"From microquasars to quasars"

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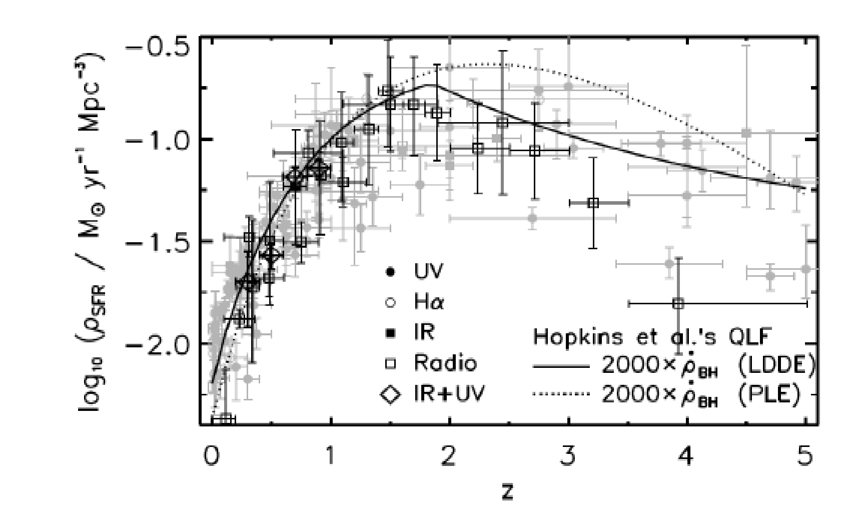
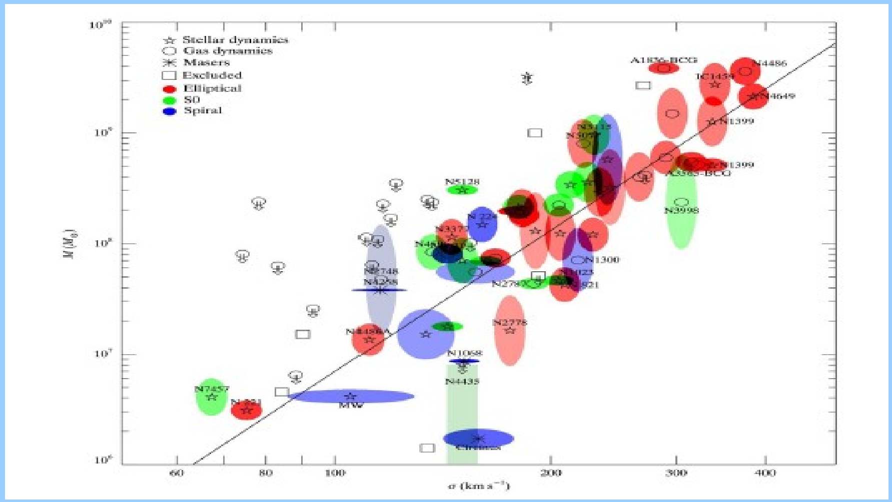
Importance of the subject:

Quasars are important for
- understanding of galaxy formation (feedback; star formation, element enrichments etc.)



Zheng et al. 2009



Gultekin 2009

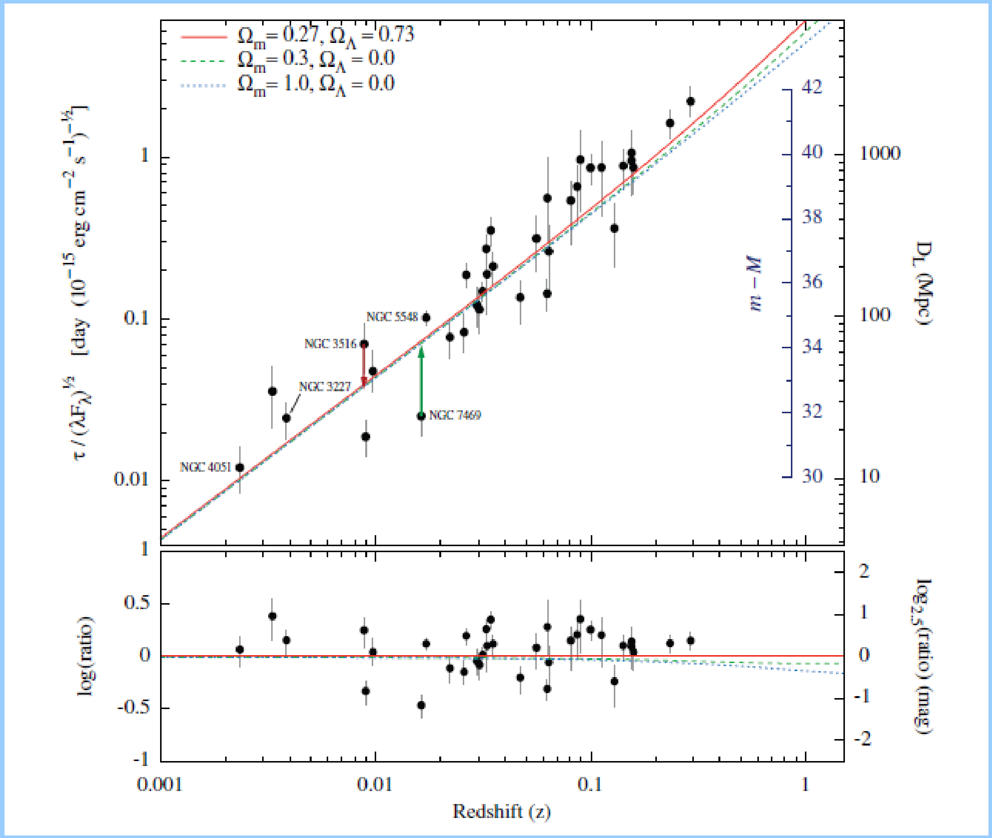
The coupling likely happens through mechanical **feedback** – outflow in radio-loud and radio-quiet AGN. Understanding of wind mechanisms opens a possibility to model the outflow from an accretion disk at all radii, and later to estimate its feedback on the whole galaxy.

Importance of the subject:

Watson et al. 2011

$$\log R_{BLR}[H\beta] = 1.538 \pm 0.027 + 0.5 \log L_{44,5100},$$

Quasars are important for
- galaxy formation
- can be used as complementary proble for dark energy



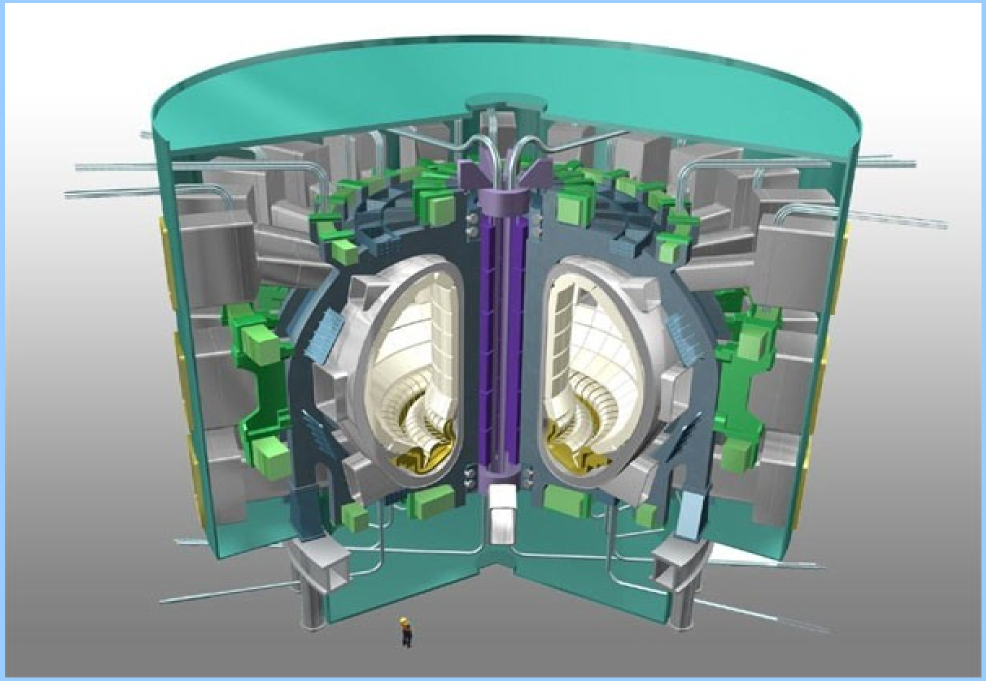
SALT telescope

Since even the high redshift quasars have the same metallicity and dust properties, there should not be a strong evolutionary effect involved

Importance of the subject:

Quasars are important for
- understanding of galaxy formation
- as probe for dark energy

Microquasars are small scale analogs of quasars, and both are important for
- testing GR in strong gravity limit
- understanding of the plasma in extreme conditions (jet formation)



Thermonuclear plant is still a dream...

A view of the International Thermonuclear Experimental Reactor (ITER), showing its main components, with a person for size reference. One of the pilot applications running in Ibercivis is devoted to ITER simulations. Image courtesy of ITER

Importance of the subject:

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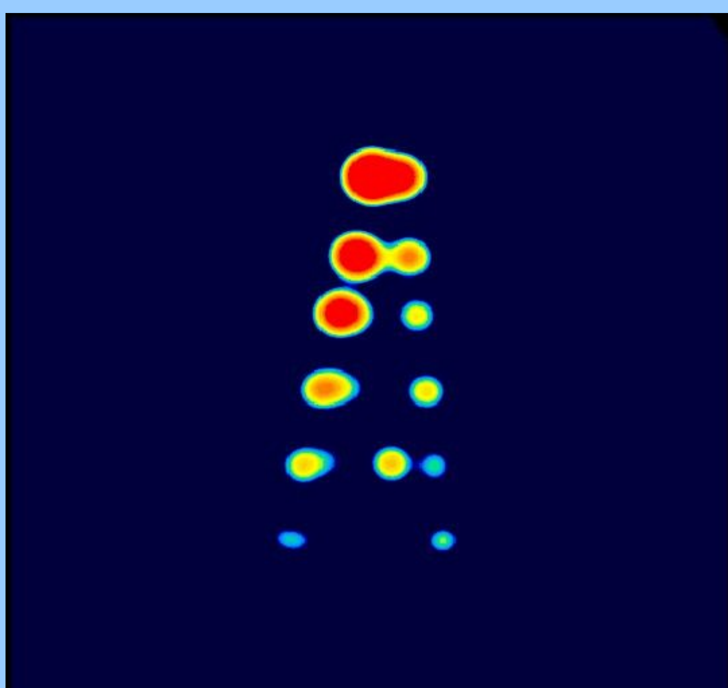
The two types of objetcts must be used together since both types offer unique insight into the physics of accretion, and provide an opportuninty of complementary studies.

But we have to understand what we are doing...

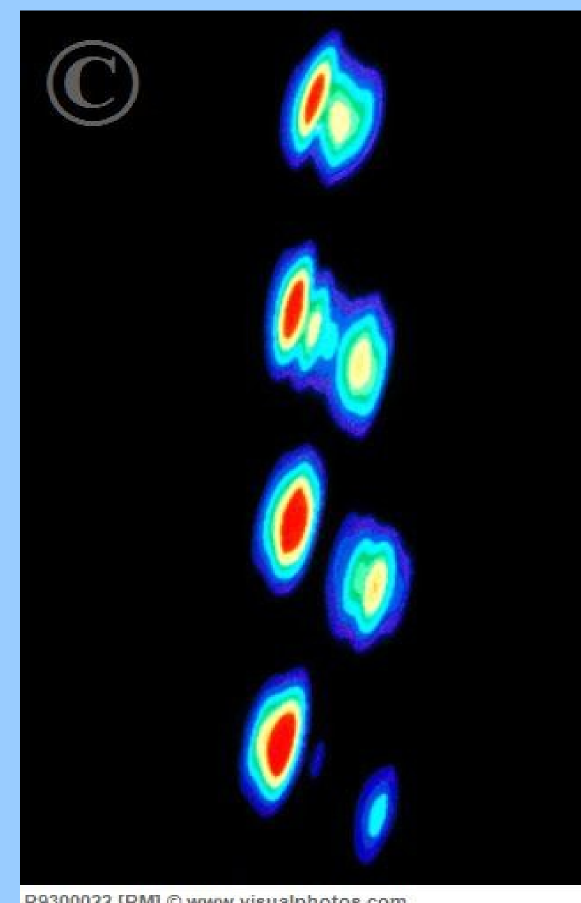
Microquasars vs. quasars

Both types of objects:

- contain black holes
- are powered by accretion
- accretion flow forms a disk
- accretion is accompanied by an outflow in the form of a jet
- jet velocities are relativistic
- VLBI images show superluminal motion



So they are actually the same!



Well, are they ?

Two dogs

Which one is actually larger and more heavy?

Two dogs

Chihuahua dog, weight 1 – 2 kg

Spitz: weight 20 – 30 kg

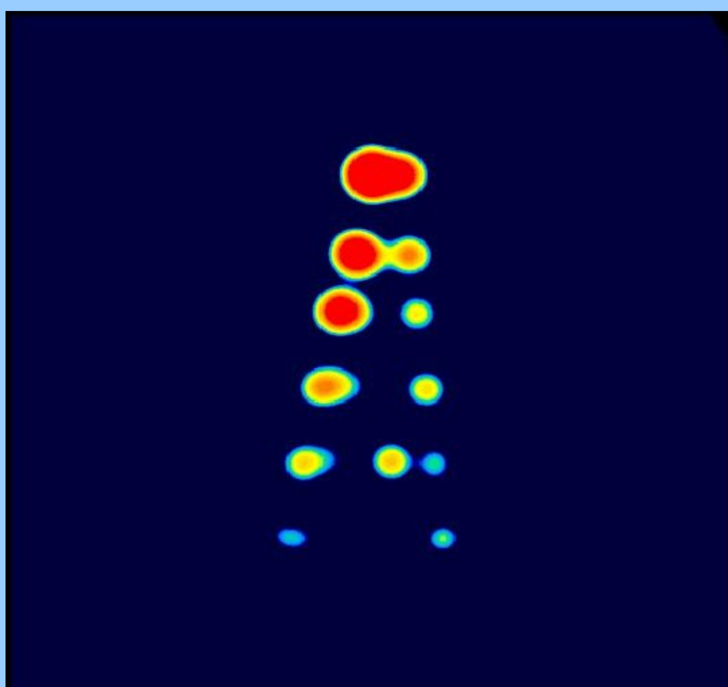
3C 273 and GRS 1915+105

GRS 1915+105
Microquasar
Low mass X-ray binary

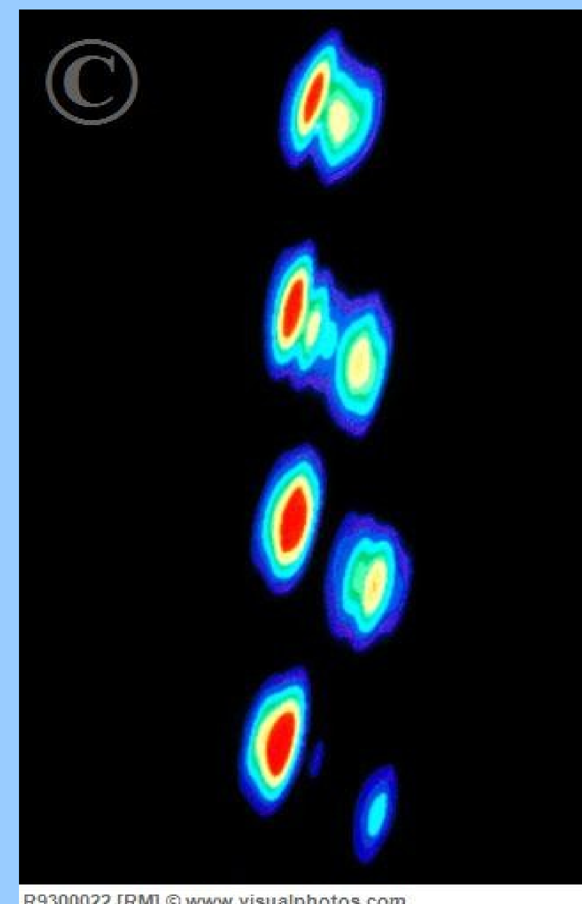
MBH = 14 Ms

3C 273
Quasar, z = 0.158

MBH = 8.8e8 Ms (reverberation; Peterson et al. 2004)



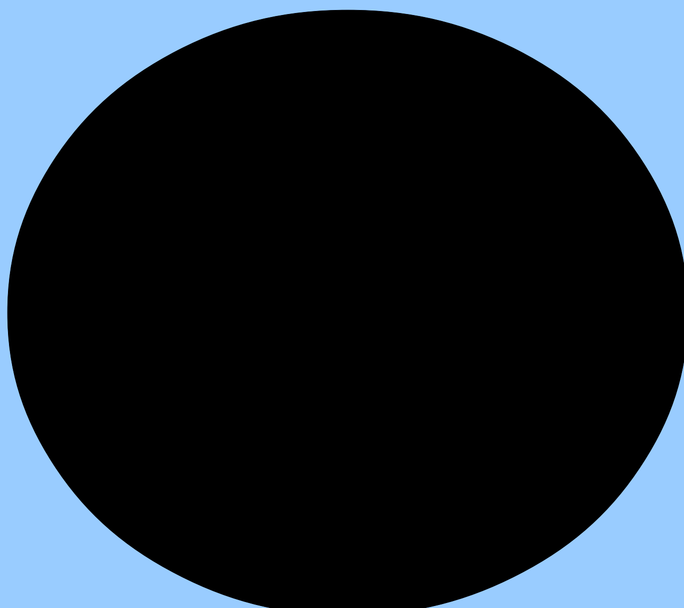
VLBI
radio
images



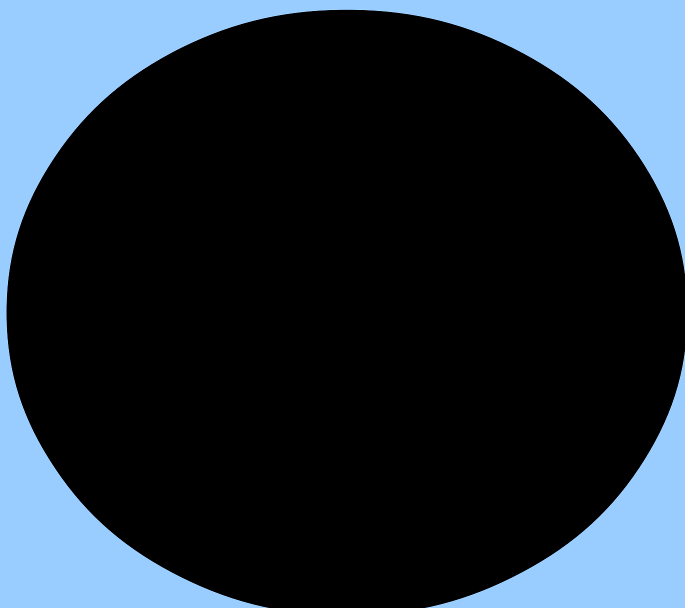
The mass ratio: 6×10^7 !

Black holes

MBH = 14 Ms



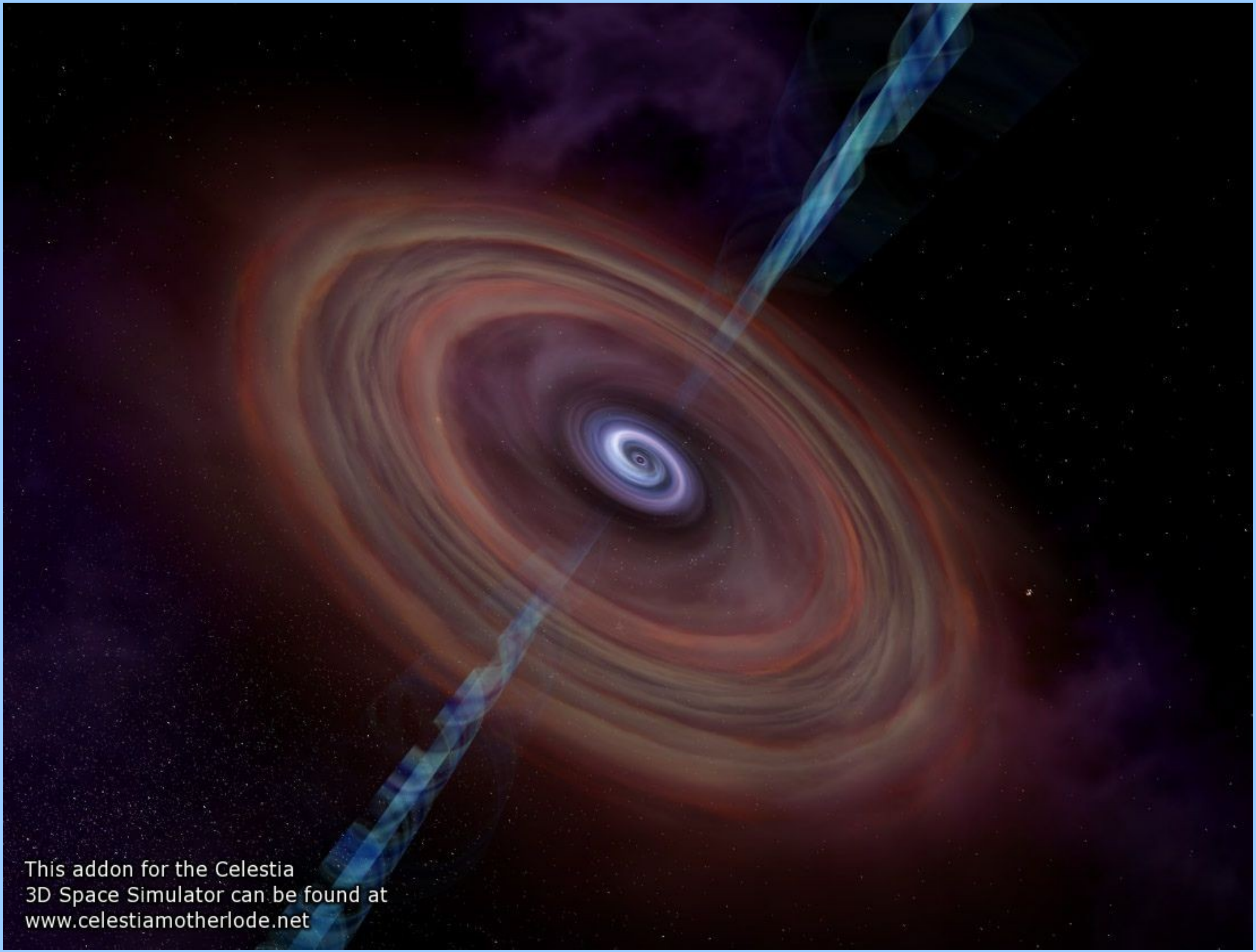
M = M_{BH} = 8.8e8 Ms



They look the same if I do not sktech the real size in cm. But the real timescale is by a factor **6×10^7 !** different. The timescale for all processes is also different by the same factor:

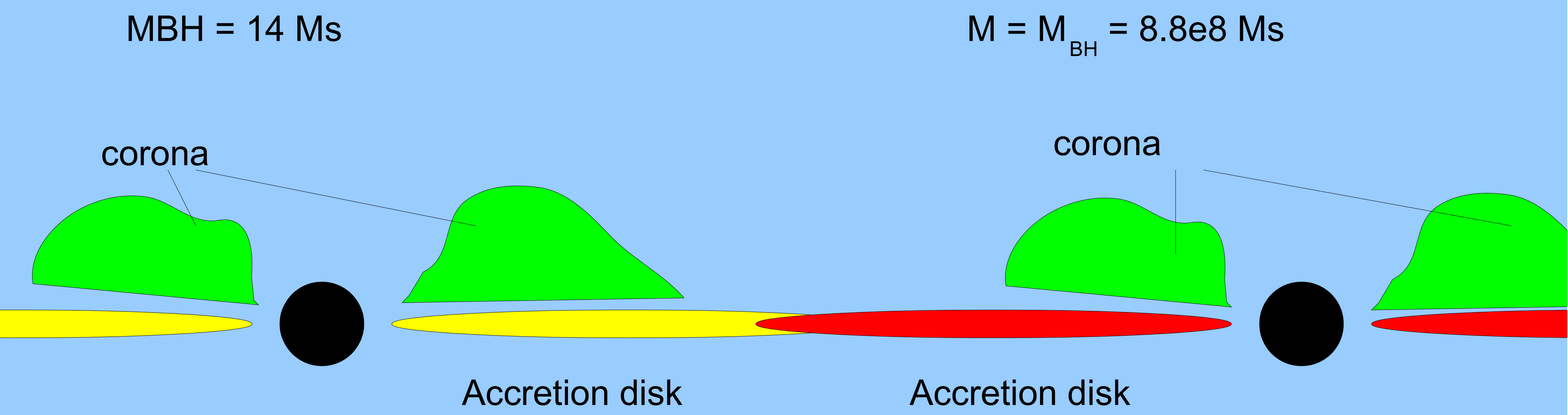
10 seconds in the life of GRS 1915+105 corresponds to 20 years of life of 3C 273!

Black hole surrounding



From this figure you cannot easily tell a microquasar from a quasar but...

Black hole surrounding



Accretion disk temperature T = 1.e7 K

Emission in X-rays

Accretion disk temperature T = 1.e5 K

Emission in opt/UV

The temperature of the hot plasma is the same, as it refers roughly to the virial temperature, with some diminishing factor due to more efficient cooling of electrons

The temperature of the cold optically thick disk depends on the black hole mass, scales as $M_{BH}^{1/4}$, for the maximum accretion rate given by the Eddington limit for luminosity (Shakura & Sunyeav 1973)

Scaling of the disk temperature with black hole mass

An approach of a mathematician:

If a disk is spherically symmetric, then it hs a radius of a black hole horizon

$R_{schw} \sim M_{BH}$
Surface = $4 \pi R_{schw}^2 \sim M_{BH}^2$
Luminosity $\sim M_{BH}$ (if Eddington luminosity)

And since Luminosity = $4 \pi R_{schw}^2 \sigma T_{eff}^4$

Effective temperature $\sim (M_{BH}/M_{BH}^2)^{1/4} \sim M_{BH}^{1/4}$

Knowing the obvious differences we can now attempt a comparison...

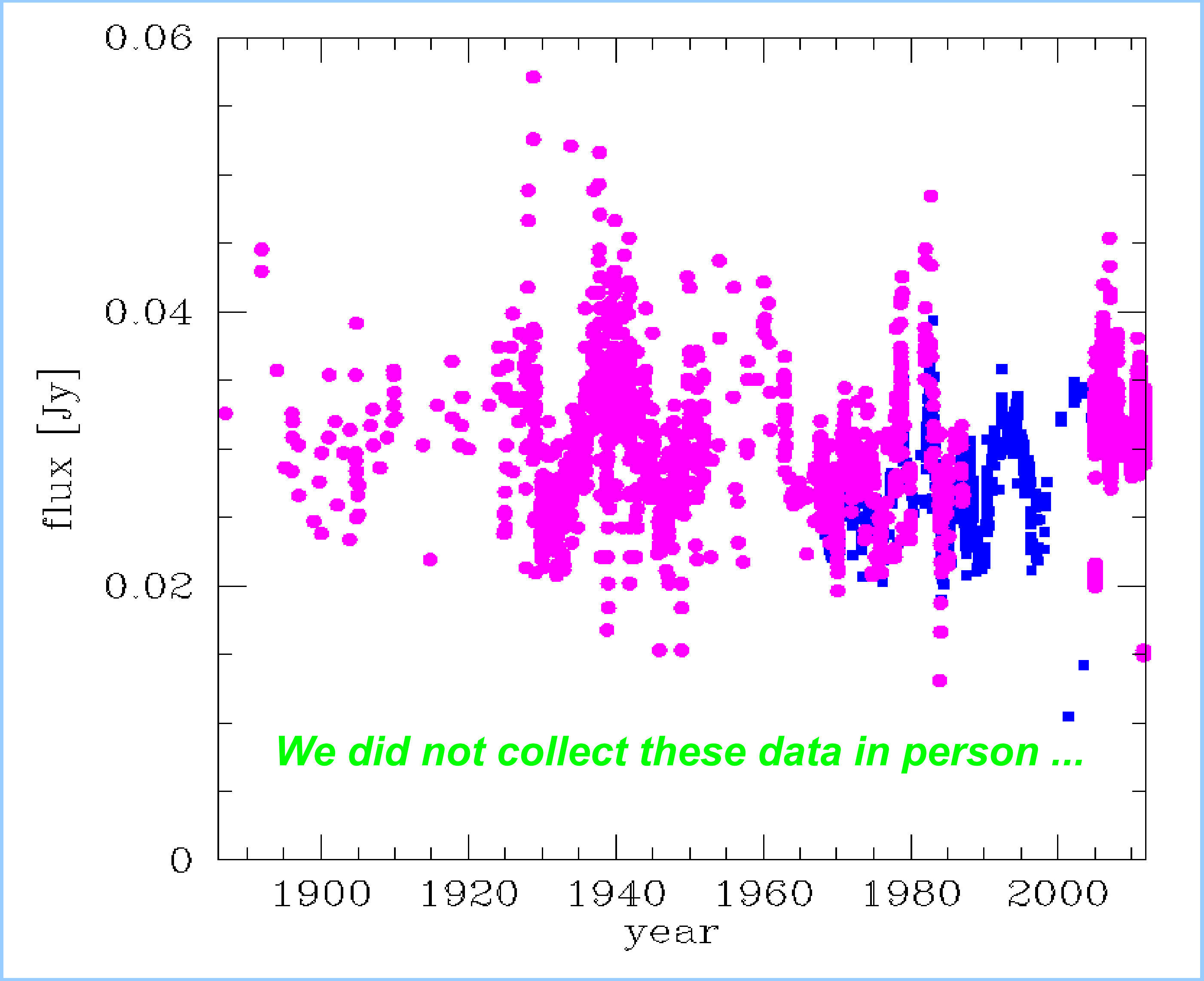
20 years of 3C 273 - 10 seconds of GRS 1915+105

Optical/UV of 3C 273 - soft X-rays of GRS 1915+105

X-rays of 3C 273 - hard X-rays of GRS 1915+105

Problem of the data: we should take the longest possible data for an AGN – it will be still the small fraction of the lightcurve of a galactic source. On the other hand the best samplling of an AGN (100 s in X-rays, 30 minutes in optical for Kepler data) should be matched by microsecond resolution for galactic source...

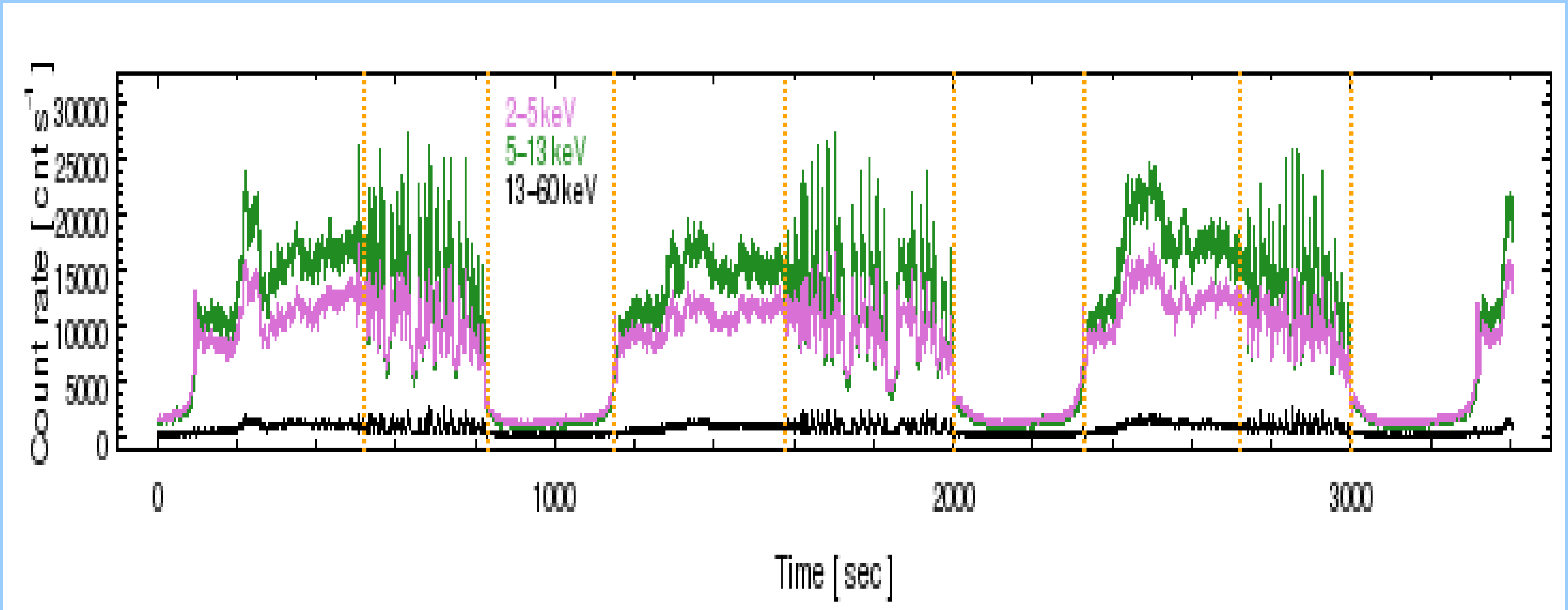
Optical data for 3C 273



Over 100 years of historical data, older data from plates, newer data from recent monitoring (Blue points from Courvoisier et al.)

That should be matched by 70 seconds of GRS 1915+105

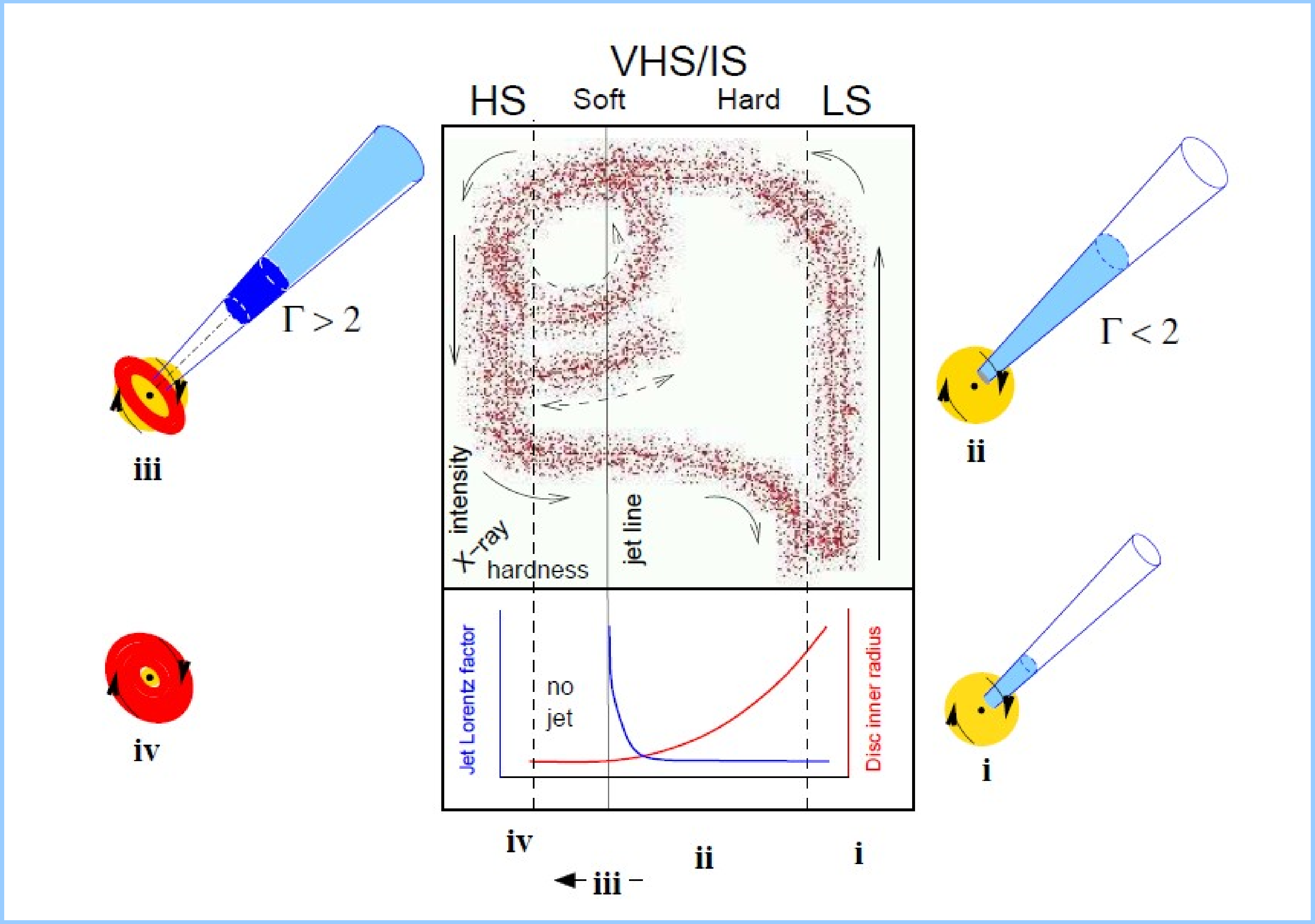
GRS 1915+105 data



Which 70 seconds to take ??? !!!!

And this is only a small ffragment of the available data; in other periods the source looks quite different....

States in the galactic sources



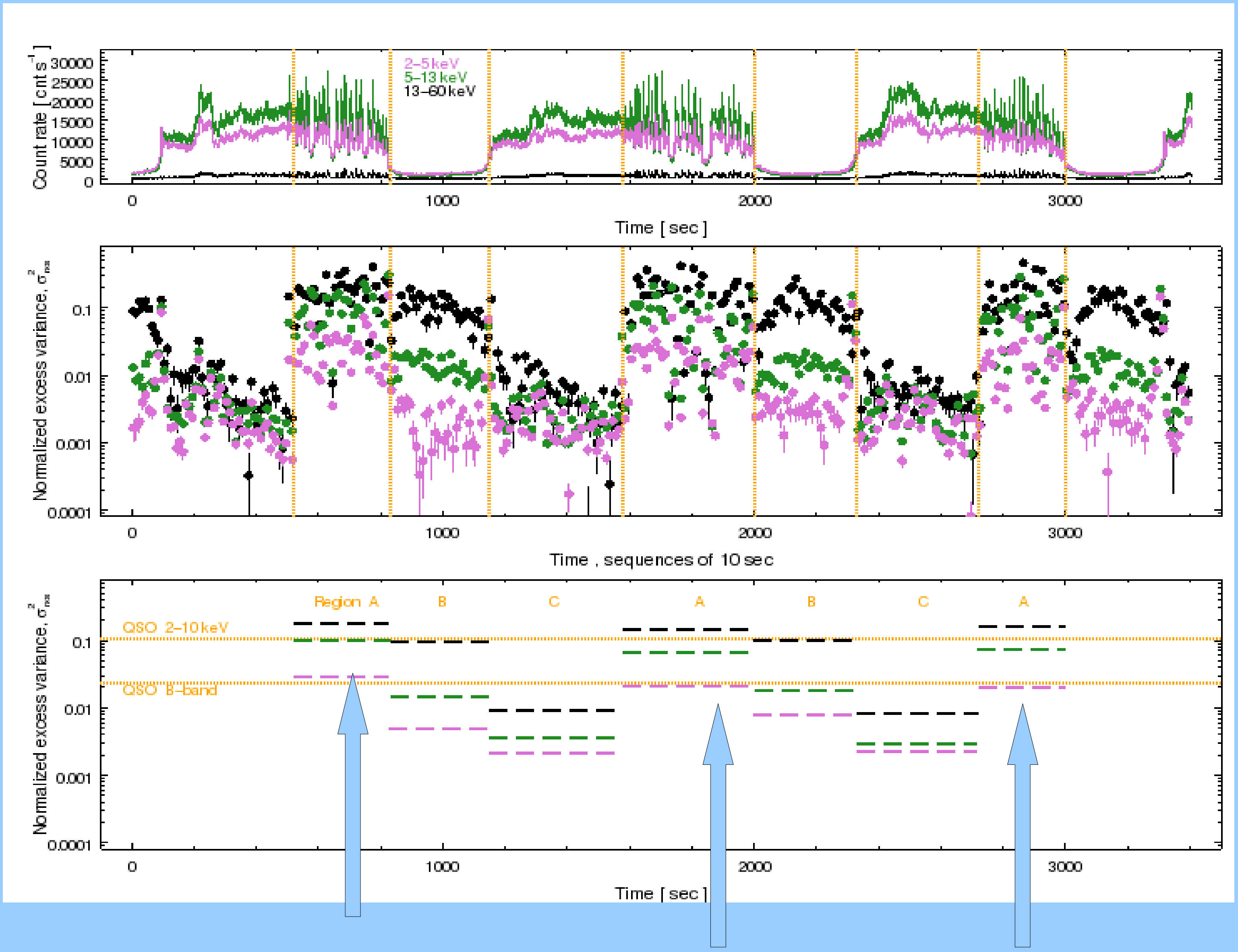
From Fender, Belloni & Gallo 2004

Any AGN corresponds just a snapshot from this picture

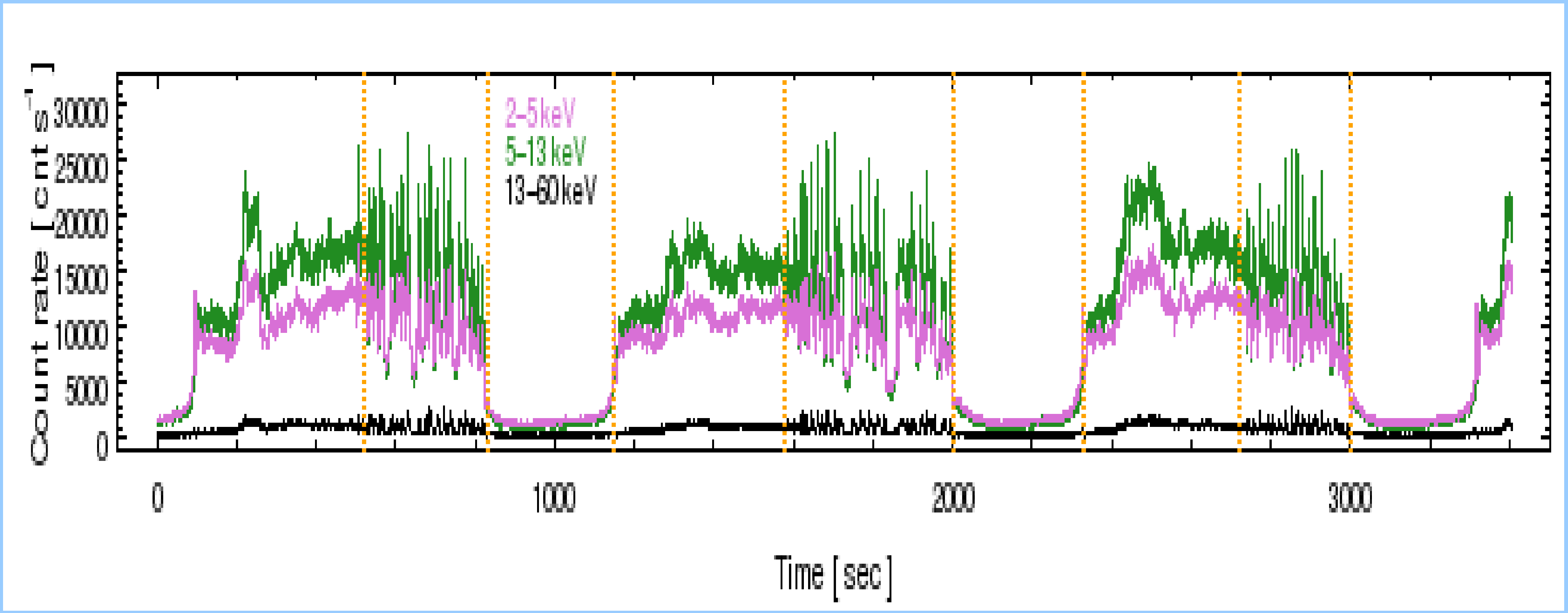
Our current approach:

We determined the normalized variance in 20 year bin for the available data for 3C 273 and we separately calculate the same variance for various 10 s bins for GRS 1915+105

Some of the substates of this general *lambda state* are promising



3C 273 phase based on GRS 1915+105 view



GRS 1915+105 outburst:
- in general active phase lasts over 30 years
- here each of the 1000 s outbursts are likely due to radiation pressure instability
- at the end of a single 1000 s outburst we have several rapid aperiodic oscillations; they happen every 10 seconds or so.

This stage likely corresponds to 3C 273 with its blob ejections!

Ejection of superluminal blobs in 3C 273

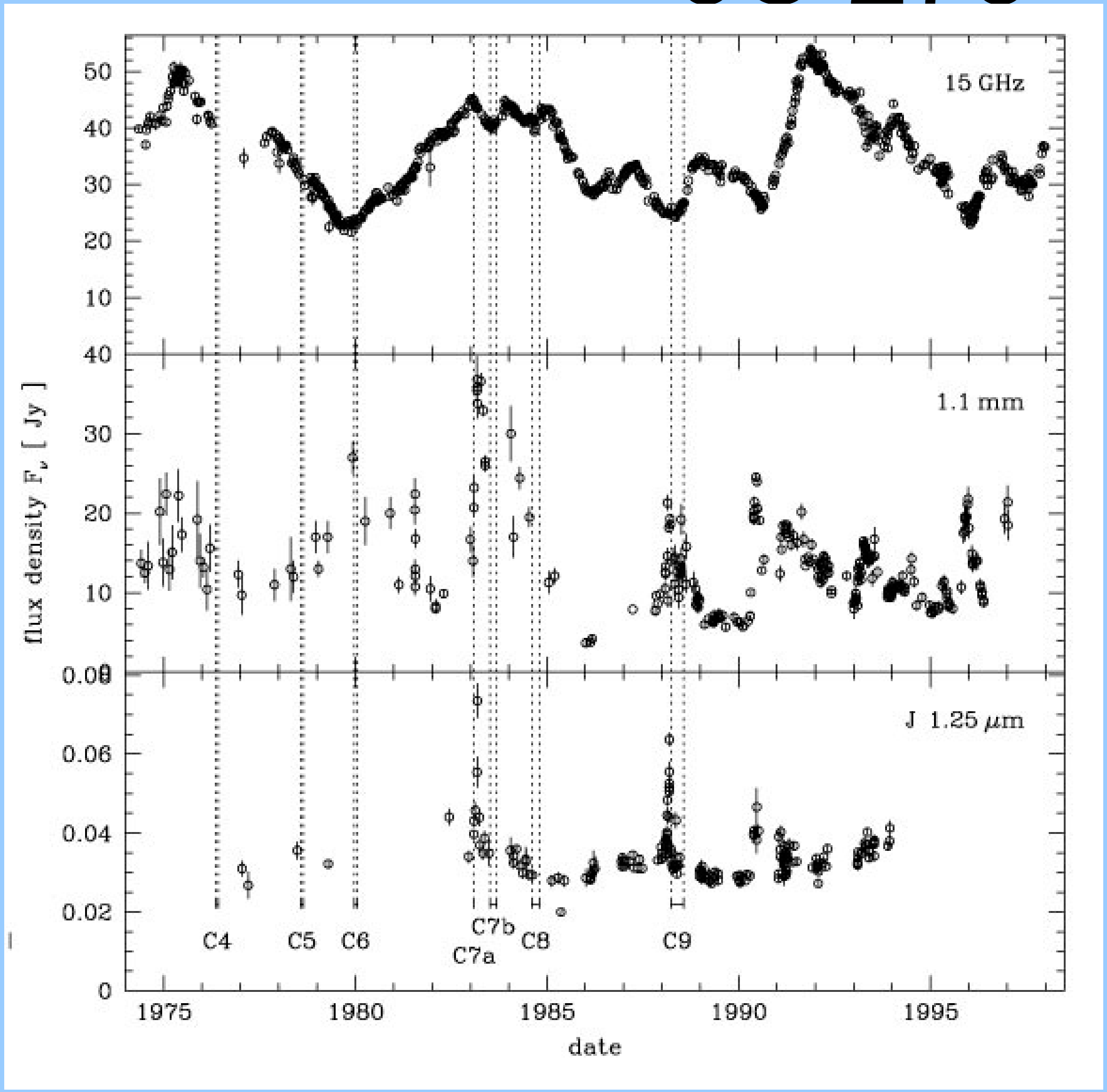


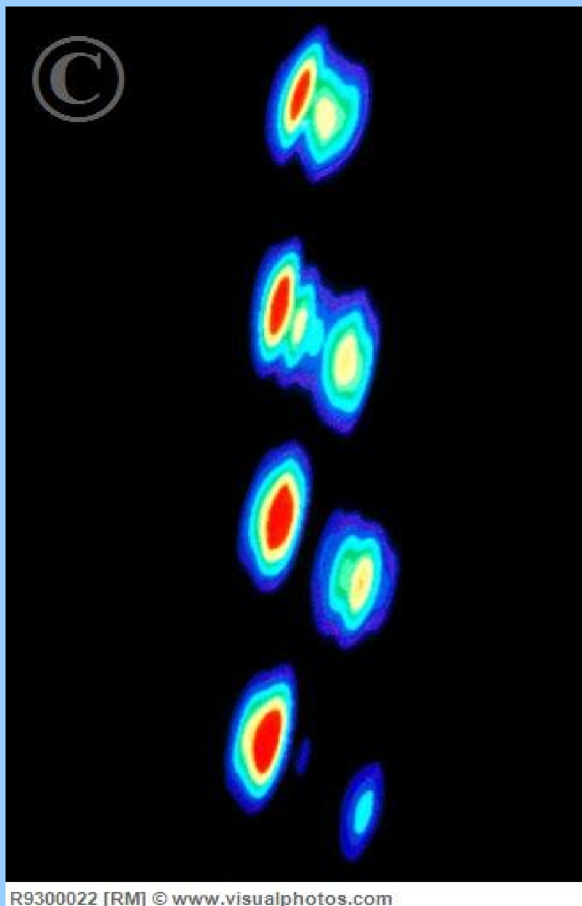
Figure 11. millimetre and infrared light curves and dates of appearance of new VLBI jet components (see the text). The components are labeled as in . The epochs of ejection of the components are from . The uncertainty in the ejection epochs are shown by a short range.

Outbursts in radio typically every 8.1 year (Zhang 2010)

Outbursts are accompanied by ejections of superluminal blobs

http://ned.ipac.caltech.edu/level5/March02/Courvoisier/Cour6_2.html

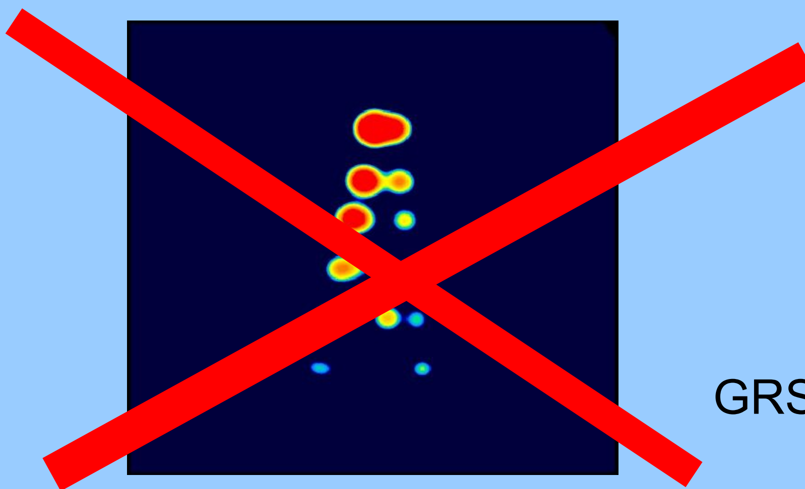
VLBI images



3C 273 blobs

The corresponding ejections in GRS 1915+105 should happen every 10 seconds!

We probably cannot follow them observationally.



GRS 1915+105

Those ejections are something else !

The corresponding events in quasars should take hundreds of thousands of years! Do we have such phenomena in radio galaxies?

Conclusions:

No conclusions

Work in progress !