X-ray / optical correlations in the transient black hole system KV UMa (J1118+48)

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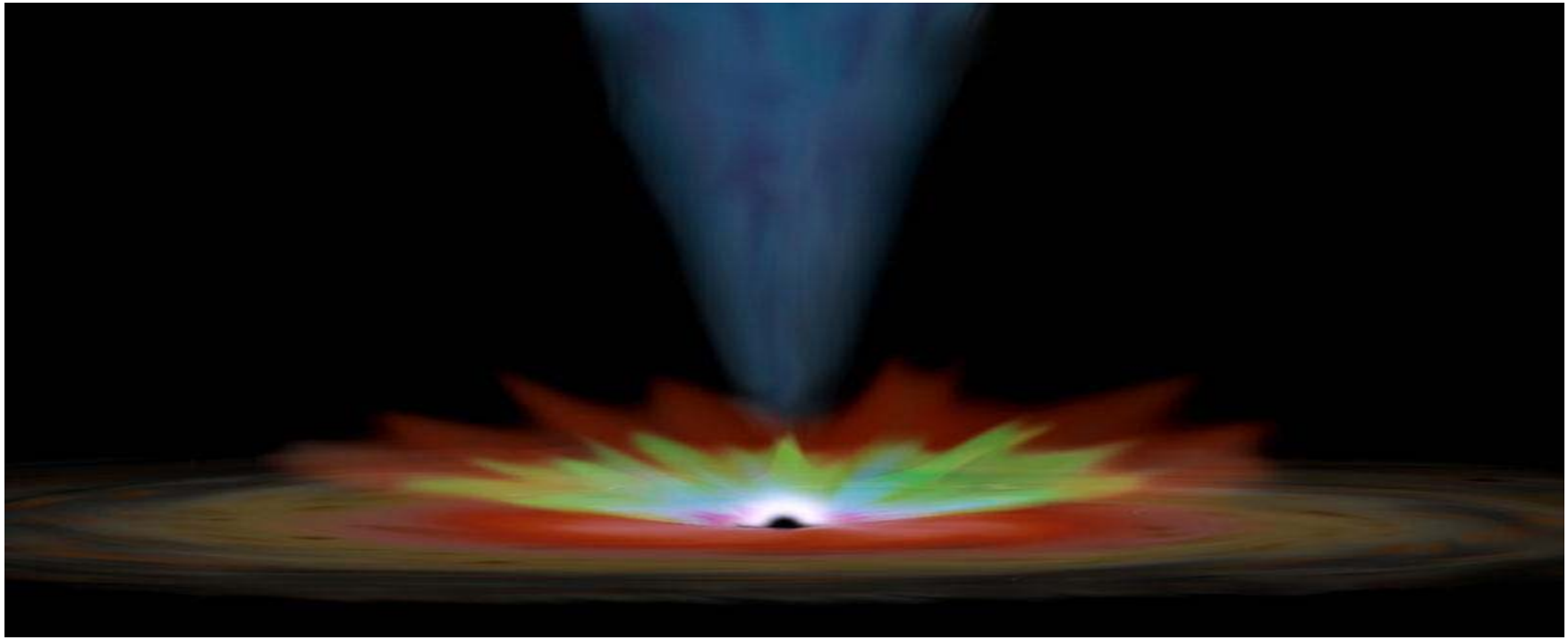
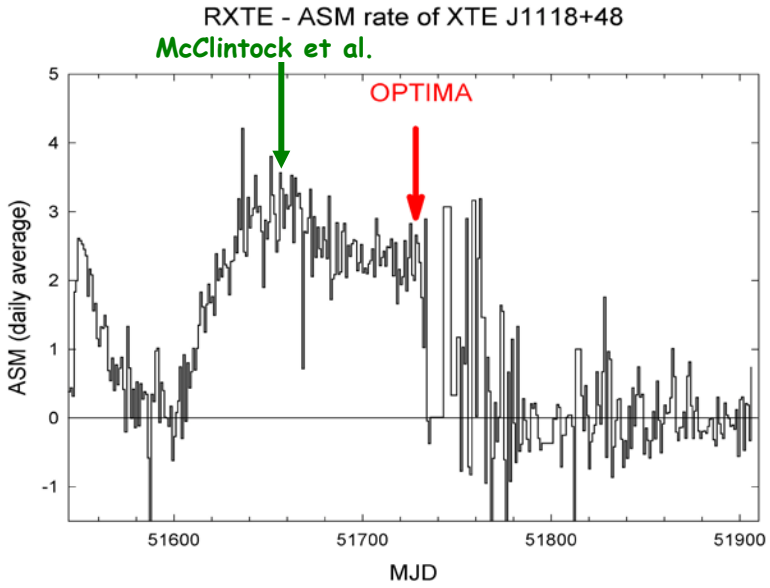
T. Belloni (Oss. di Brera)



The year 2000 transient: XTE J1118+48 (=KV UMa)

- transient X-ray source during Jan – Jul 2000
- nearby object (~ 2 kpc) at high galactic latitude
- estimated mass of compact star > 6 $M_\odot$
- Hard spectral state with high variability
- high optical / X-ray luminosity ratio



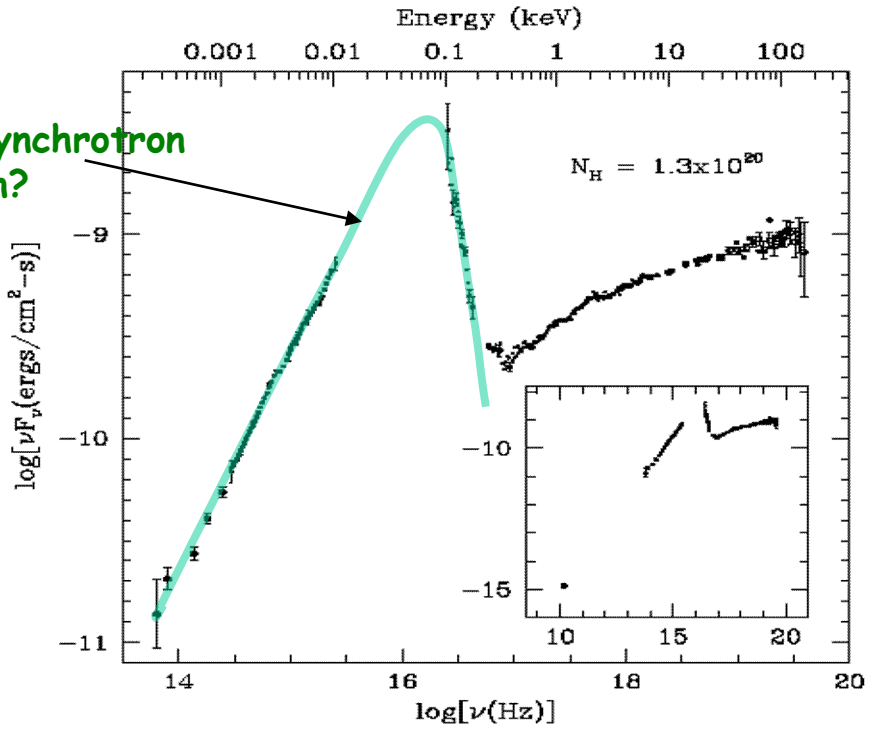
Correlated observations using a RXTE-PCA ToO program and OPTIMA from Skinakas observatory, Crete were carried out during July 4-8, 2000
A total of 2.5 hours of coincident measurements were performed!

(Kanbach, Straubmeier, Spruit, and Belloni, 2001, Nature **414**, 180)

Optical-EUV-X-ray spectrum

XTE J1118+48 (KV UMa)

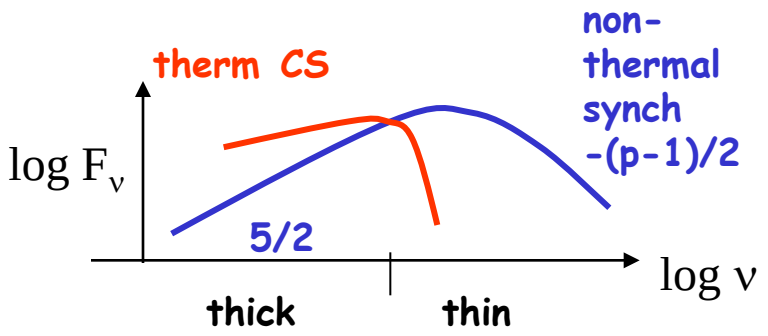
thermal cyclo-synchrotron emission?



$L_{opt-EUV} \sim 10^{36}$ erg $s^{-1} > L_X \Rightarrow$ variable optical radiation can <u>not</u> be reprocessed X-rays

Synchrotron emission?

- steep turn-over of spectrum at EUV is hard to explain with non-thermal synchrotron emission
- a thermal cyclo-synchrotron emission is more likely with $T_e \sim 200$ keV, B~10^6 G, optical thickness up to ~ 100



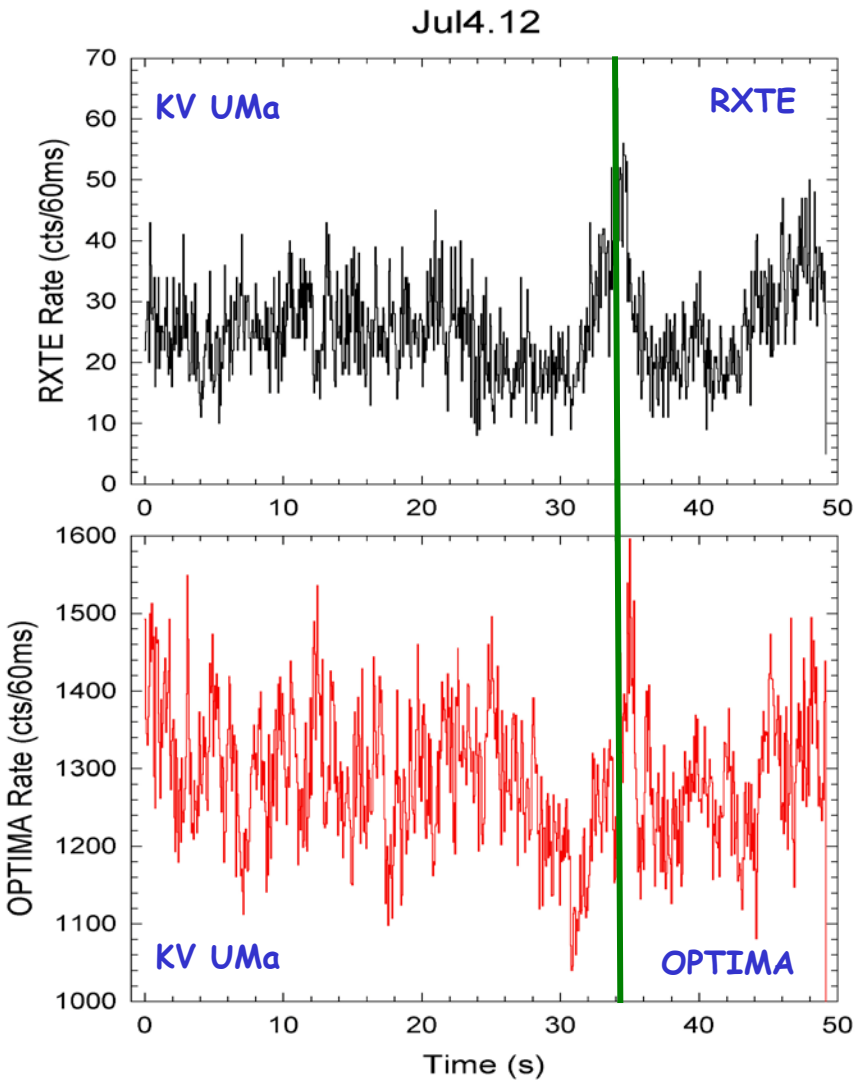
High optical / X-ray luminosity ratio!

Data from April 18, 2000

EUVE data from April 16, 2000

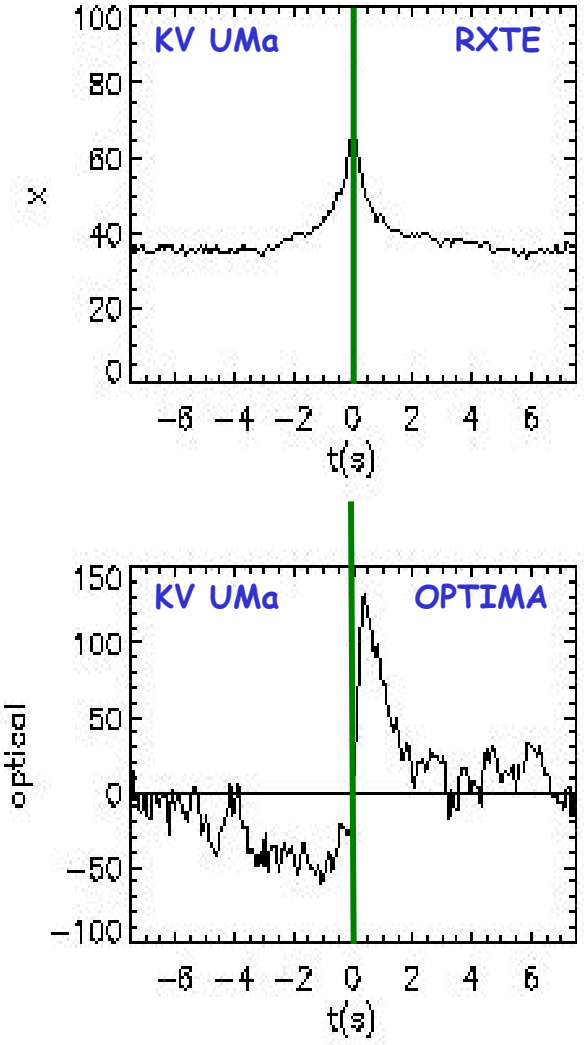
McClintock et al., 2001, ApJ, 555, 477

RXTE and OPTIMA Lightcurves

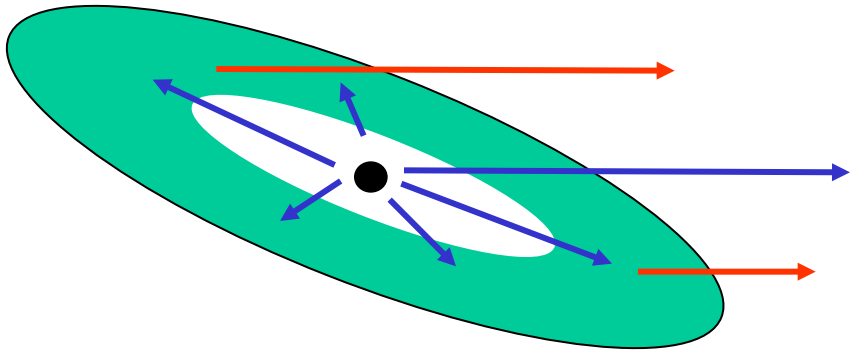


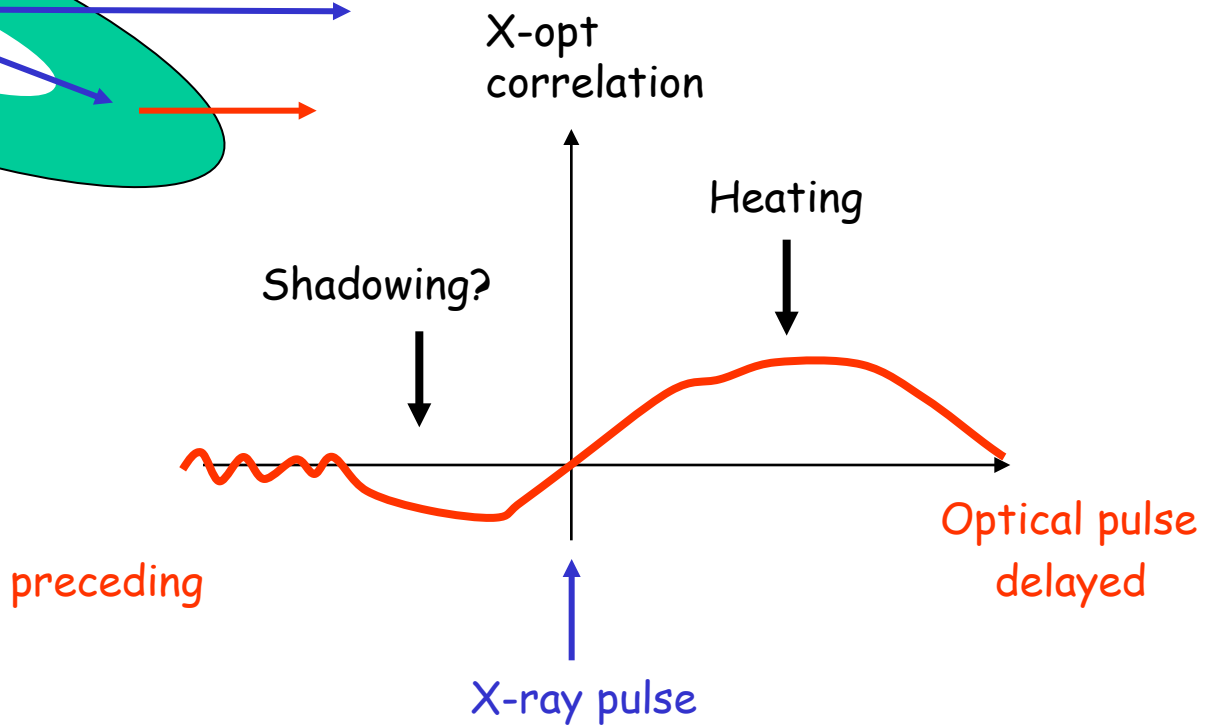
Mean X-Ray and Optical „Flares"

(~100)

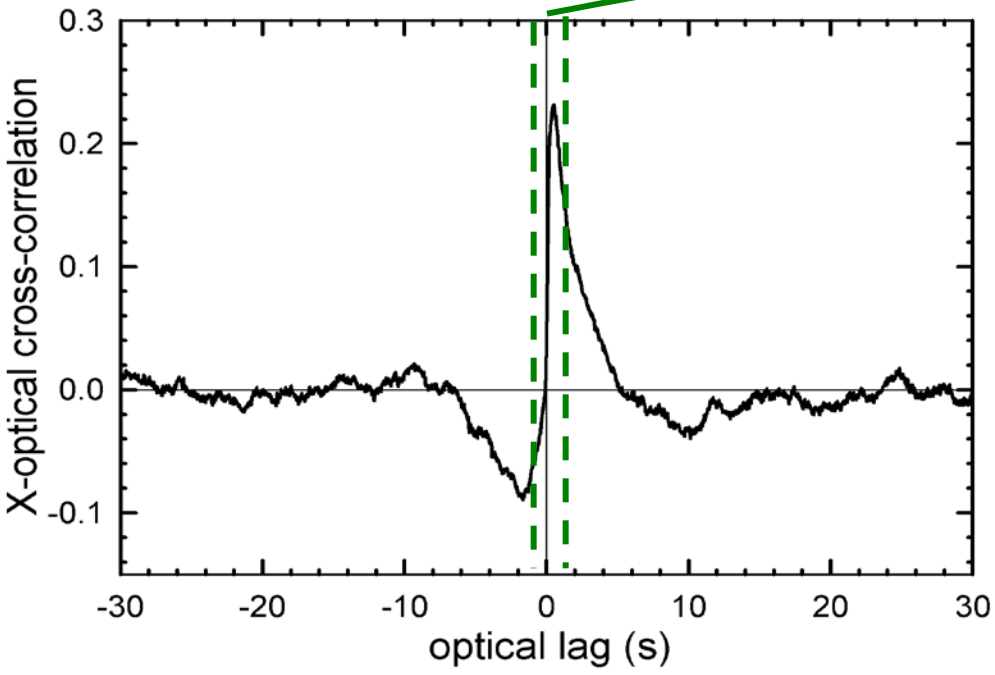


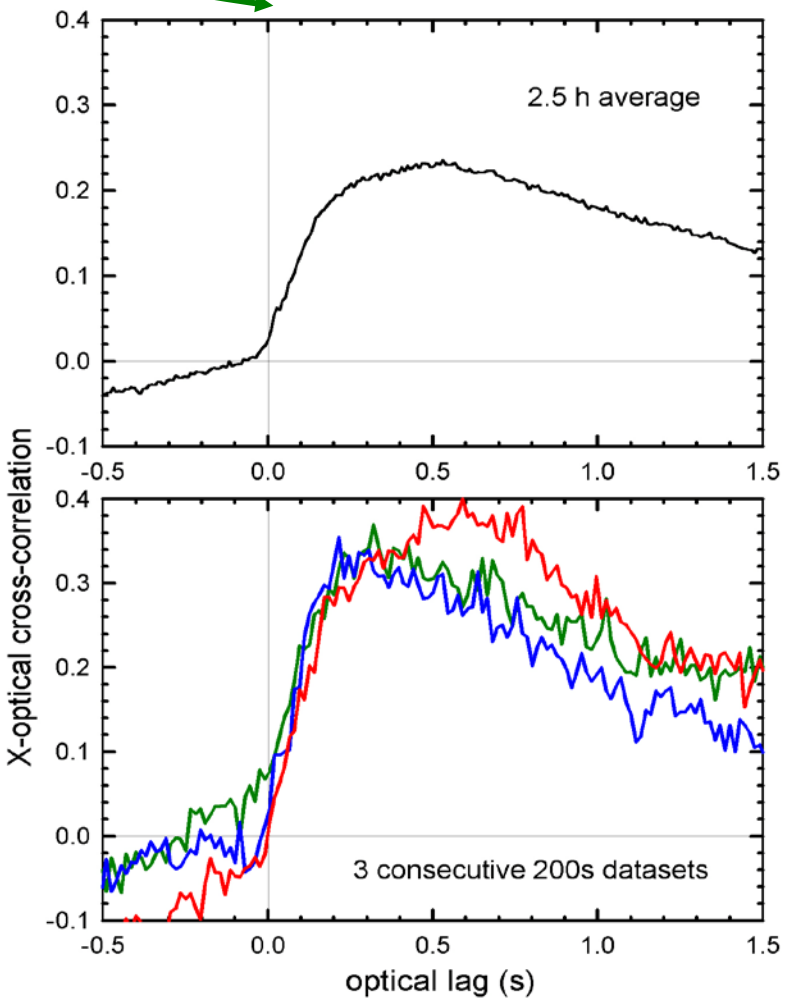
´Reprocessing´ or ´Light-Echoes´





X-ray optical correlations

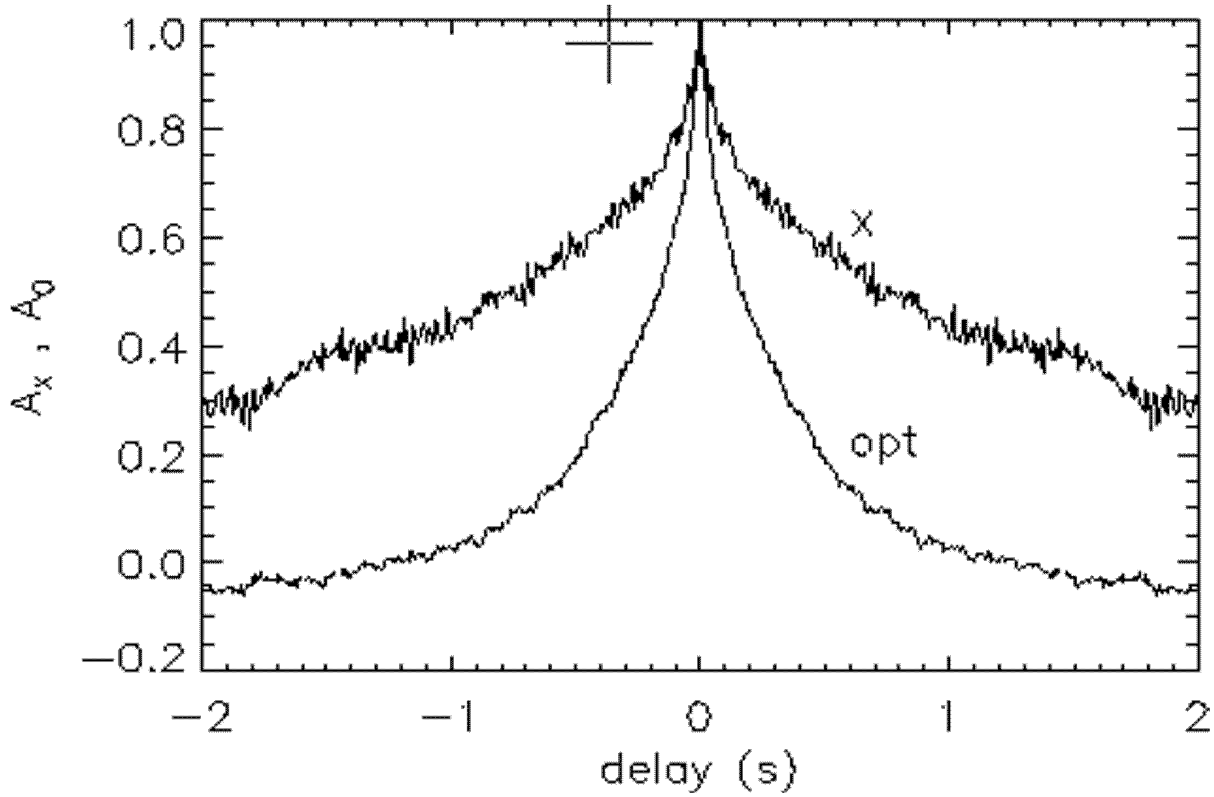




Positive correlation with short rise (~ 100ms)
Maximum at ~ 500 ms; length ~ 5 sec;
onset of sharp rise within 30 ms of
X-ray peak;

Anti-correlation at –2 sec:´precognition dip´

Autocorrelation Functions



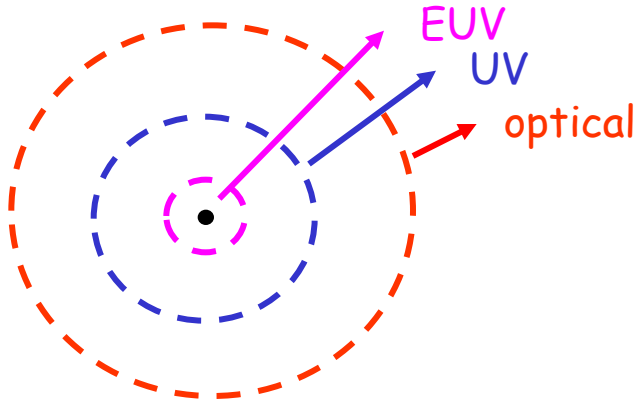
Time scales of the optical emission are much shorter than at X-rays.
This is inconsistent with a reprocessing scheme!

Emission Models:

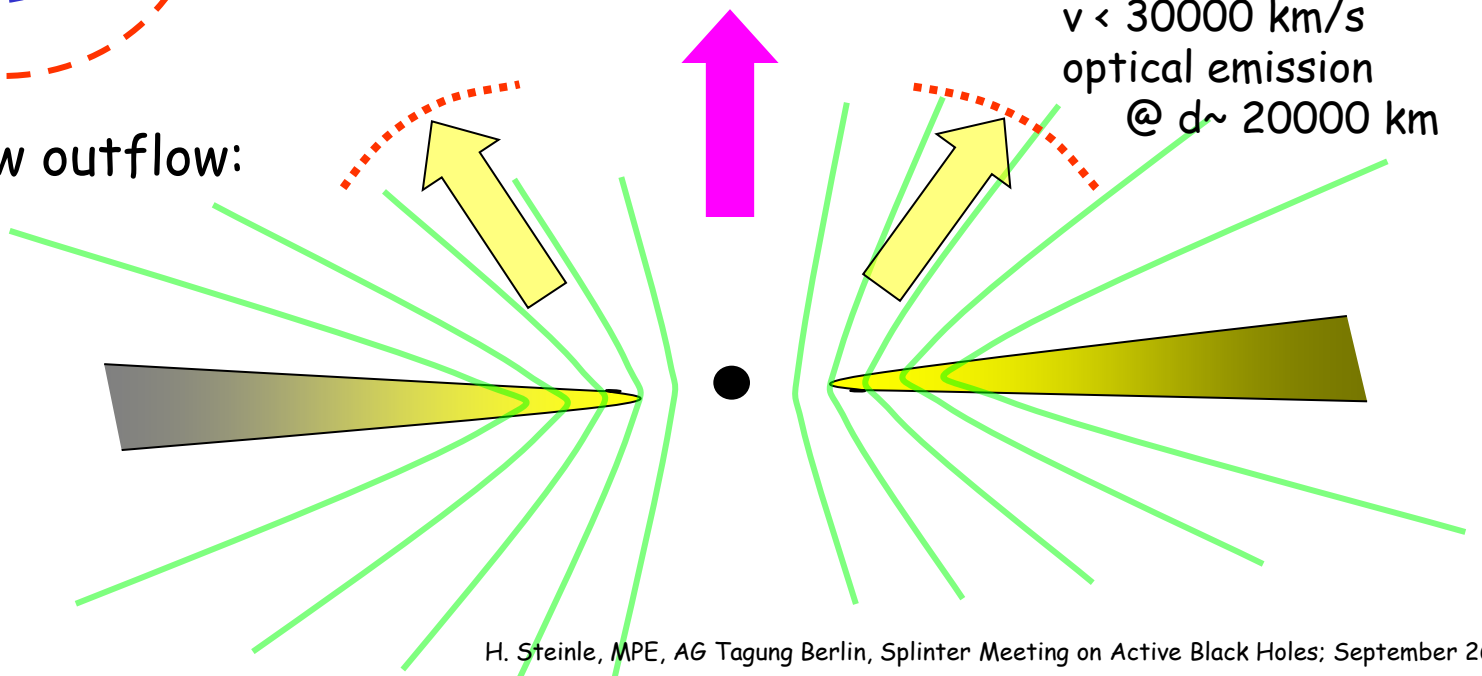
The brightness temperature and the SED indicate that self-absorbed cyclo-synchrotron emission causes the optical signal
The size of the emitting region is < 30,000 km

A ´quasi spherical´ slow outflow crossing photospheric surfaces:

EUV @ 10^7- 10^8 G
optical @ 10^6 G, r=20000 km



A ´jet-like´ slow outflow:

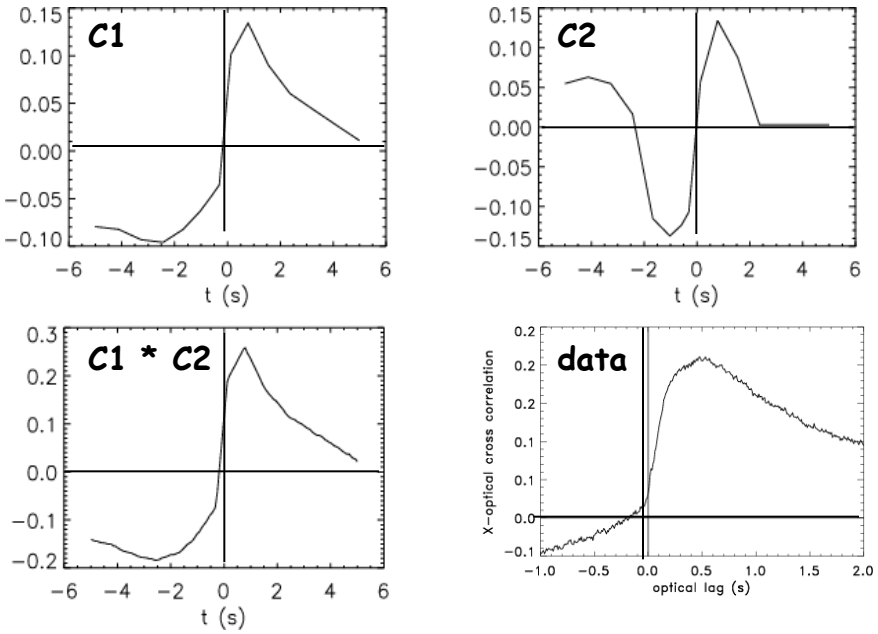


New Analysis

Principal Components Analysis

(Spruit & Kanbach A&A **391**, 225-233, 2002)

Analysis of 250 events +/- 100 s_ results in 2 independent components:



➡ no time-of-flight effect? both dip and peak are properties of optical light

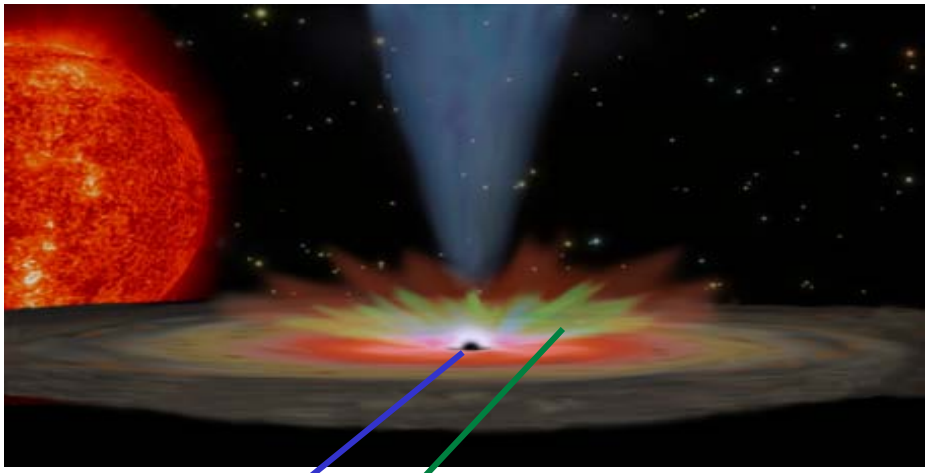
Shot Analysis

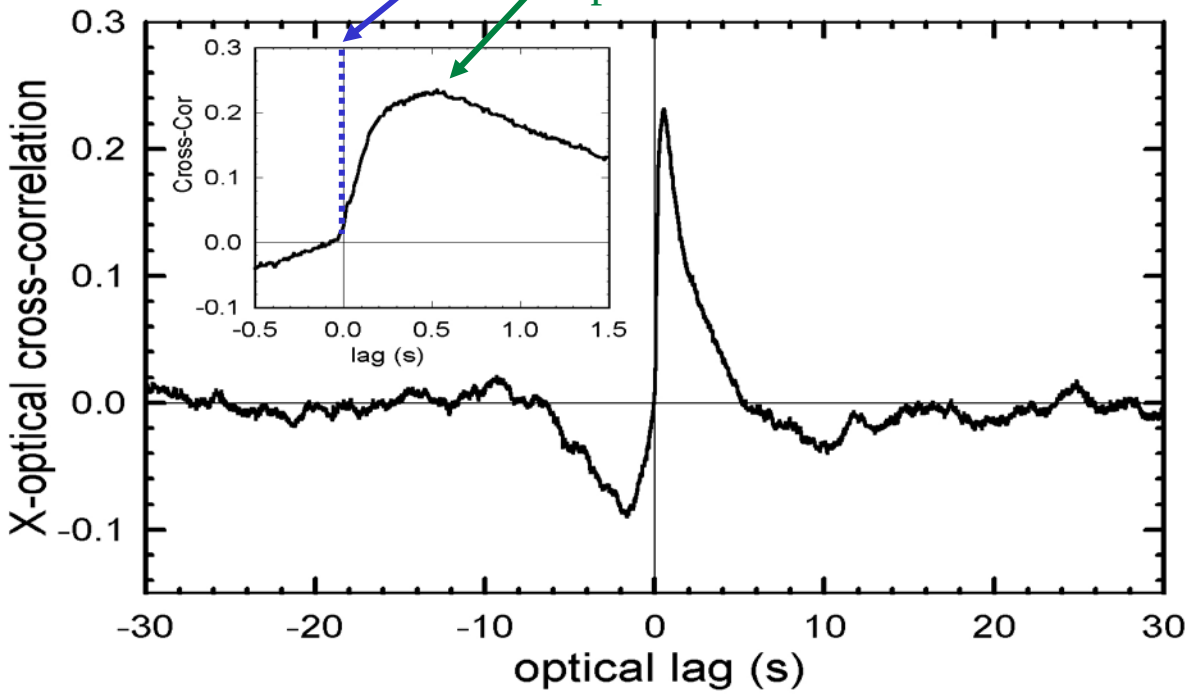
(Malzac et al. Proc. Cargese WS „Black Holes", 2002)

- analysis of different (RXTE) X-ray spectral bands
  - ➡ events similar in all spectral bands **and** correlated with optical; anticorrelation of X-ray flux and hardnes ratio
- separate analysis of strong and weak events (shots)
  - ➡ events similar

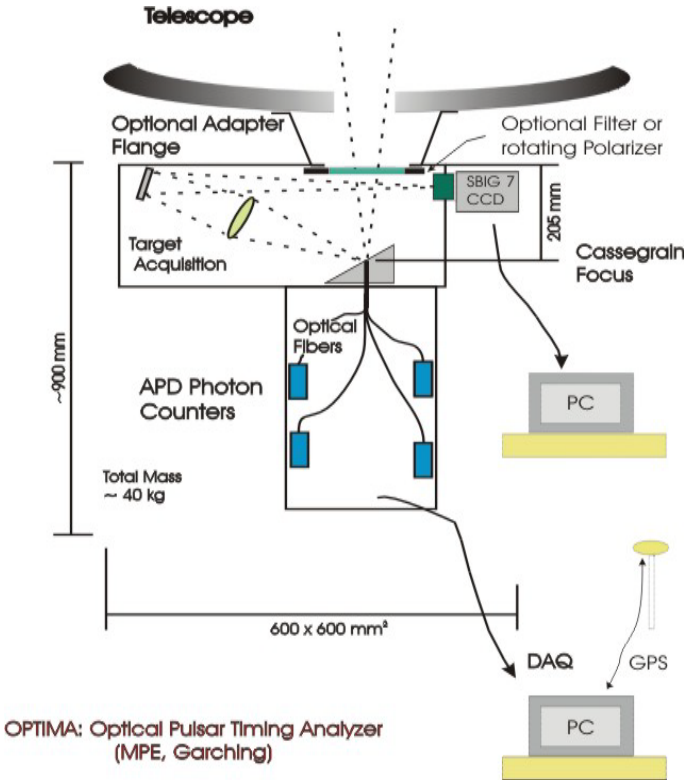
➡ Conclusion:
one emission process that creates X-ray and optical emission. Similar structure on different time scales.

Optical emission from slow outflow





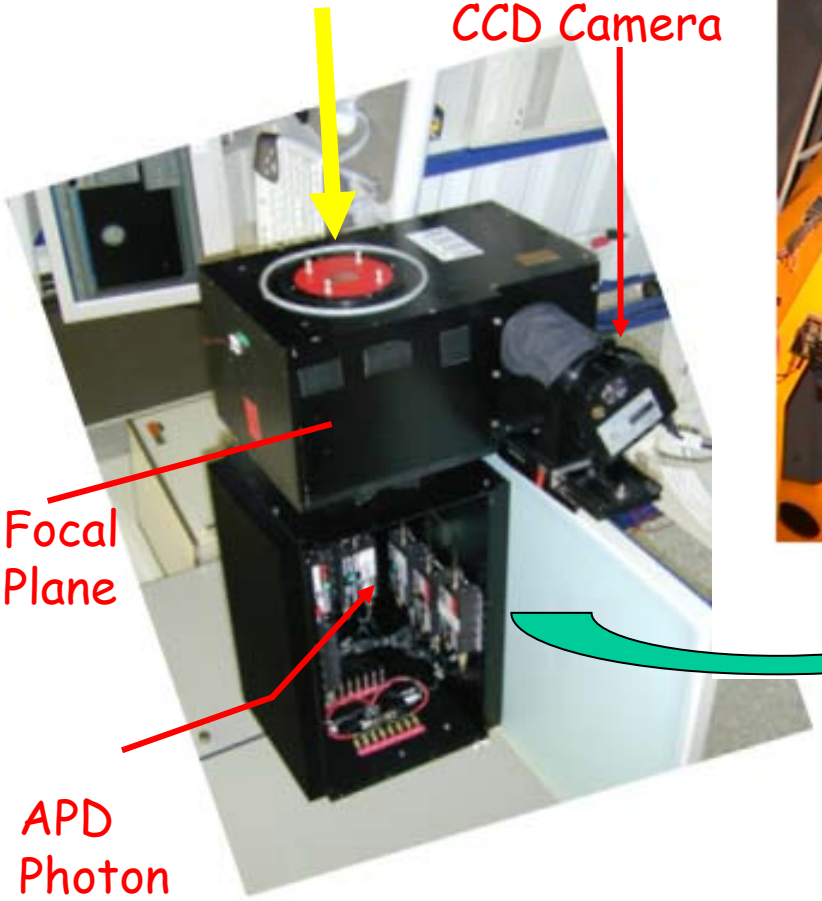
The OPTIMA photometer



APD:
high Q.E. ~60%
(450-950 nm)

Timing with GPS
~ 2 μs

Standby Mode



OPTIMA @
1.3m Skinakas

Origin of Optical-EUV spectrum (continuum with weak lines)

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