# MODELING MAXI J1836-194 JET EMISSION

## USING THE ACCRETION FLOW VARIABILITY

Mathias Péault

Advisors: Julien Malzac & Mickael Coriat

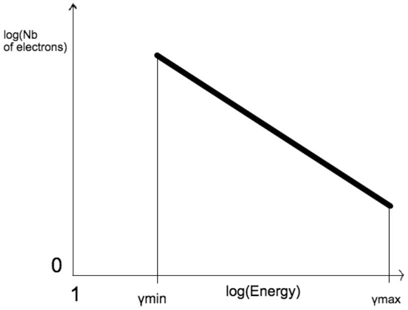
Institut de Recherche en Astrophysique et Planétologie (IRAP) – Toulouse

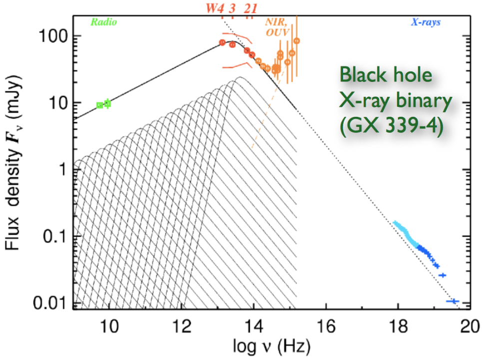
Microquasars workshop – Porquerolles

September 27, 2017

# JET EMISSION INTERPRETATION

Blandford and Konigl (1979) :
synchrotron emission from accelerated e- with a power law energy distrib



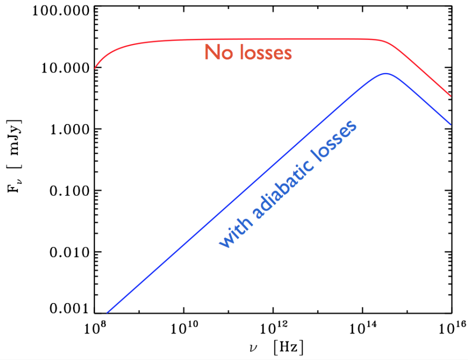




(Gandhi et al. 2011)

# ADIABATIC LOSSES

Standard model $\Longrightarrow$ neglects the cooling of e-

adiabatic cooling = jet expansion in the external medium

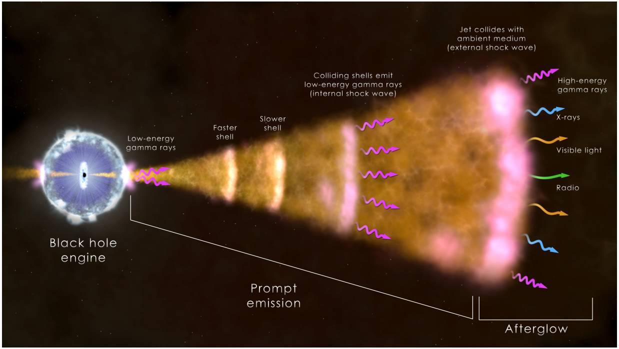



How to re-energise the electrons? $\rightarrow$ need for a compensation

# ONE POSSIBLE MECHANISM: INTERNAL SHOCKS

Solution: Gamma-ray burst model applied to X-ray binaries!

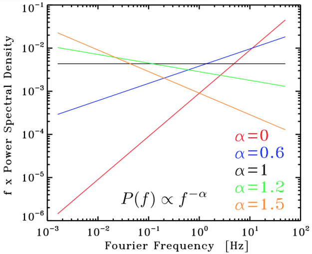
**Internal shock model** ⇒ shocks re-accelerate the electrons



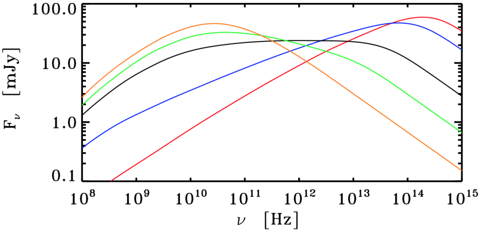

(Description of a gamma-ray burst)

# LORENTZ FACTOR FLUCTUATIONS

Results depend on amplitude & time scales of injected fluctuations
⟶ input power spectrum




PSD of Lorentz factor




Spectral energy distribution

SED shape is -almost- ENTIRELY determined by the PSD of the velocity fluctuations !

# FLICKER NOISE FLUCTUATIONS

- In Malzac 2013:
  - Flicker noise fluctuations of Lorentz factor (PSD $\propto$ $f^{-1}$)
    $\rightarrow$ maintain the good spectral shape
  - Accretion flow variability (X-rays) close to $1/f$ within a certain range of frequencies!!

Hypothesis: As natural connection between accretion flow and jets

$\longrightarrow$ same variability in accretion flow & base of the jet

## MY WORK

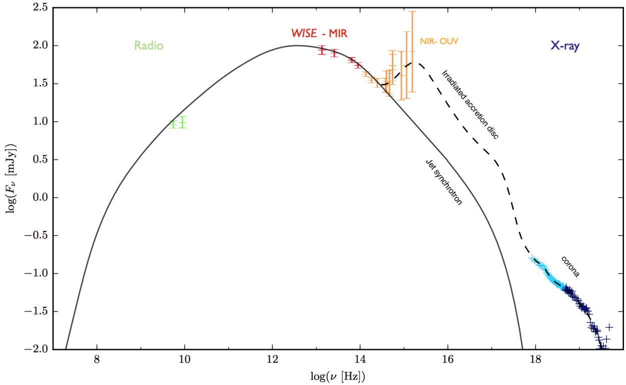
Model the multi-$\lambda$ emission of the jet in MAXI J1836-194

Using:

- Multi-$\lambda$ observations
- ISHEM (Malzac 2014): synchrotron only !
- Observed accretion flow fluctuations (X-rays)

# PREVIOUS WORK

Reproduction of the jet spectrum in GX 339-4 in the hard state



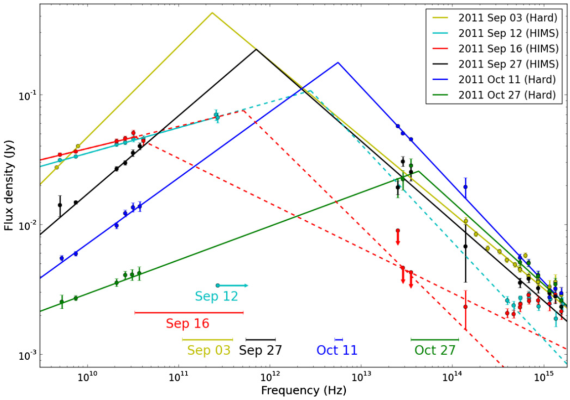

(Drappeau et al. 2015)

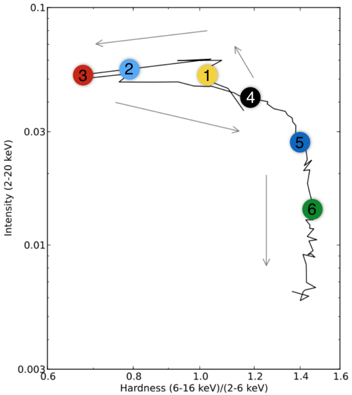
# MAXI J1836-194

- BH transient discovered in 2011
  - Quasi-simultaneous observations :
    VLA (Radio), VLT (IR), Faulkes Ts (Opt.), Swift, RXTE (X-rays)
  - Failed state transition: Hard state ⟶ HIMS ⟶ Hard state

- Why interesting ?
  - Several data sets ⇒
    Different levels of L → study the jet evolution
  - The source is jet-dominated up to Optical
    → Low inclination ? [4-15°] T.Russell et al., 2014

# DATA SETS



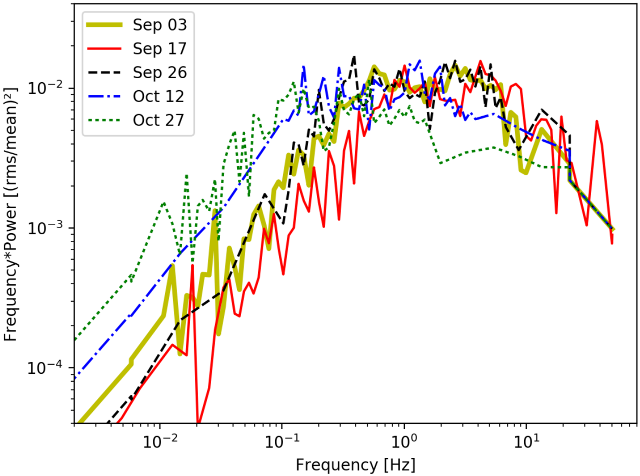




(D.M. Russell et al. 2013)

Reproduce the 5 jet spectra:

1/ good fits – 2/ min var parameters – 3/ most realistic parameters

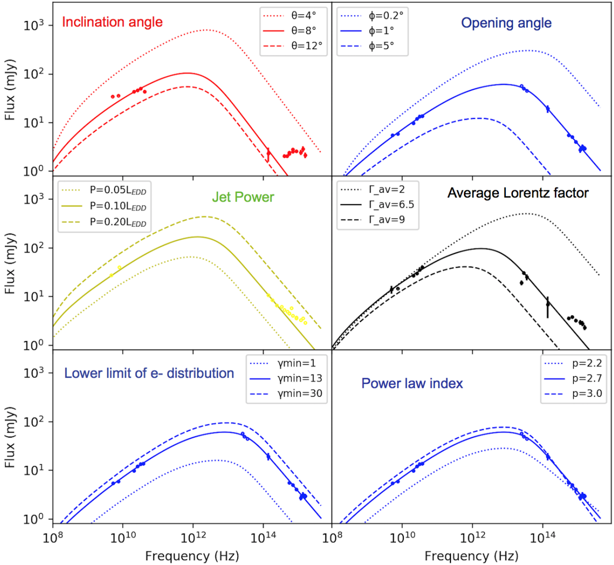
# POWER SPECTRA



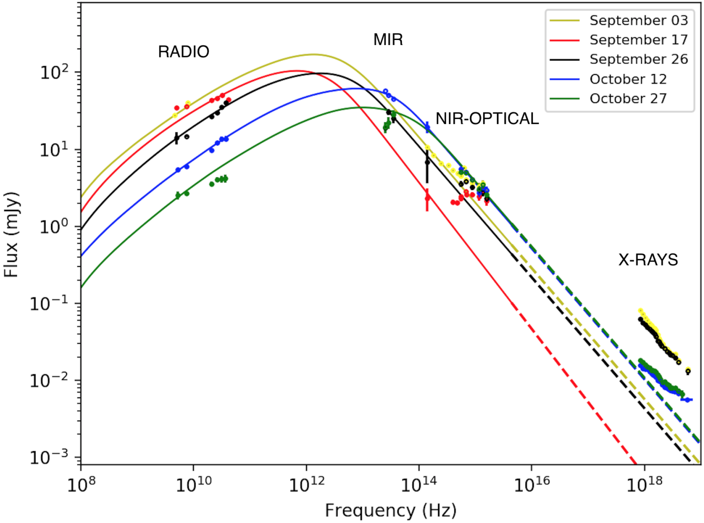
# MAIN PARAMETERS OF THE STUDY

| Parameters | | |
|---|---|---|
| Distance [4-10kpc]<br>Inclination [4-15°]<br>T.Russell et al., 2014 | ⟺ | Related to the source |
| Index [2-3]<br>Gamma min [<20] | ⟺ | Electron power law distribution |
| Jet power [few %$L_{EDD}$]<br>Opening angle [around 1°]<br>Average Gamma [1-?] | ⟺ | Jet properties |

# INFLUENCE OF THE PARAMETERS



# RESULTING SEDS



# ONE POSSIBLE SCENARIO

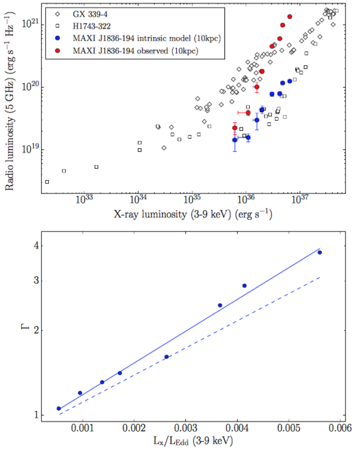
Distance=4kpc & Inclination=8°

| Obs | Index | $\gamma_{min}$ | Jet power $L_{EDD}$ | Opening | $\Gamma_{av}$ |
|---|---|---|---|---|---|
| Sep 03 | 2.7 | 13 | 0.10 | 1° | 9 |
| Sep 17 | 2.9 | 13 | 0.19 | 1.2° | 13 |
| Sep 26 | 2.7 | 13 | 0.034 | 1° | 6.5 |
| Oct 12 | 2.7 | 13 | 0.008 | 1° | 2 |
| Oct 27 | 2.7 | 13 | 0.0032 | 1° | 1.06 |

Need of at least two variable parameters !

⚠ This is only one possible scenario → huge degeneracy

# STEEP RADIO/X CORRELATION




(T.D. Russell et al. 2015)

- T.D. Russell (2015):

  Weird radio/X correlation !

  → $L_R \propto L_X{}^{1.8}$

  ⟹ Possible solution: $\Gamma_{av}$ increases with L

# CONCLUSION

- Success: we now have a method to fit jet multi-$\lambda$ emisson
- Jet evolution with at least 2 variable parameters: P et $\Gamma_{av}$
  Qualitatively in accordance with the 1.8 radio/X corr
- Huge degeneracy: lots of more possible sets of parameters
  Some "extreme" parameters → more reasonable using more variables parameters