

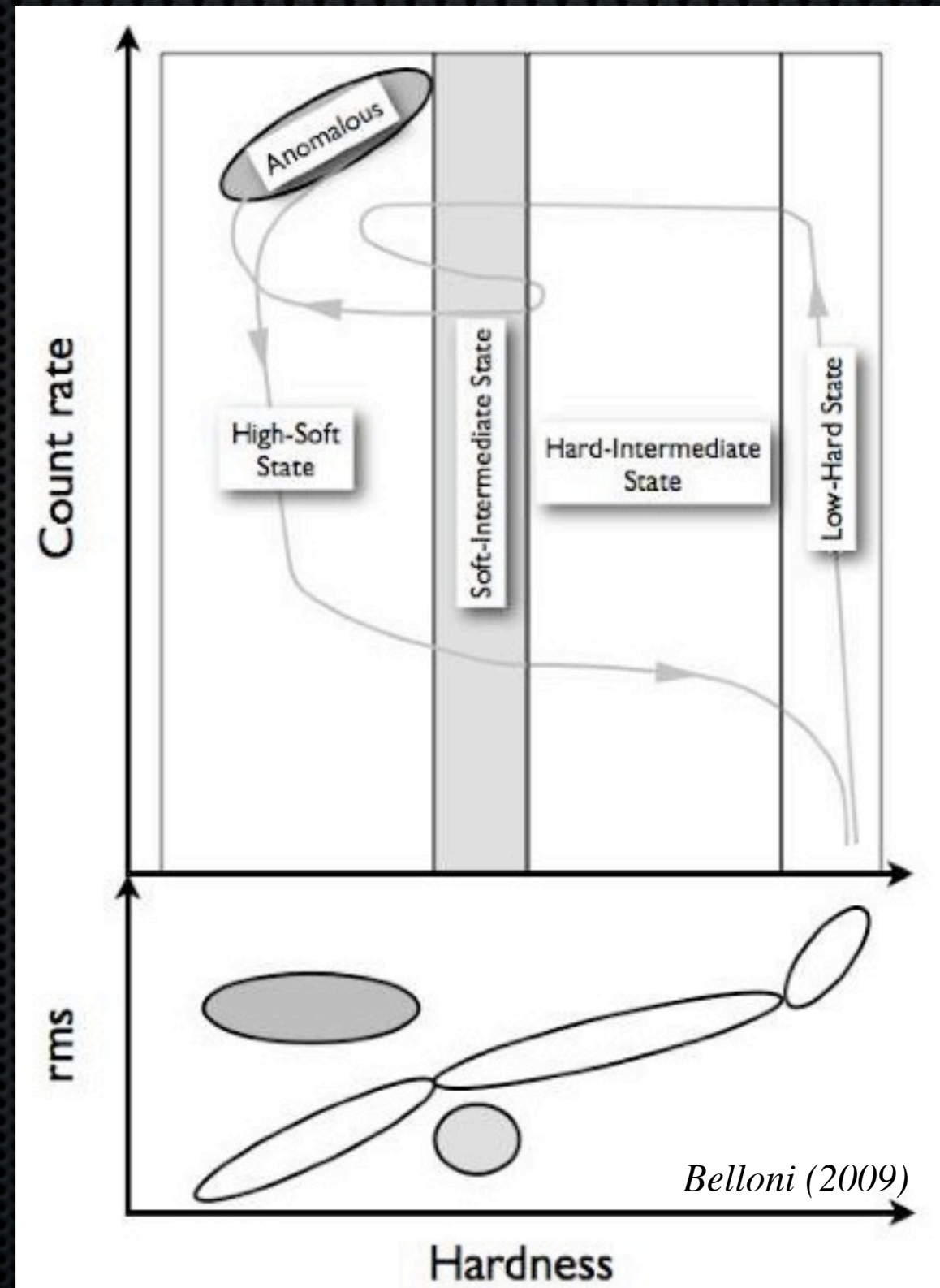
# The evolution of black-hole binaries

Tomaso Belloni (INAF - OAB)



# Black-hole transients

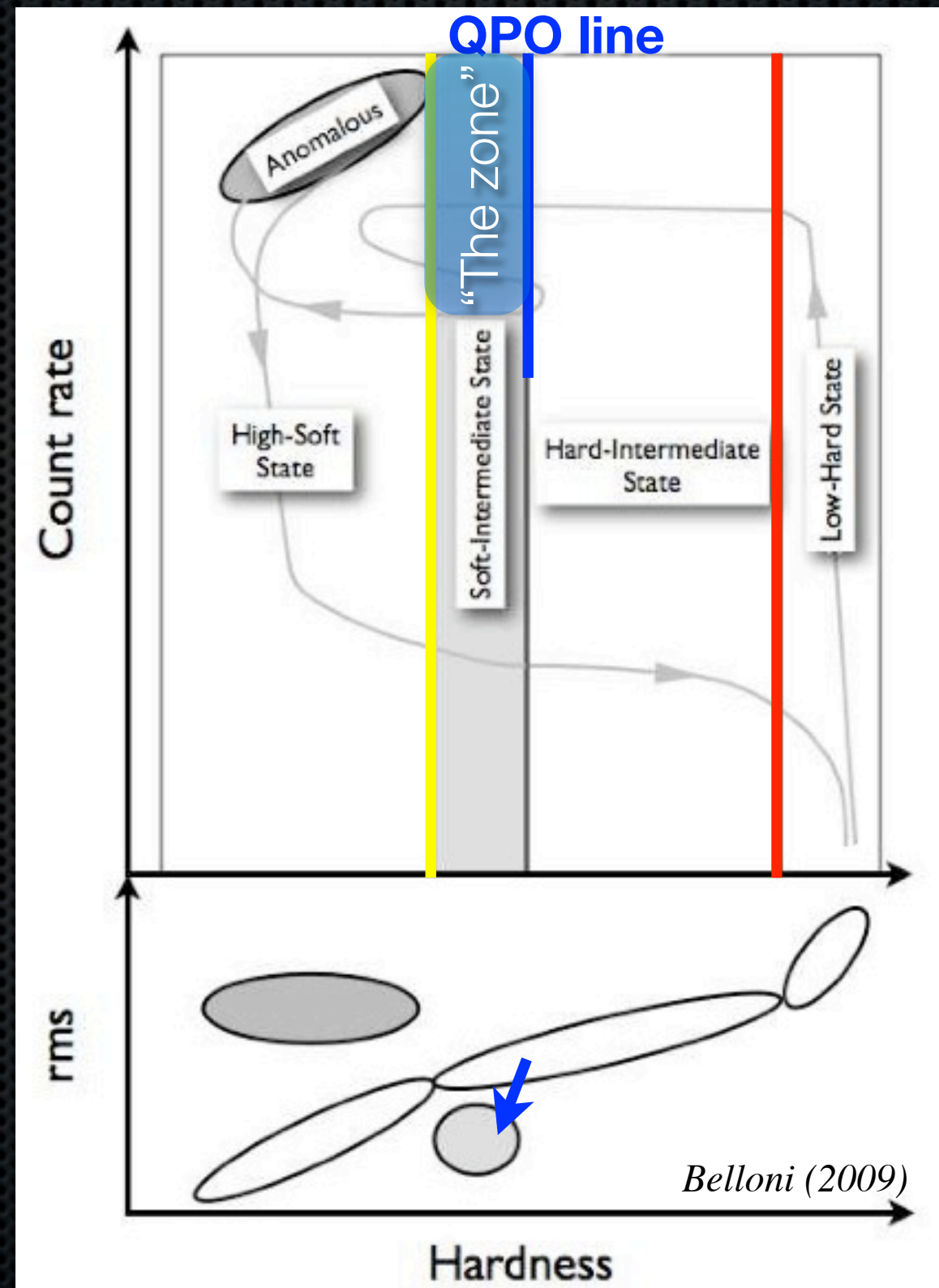
- ✧ All in two diagrams
- ✧ Hardness/intensity
- ✧ Hardness/variability
- ✧ 4 clear states





# Timing connection

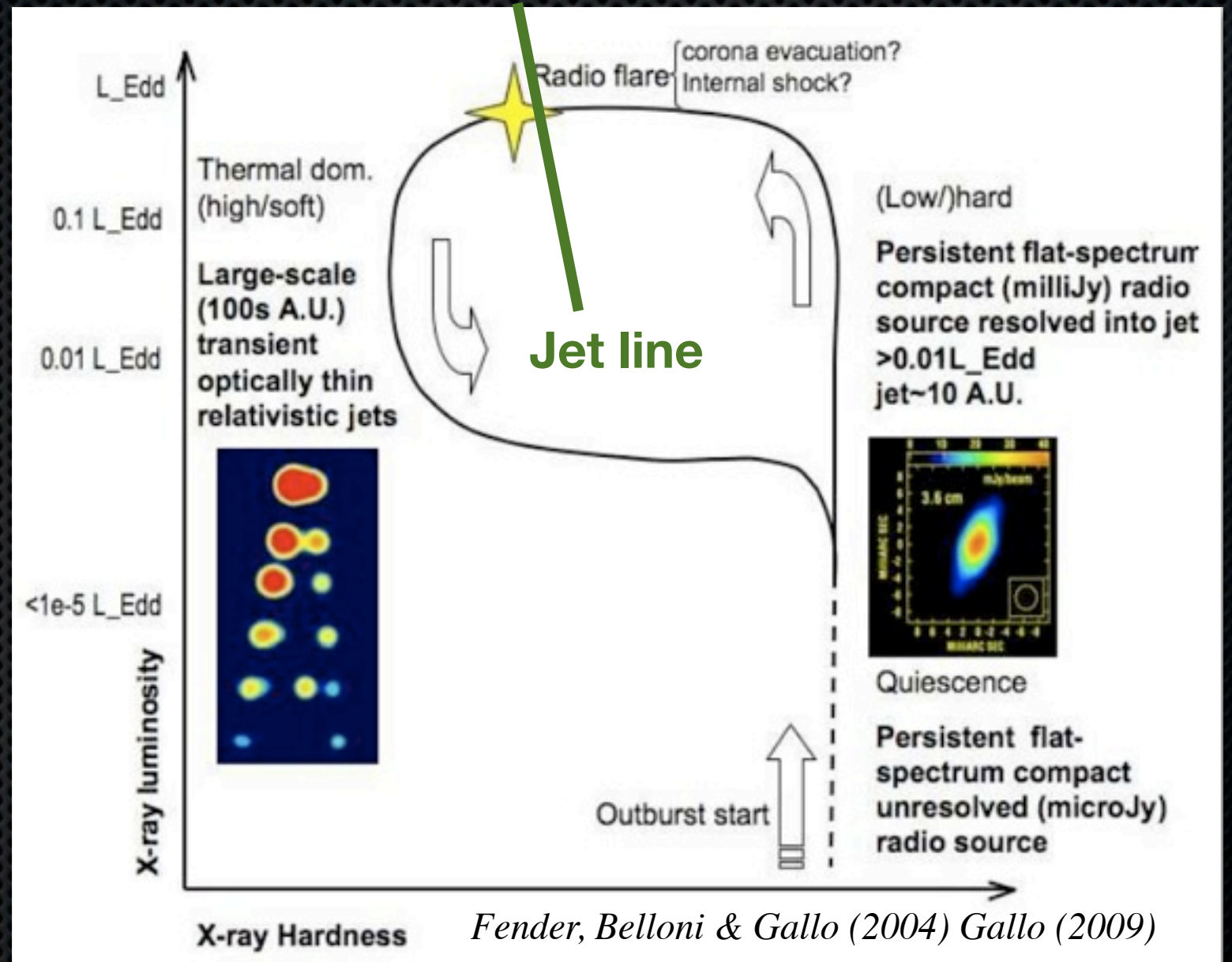
- ✧ Time variability
- ✧ **QPO line:**
  - ✧ drop in variability
  - ✧ different oscillation
- ✧ High-frequency oscillations right there





# Jet connection

- ✧ Hard: radio loud
- ✧ Soft: radio quiet
- ✧ Jet/no-jet
- ✧ **Jet line**
- ✧ QPO ~ jet



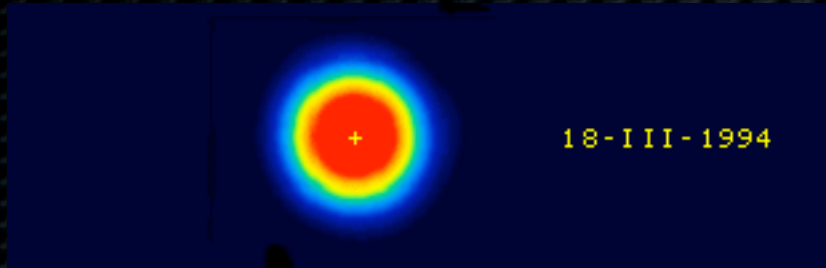


# This is the starting point

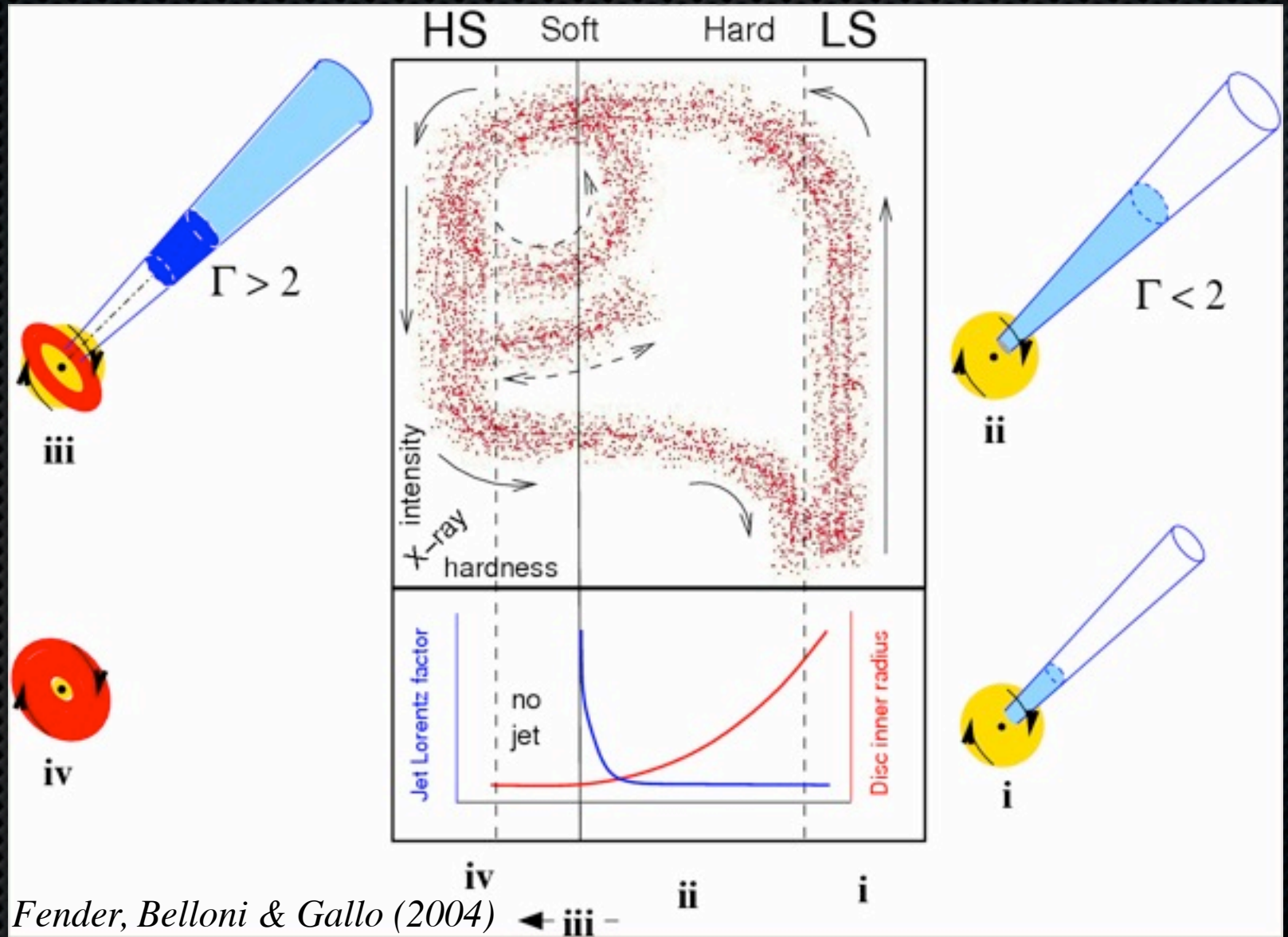
- ✧ Relativistic jet ejection
- ✧ Annihilation line emission
- ✧ High-energy tail
- ✧  $\gamma$ -ray emission
- ✧ AGN connection



# Relativistic jet ejection



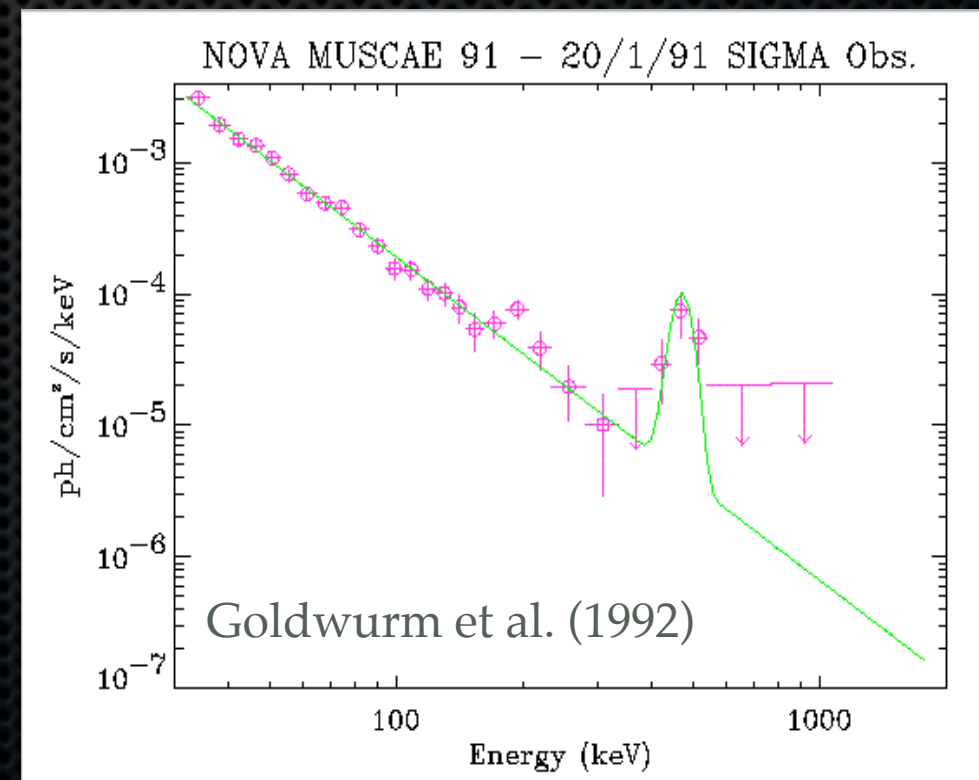
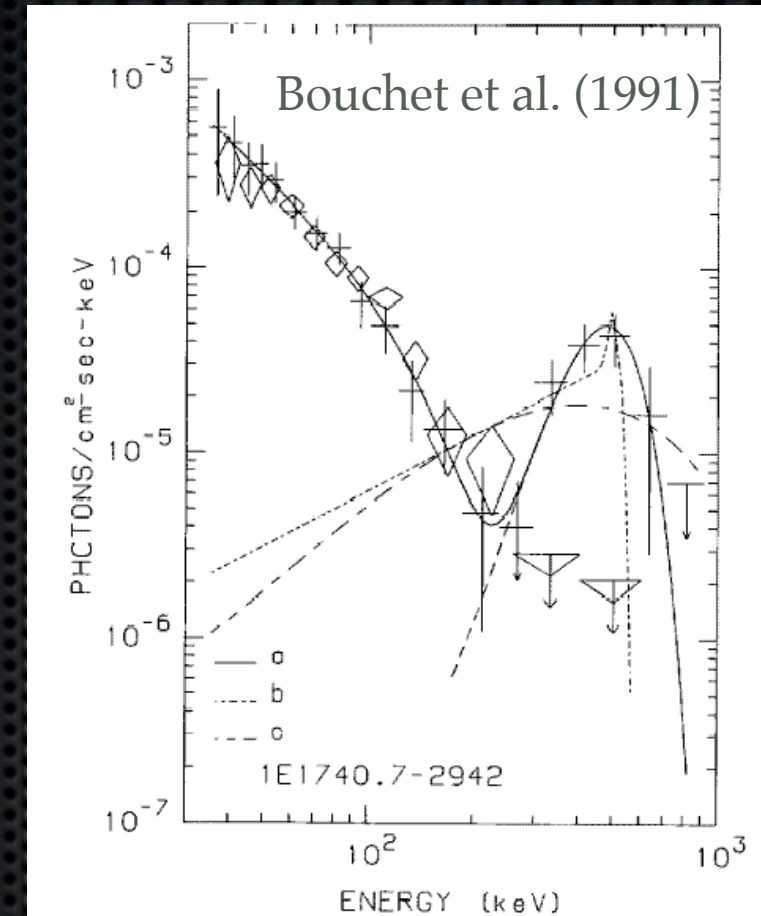
- ✧ Toy model
- ✧ Basics still work





# Annihilation line

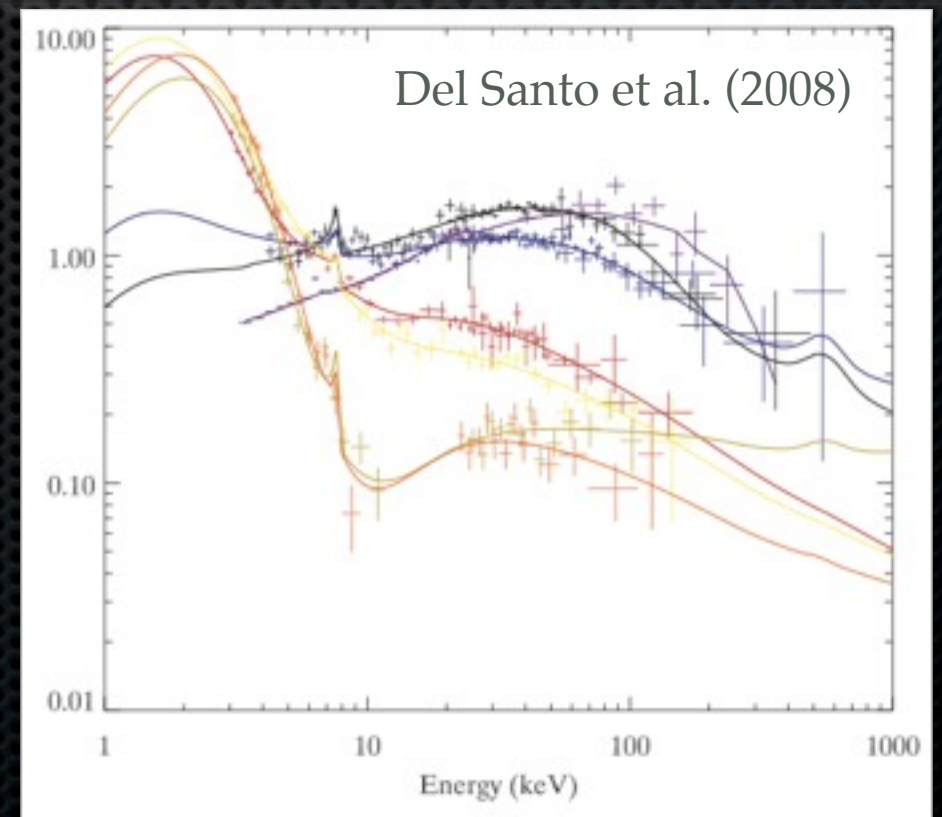
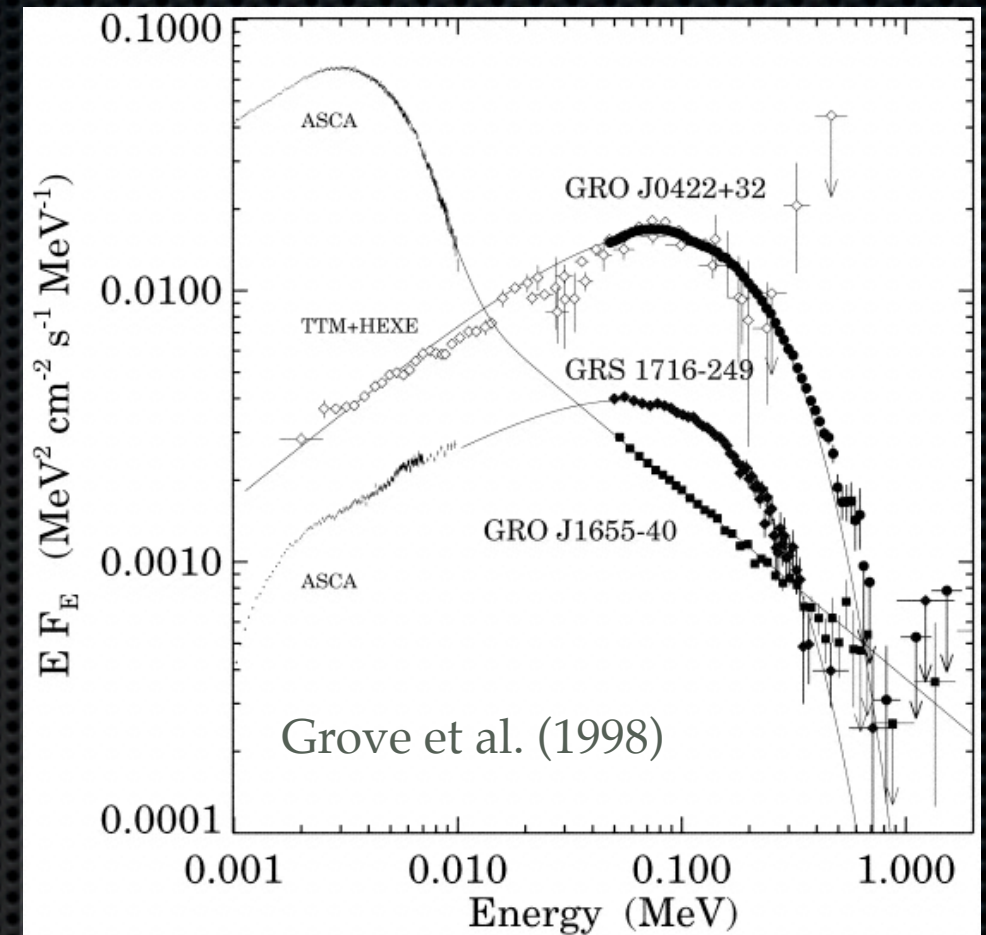
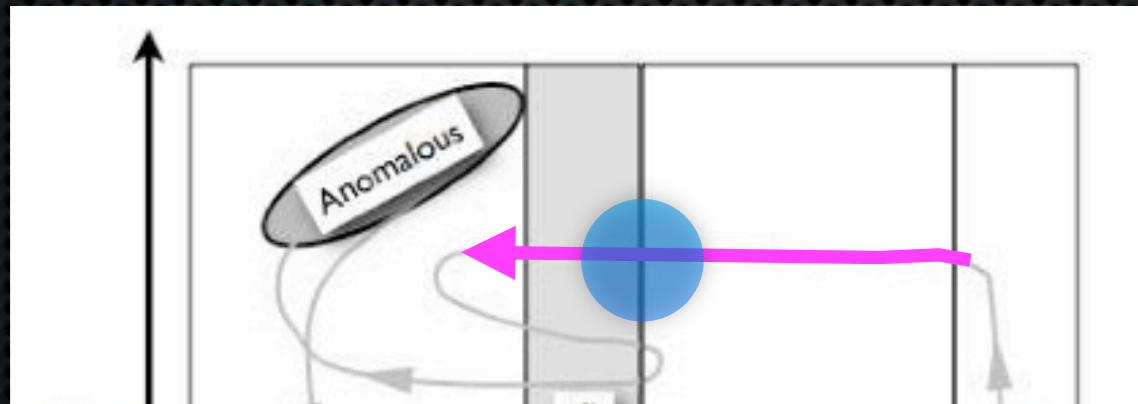
- ✧ Sigma detection even in image
- ✧ Transient line
- ✧ Unconfirmed by INTEGRAL
- ✧ GS 114-68 was close to QPO line (“the Zone”)
- ✧ Still possible (jet ejection, maximum  $\Gamma$ )





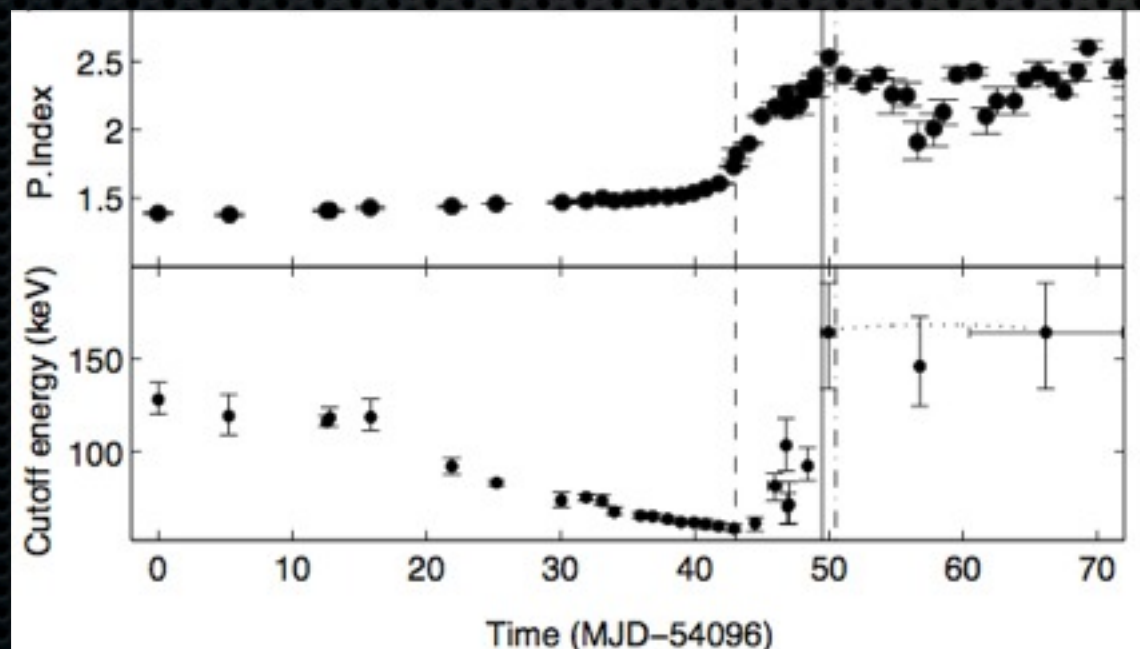
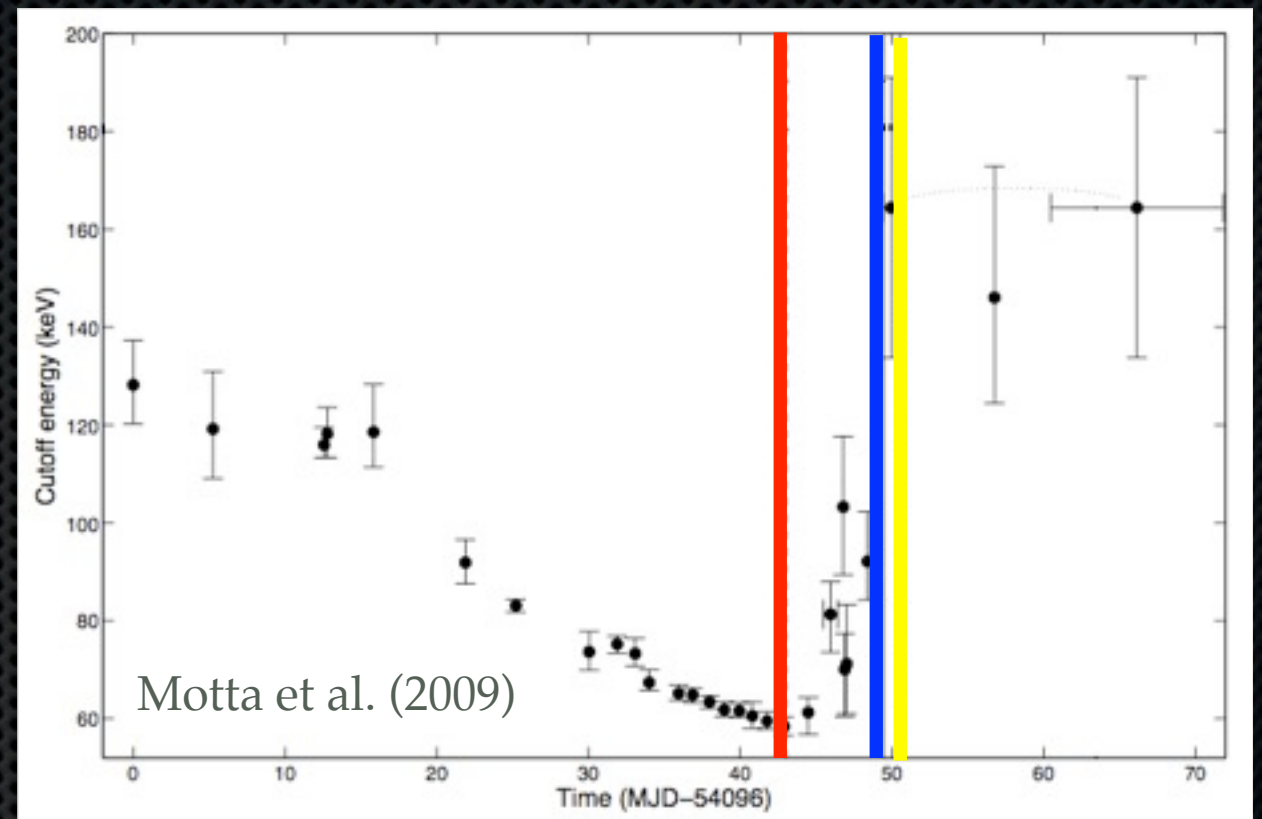
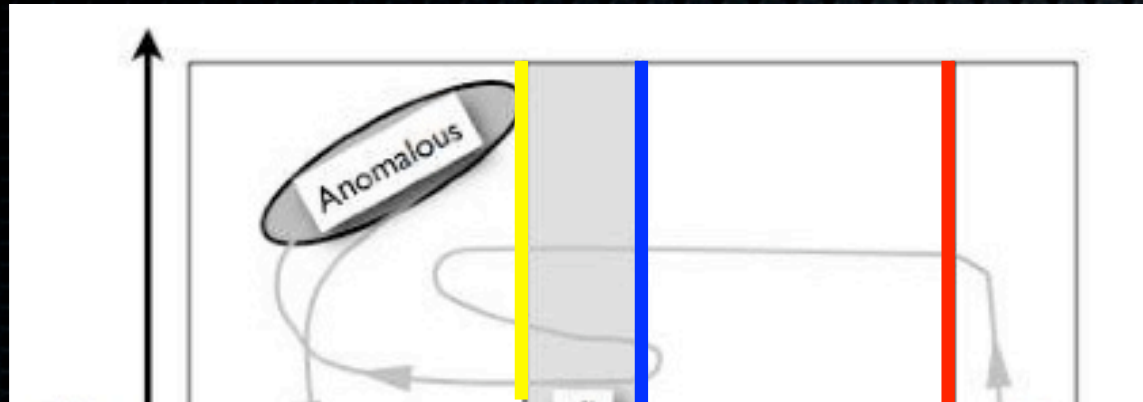
# High-energy tail

- ✧ Hard state: thermal Compton
- ✧ Soft state: non-thermal Compton, jet component, bulk-motion Compton
- ✧ Hybrid models (th.+nonth.)
- ✧ Key is transition!





# Best coverage: GX 339-4

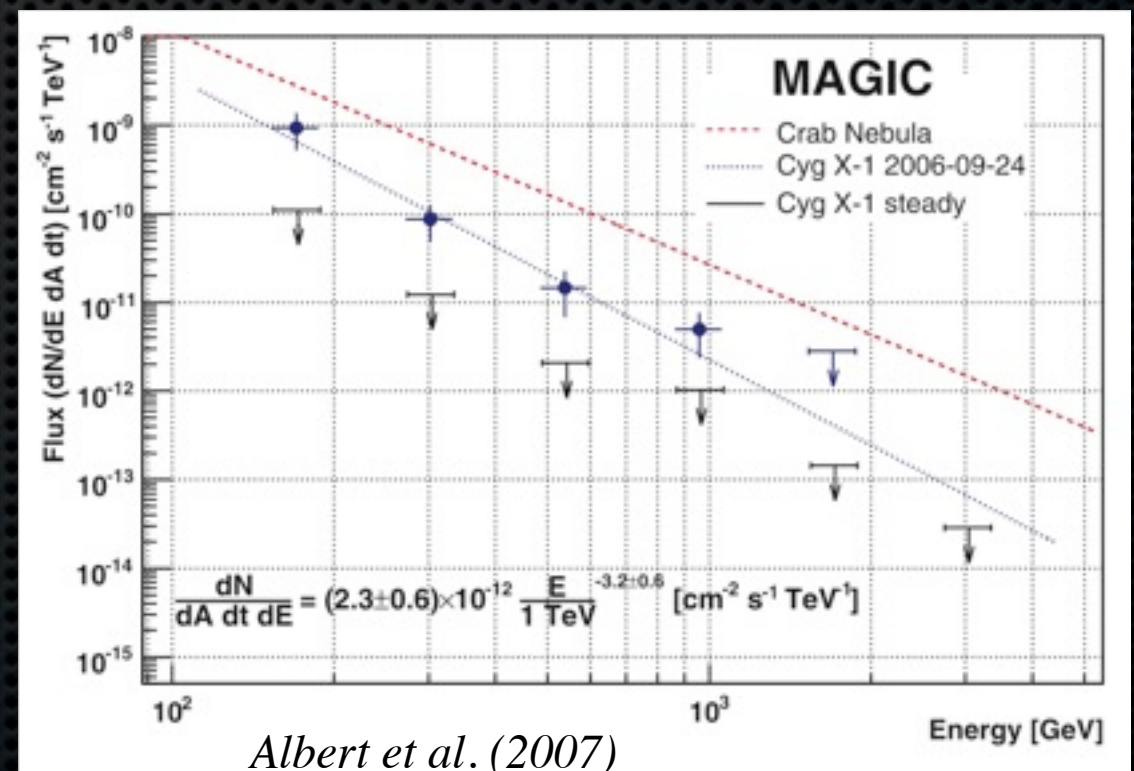
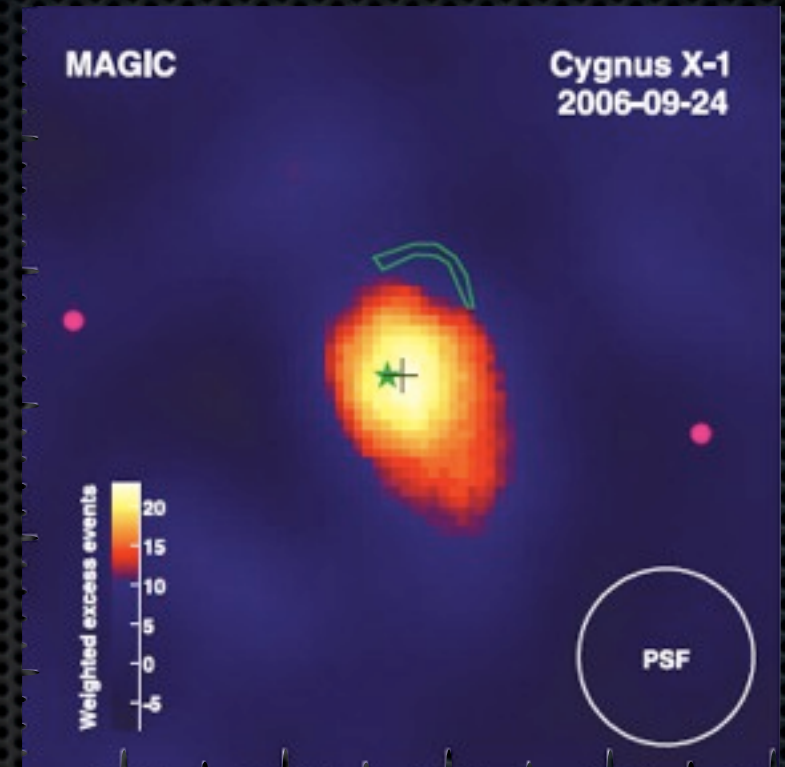


- ✧ Smooth, non-monotonic evolution of temperature
- ✧ Photon index also smooth
- ✧ Two components??



# $\gamma$ -ray emission

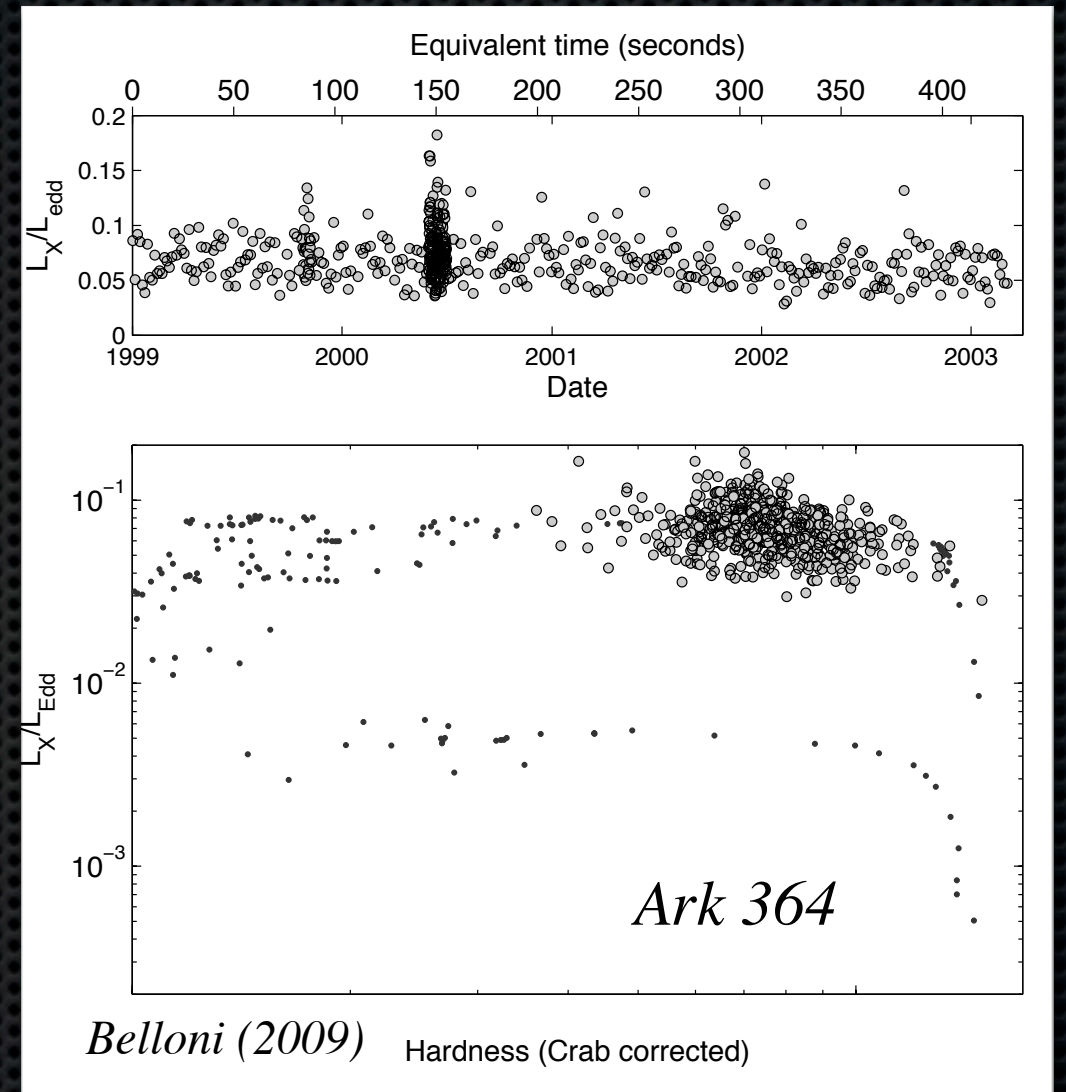
- ✧ Cyg X-1: MAGIC detection
- ✧ Only for 1-2 hours
- ✧ Also X-ray “flare” (few days)
- ✧  $\Phi_{\text{orb}} = 0.91$
- ✧ Origin far from black hole  
(no  $\gamma$ - $\gamma$  absorption in stellar  
photon field)





# AGN connection

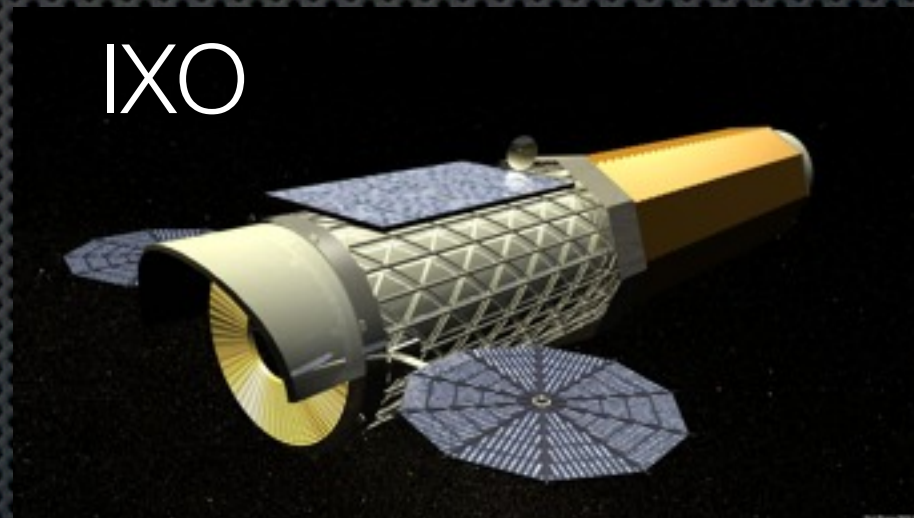
- ✧ Most AGN are on hard branch..
  - ✧ .. a couple are in between
  - ✧ Variability says: quiet..
  - ✧ .. a couple are in between
- 
- ✧ Do we see radio quiet BHBs?





# Future prospects

- ✦ We need.. coverage
- ✦ We need.. timing
- ✦ We need.. flexibility





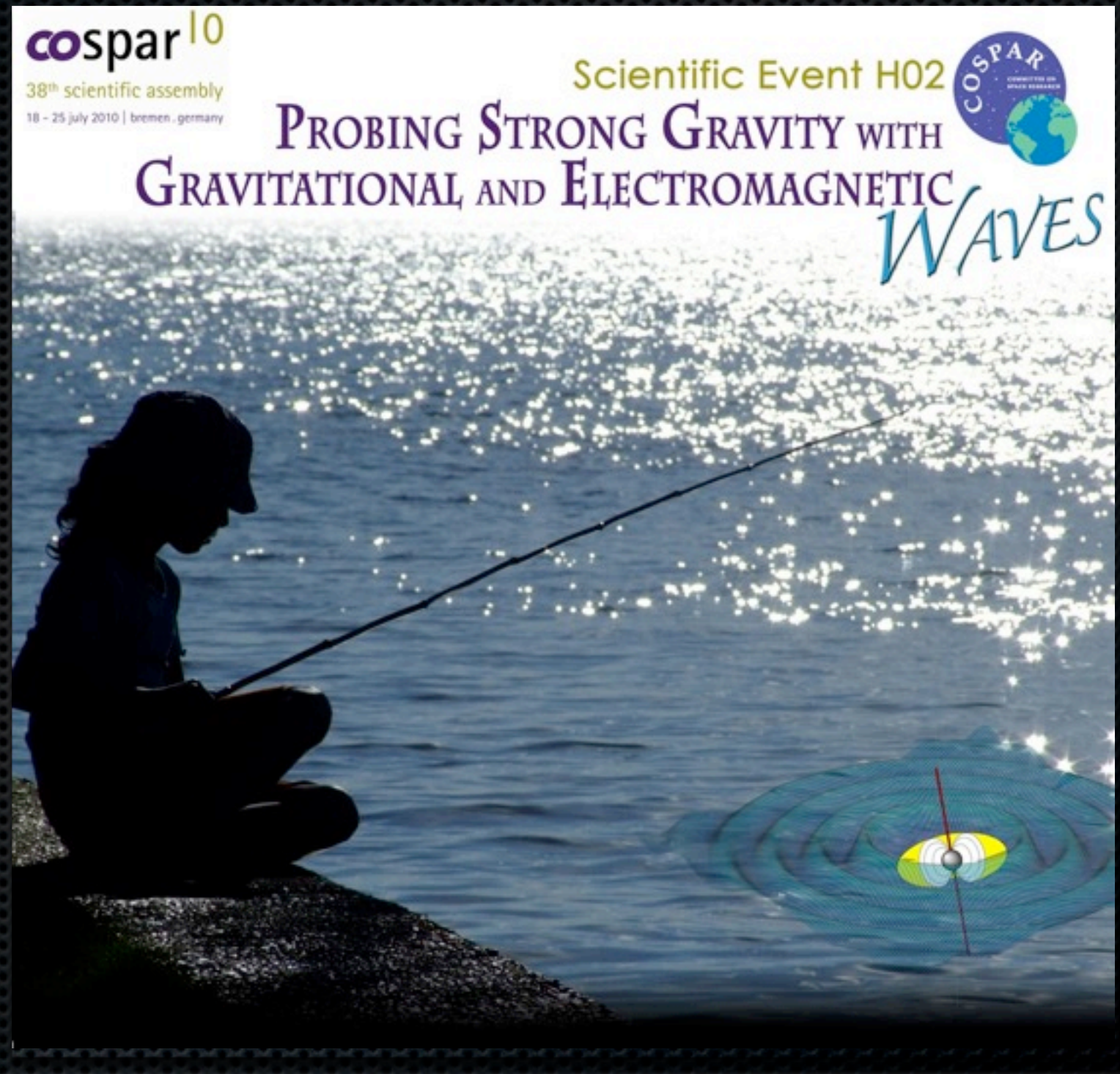
# The jet paradigm: microquasars to quasars

- ✦ Springer LNP
- ✦ 10 chapters
- ✦ Publication: November 2009
- ✦ X-ray binaries to AGN
- ✦ All chapters on arXiv (Sep. 2009)



# COSPAR Event 2010

- ✦ Bremen,  
2010 July



7<sup>th</sup> AGILE workshop