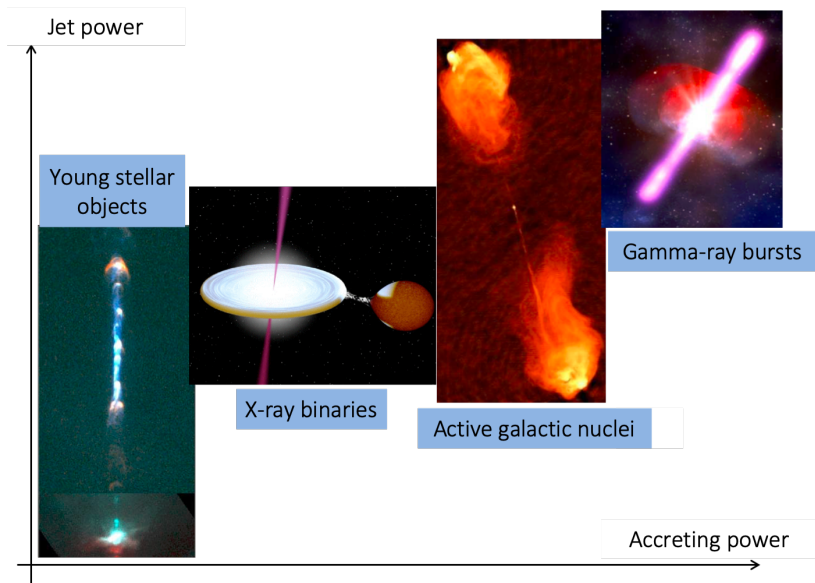# Relativistic X-ray jets in the black hole MAXI J1820+070
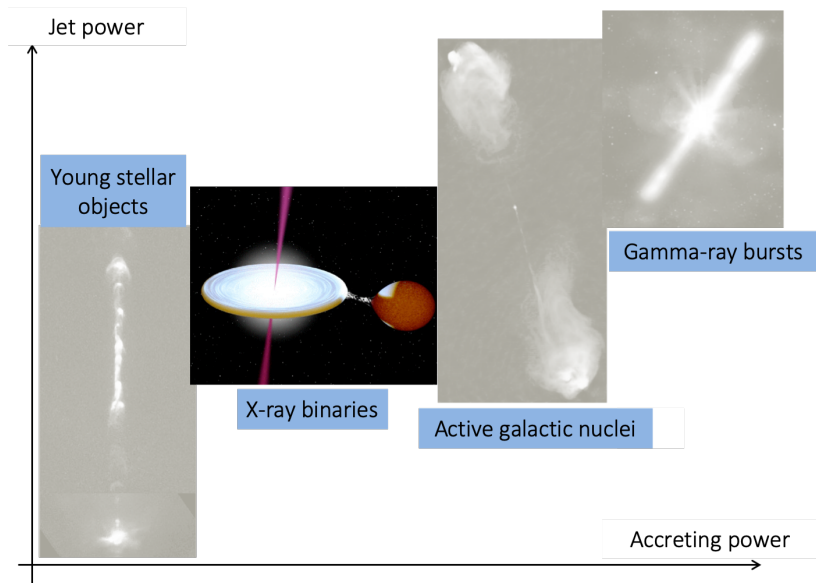
Mathilde Espinasse & Stéphane Corbel

AIM / CEA Saclay / Université de Paris
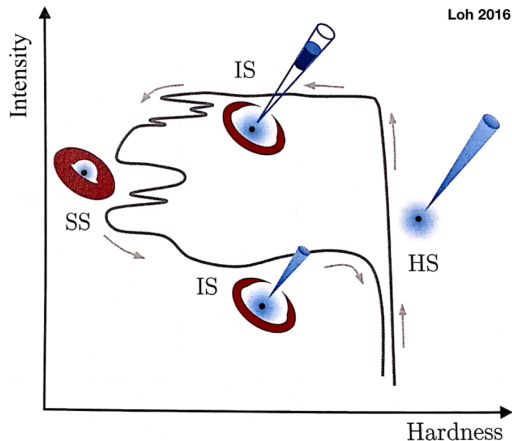
Accretion and ejection

Jet power

Young stellar objects

X-ray binaries

Gamma-ray bursts

Active galactic nuclei

Accreting power

Accretion and ejection

Jet power

Young stellar objects

X-ray binaries

Gamma-ray bursts

Active galactic nuclei

Accreting power

Black hole X-ray binaries and jets


Loh 2016

- **Compact jets** : supersonic conic jets emitting self-absorbed synchrotron radiation

- **Discrete ejecta** : expanding plasma bubbles emitting optically thin synchrotron radiation

Interaction of discrete ejecta with the interstellar medium

Corbel et al. 2005

Migliori et al. 2017
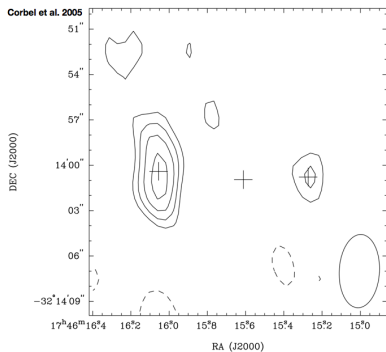
- H1743-322, XTE J1550-564
- Reappearance of the jets by interaction with ISM
- Synchrotron emission from radio to X-ray

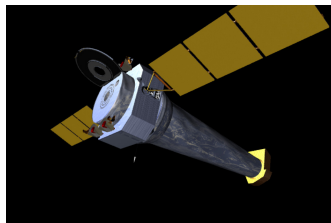# Instruments
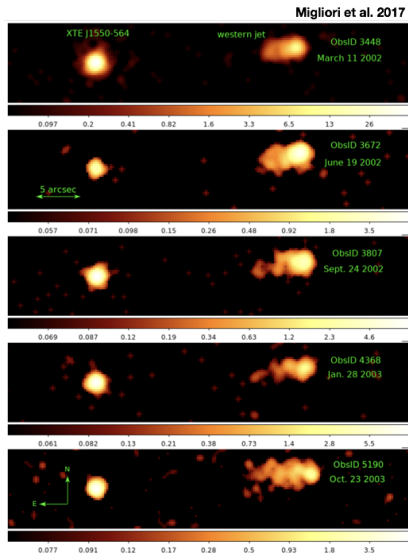
Radio

MeerKAT & VLA :
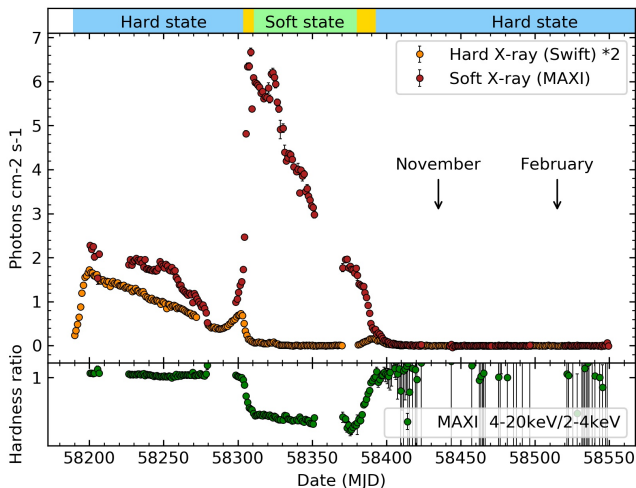- 1.28 GHz & 5 GHz and 7 GHz

X-rays

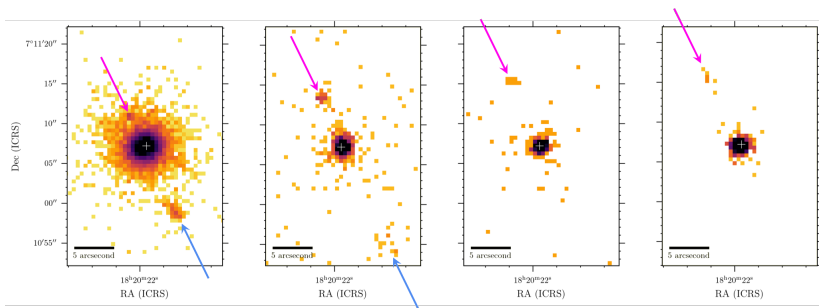*Chandra X-ray Observatory :*
- 0.5 arcsec resolution
- 0.5 - 8 keV

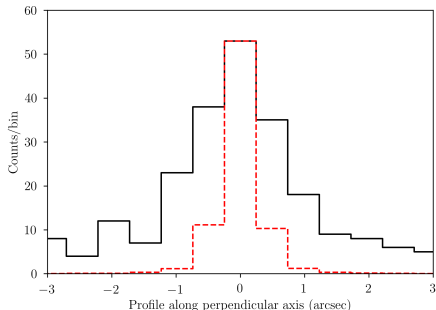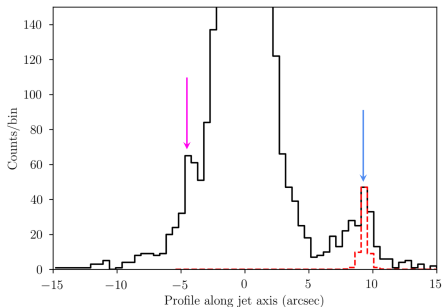# MAXI J1820+070 (a.k.a. ASASSN-18ey)

- Chandra observations in 11/2018, 02/2019, 05/2019 and 06/2019
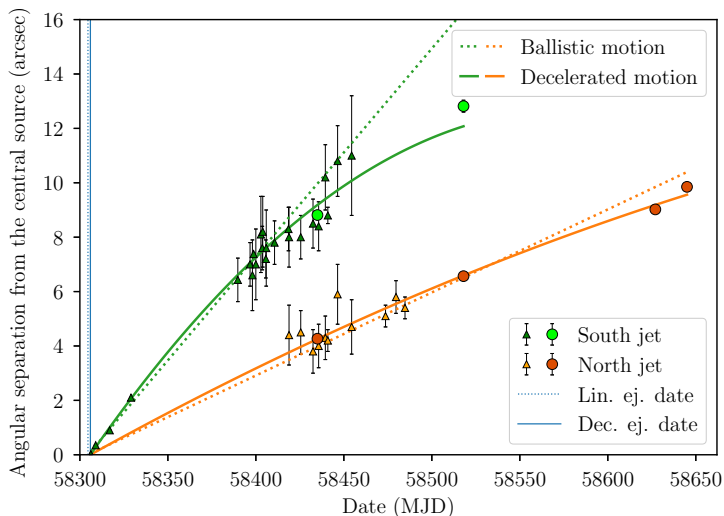
Detection of the jets

Espinasse et al. submitted

Morphology
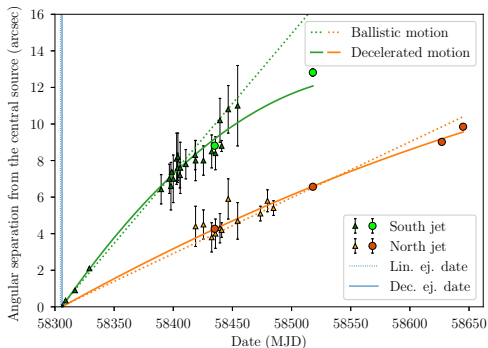

- Profiles of the south jet in November 2018
- Dashed red line = rescaled profile of simulated PSF

Apparent motion

▲ Bright+2020   ● Espinasse+2020

Apparent motion
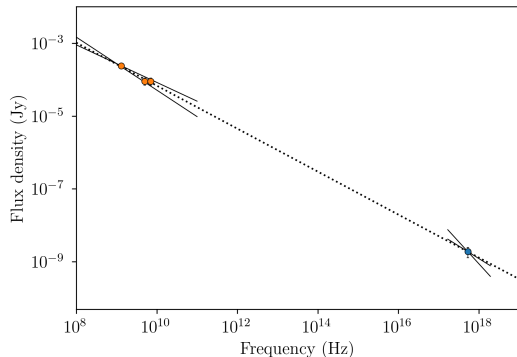

▲ Bright+2020   • Espinasse+2020

Ballistic model :

- $\chi^2 = 40$ (!)
- $v_{\texttt{south}} = 76.4 \pm 0.3$ mas.d^{-1}
- $v_{\texttt{north}} = 30.5 \pm 0.2$ mas.d^{-1}

Constant deceleration model :

- $\chi^2 = 7$
- $v_{\texttt{south}}^0 = 93.3 \pm 0.6$ mas.d^{-1}
- $v_{\texttt{north}}^0 = 35.9 \pm 0.5$ mas.d^{-1}

$\Rightarrow$ Interaction with ISM

Spectrum and energy

- Synchrotron radiation
- South jet : $\alpha = -0.59 \pm 0.01$
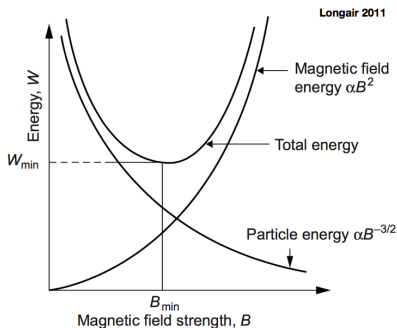- North jet : $\alpha = -0.65 \pm 0.03$

Equipartition

- Hypotheses : truncated cone, filling factor $f = 0.1$
- $B = 2.0 \times 10^{-4}$ G
- $E_{min} = 4.9 \times 10^{41}$ erg
- $\Rightarrow$ accelerated e$^-$ > 10 TeV

Conclusion

- Detection of resolved X-ray jets associated to radio emission ⇒ 3rd source only !
- Optically thin synchrotron radiation ⇒ particles accelerated by shocks

Longair 2011

- $E_{\mathrm{mag}} = \frac{B^2}{8\pi} fV$
- $E_{\mathrm{e}^-} = \mathrm{cst}\ B^{-3/2} L$

- $E_{\mathrm{mag}} = \frac{3}{4}\eta E_e$

- $E_{\mathrm{e}^-} = 2.8 \times 10^{41}$ erg
- $E_{\mathrm{mag}} = 2.1 \times 10^{41}$ erg
- Filling factor $f = 0.1$
- $L = 2.5 \times 10^{31}$ erg s^{-1}