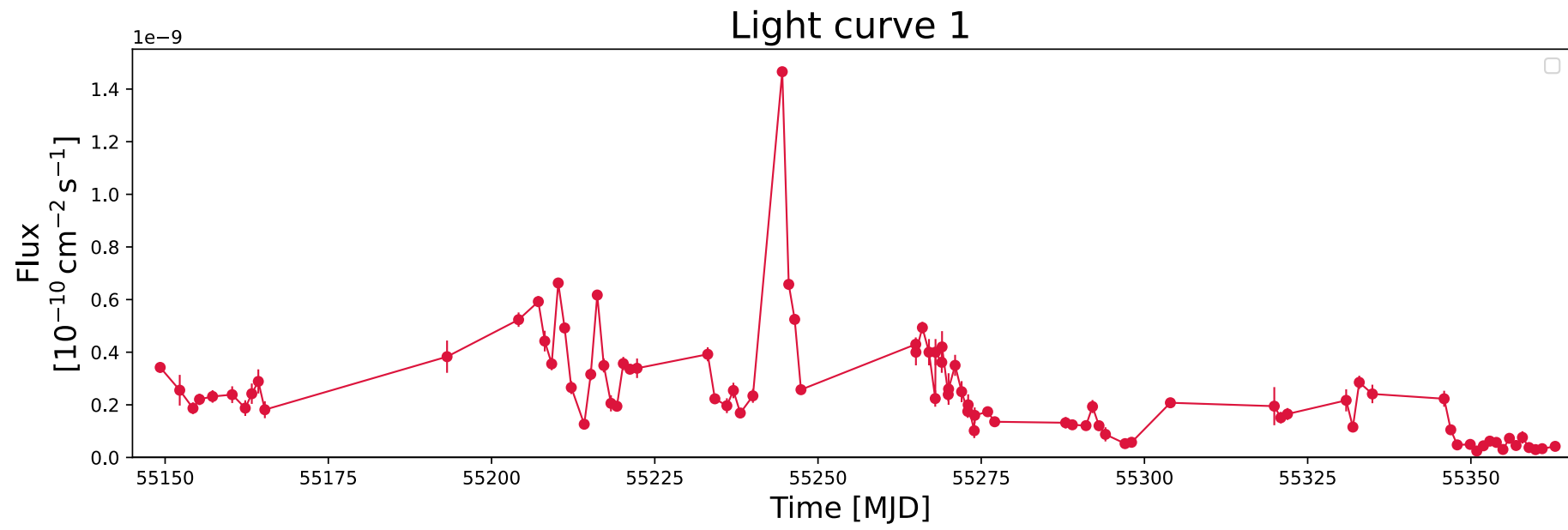


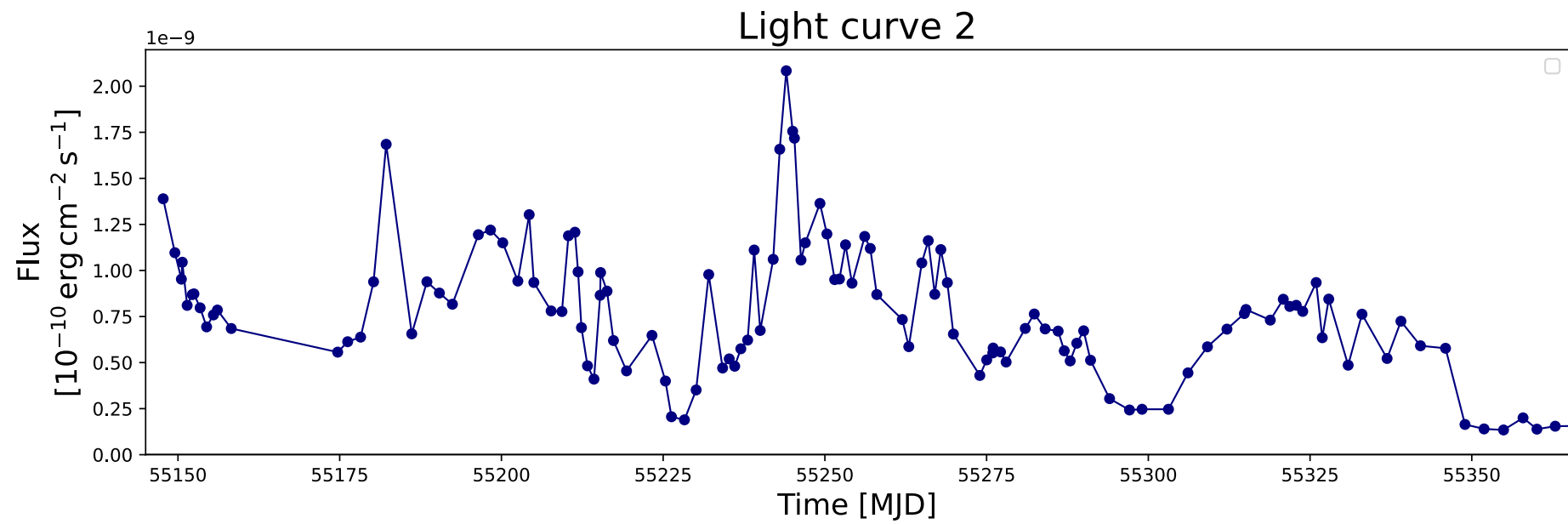
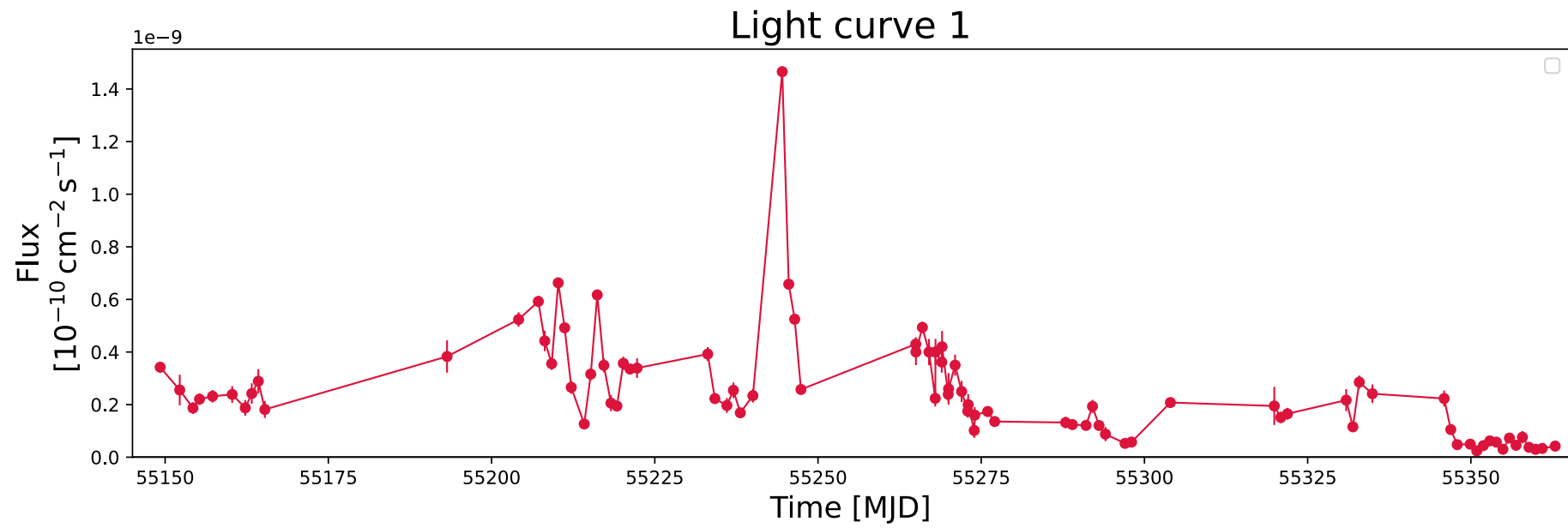
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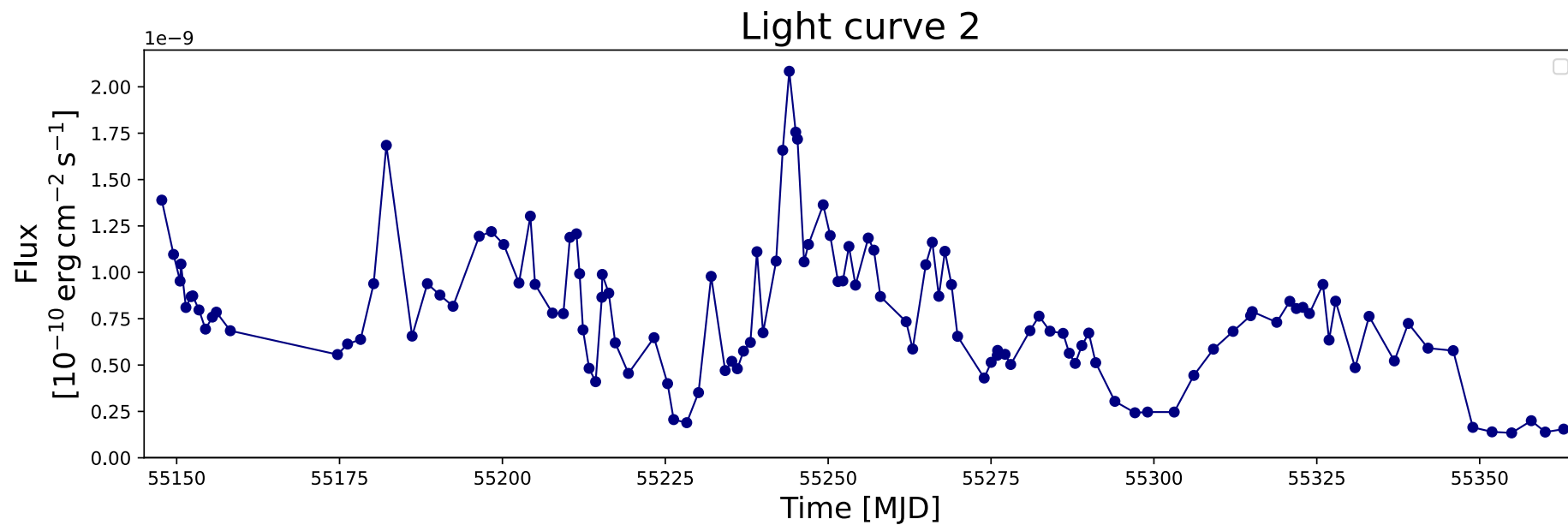
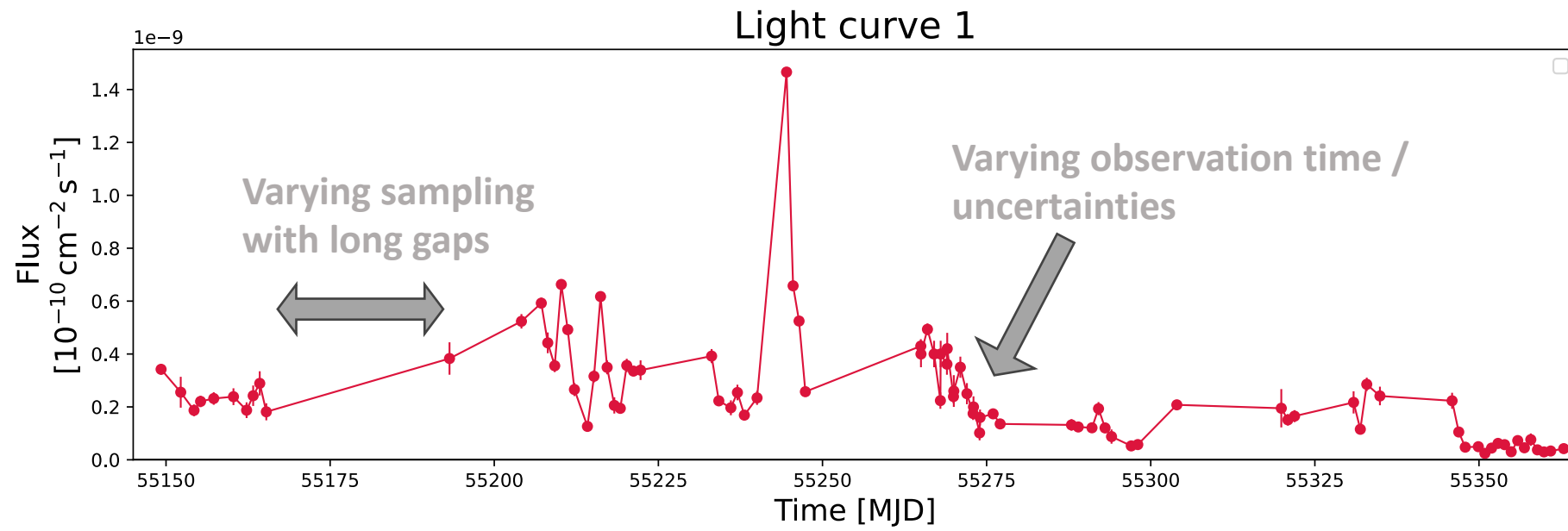
$$CF(\tau) = \frac{E\{[a(t) - \bar{a}][b(t + \tau) - \bar{b}]\}}{\sigma_a \sigma_b}$$



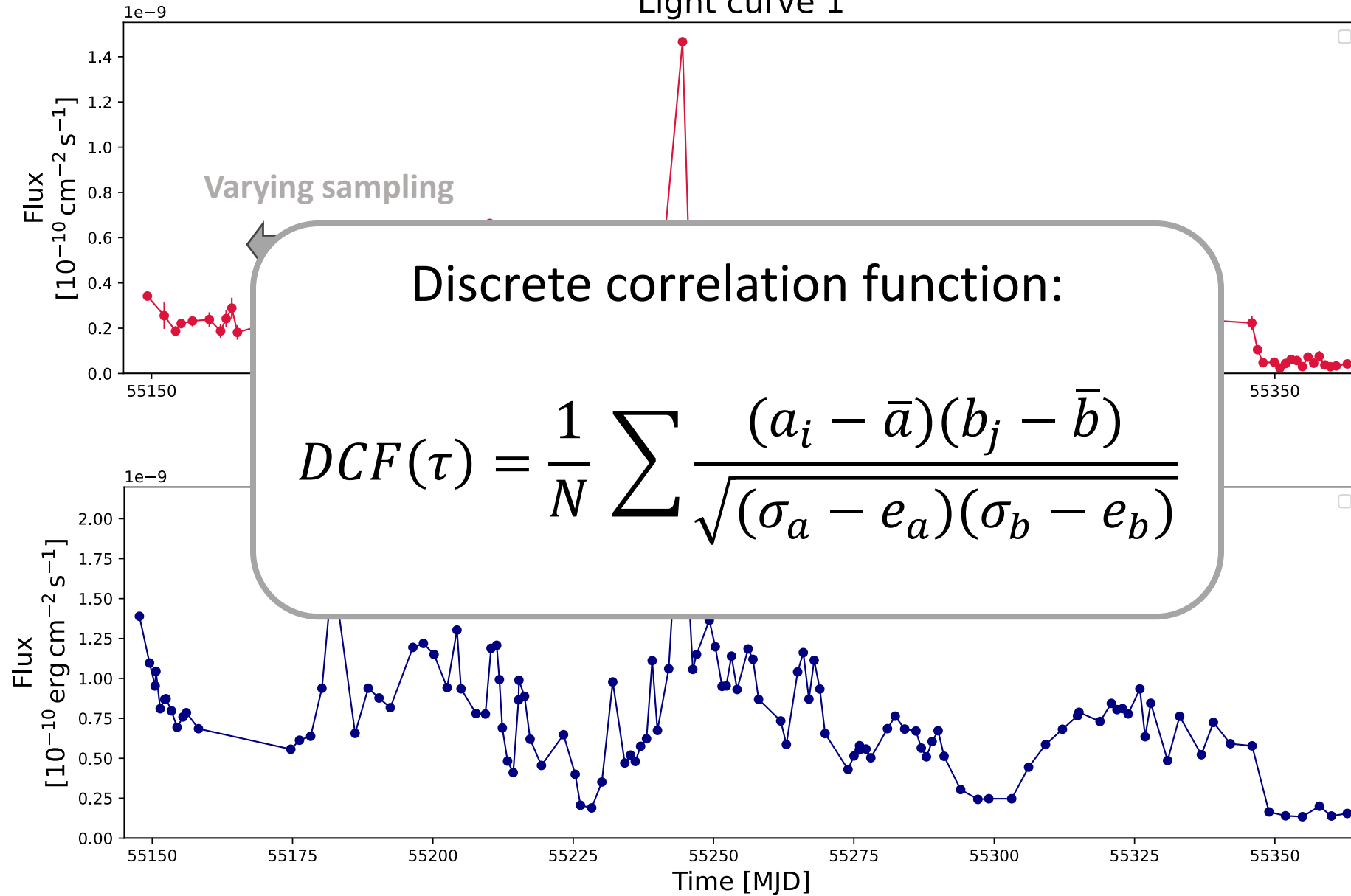


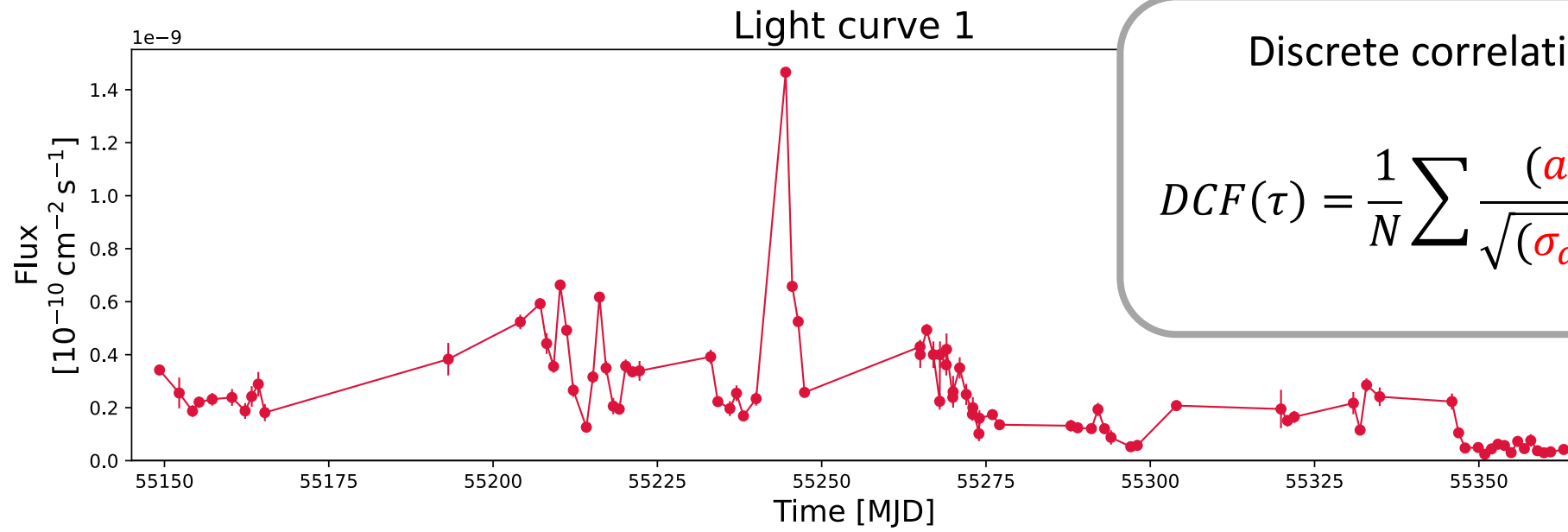






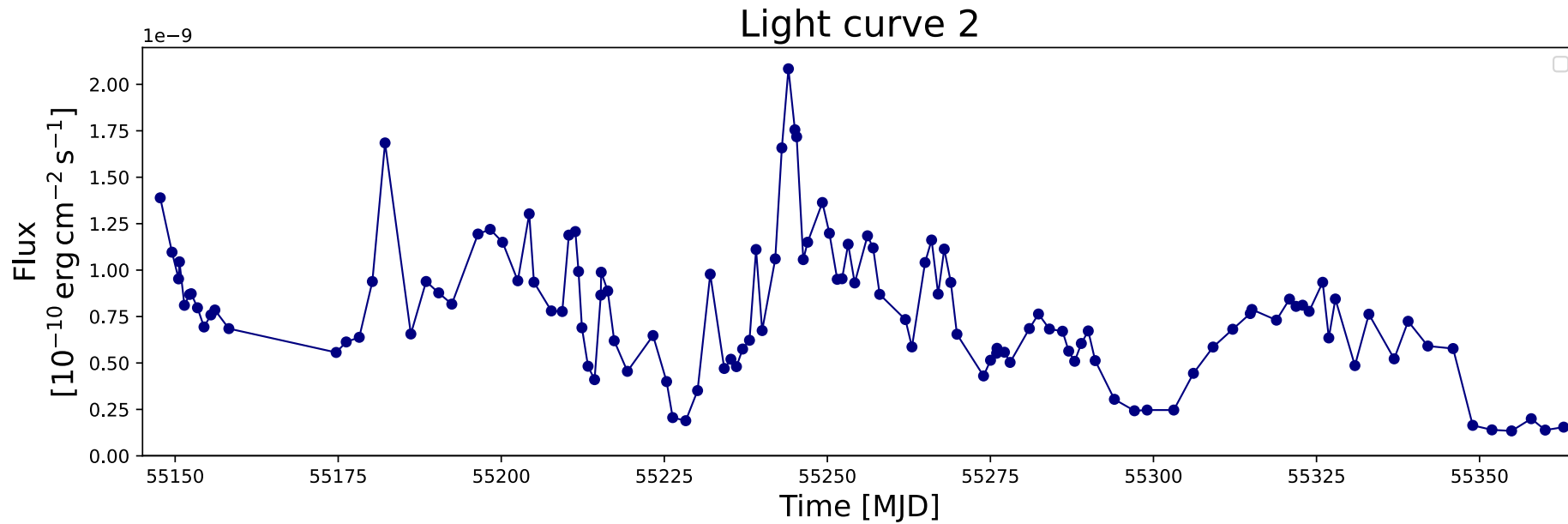
Light curve 1

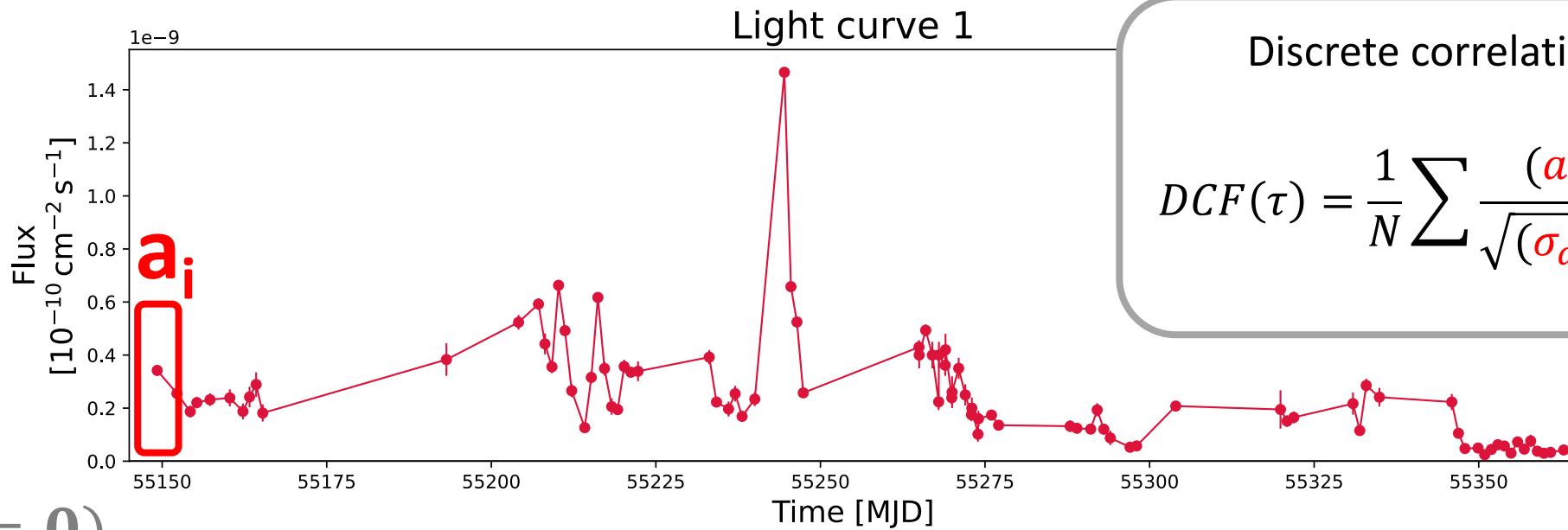




Discrete correlation function:

$$DCF(\tau) = \frac{1}{N} \sum \frac{(a_i - \bar{a})(b_j - \bar{b})}{\sqrt{(\sigma_a - e_a)(\sigma_b - e_b)}}$$

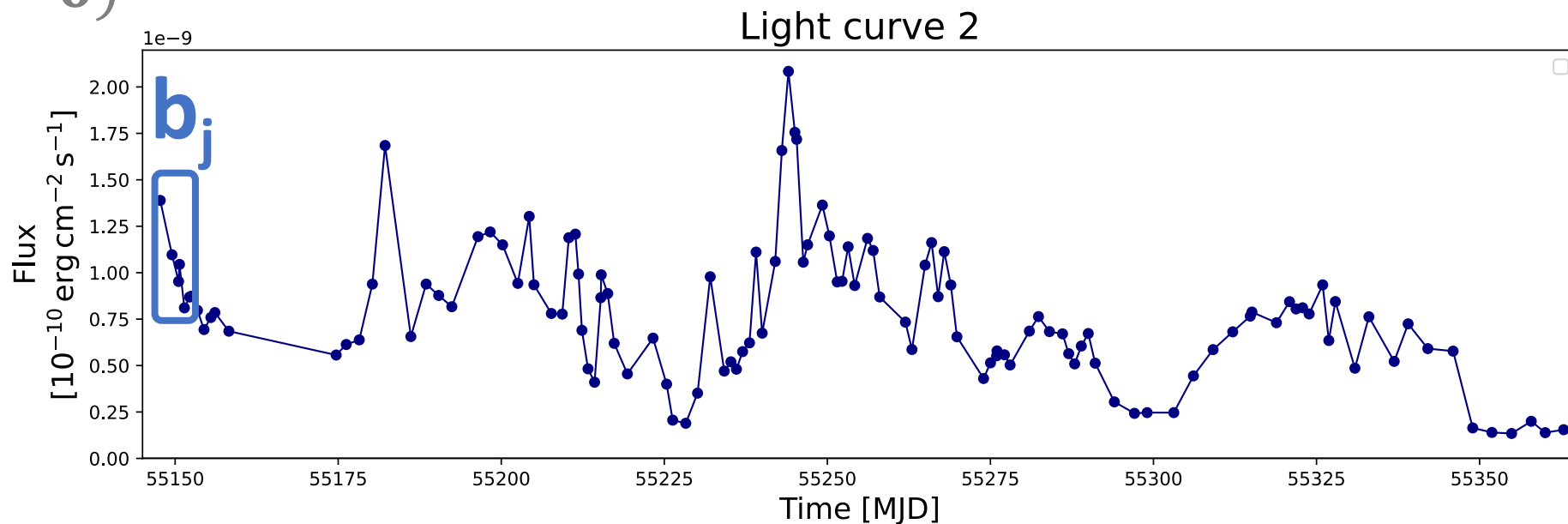


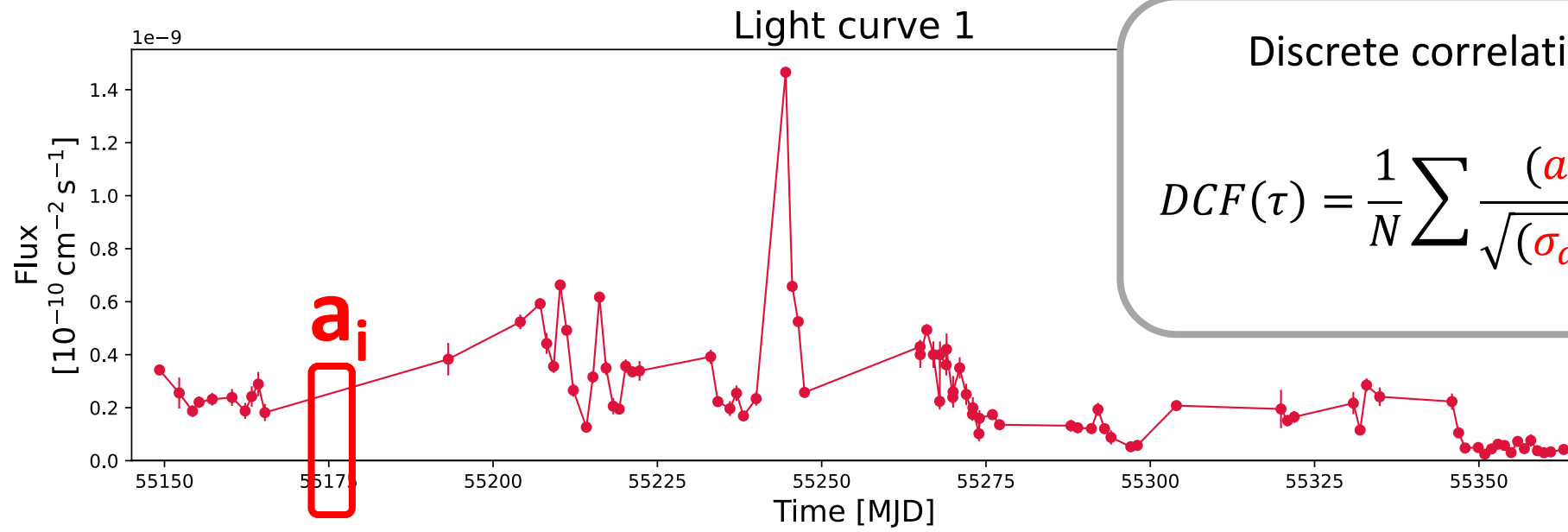


Discrete correlation function:

$$DCF(\tau) = \frac{1}{N} \sum \frac{(a_i - \bar{a})(b_j - \bar{b})}{\sqrt{(\sigma_a - e_a)(\sigma_b - e_b)}}$$

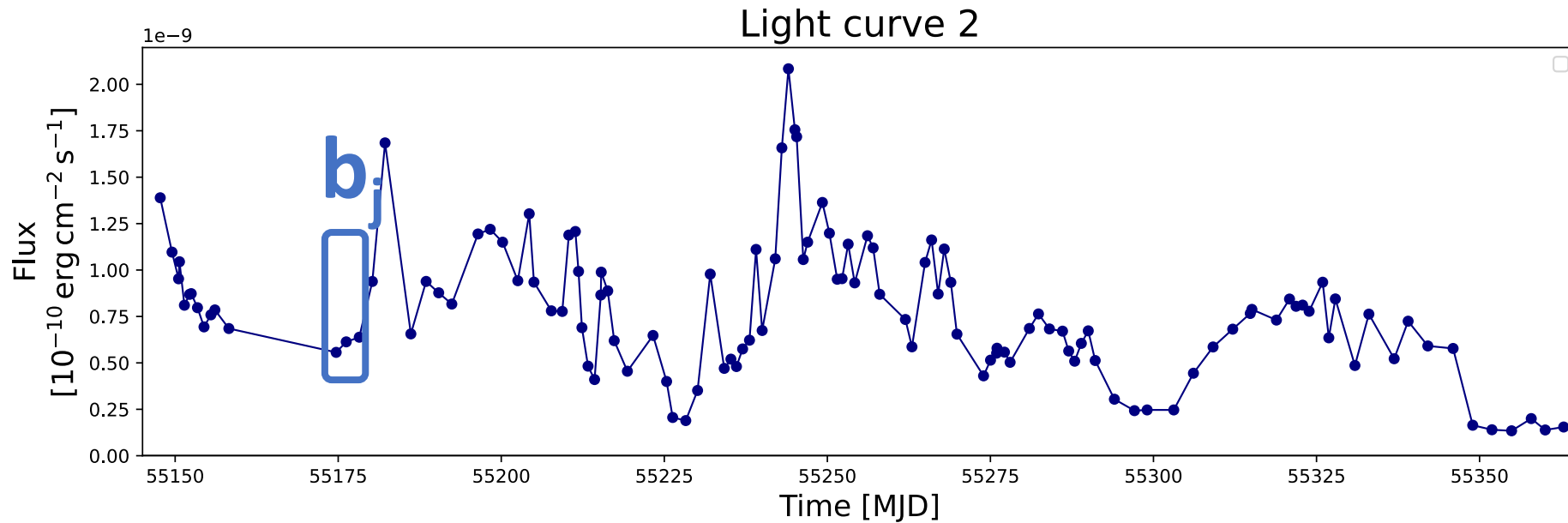
$DCF(\tau = 0)$

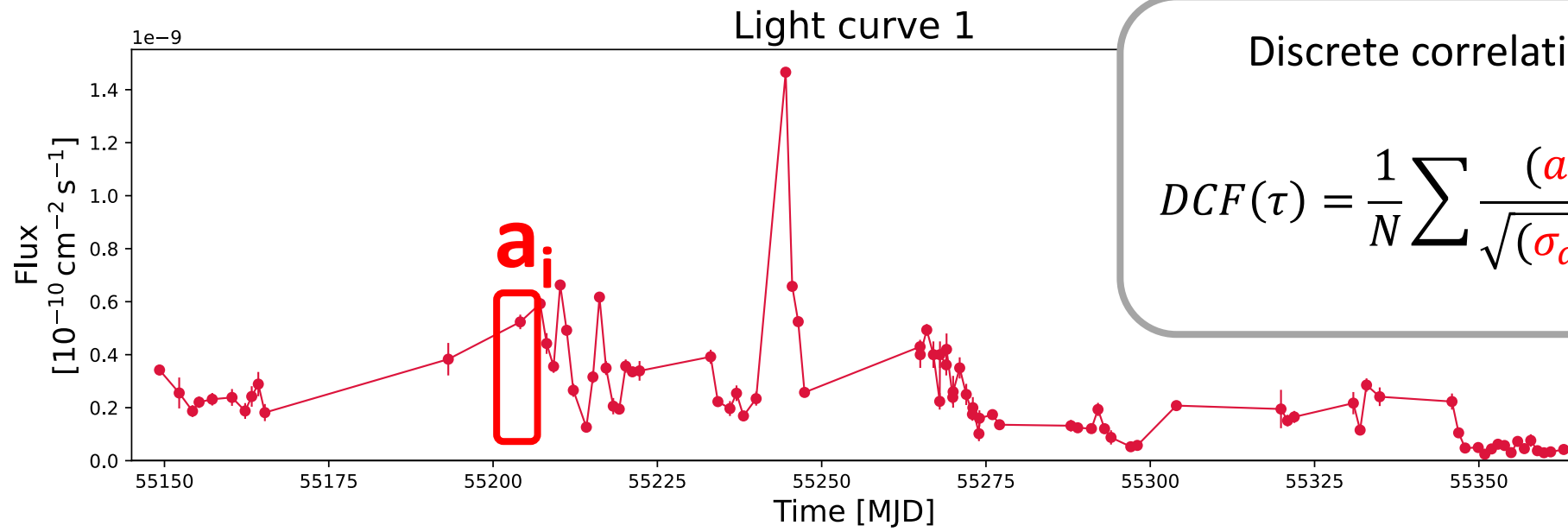




Discrete correlation function:

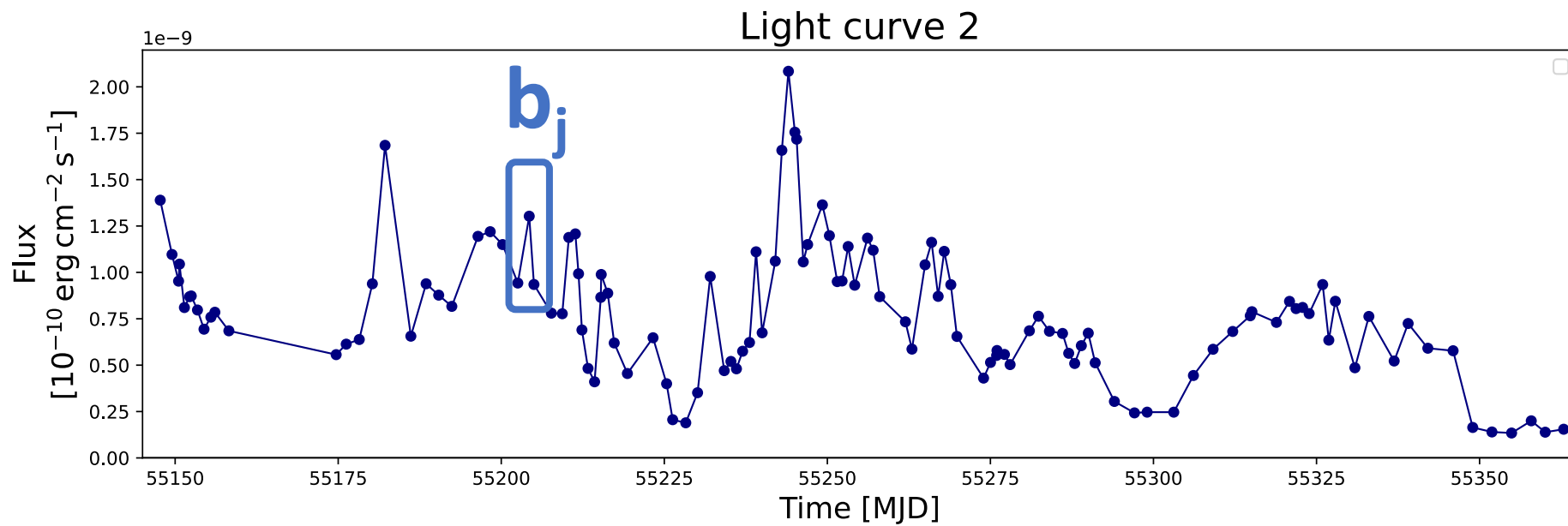
$$DCF(\tau) = \frac{1}{N} \sum \frac{(a_i - \bar{a})(b_j - \bar{b})}{\sqrt{(\sigma_a - e_a)(\sigma_b - e_b)}}$$

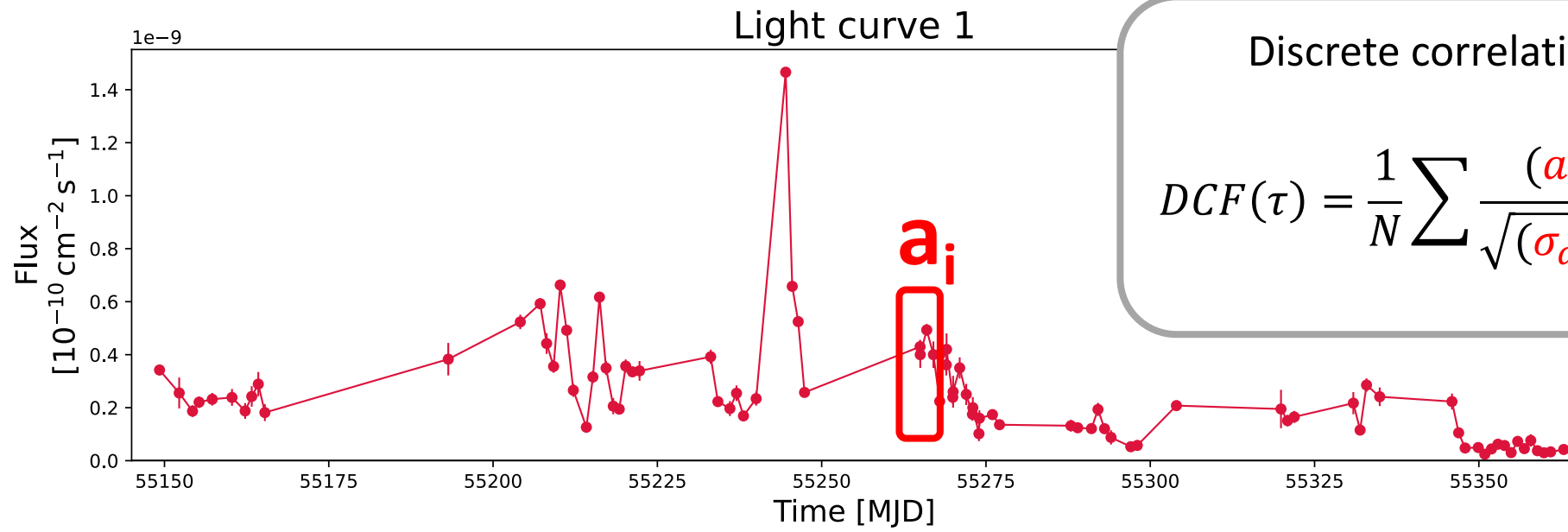




Discrete correlation function:

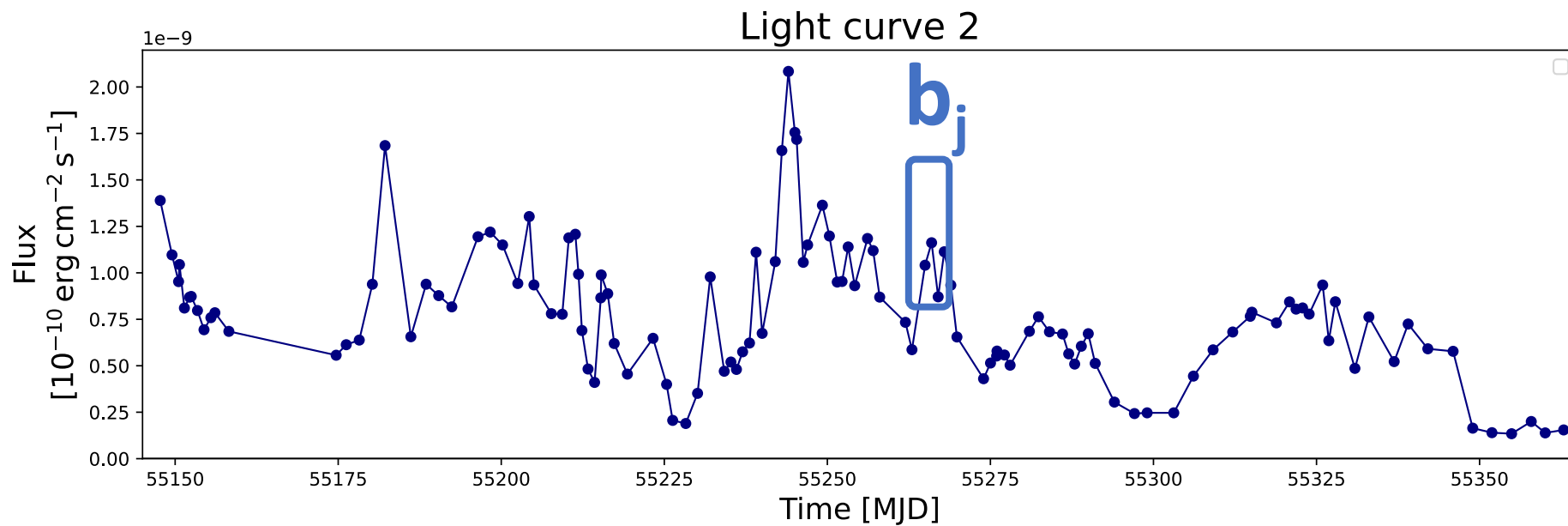
$$DCF(\tau) = \frac{1}{N} \sum \frac{(a_i - \bar{a})(b_j - \bar{b})}{\sqrt{(\sigma_a - e_a)(\sigma_b - e_b)}}$$

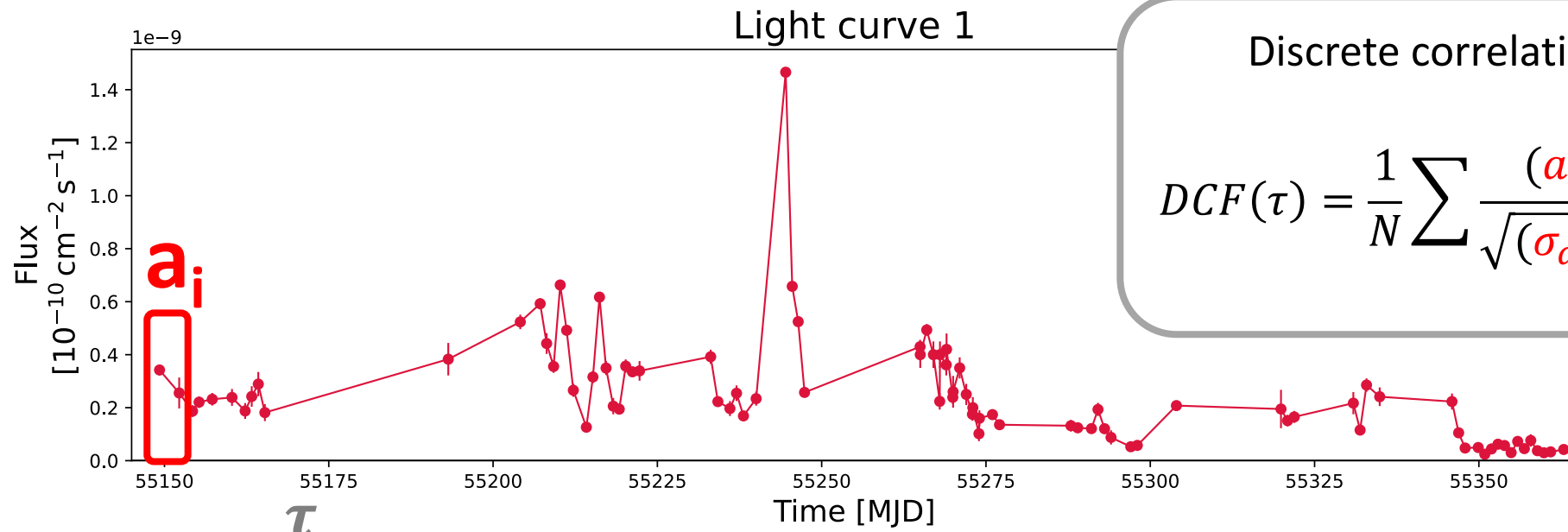




Discrete correlation function:

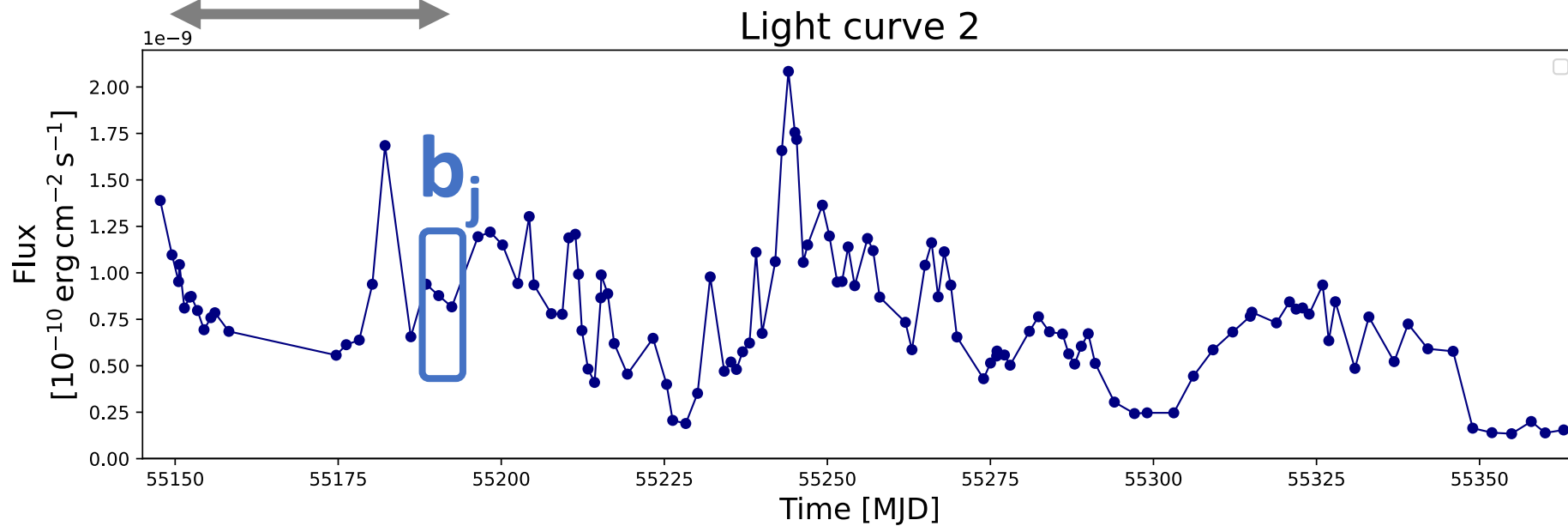
$$DCF(\tau) = \frac{1}{N} \sum \frac{(a_i - \bar{a})(b_j - \bar{b})}{\sqrt{(\sigma_a - e_a)(\sigma_b - e_b)}}$$

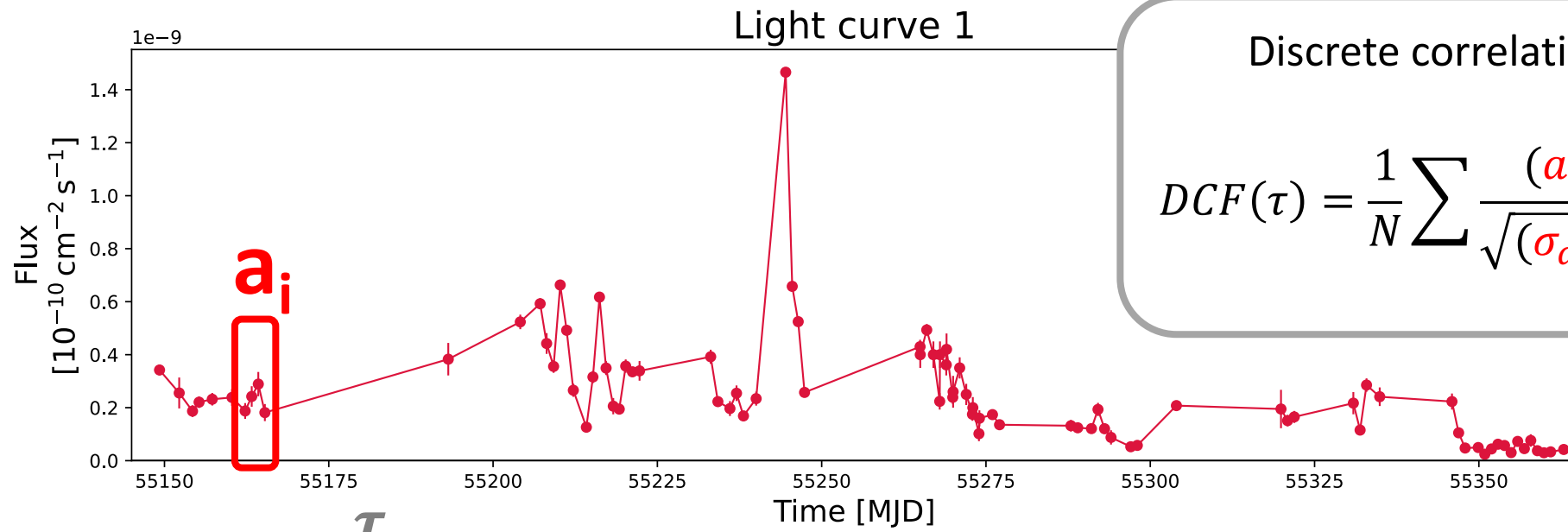




Discrete correlation function:

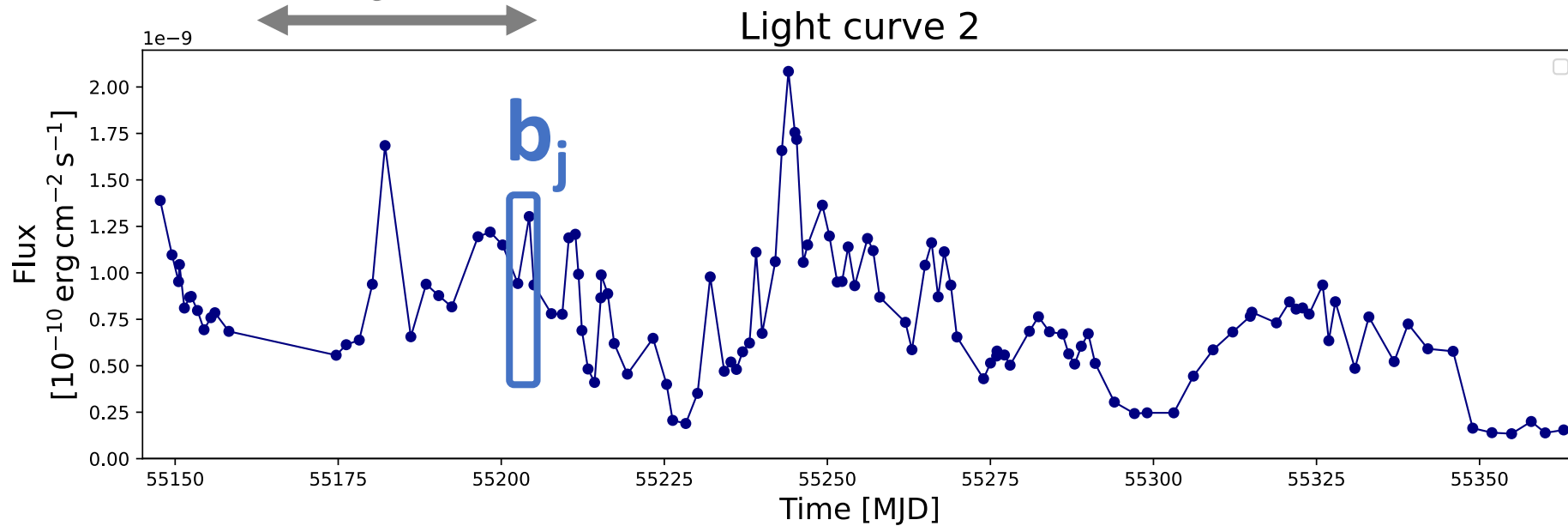
$$DCF(\tau) = \frac{1}{N} \sum \frac{(a_i - \bar{a})(b_j - \bar{b})}{\sqrt{(\sigma_a - e_a)(\sigma_b - e_b)}}$$

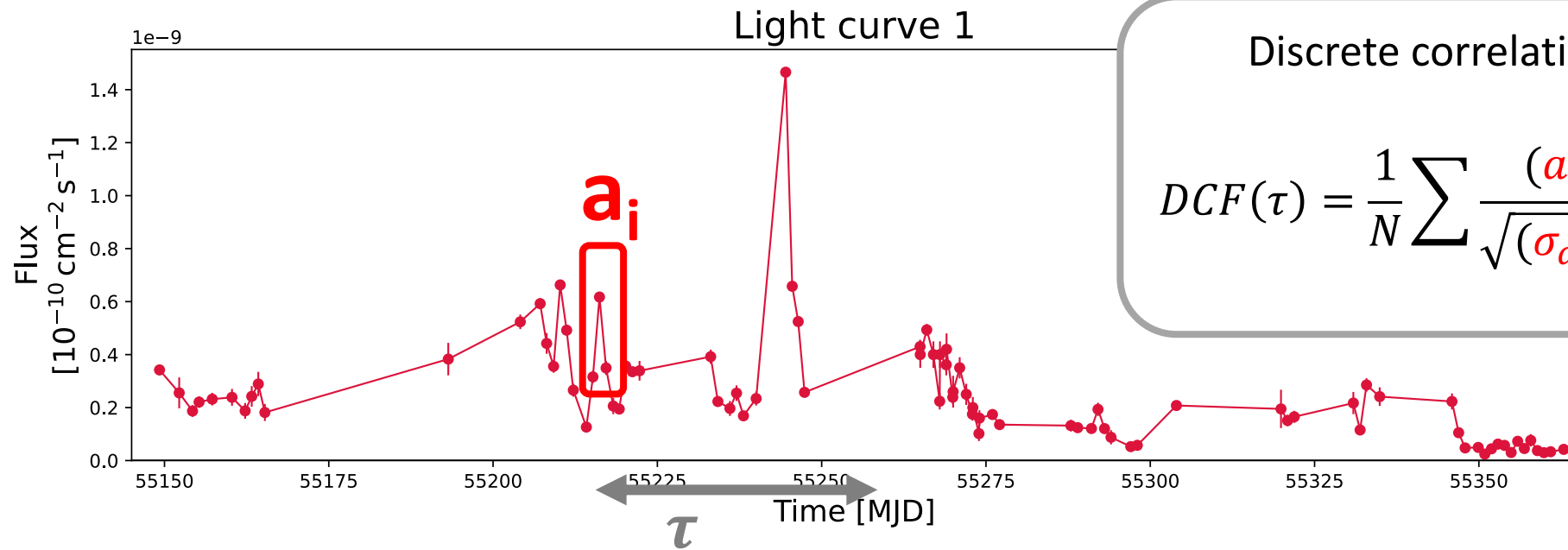




Discrete correlation function:

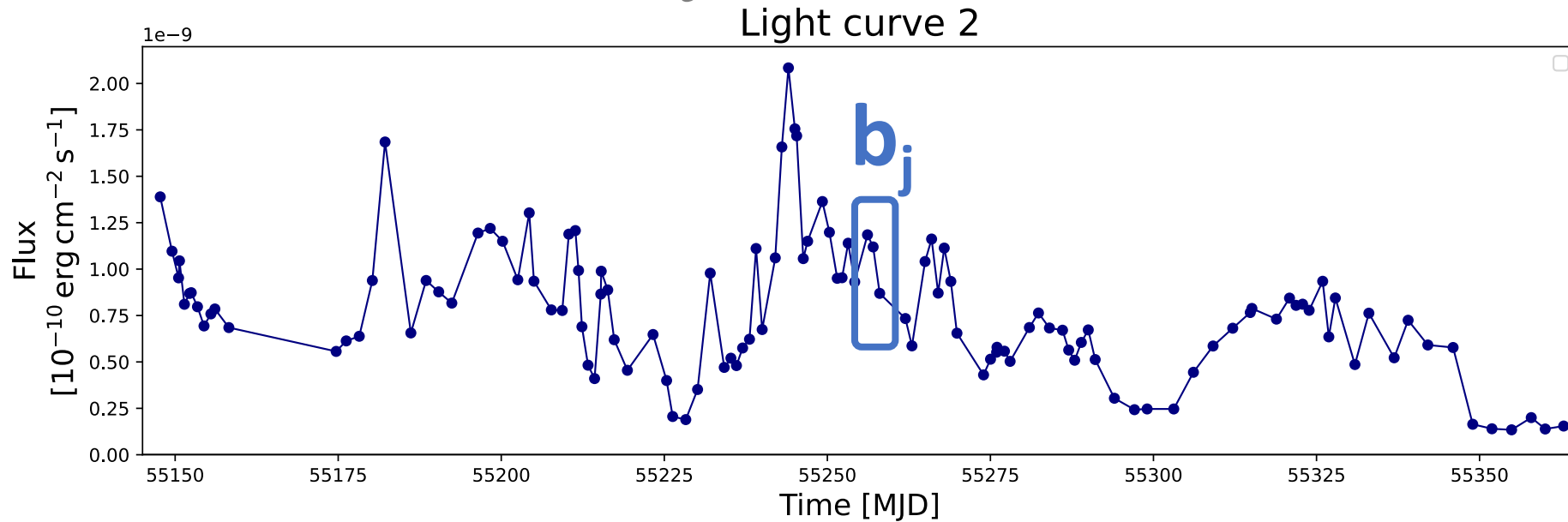
$$DCF(\tau) = \frac{1}{N} \sum \frac{(a_i - \bar{a})(b_j - \bar{b})}{\sqrt{(\sigma_a - e_a)(\sigma_b - e_b)}}$$

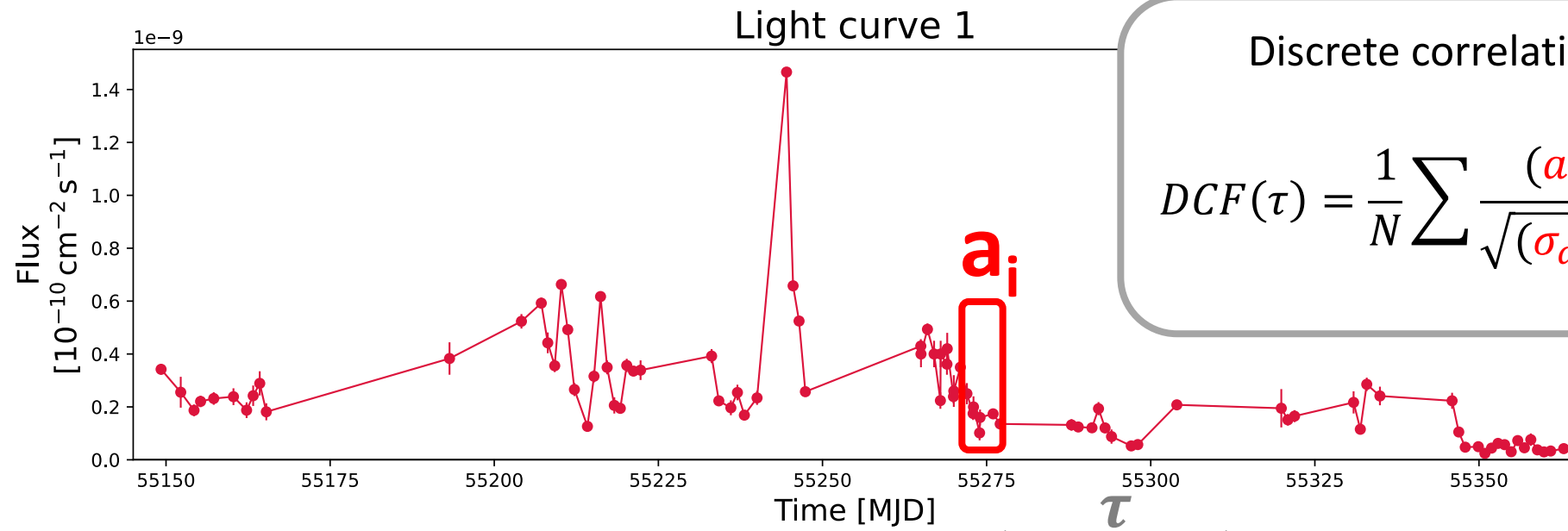




Discrete correlation function:

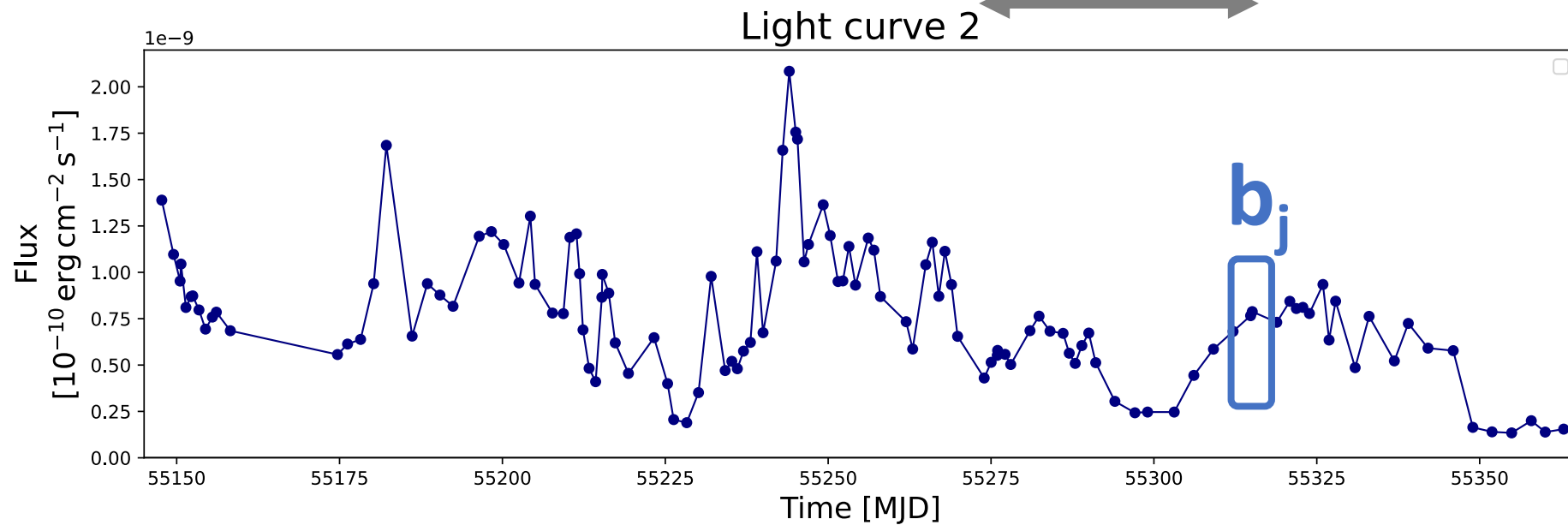
$$DCF(\tau) = \frac{1}{N} \sum \frac{(a_i - \bar{a})(b_j - \bar{b})}{\sqrt{(\sigma_a - e_a)(\sigma_b - e_b)}}$$

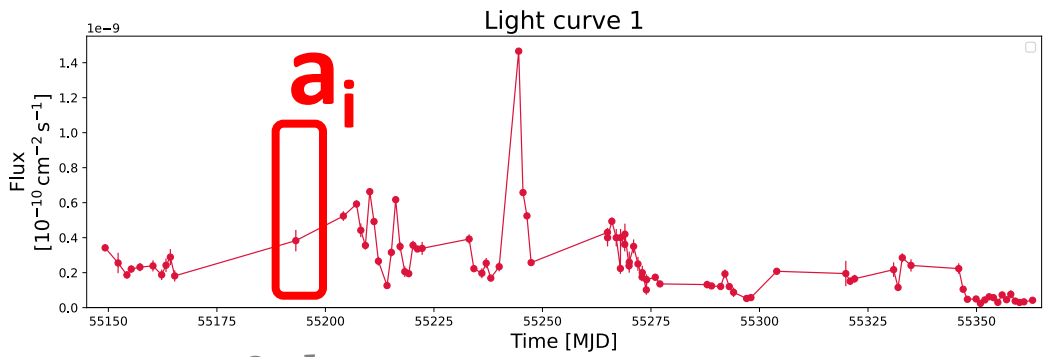




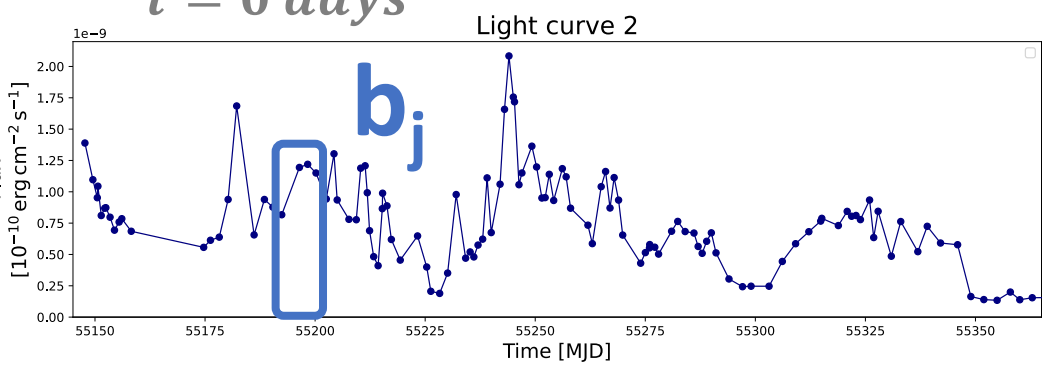
Discrete correlation function:

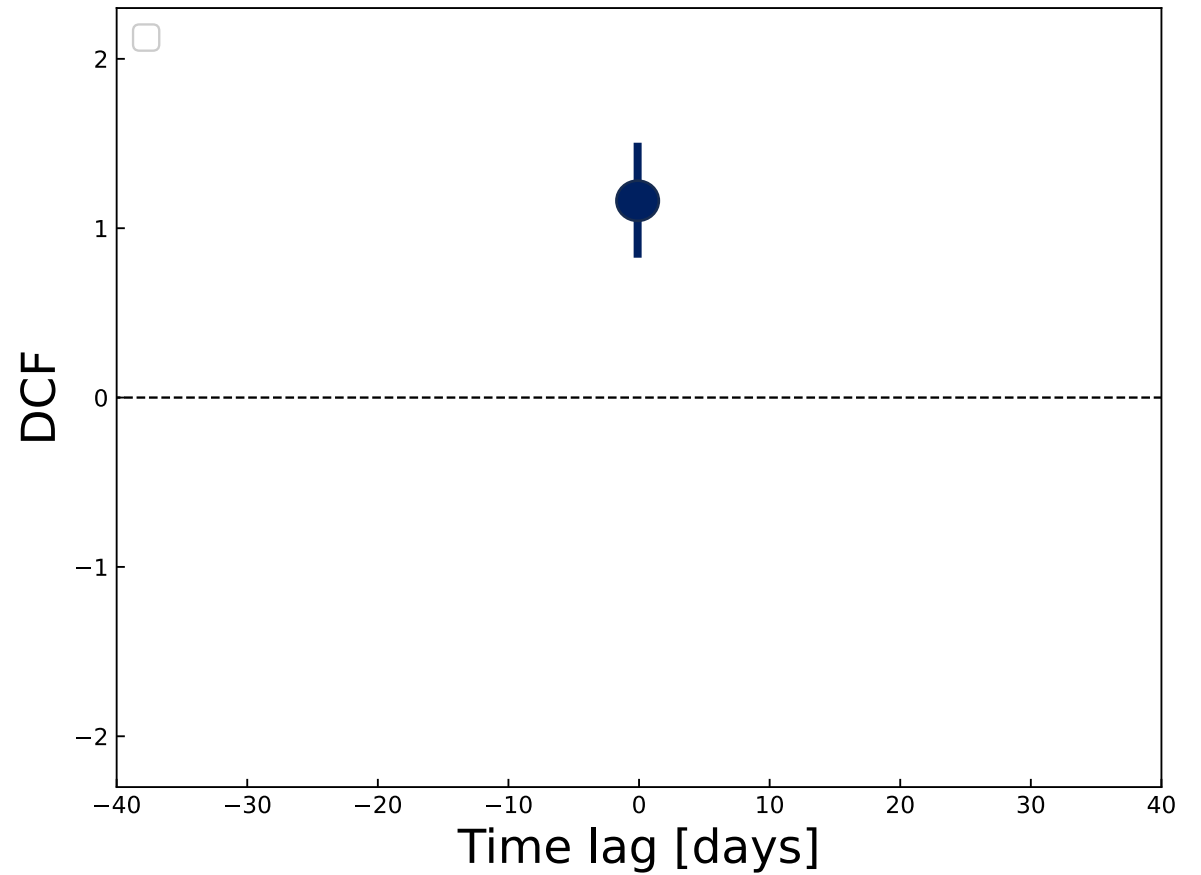
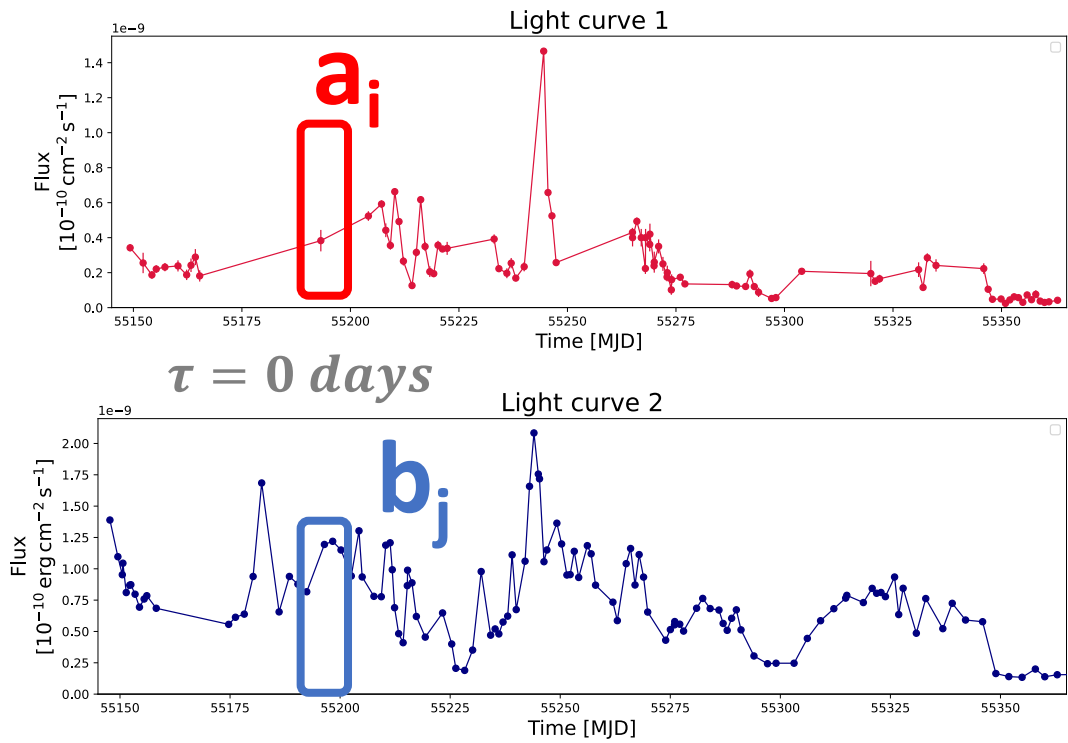
$$DCF(\tau) = \frac{1}{N} \sum \frac{(a_i - \bar{a})(b_j - \bar{b})}{\sqrt{(\sigma_a - e_a)(\sigma_b - e_b)}}$$

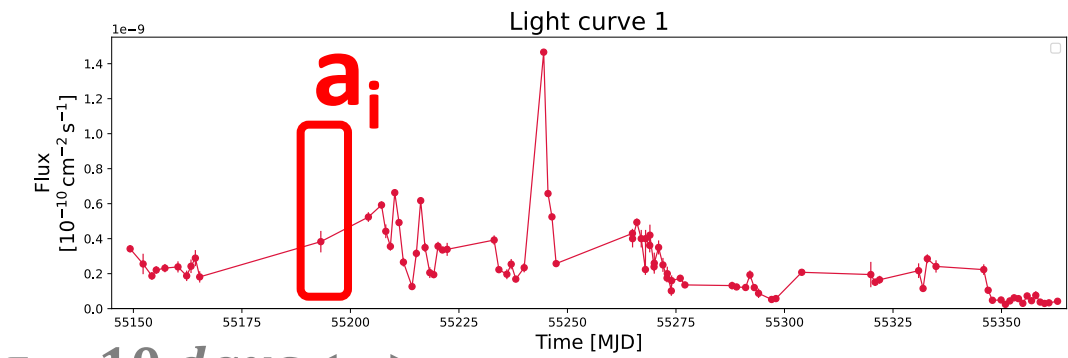




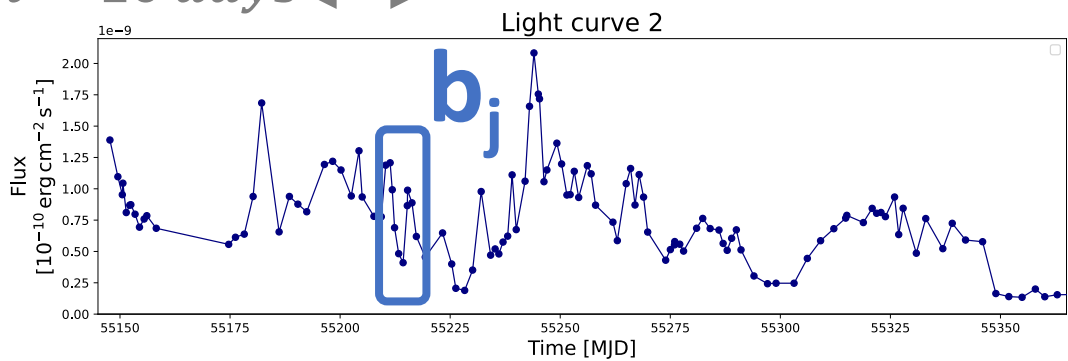
$\tau = 0$ days



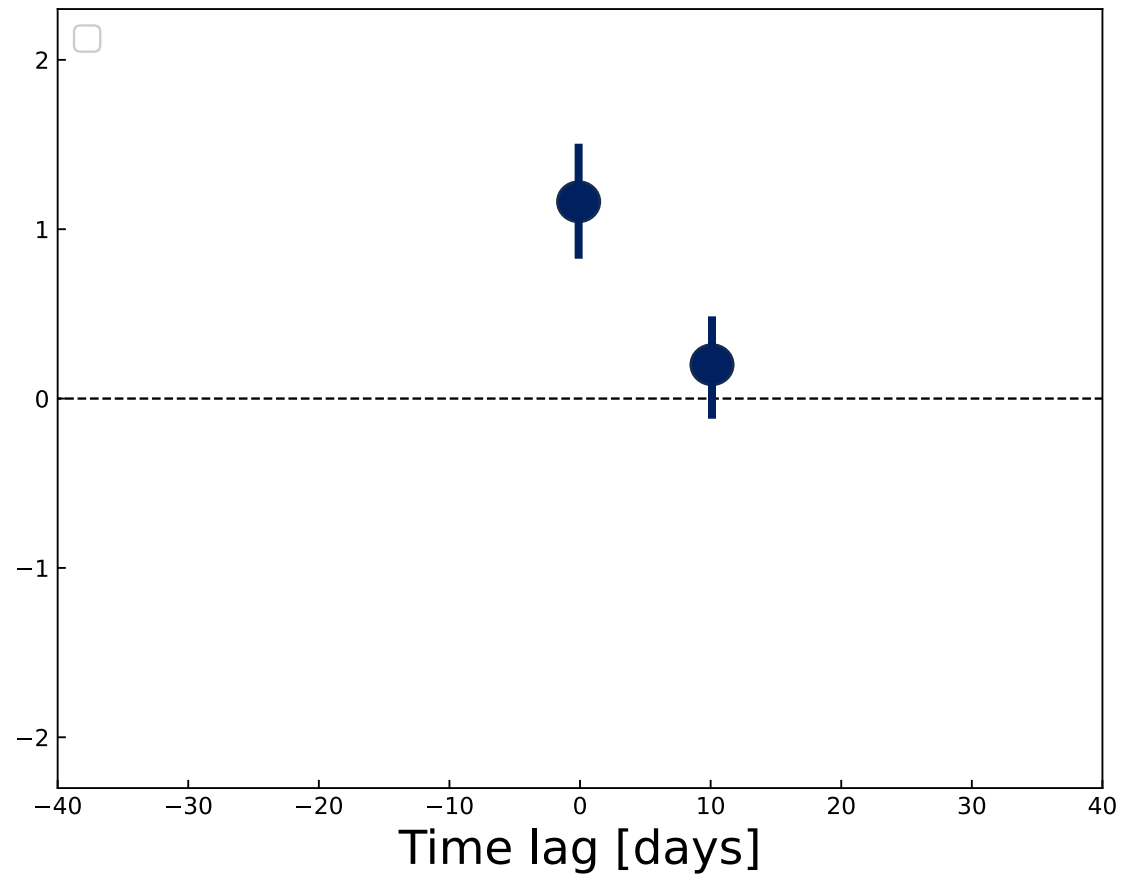


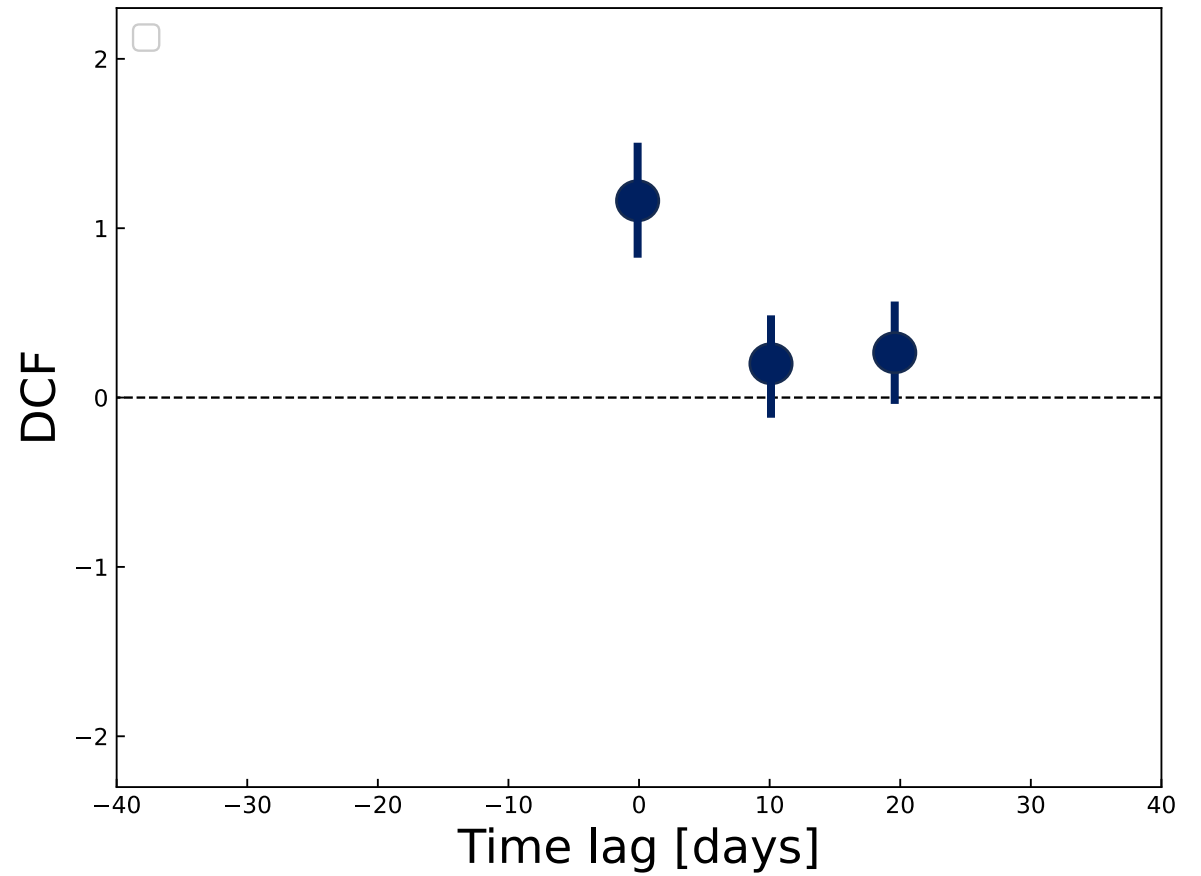
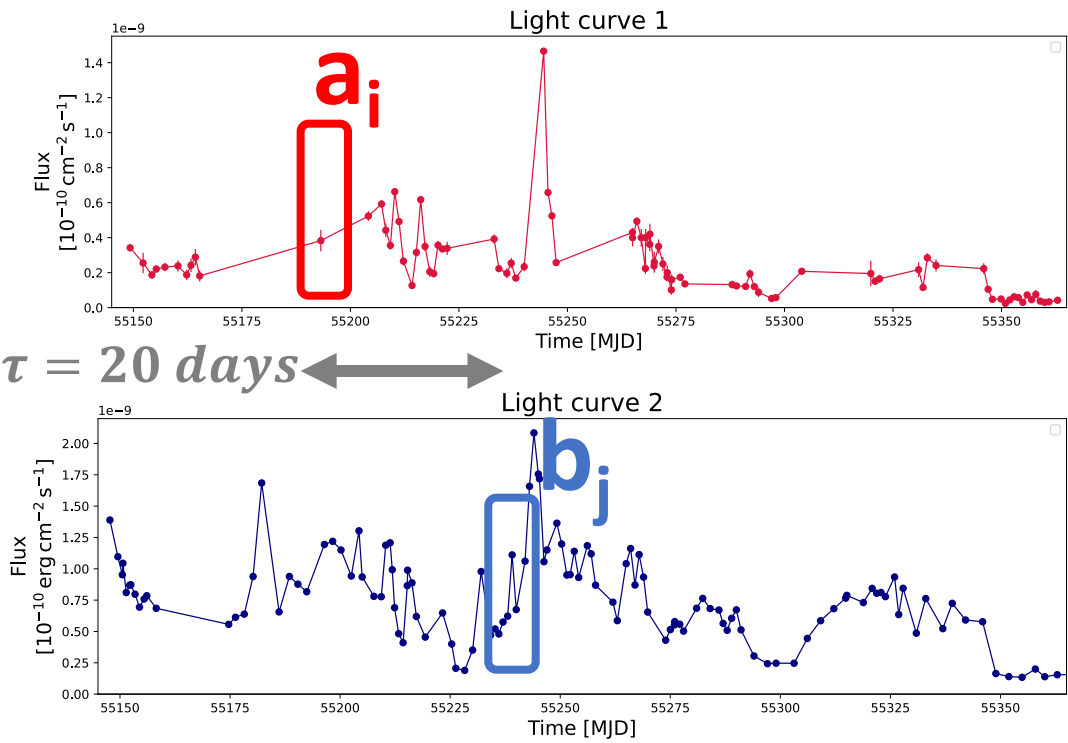


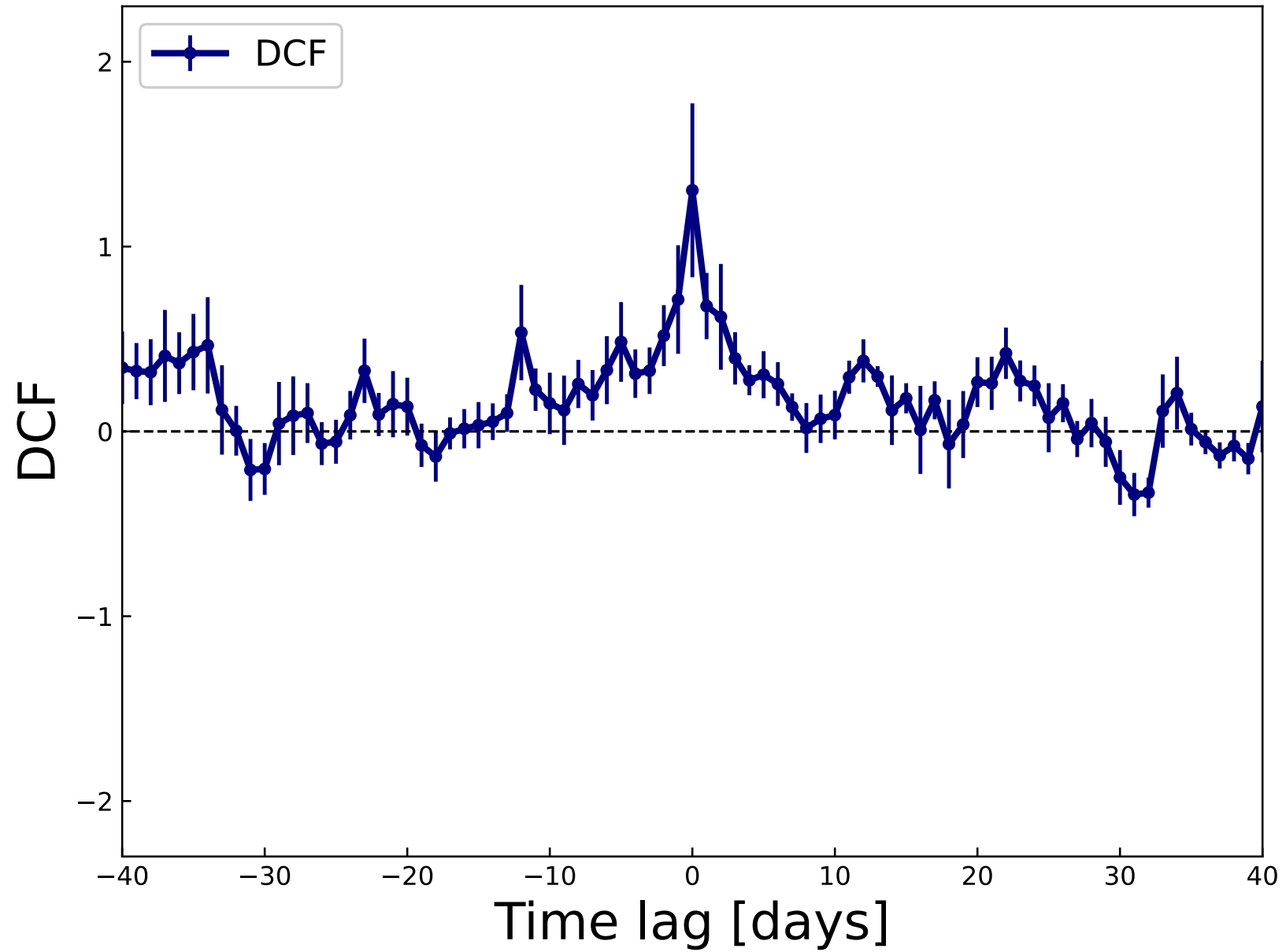
$\tau = 10 \text{ days}$

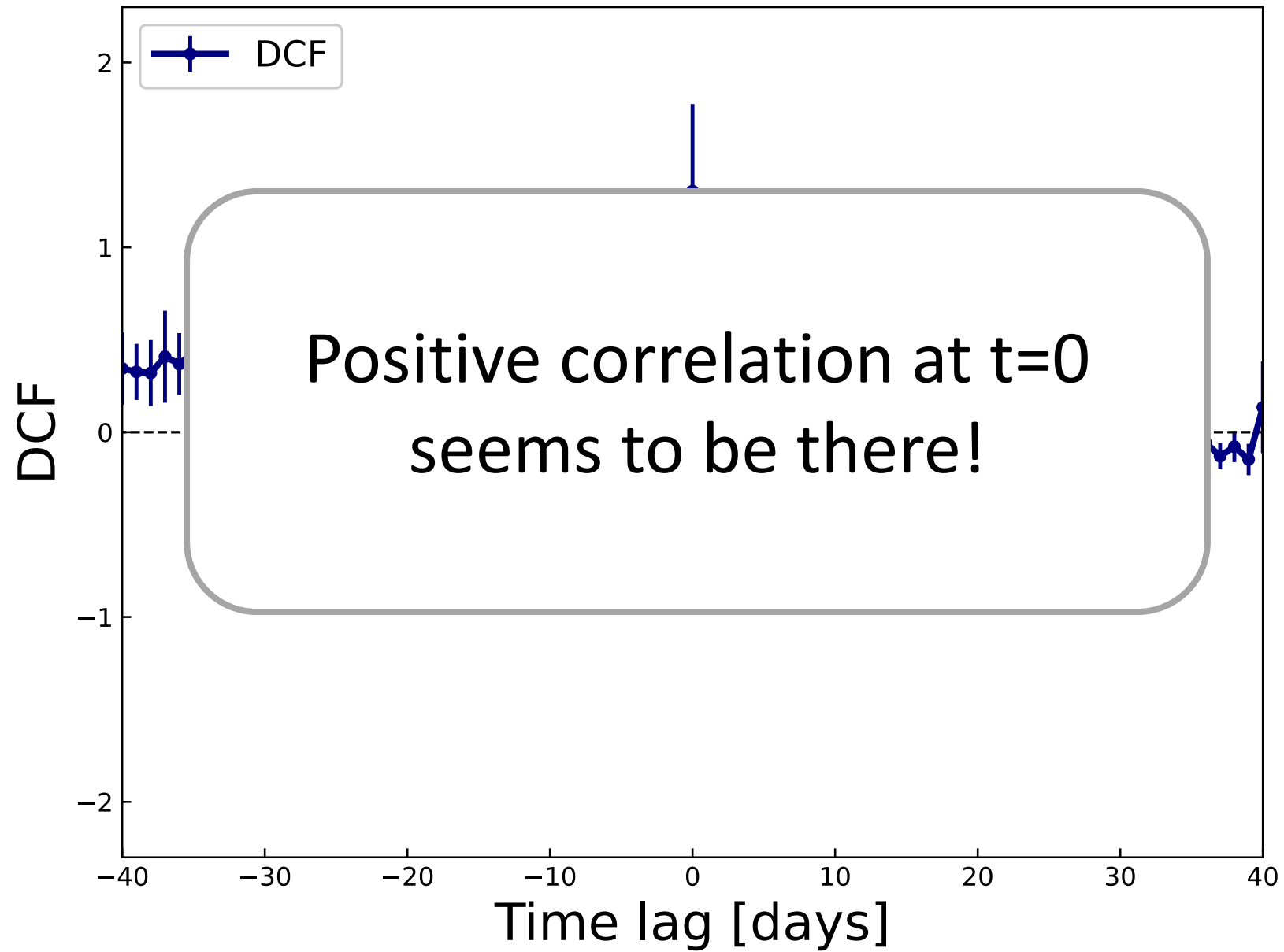


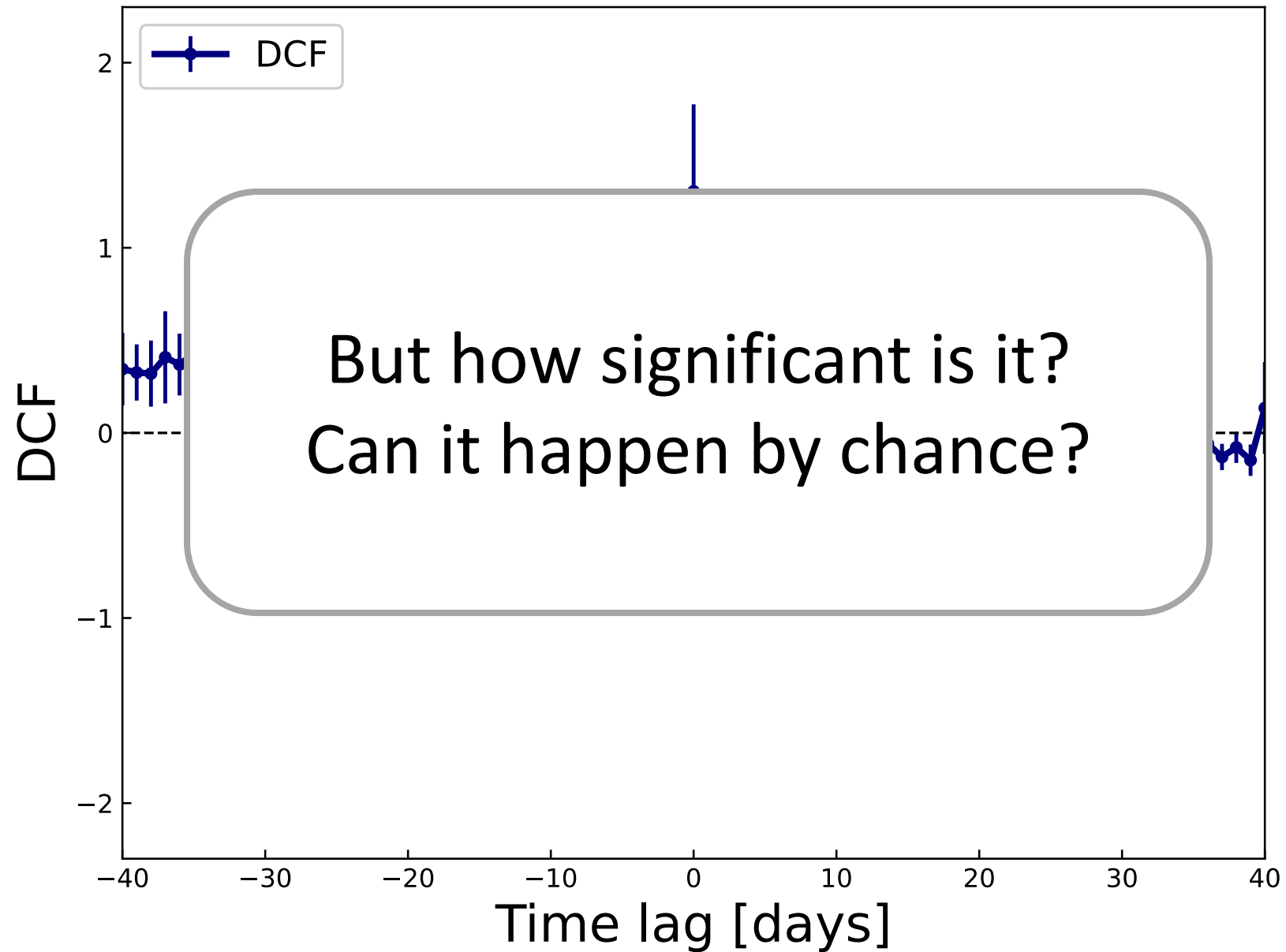
DCF

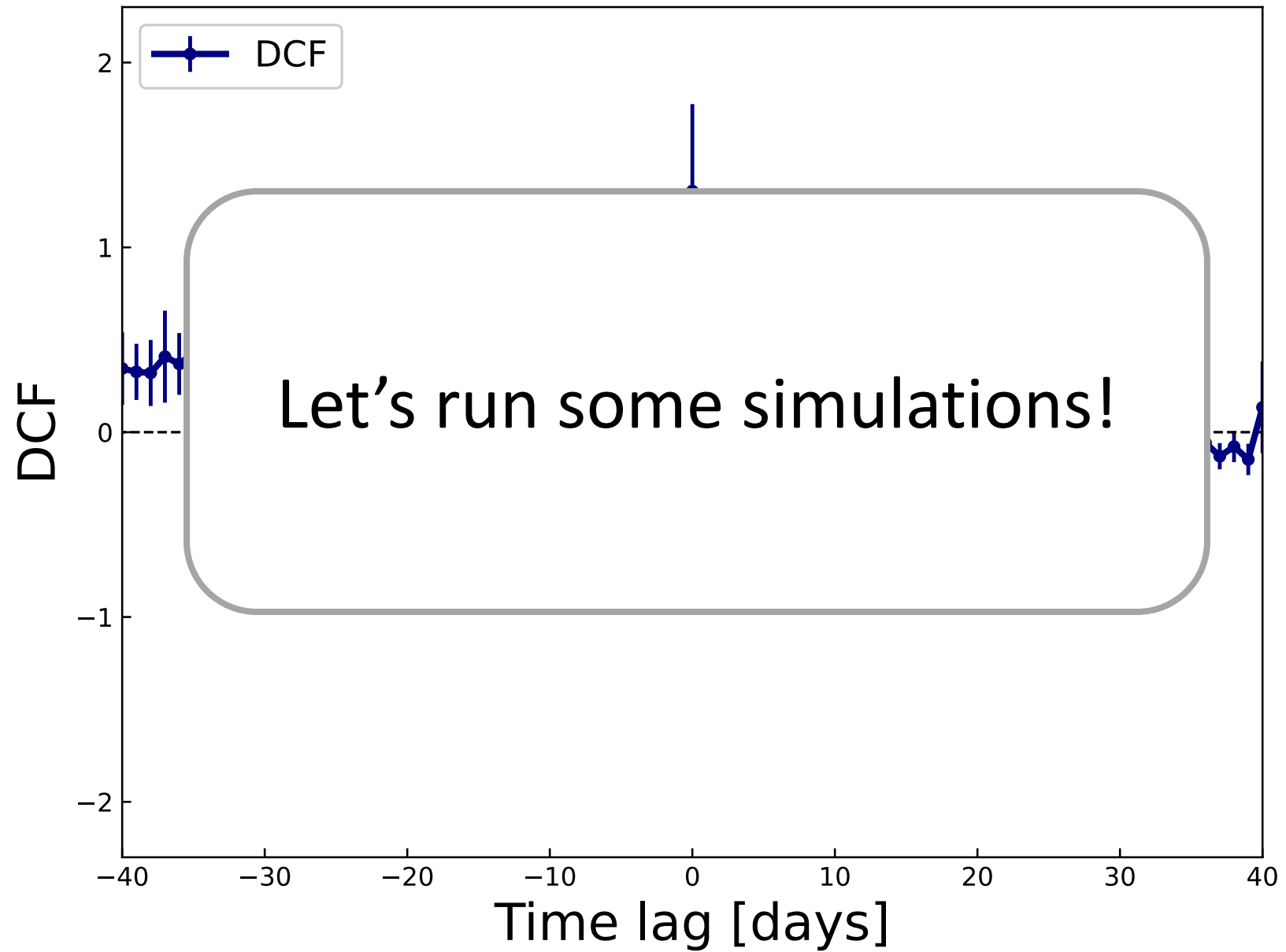




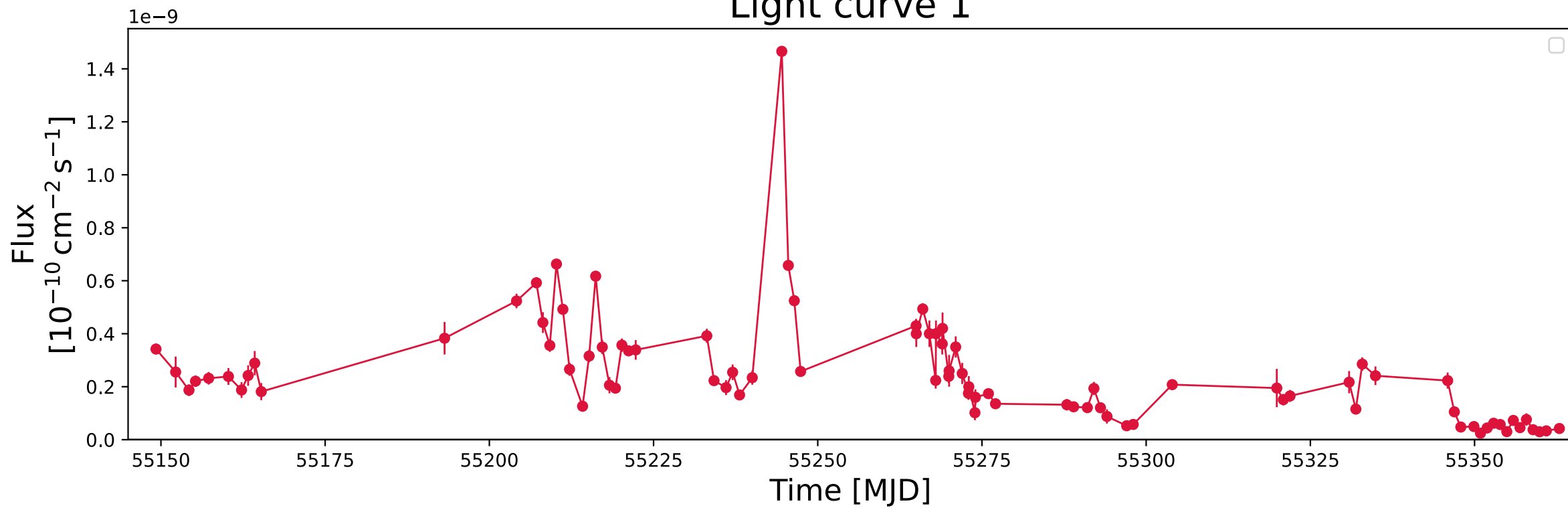




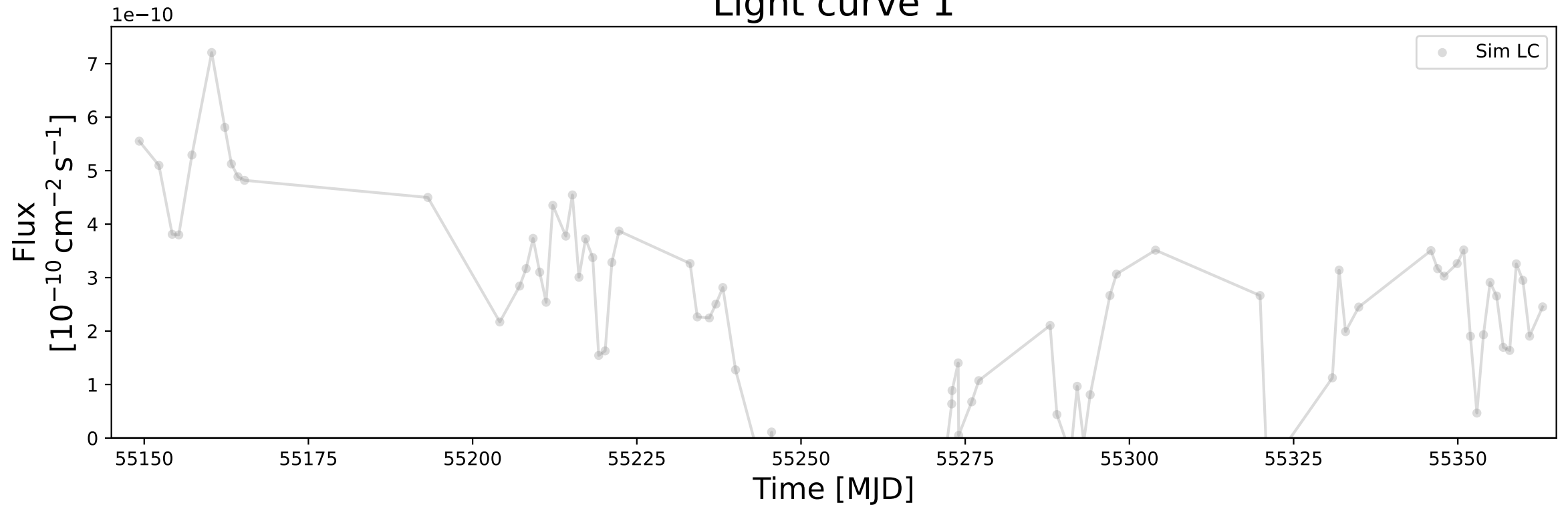




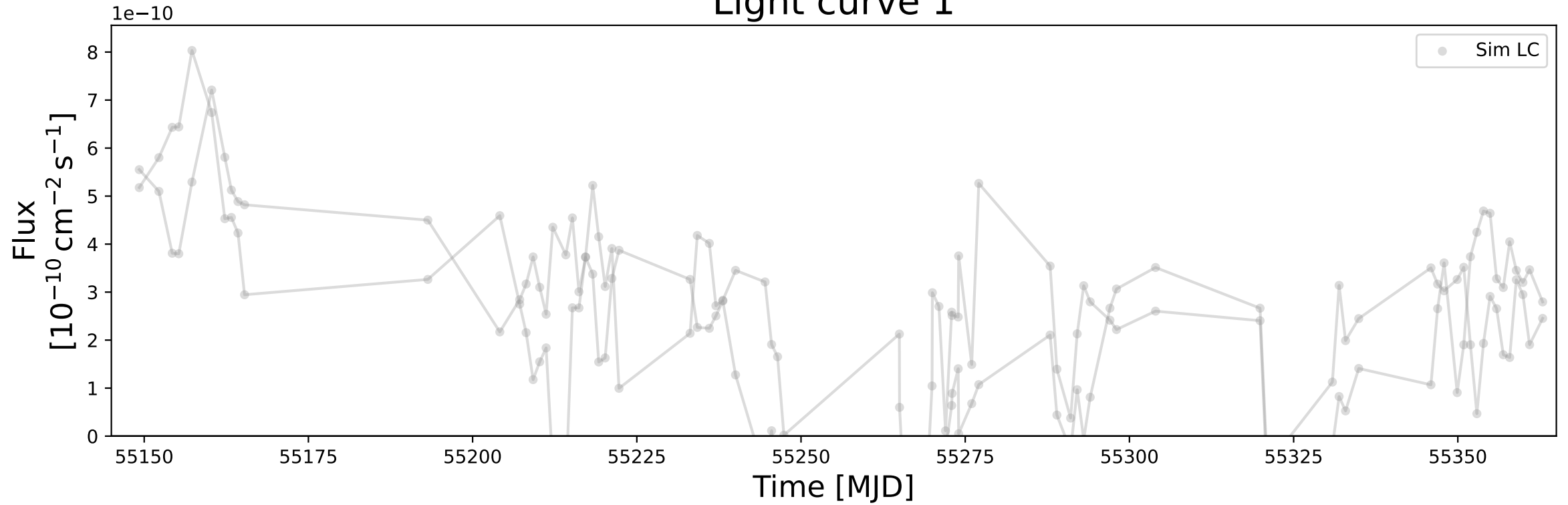
Light curve 1



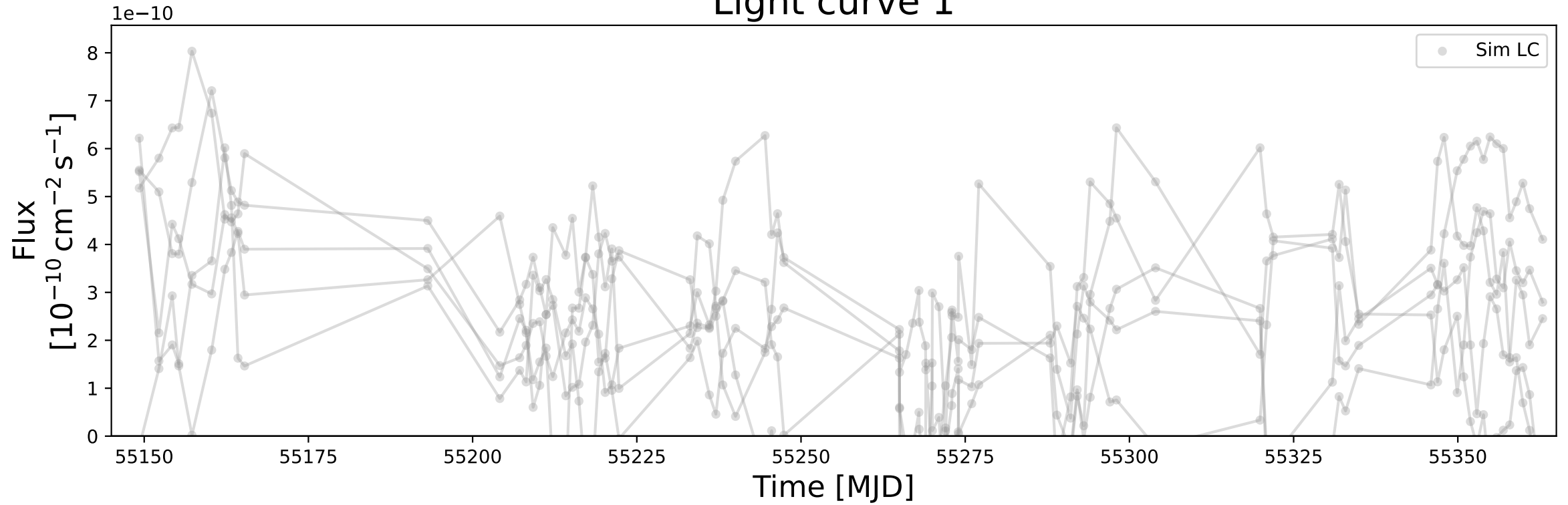
Light curve 1



Light curve 1

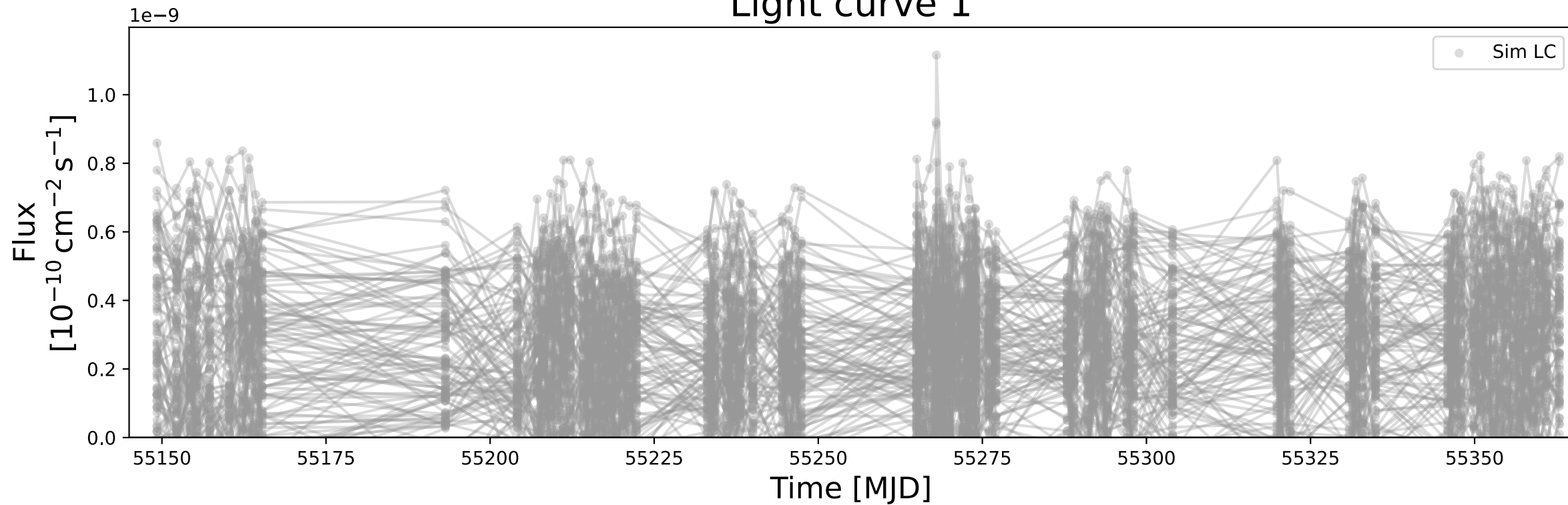


Light curve 1

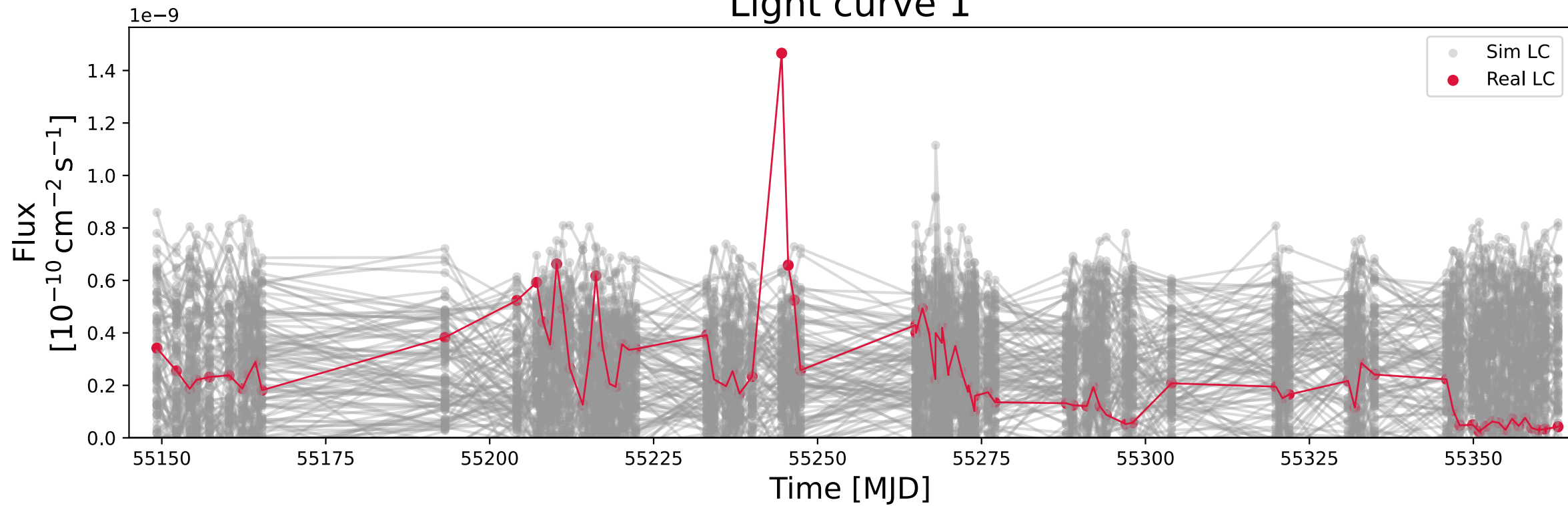


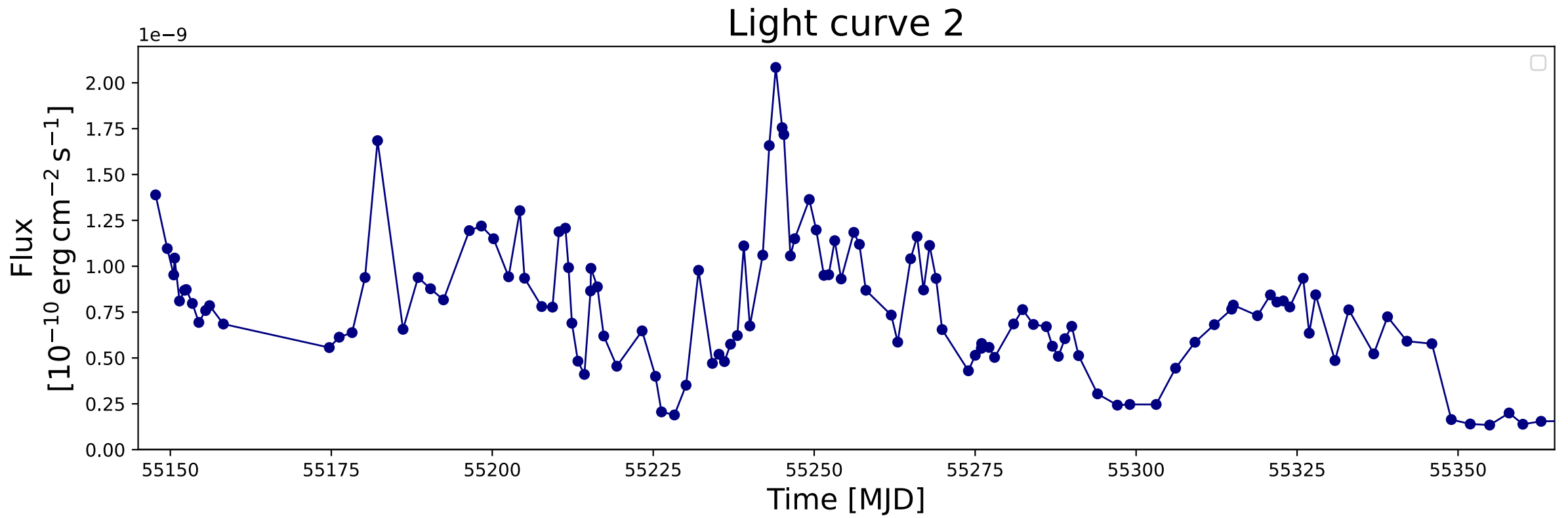
N ≈ 10000

Light curve 1

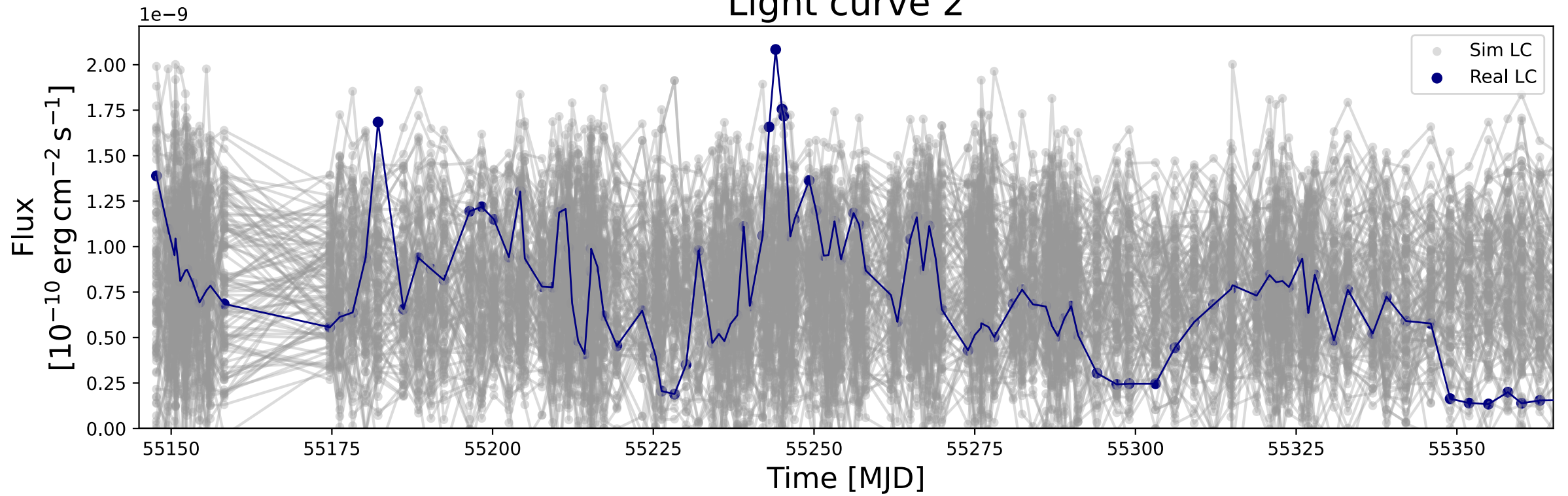


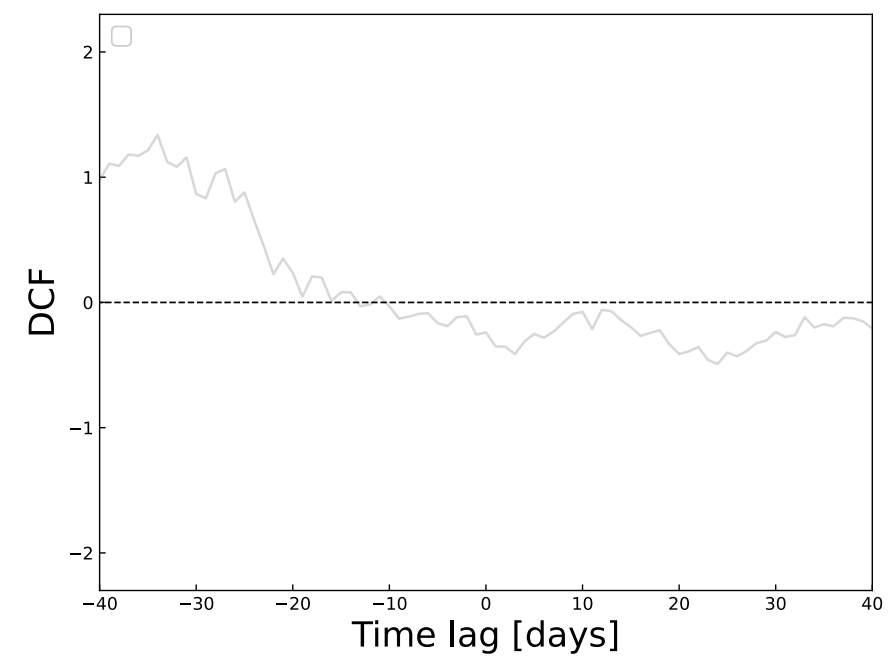
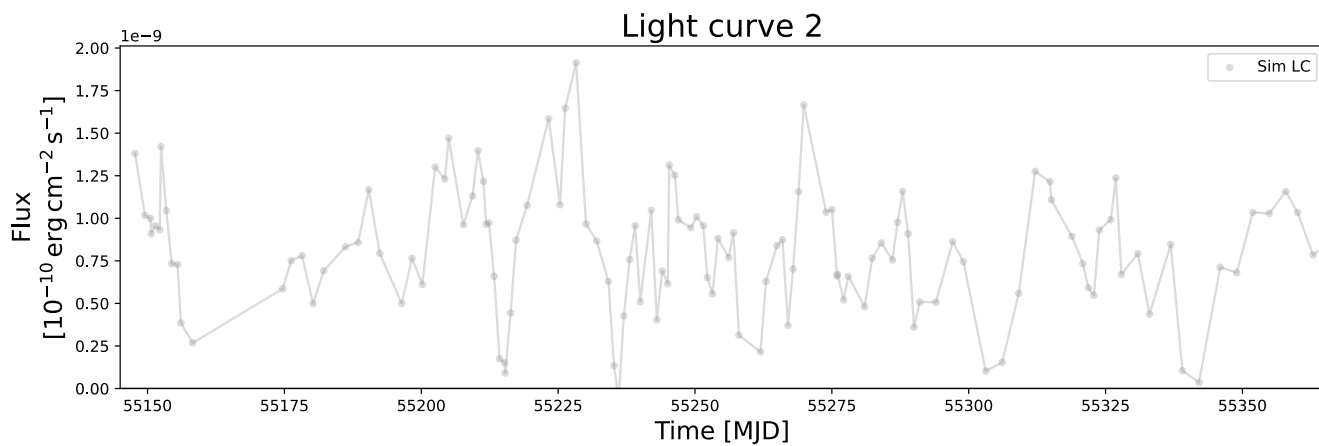
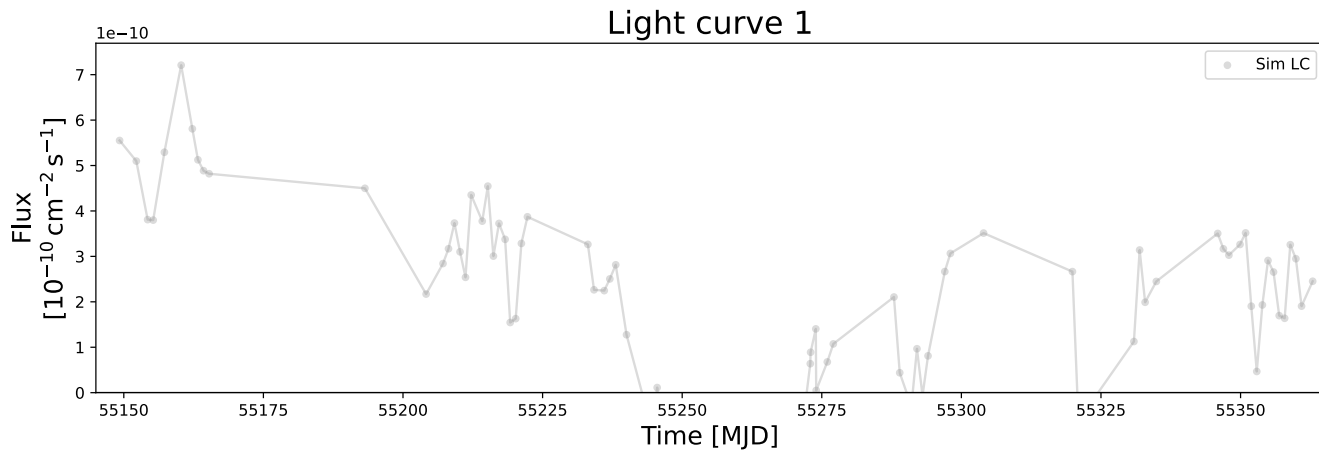
Light curve 1

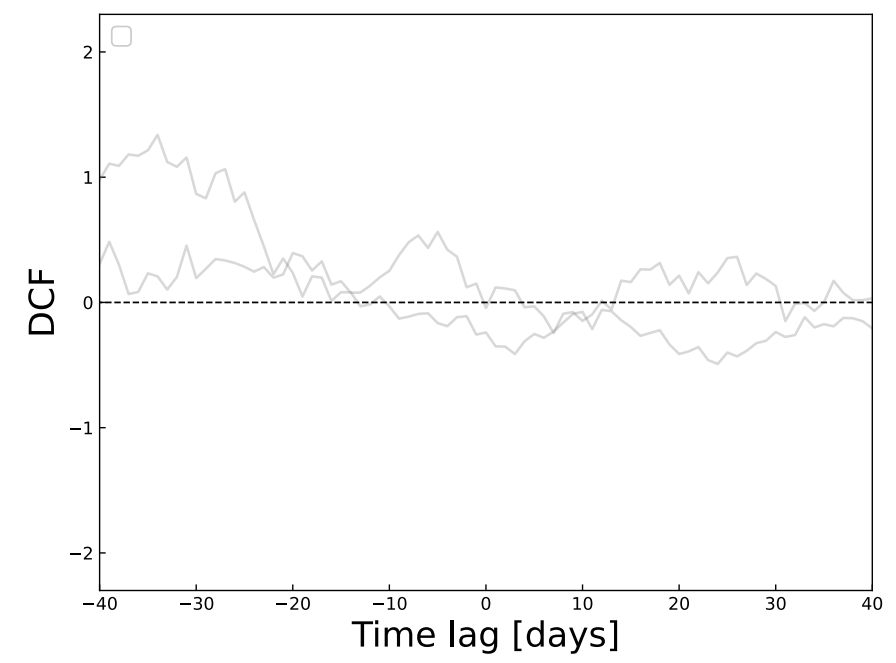
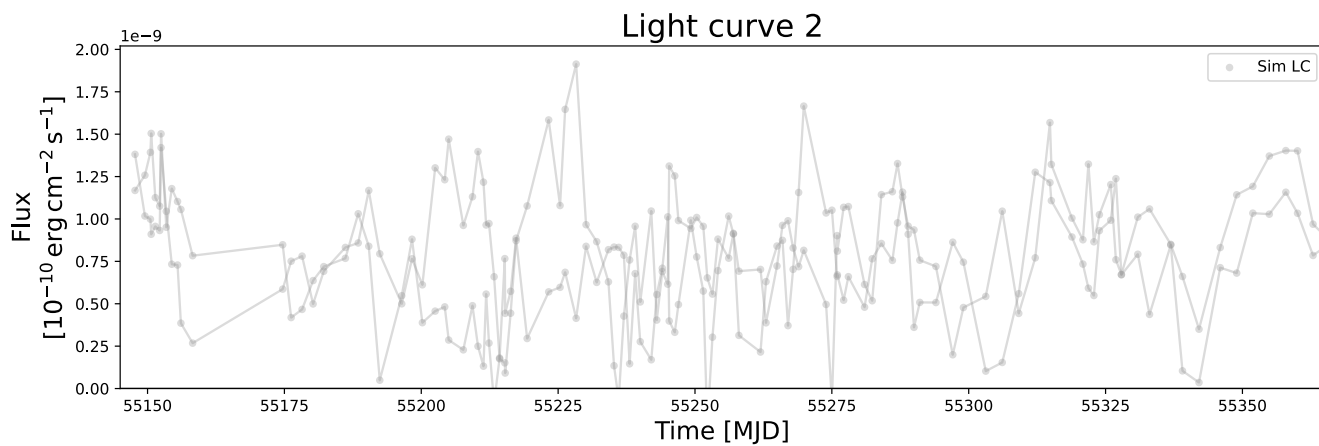
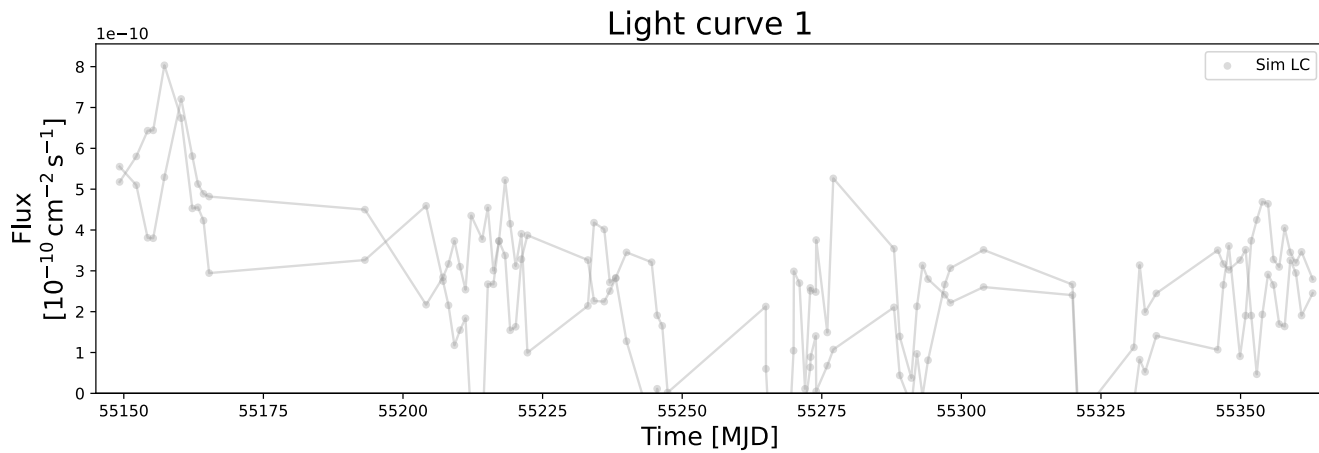


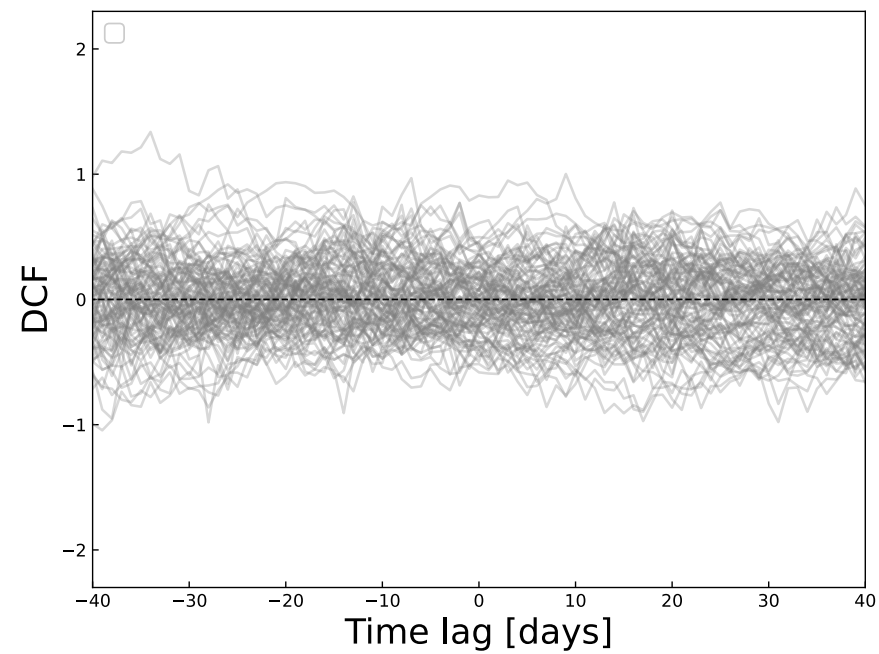
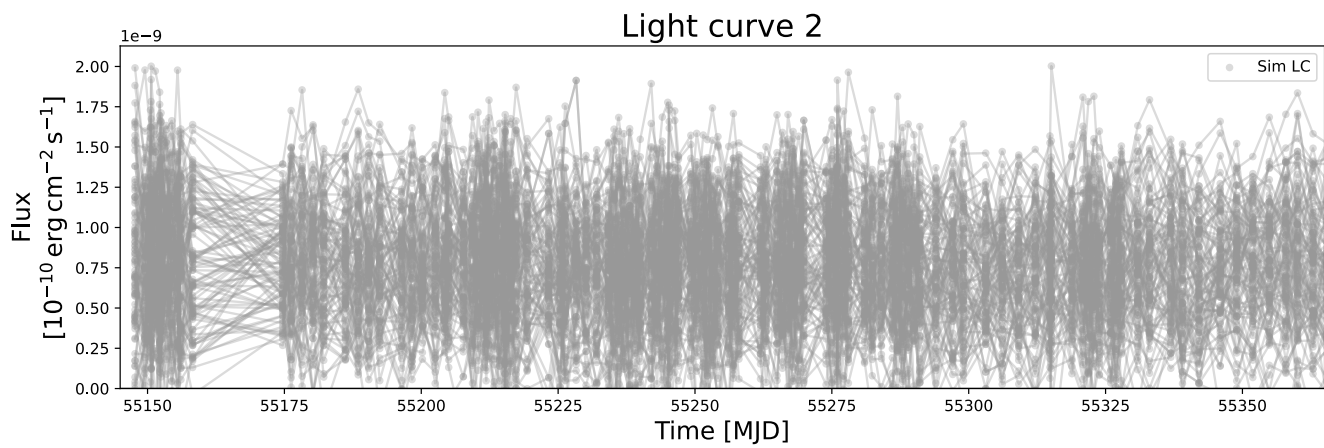
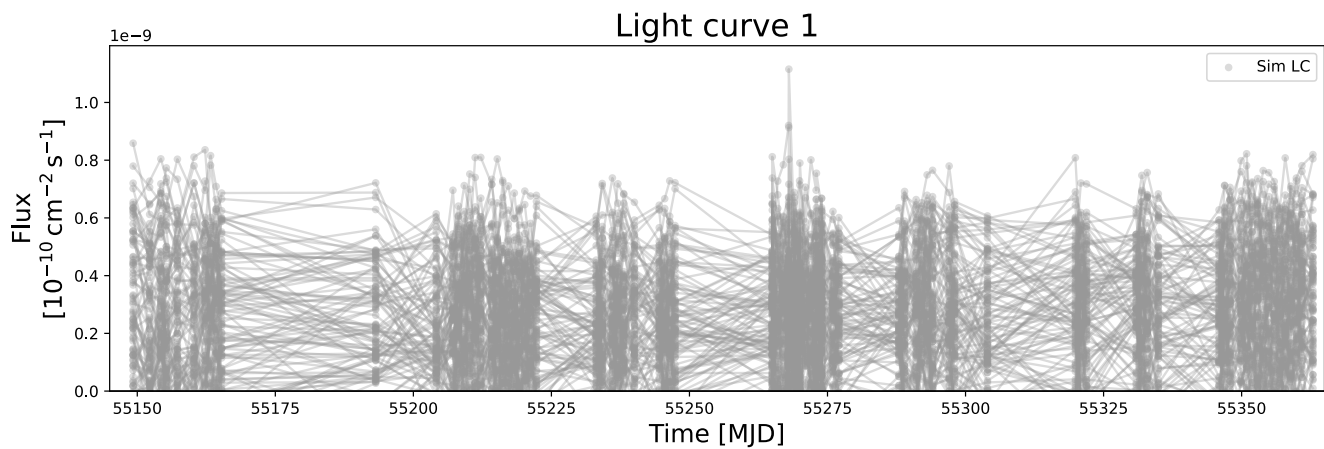


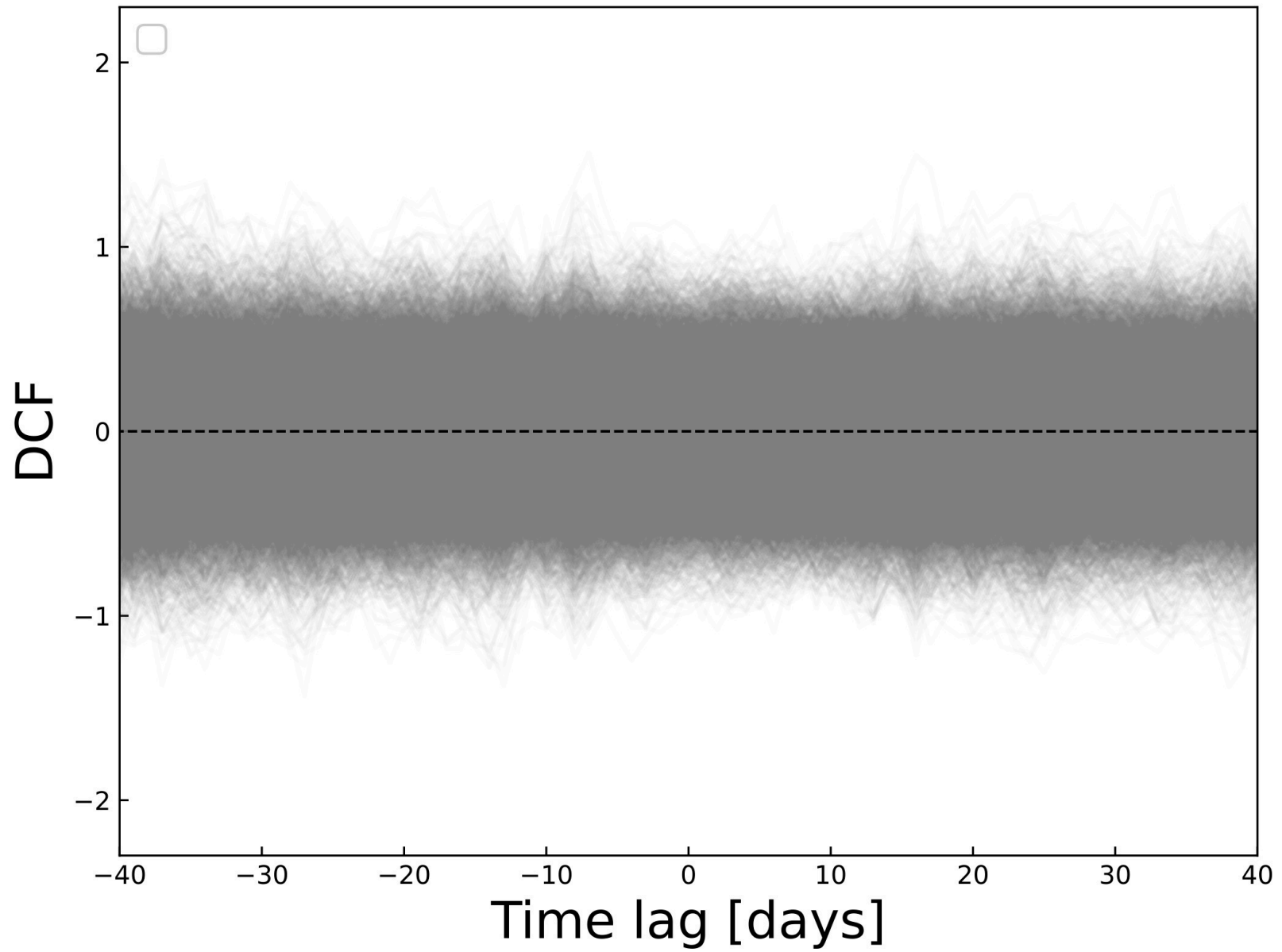
Light curve 2

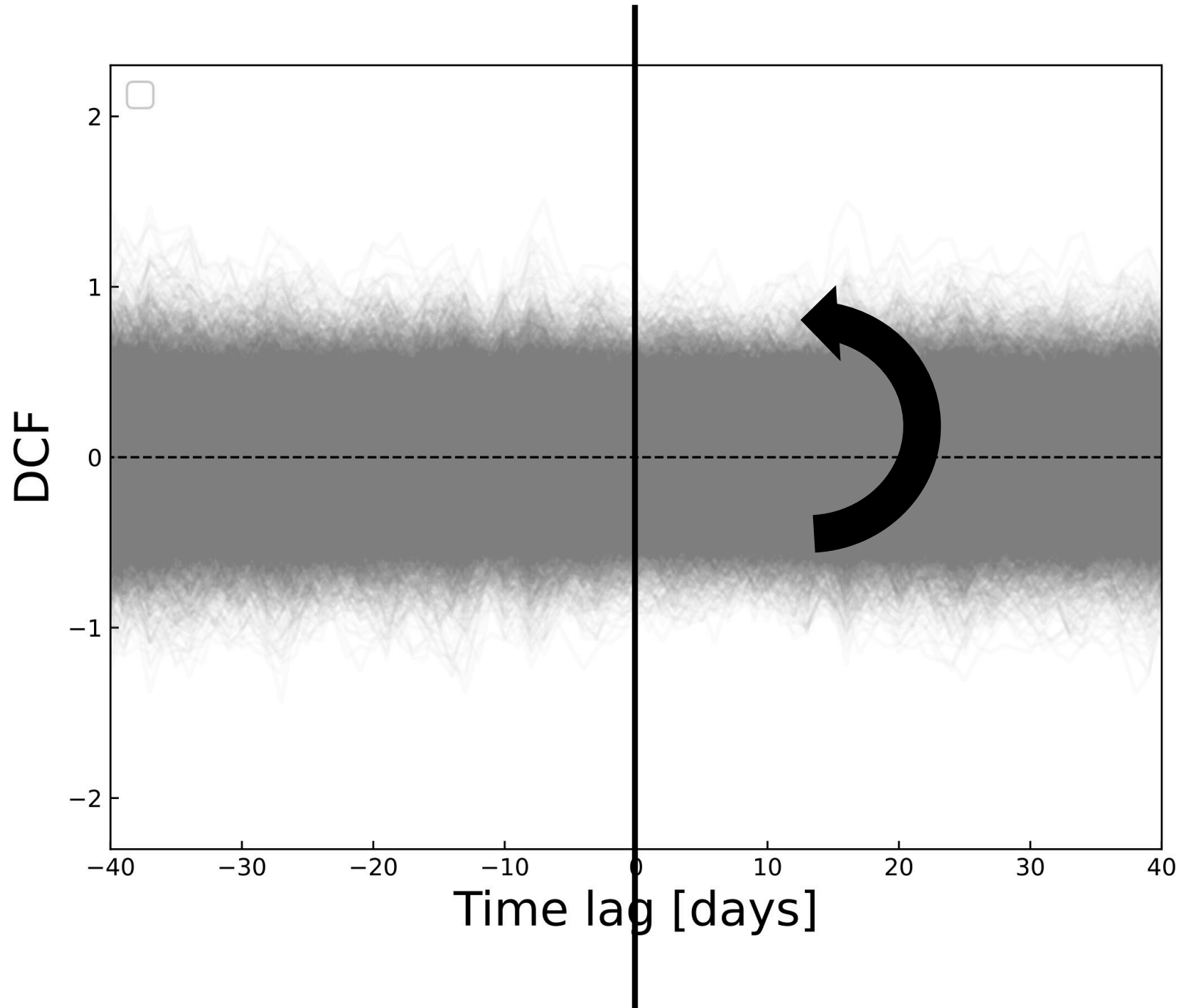


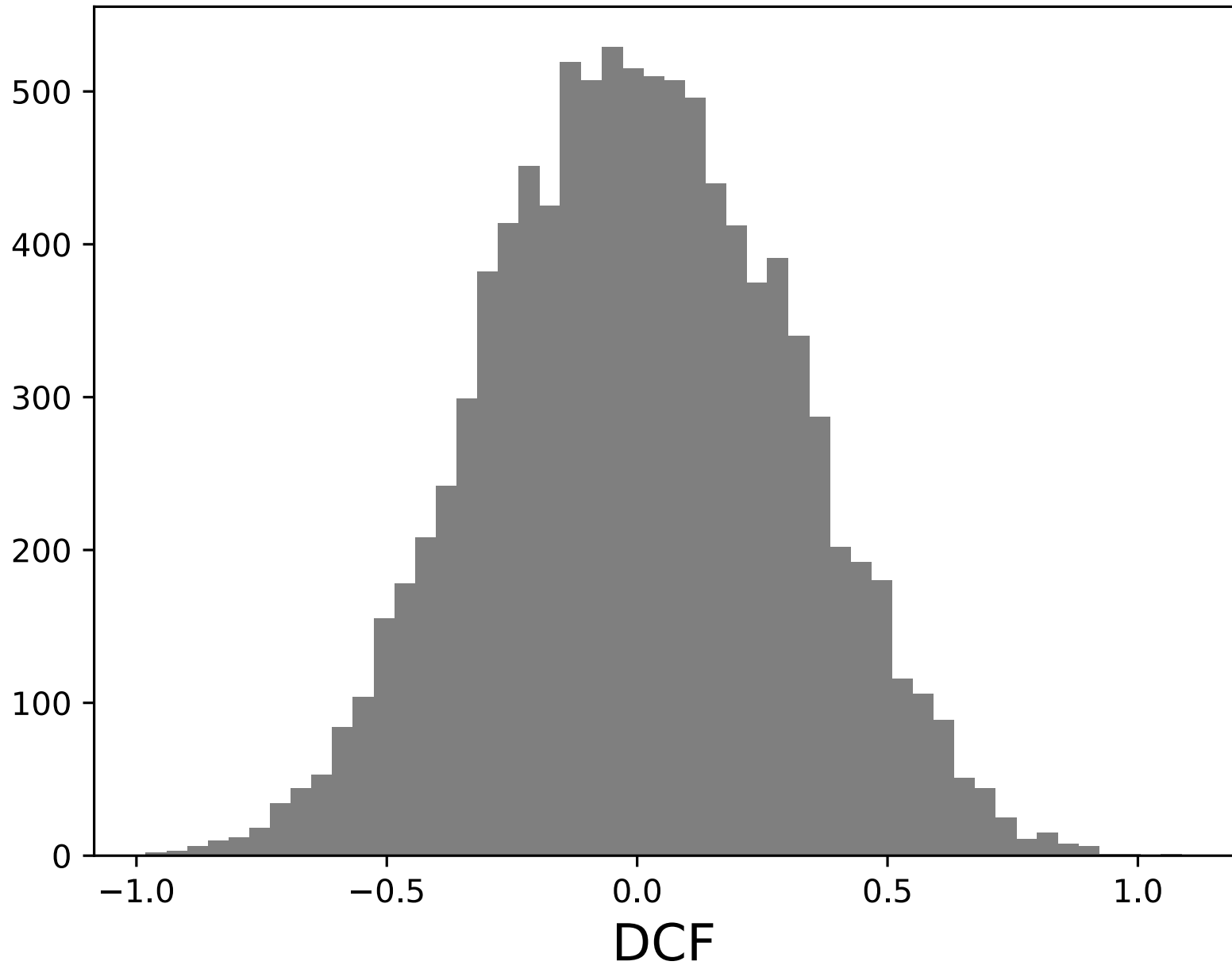




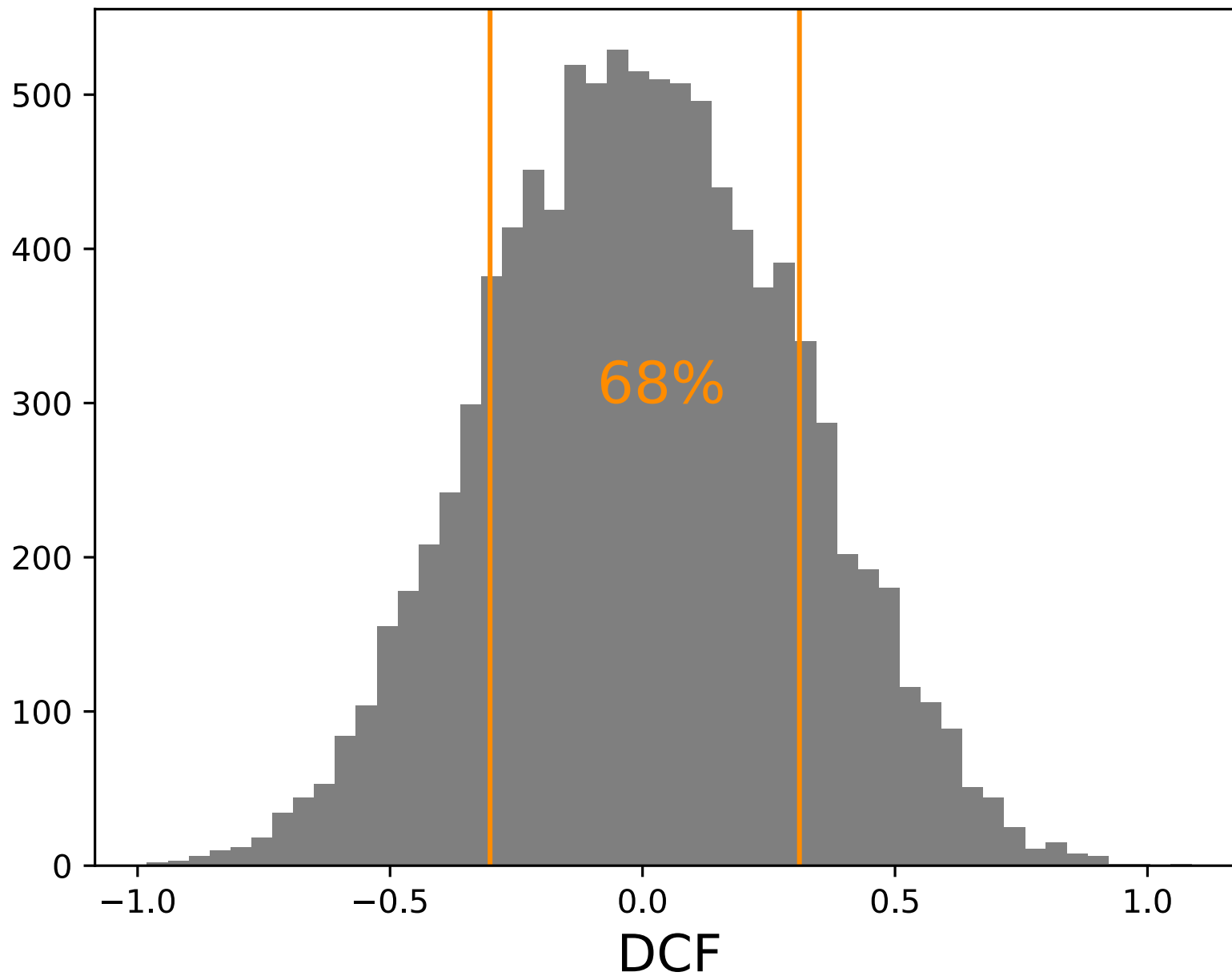




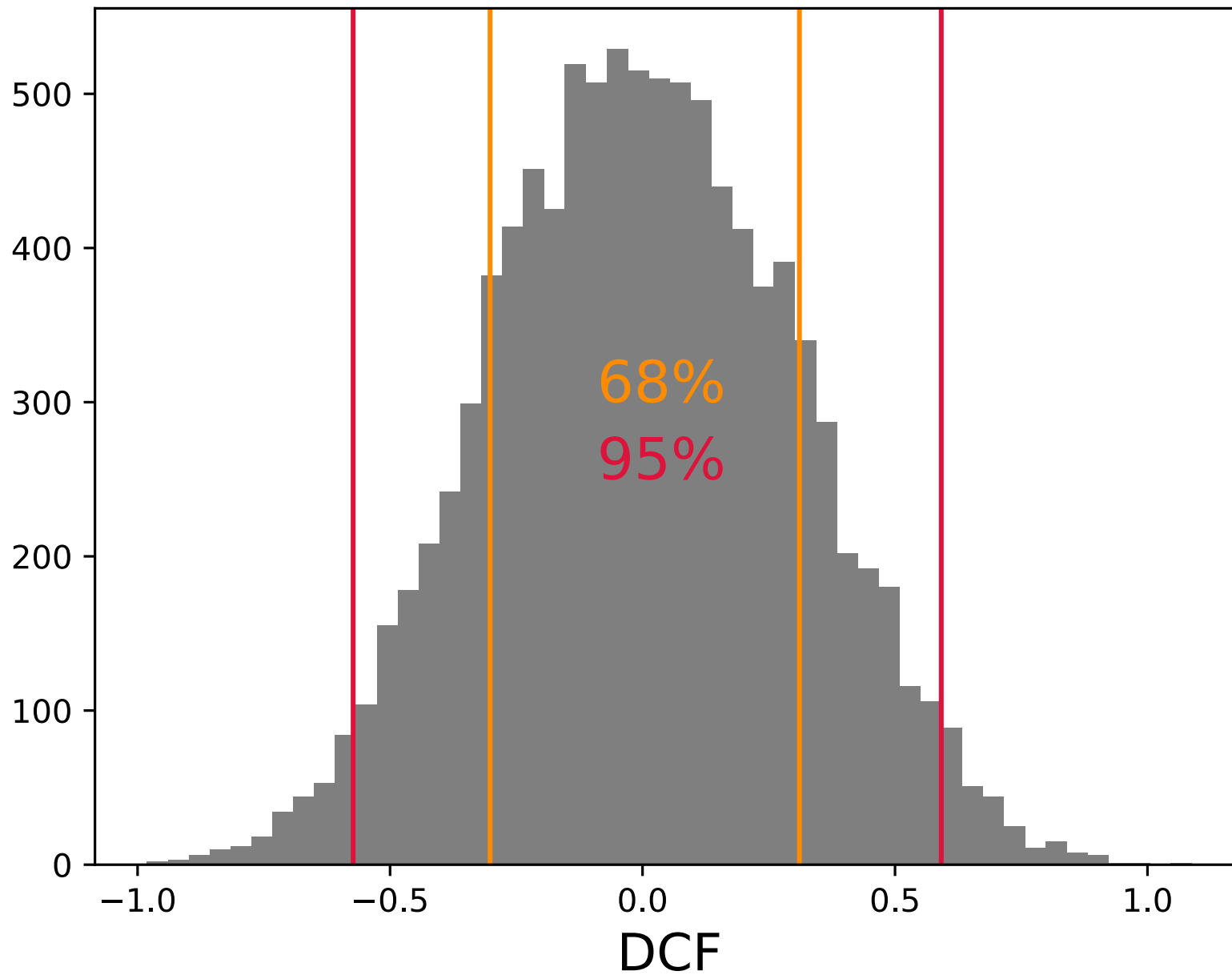




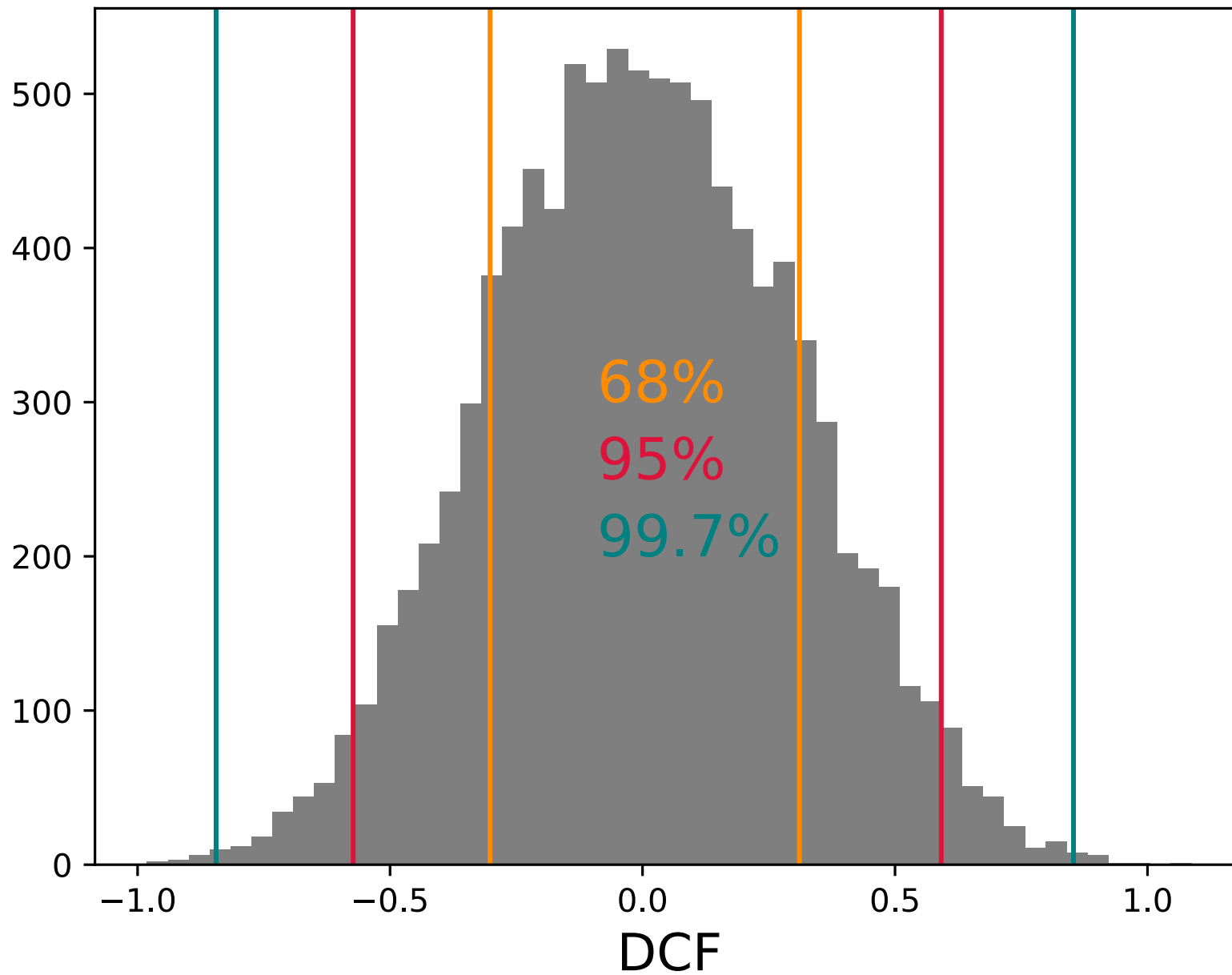
1σ

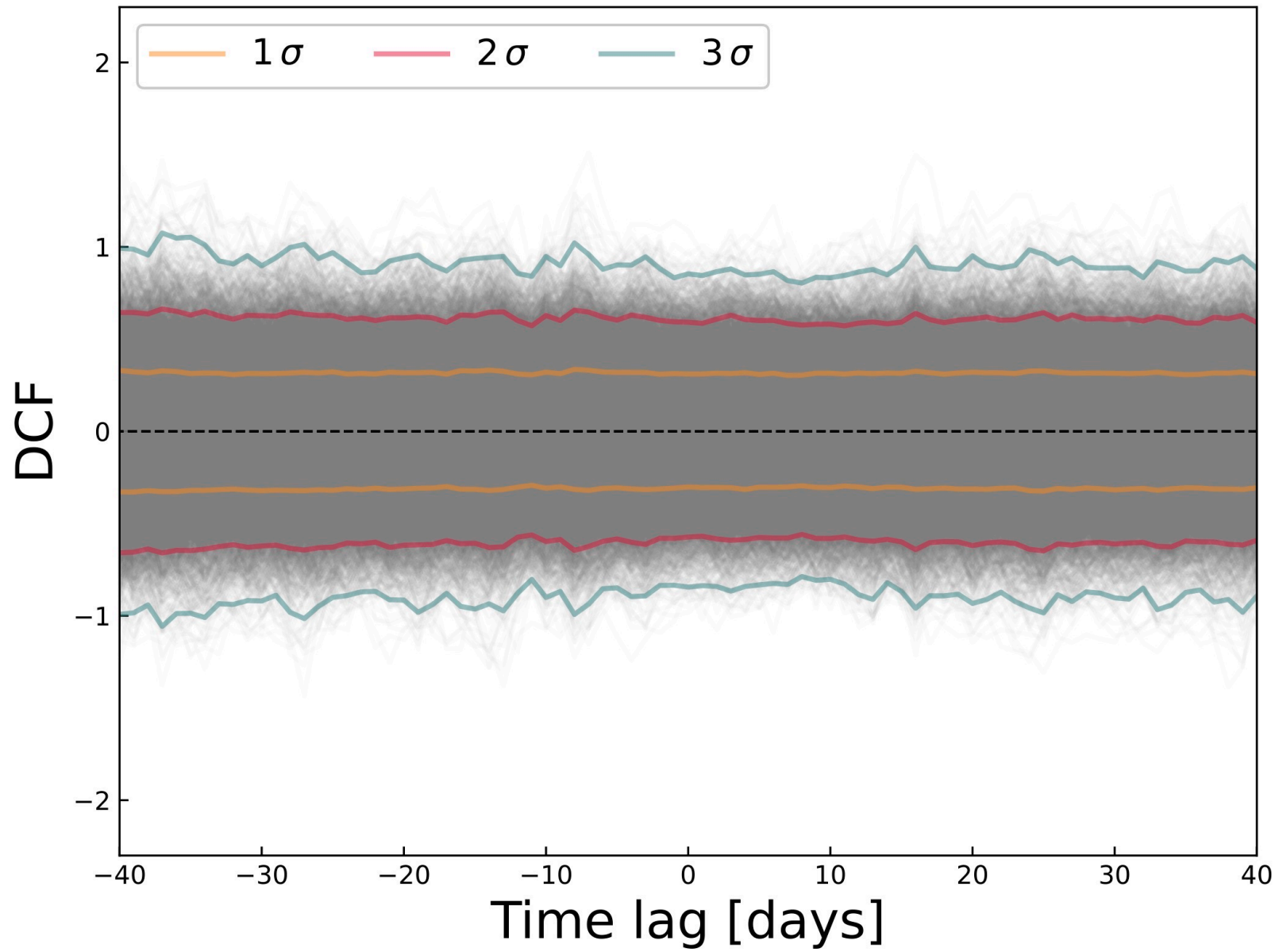


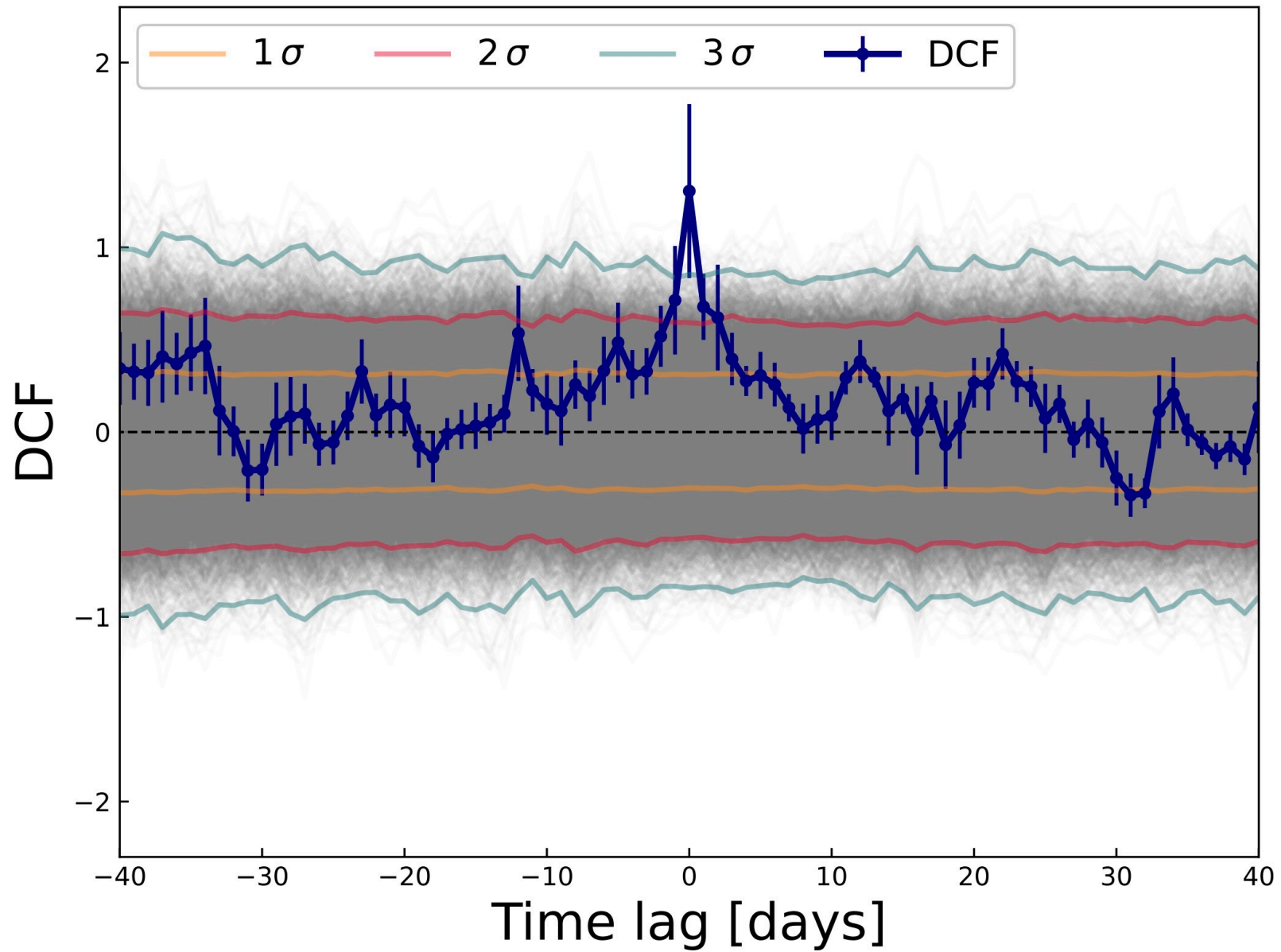
2σ

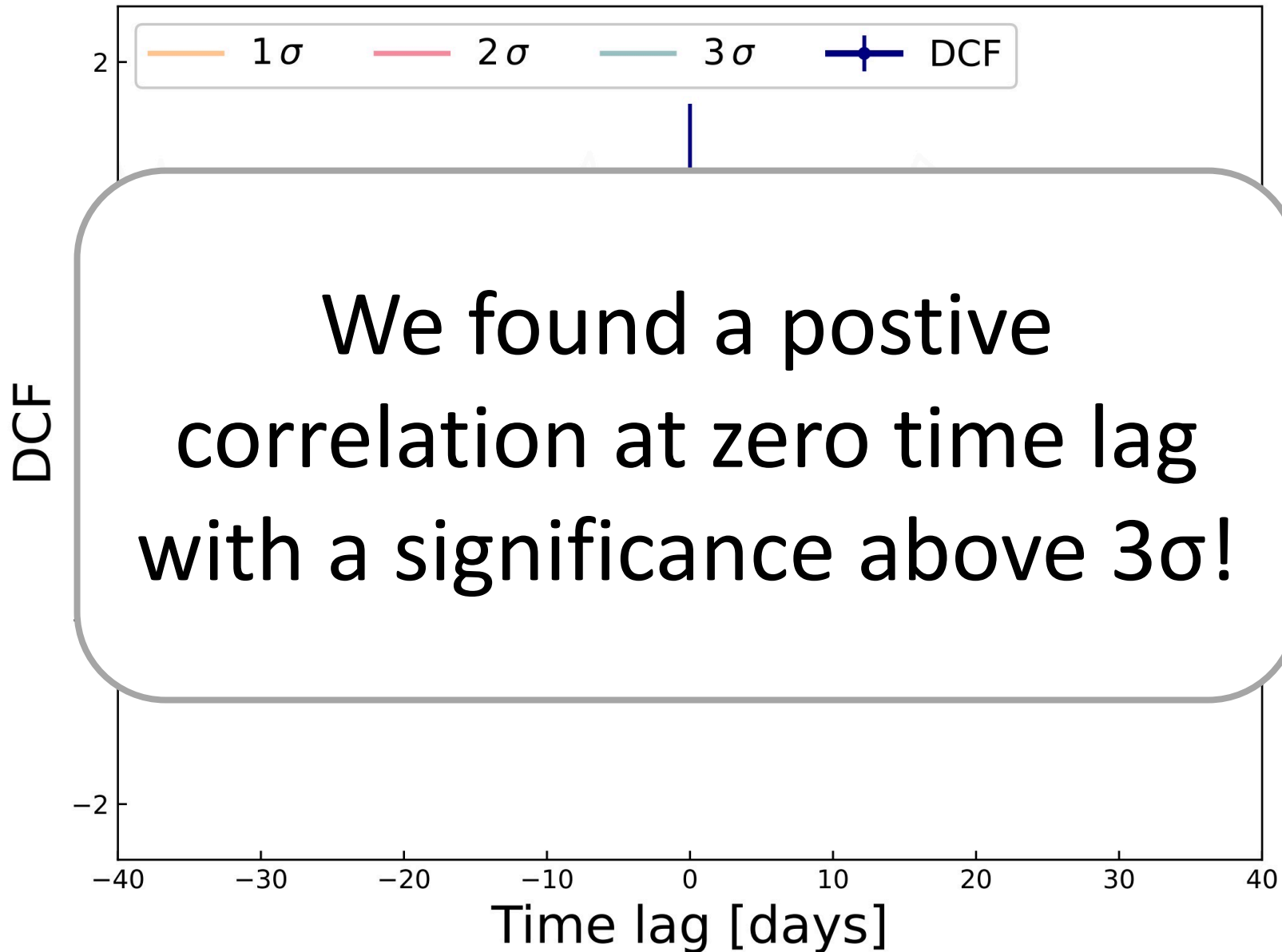


3σ

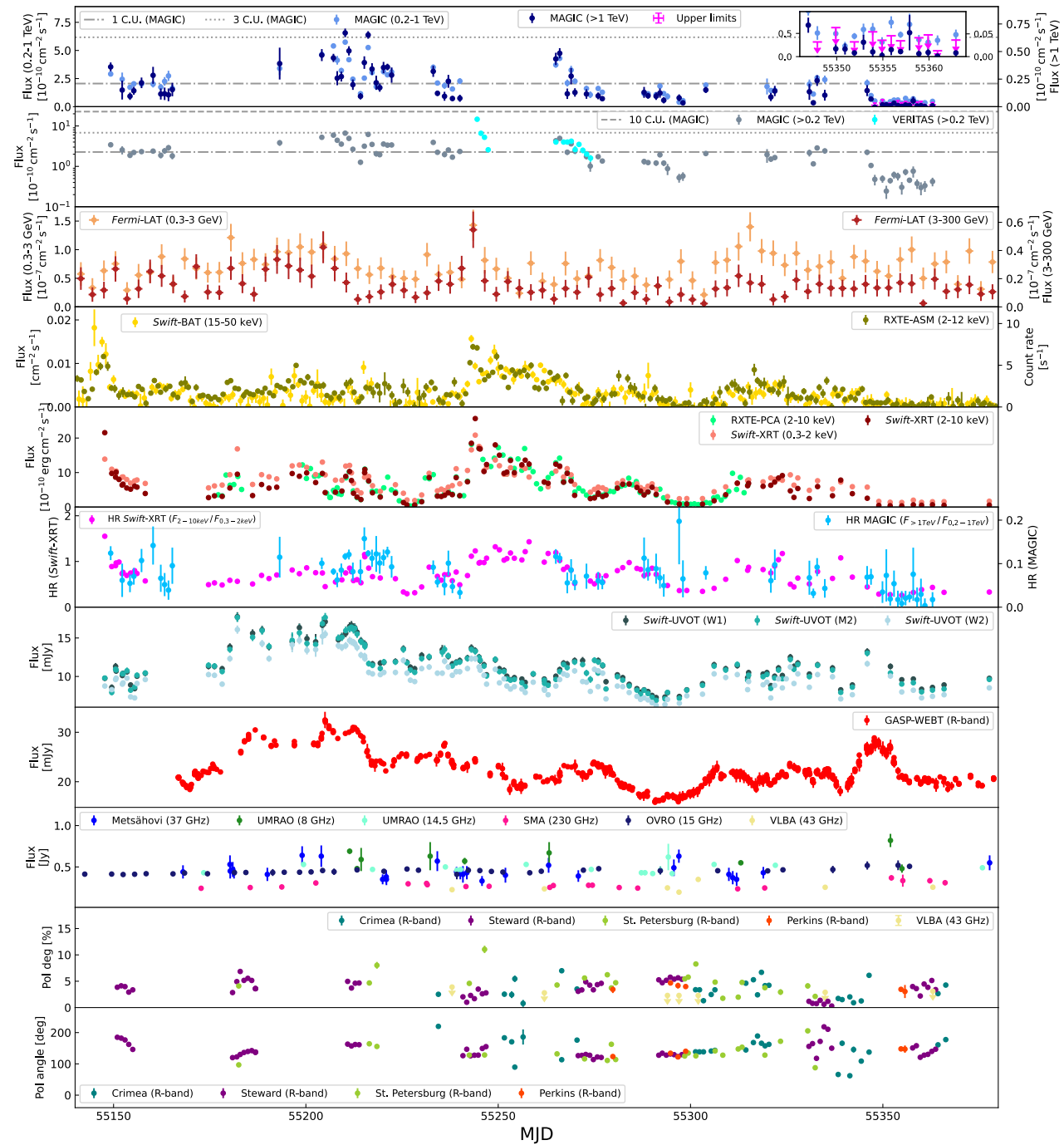


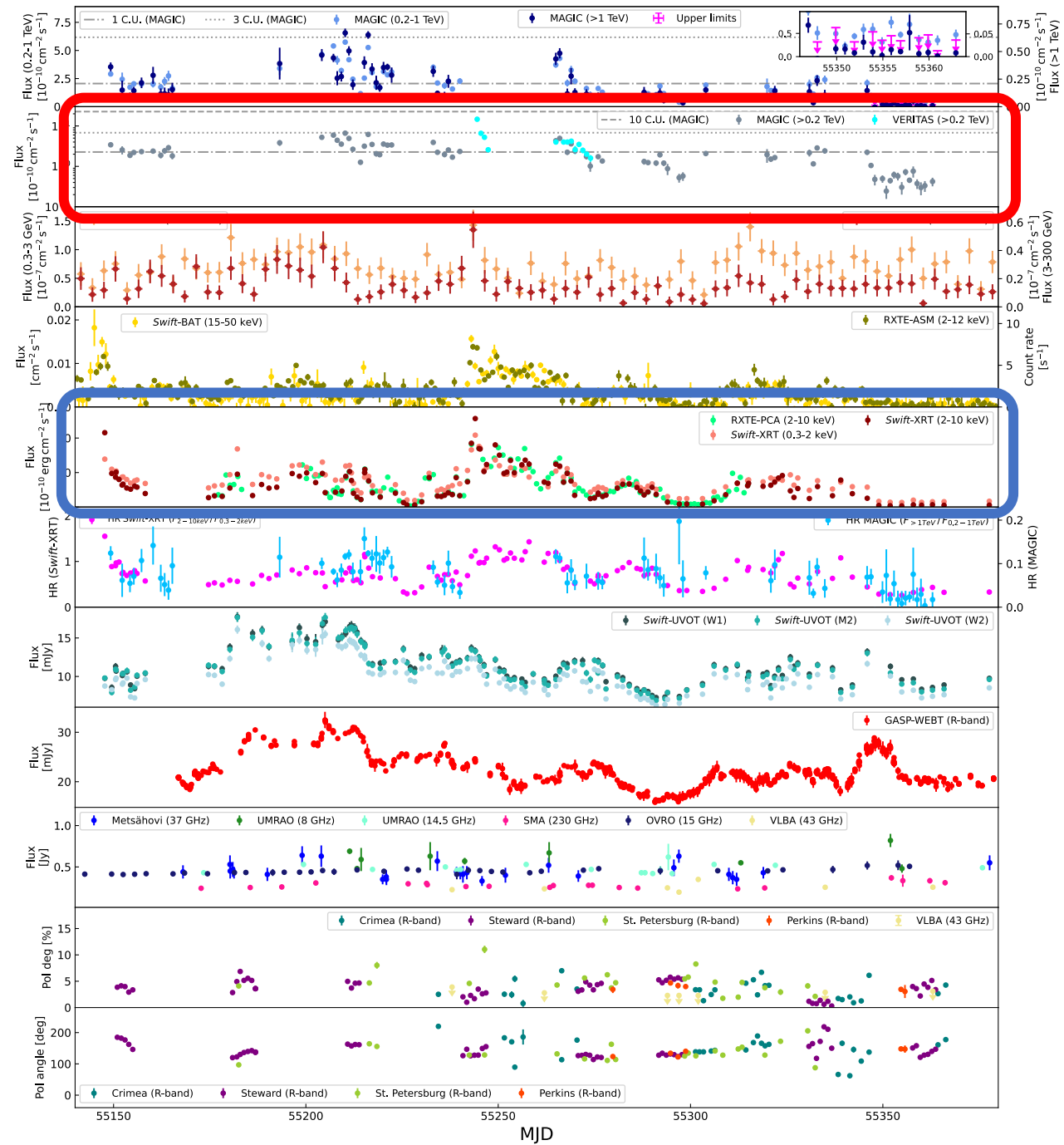






Some final words about my own work...



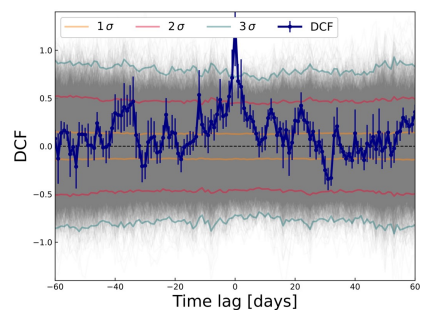
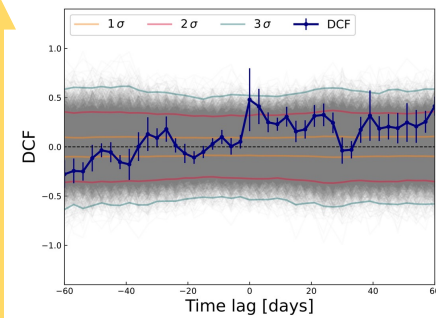
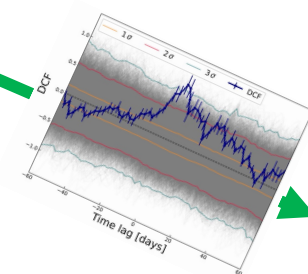
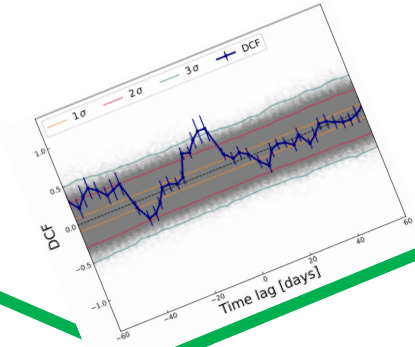
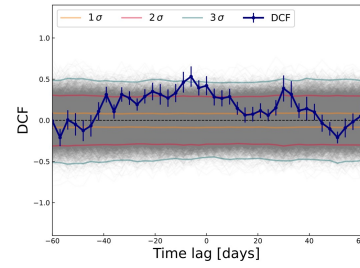
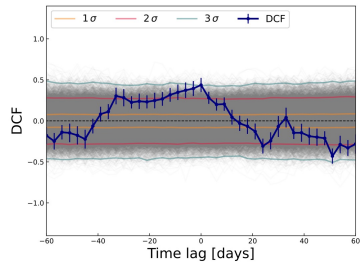


UV

GeV

X-ray

VHE



What mechanisms can produce such correlations?

