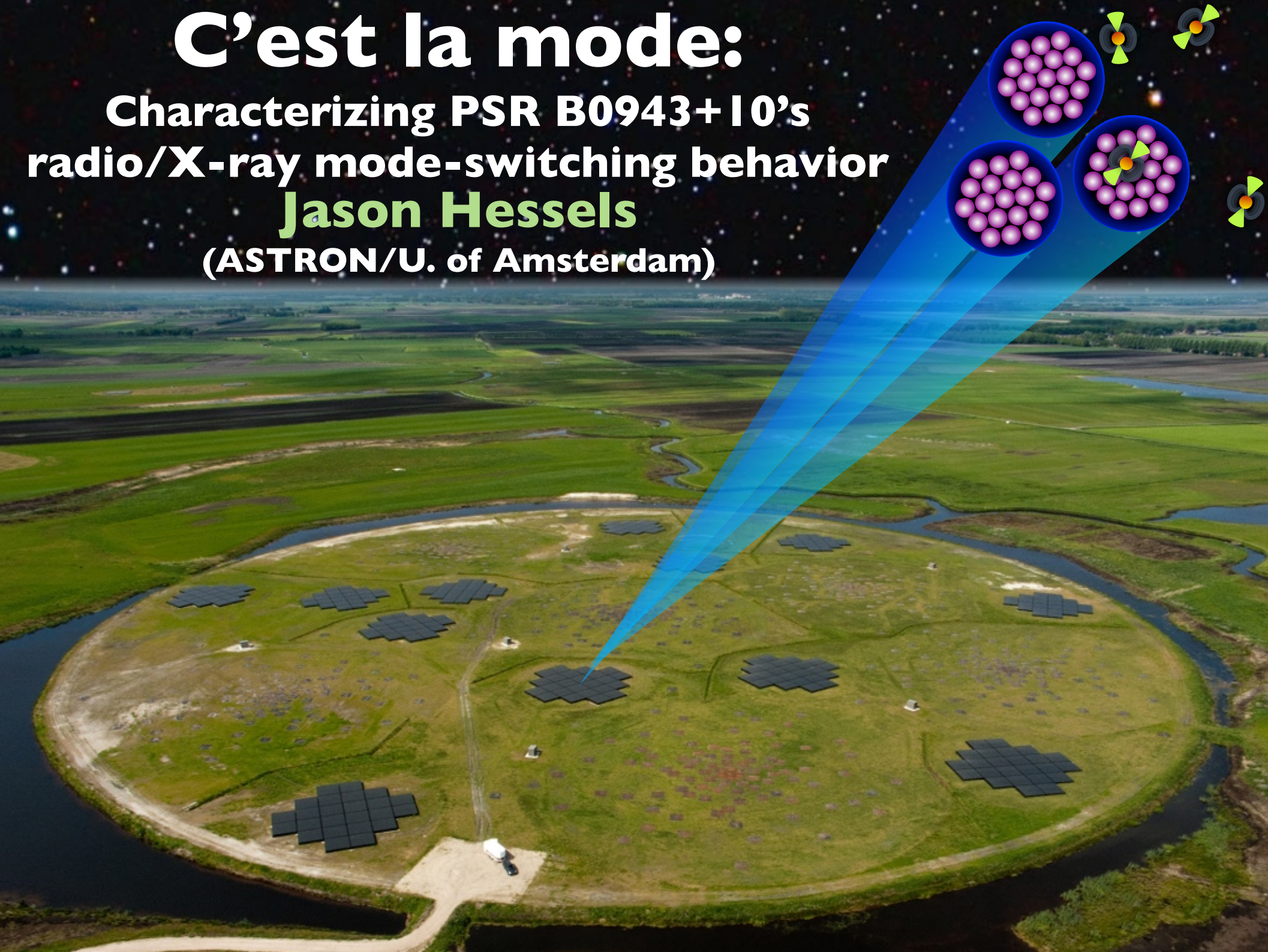
C’est la mode:

Characterizing PSR B0943+10’s radio/X-ray mode-switching behavior

Jason Hessels

(ASTRON/U. of Amsterdam)



Pulsar Variability

nanoseconds to decades

Giant pulses

Sporadic, extremely luminous and short pulses

Nulling

"Missing" pulses

Moding

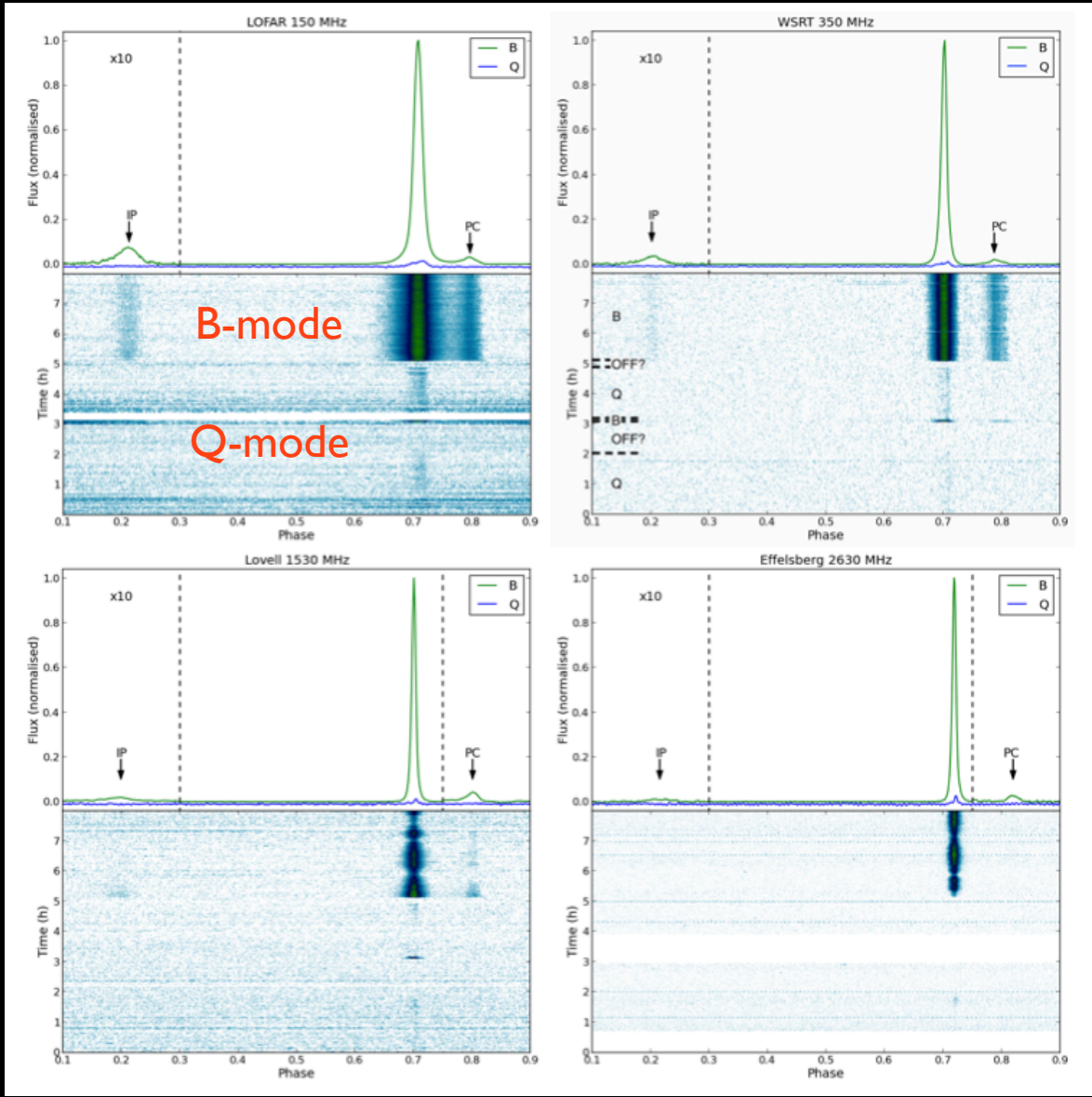
Switching between 2 or more emission modes

Intermittency

Pulsar turns "on"/"off" on weeks-months timescales

Understand pulsar emission
physics and timing

Mode-switching in PSR B0823+26

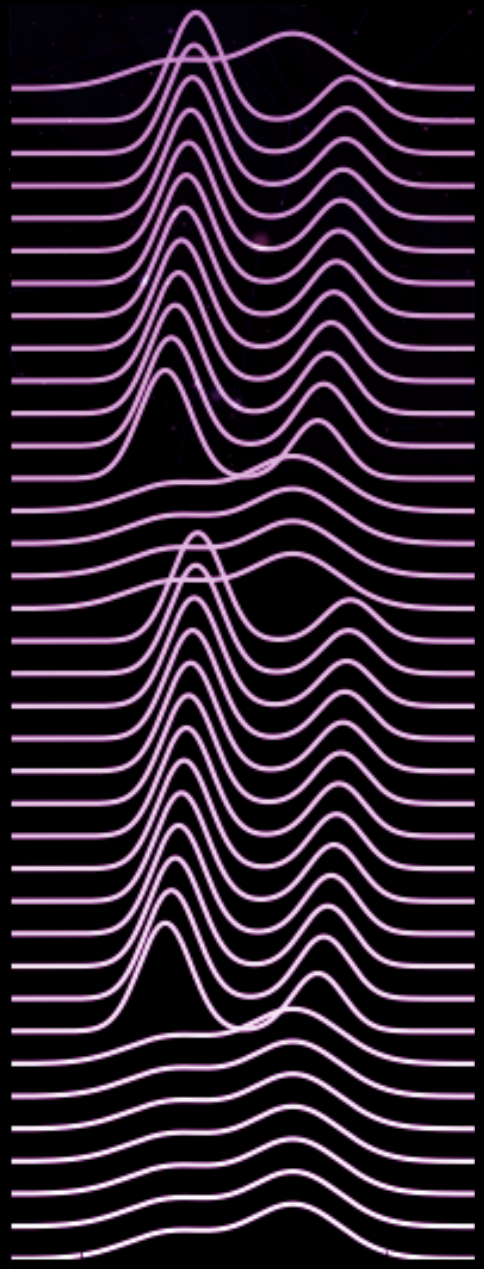


Discovery of a 170x fainter Quiet-mode

Also a true "off" mode preceding B-mode?

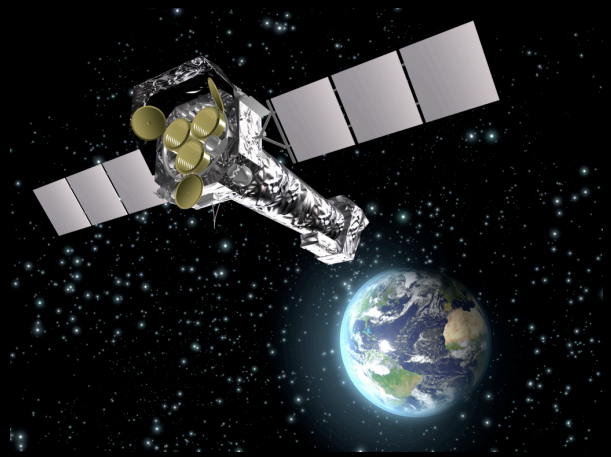
Sobey et al. 2015, *MNRAS*

The “chameleon” pulsar B0943+10



LOFAR

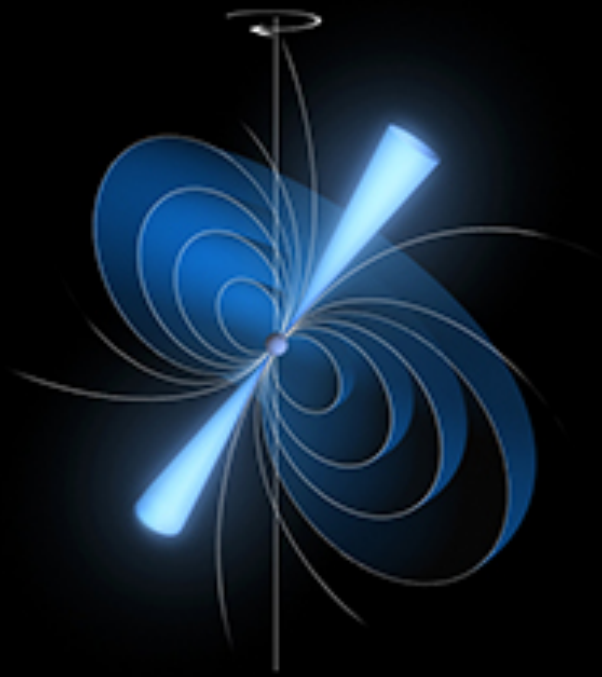
GMRT

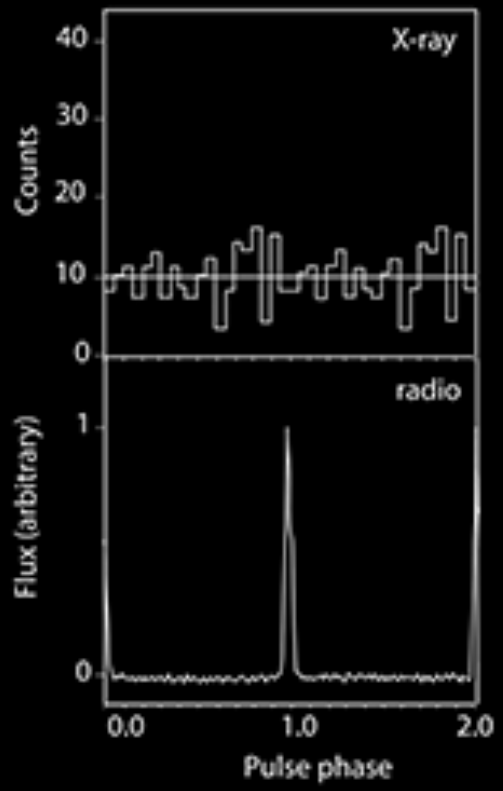


XMM-Newton

Hermsen et al. 2013, *Science*

The “chameleon” pulsar B0943+10



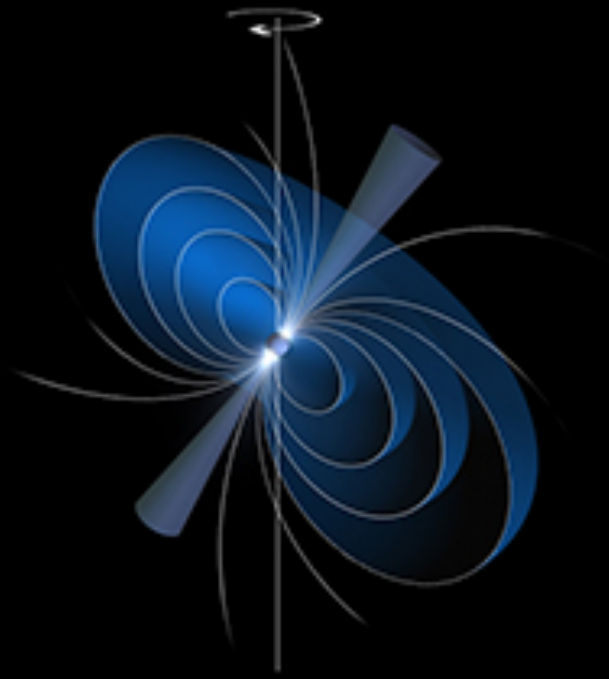


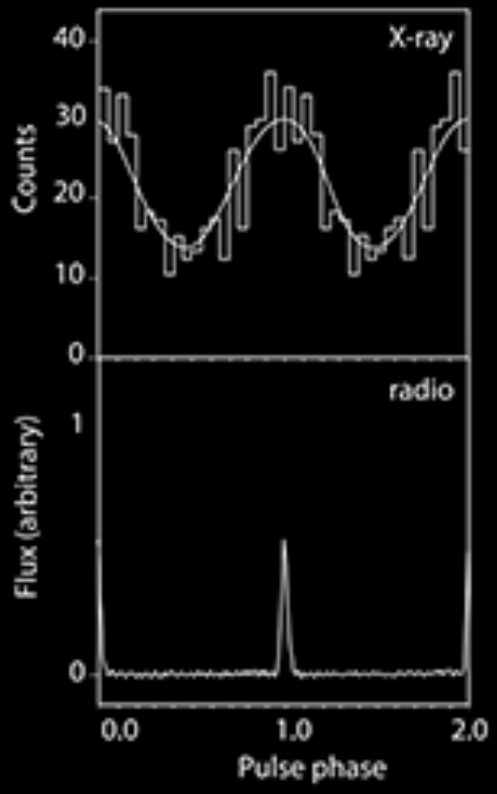
X-rays weak and unpulsed

Radio pulses bright and orderly

“B-Mode”

The “chameleon” pulsar B0943+10



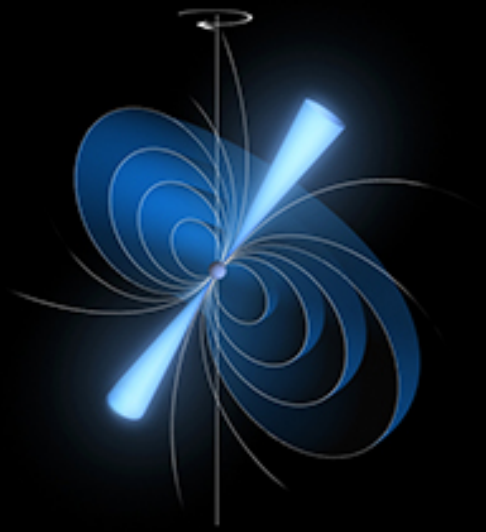


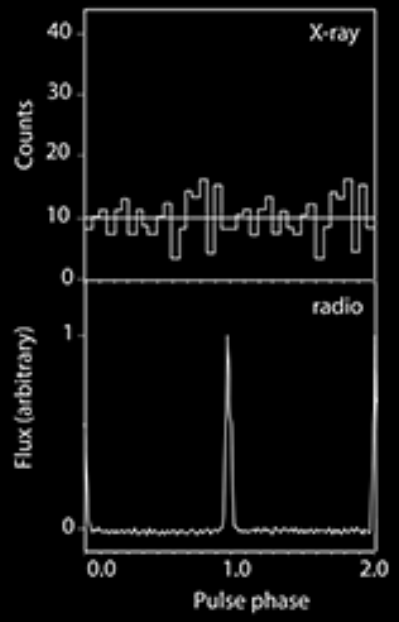
X-rays bright and pulsed

Radio pulses weak and disorderly

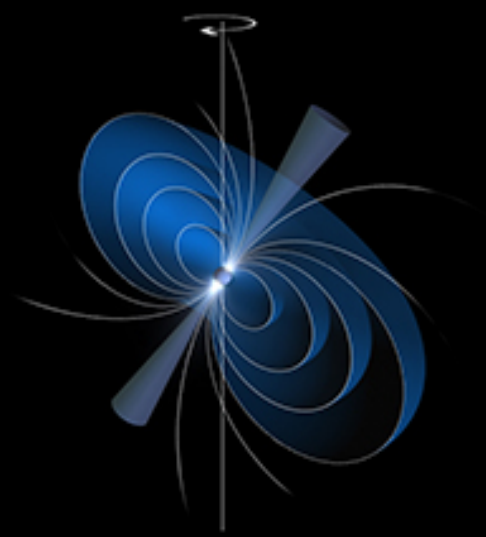
“Q-Mode”

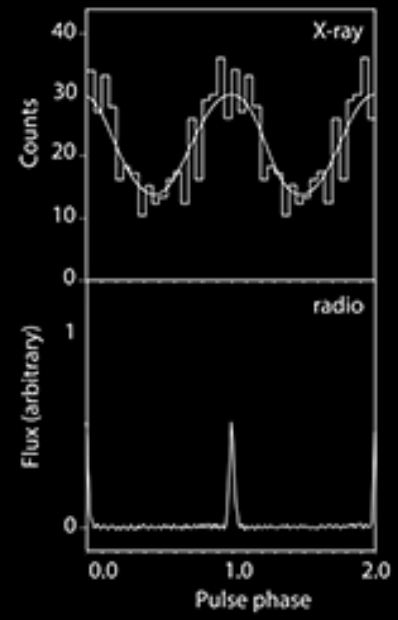
The “chameleon” pulsar B0943+10





“B-Mode”





“Q-Mode”

Are the X-ray pulsations thermal?

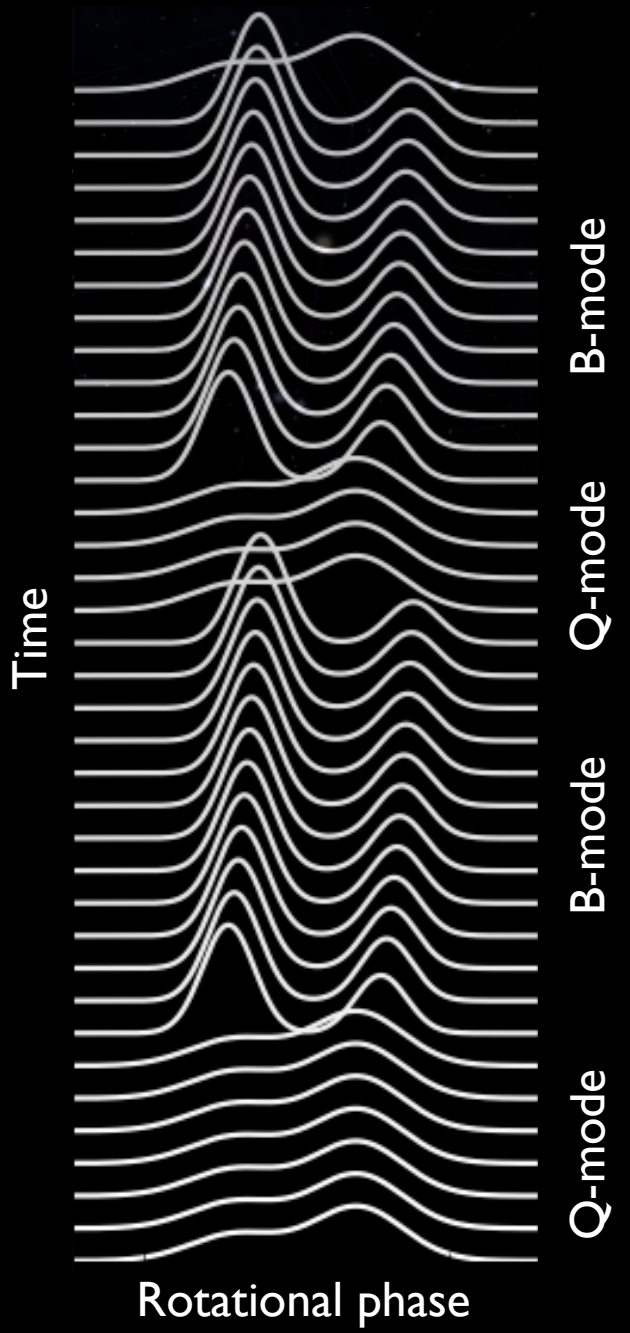
Are the B-mode X-rays also weakly pulsed?

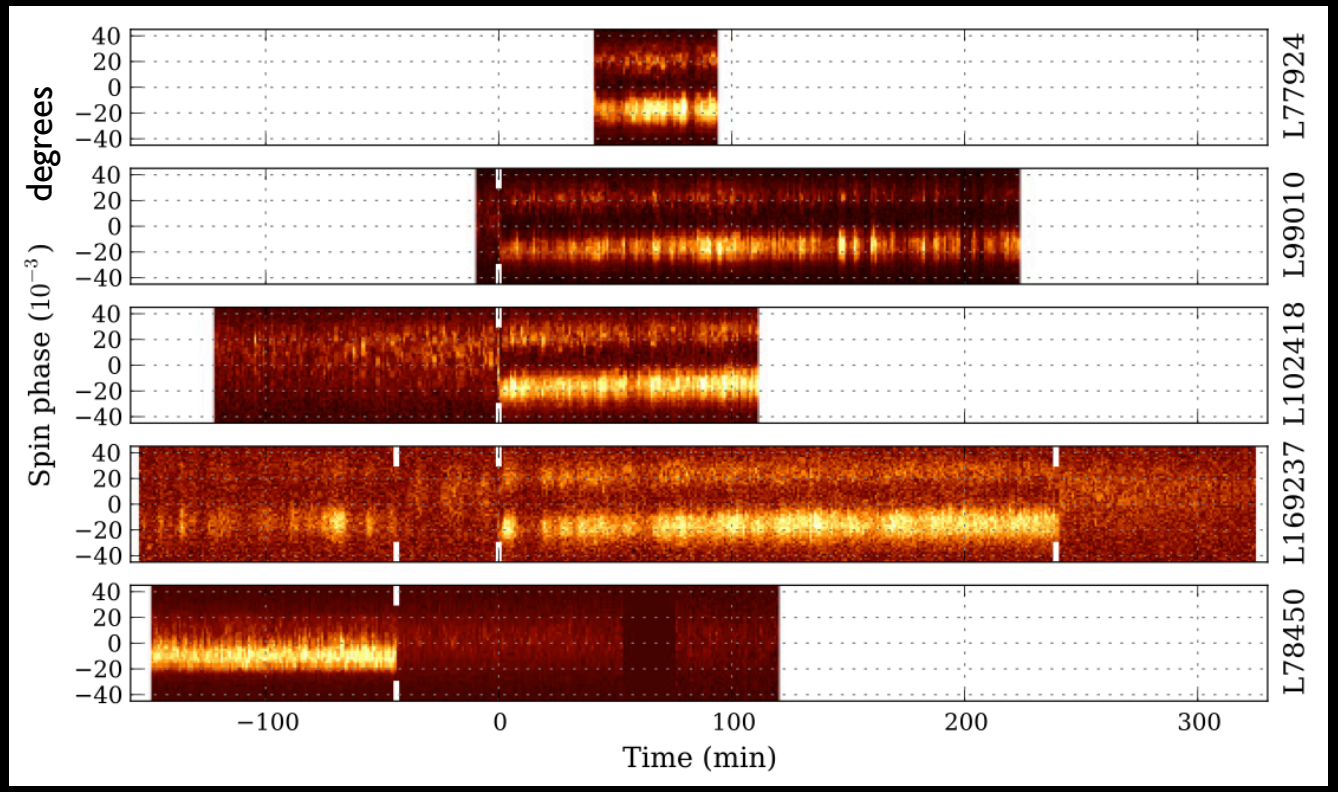
Do the X-ray properties evolve *during* the modes?

...need 3-4x more statistics

(i.e. a few more thousand photons)

PSR B0943+10 with the LBAs

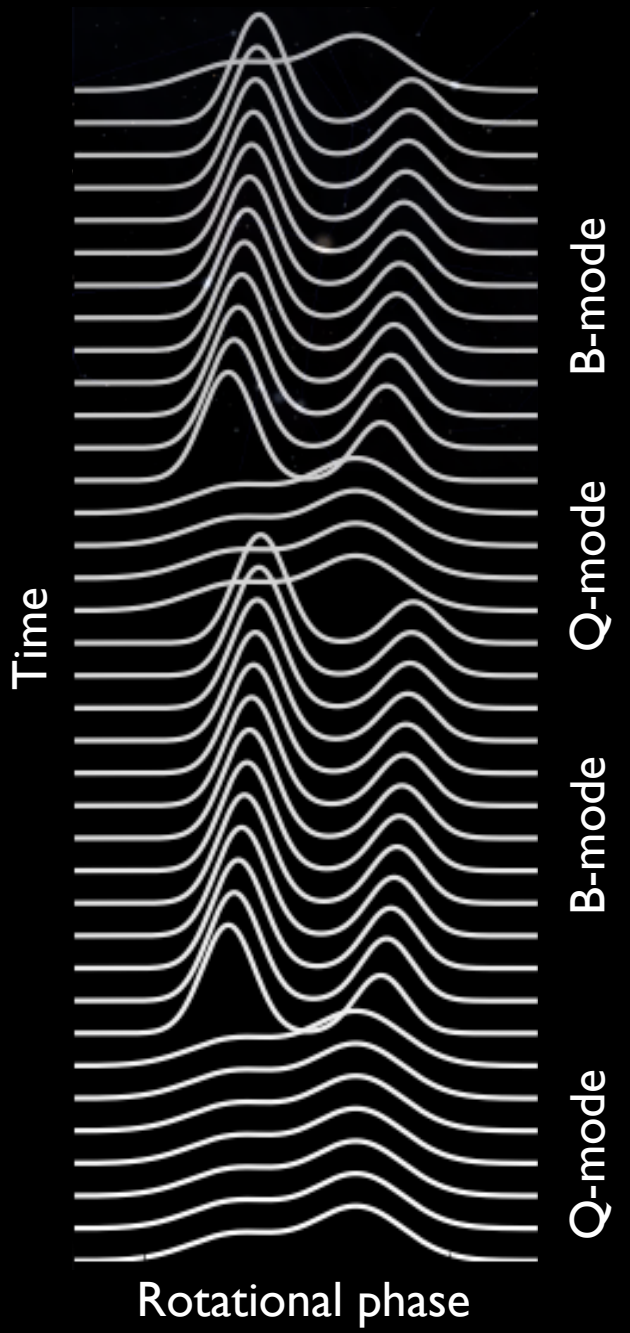


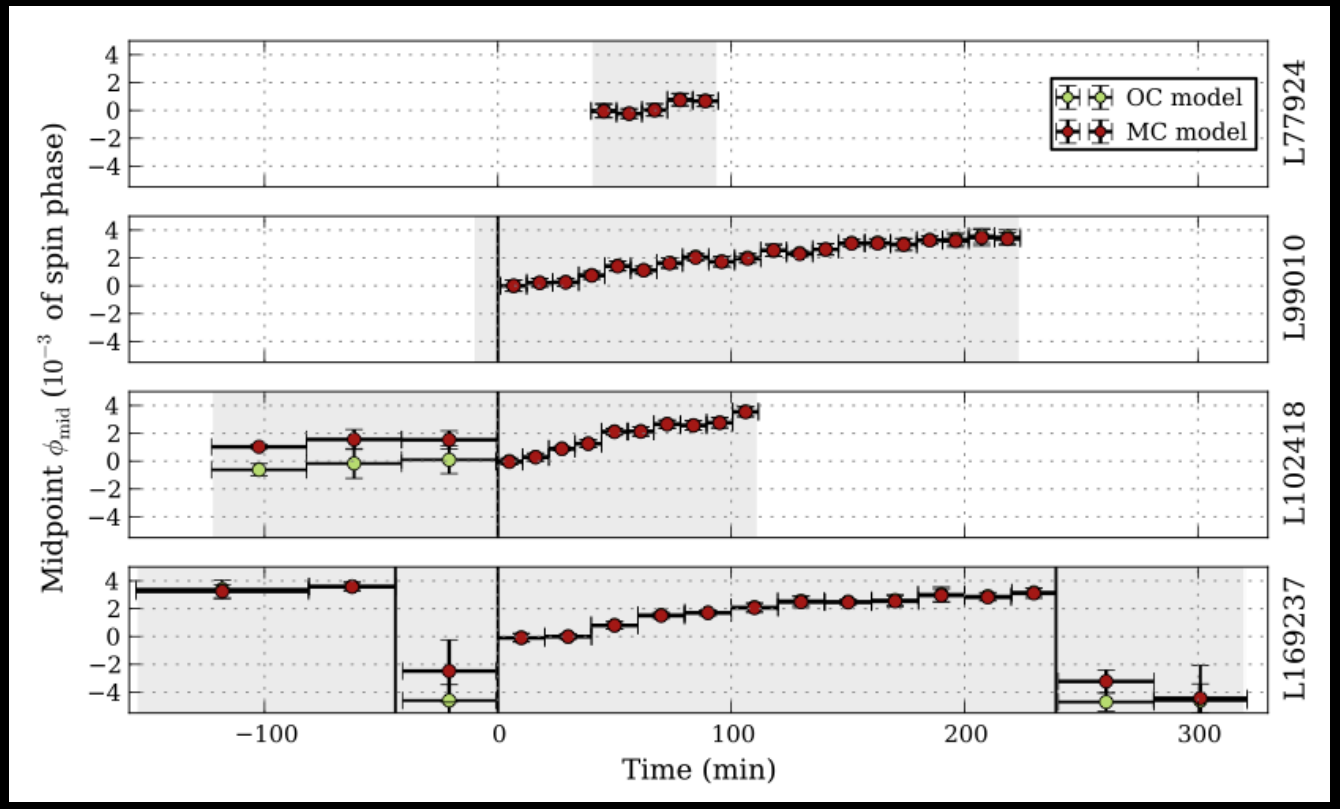


Discovery of a systematic B-Mode drift

Bilous et al. 2014, *A&A*

PSR B0943+10 with the LBAs





Discovery of a systematic B-Mode drift

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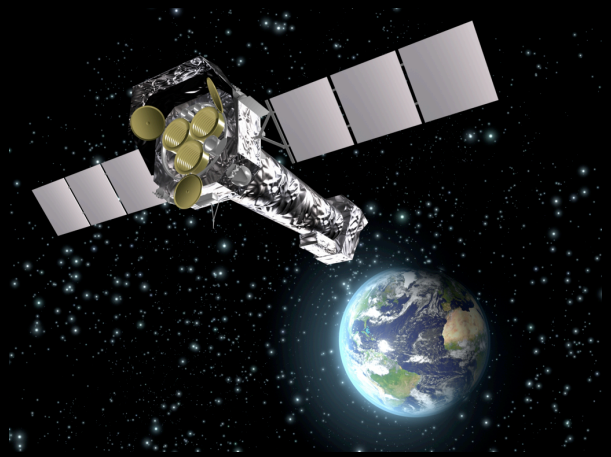
Main Telescopes + People



XMM-Newton

Wim Hermsen (SRON/UvA)
Lucien Kuiper (SRON)
Sandro Mereghetti (IASF)

LWA

Kevin Stovall (UNM)

LOFAR (international)

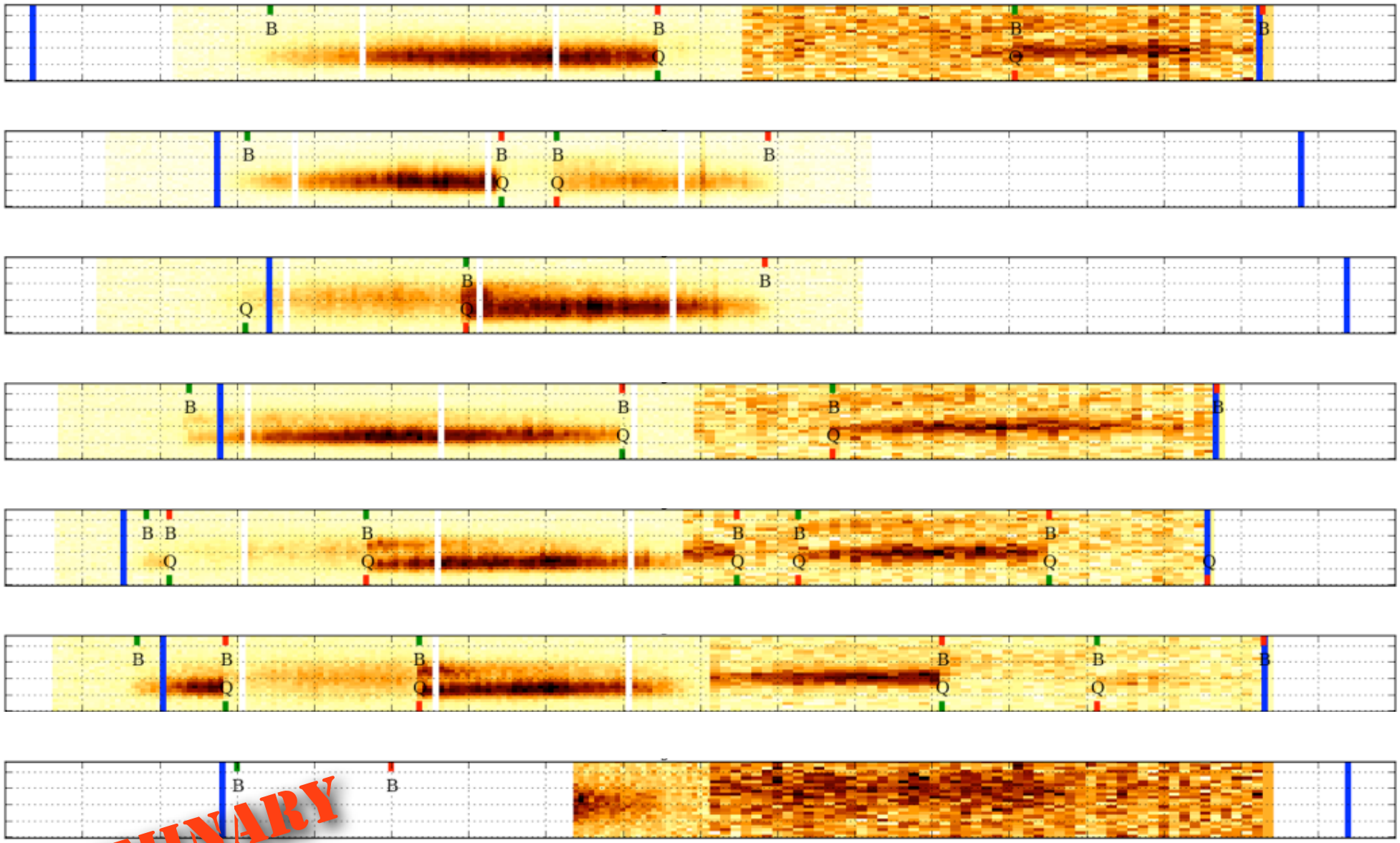
Jason Hessels (ASTRON/UvA)
Stefan Oslowski (U. Bielefeld)
Maciej Serylak (UWC)

Arecibo

Joanna Rankin (U. Vermont)
Andrea Possenti (OAC)

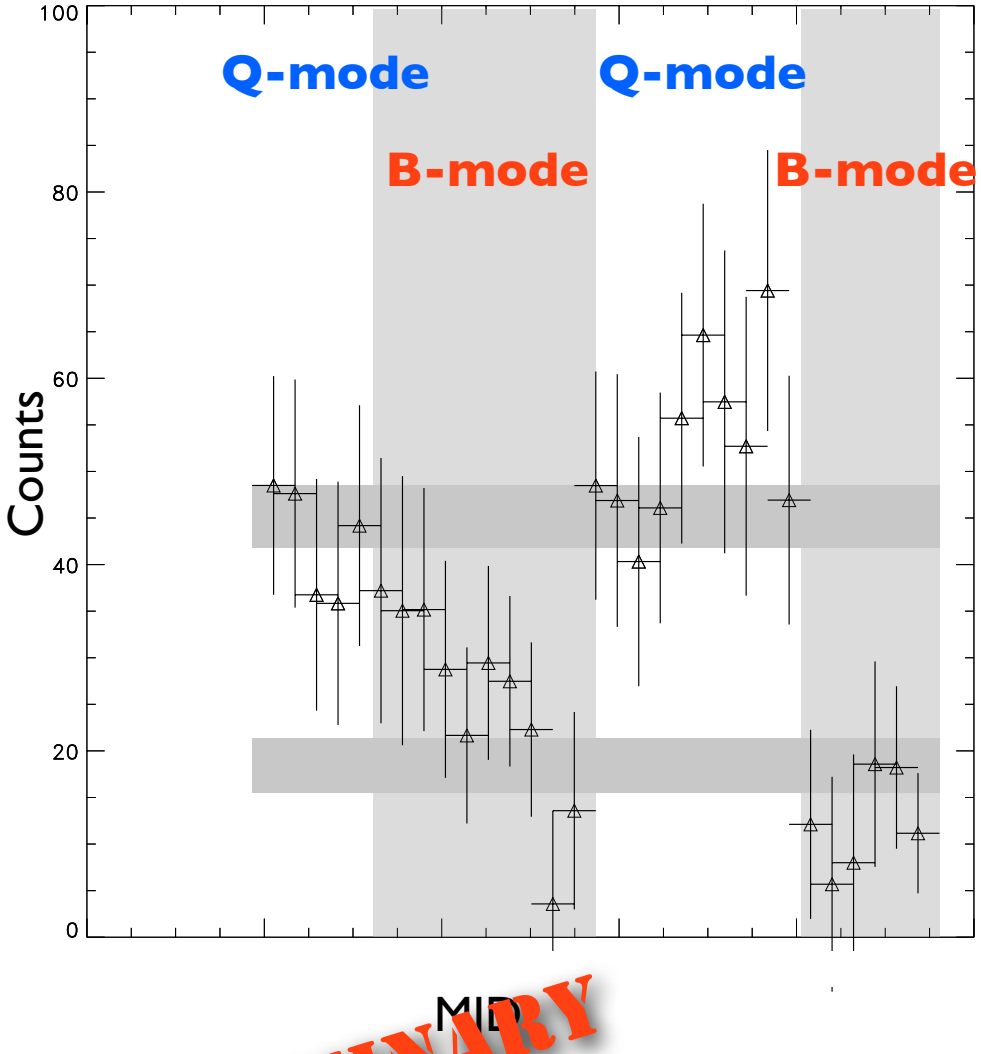
"Some science just takes time"

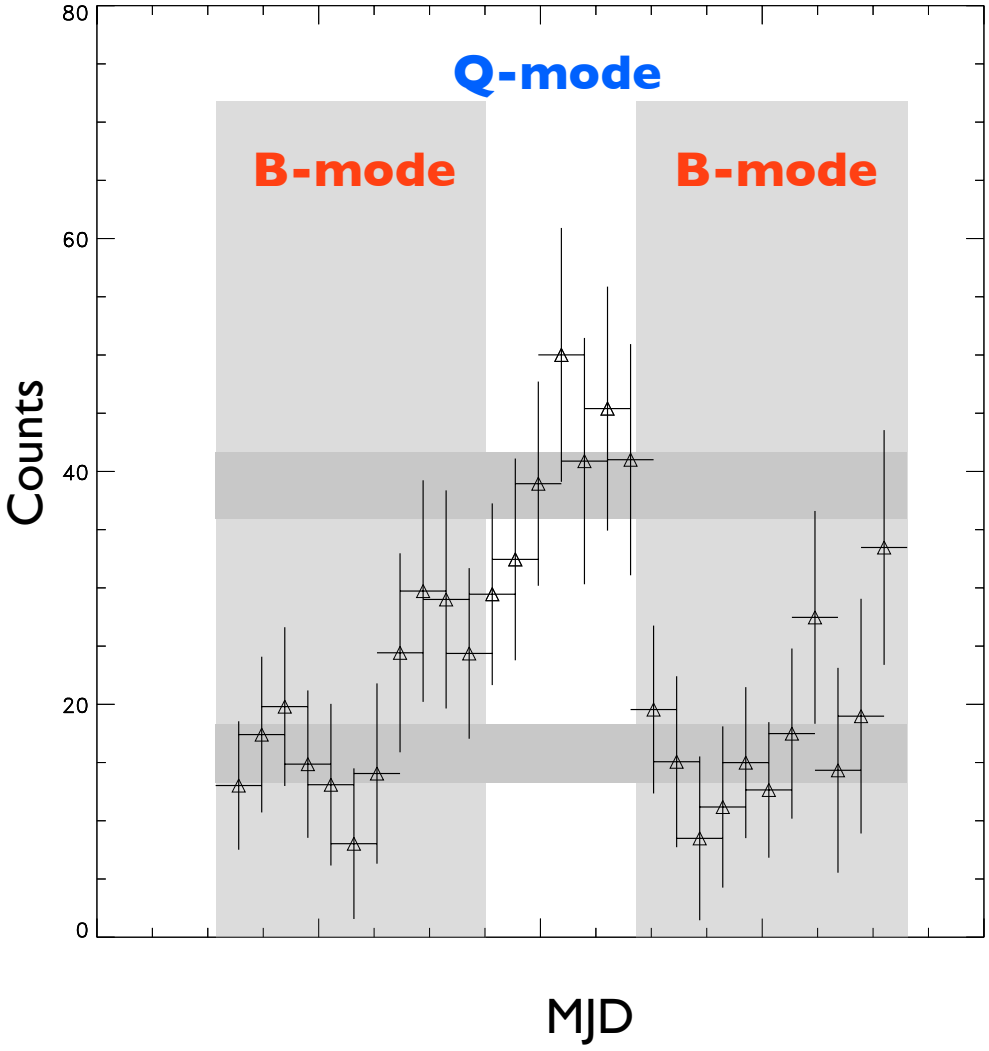
LOFAR+LWA Data



Roughly 110hrs (400ks) of new data

Sample XMM-Newton Data





PRELIMINARY

Roughly 110hrs (400ks) of new data

Summary

- Simultaneous X-ray/radio mode-switching is confirmed.
- Enough X-ray photons to conclusively establish the spectrum.
- Preliminary hints that the X-ray properties also evolve during modes.
- Really nice use of the LOFAR Int. stations and LWA.
- Trying same experiment with B1822-09, but only few pulsars are suitable for such a campaign.