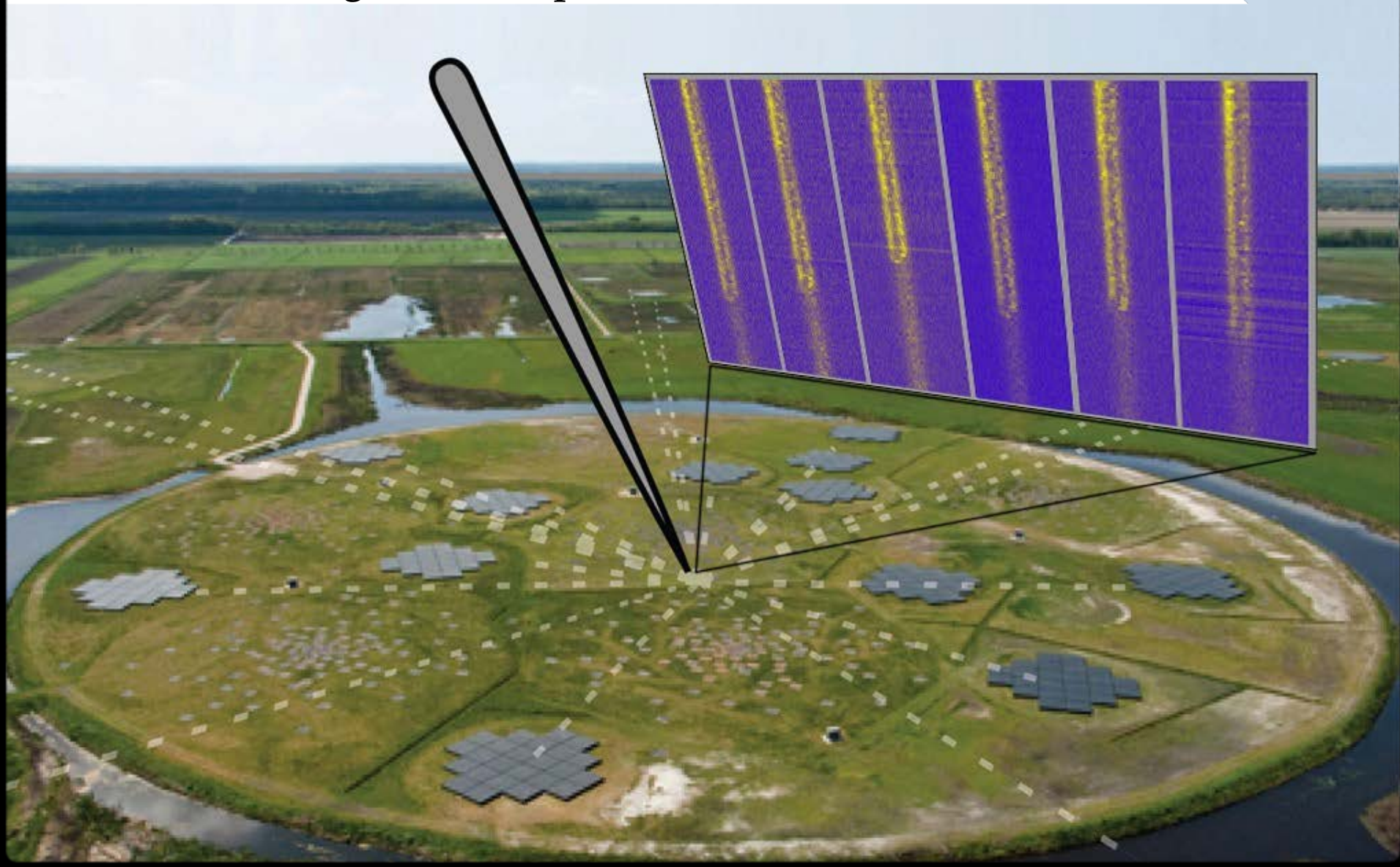
Joeri van Leeuwen

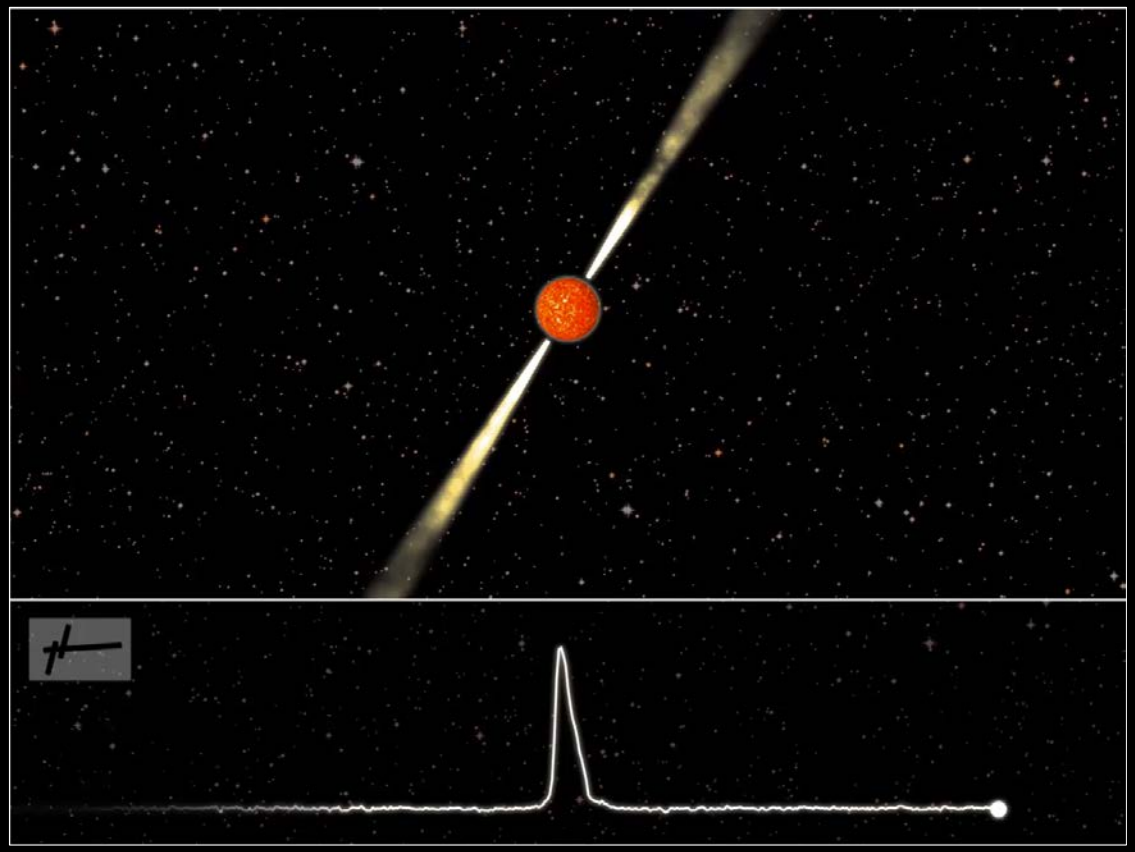
Pulsar mode changes and subpulse drift



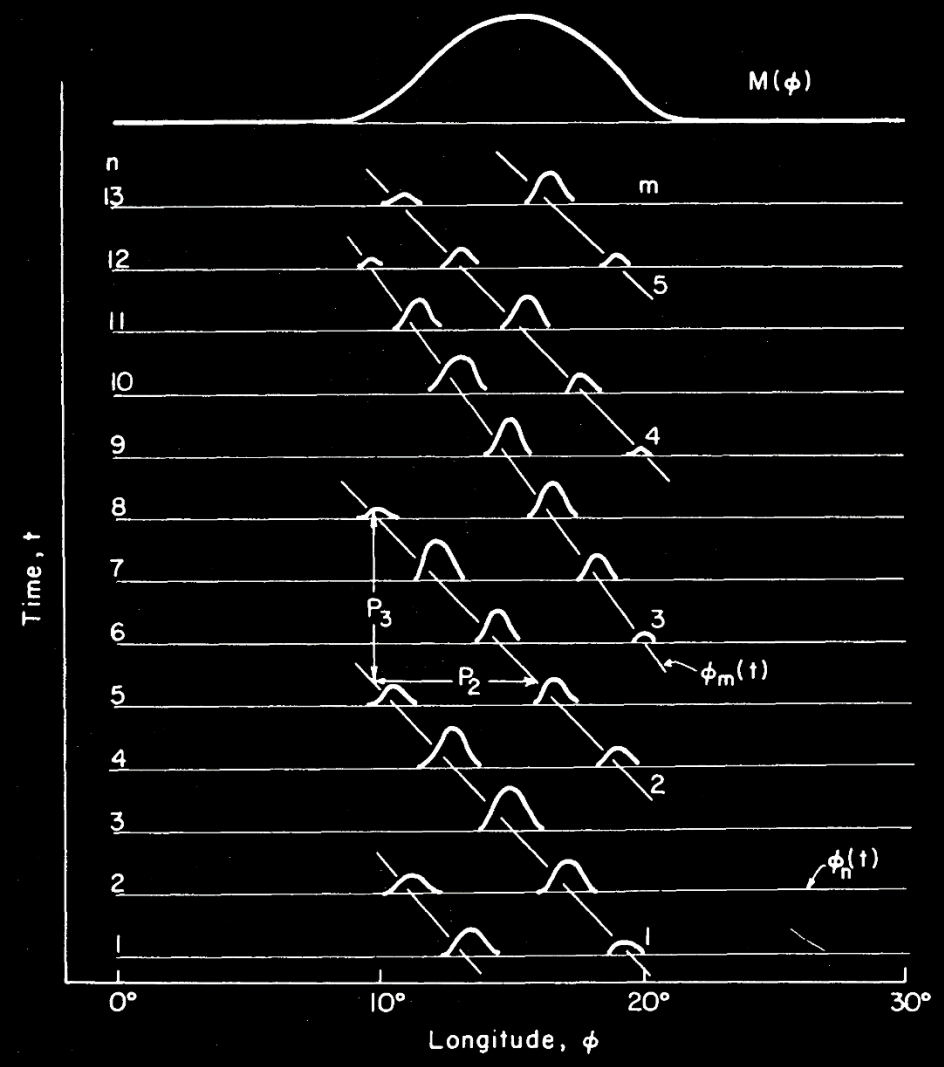
Pulsars: cosmic lighthouses

Join the 21st century already!

`http://www.astron.nl/pulsars/animations/`



Moding and drifting -- B0943+10 data



Backer (1977)

Mode changes and/or subpulse drift in four pulsars

PSR B0809+74

Very bright (B) and stable. But with nulls, then Quiet (Q) ?

PSR B0826-34

Drift-reversals in B mode; RRAT-like and bursty in Q mode

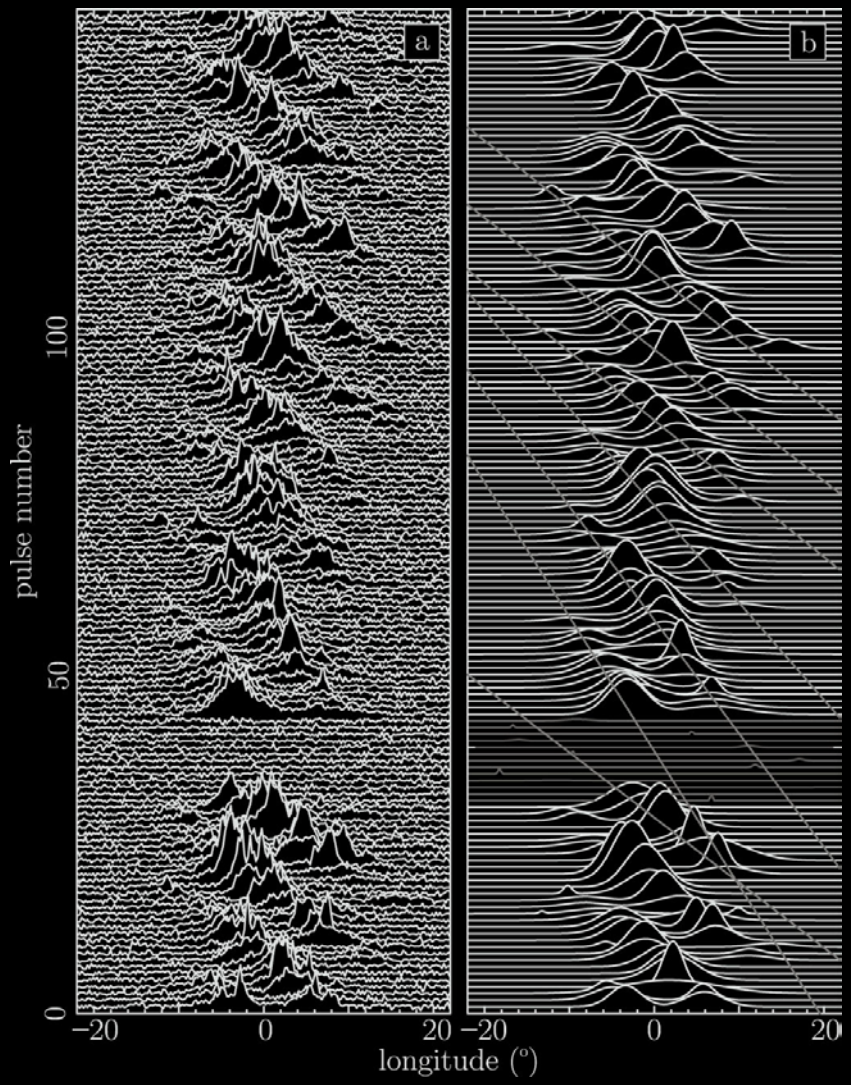
PSR B0815+0393

Bi-drifting (?) in B mode; existence of Q mode yet unknown

PSR B0943+10

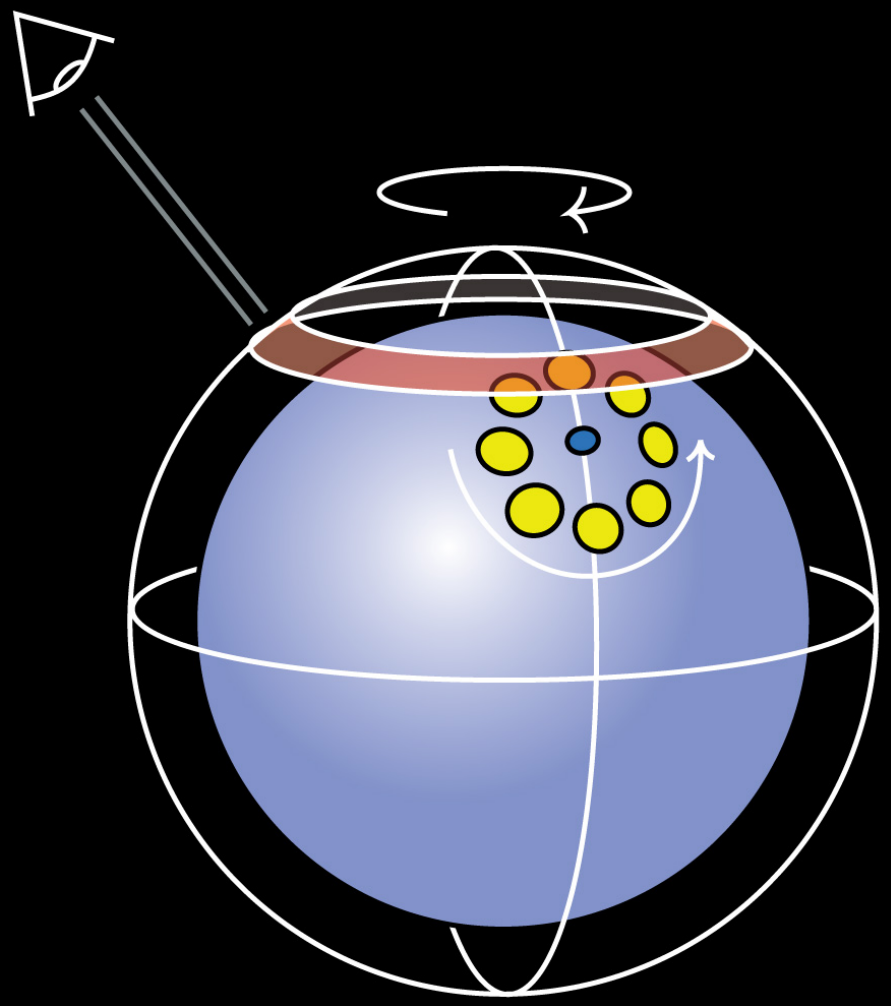
Stable drifting in B mode; chaotic in Q mode; x-ray source

The problem: subbeams move very slowly (cf. B0809+74)



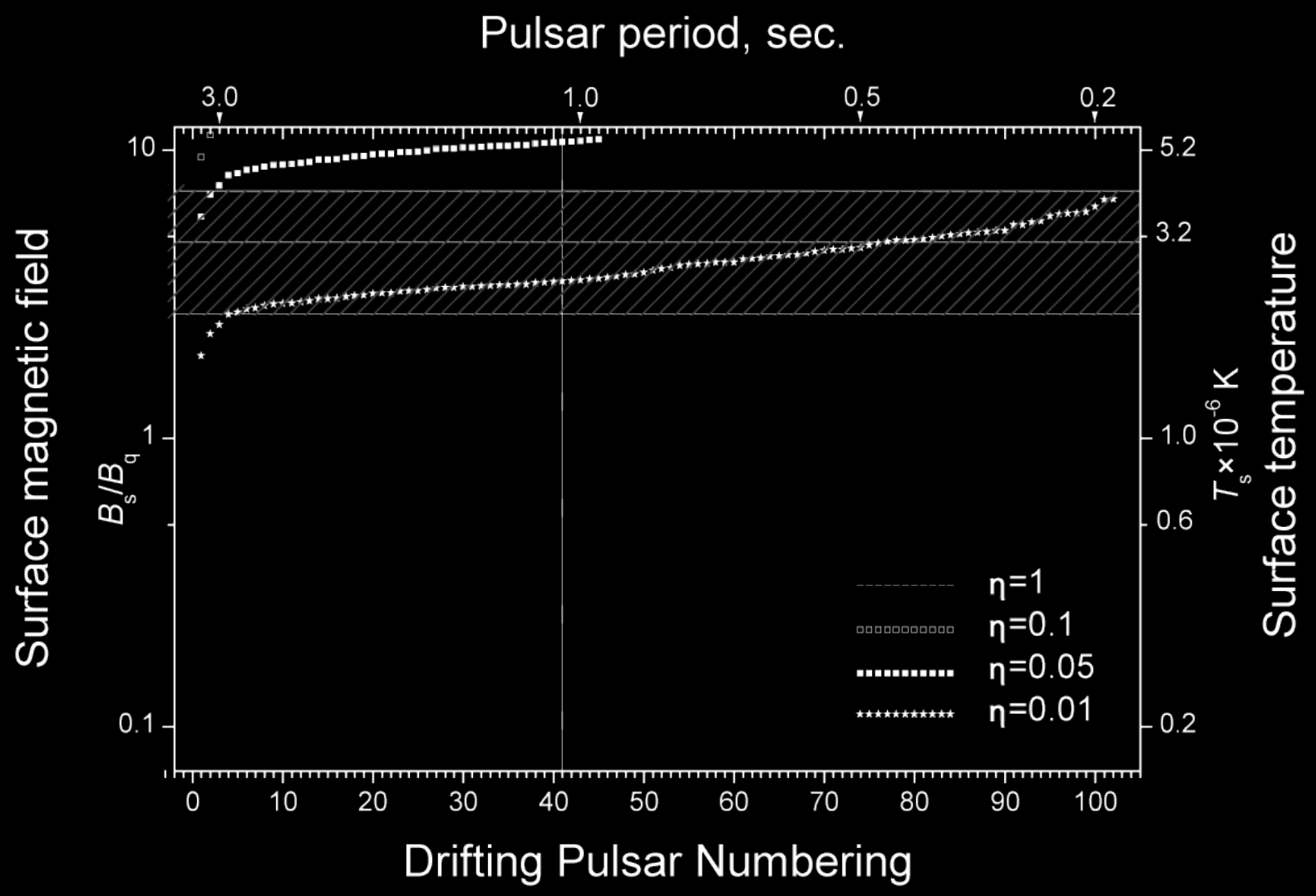
van Leeuwen et al. 2003

The basic ExB model (Ruderman & Sutherland 1975)



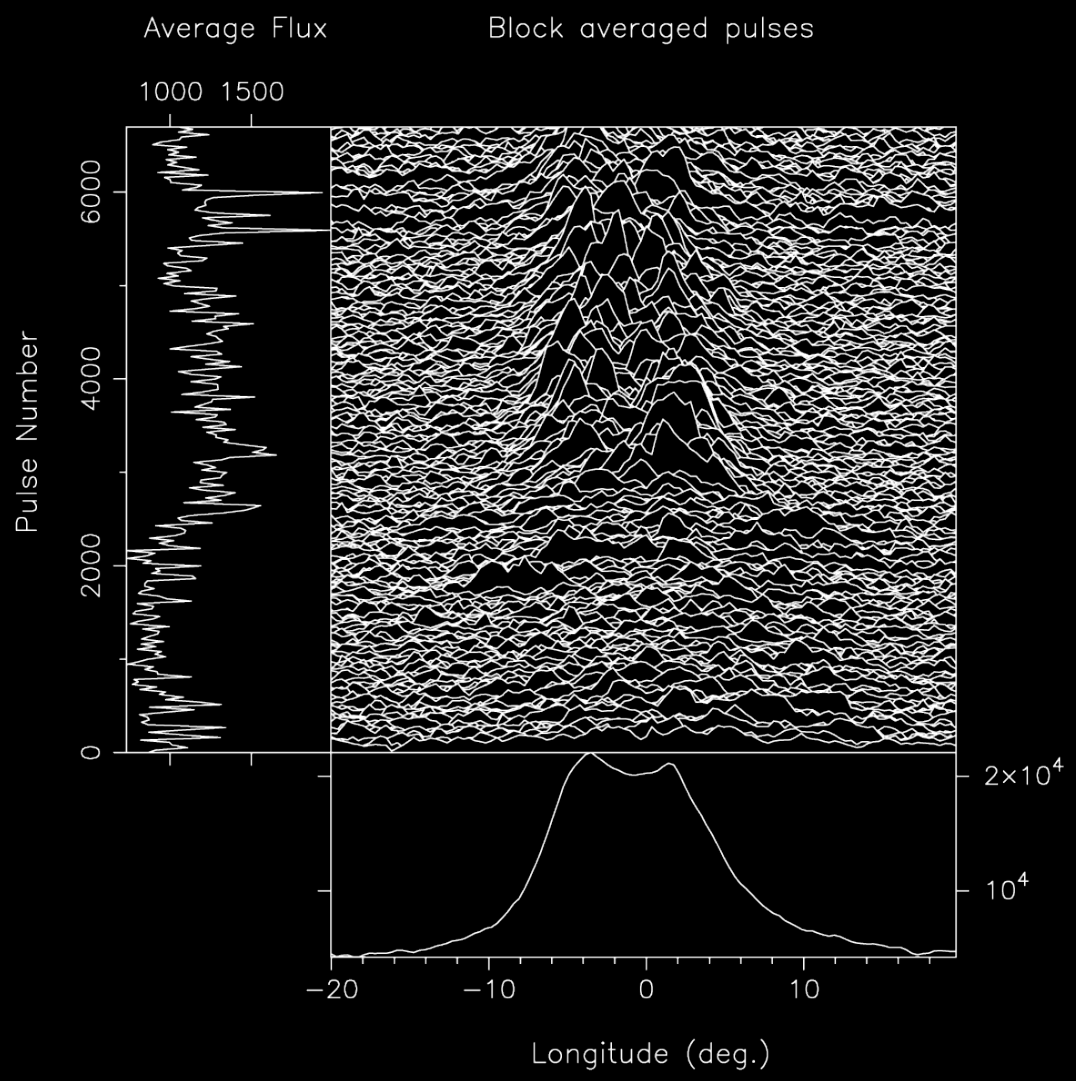
van Leeuwen 2004

A solution: a partially screened gap



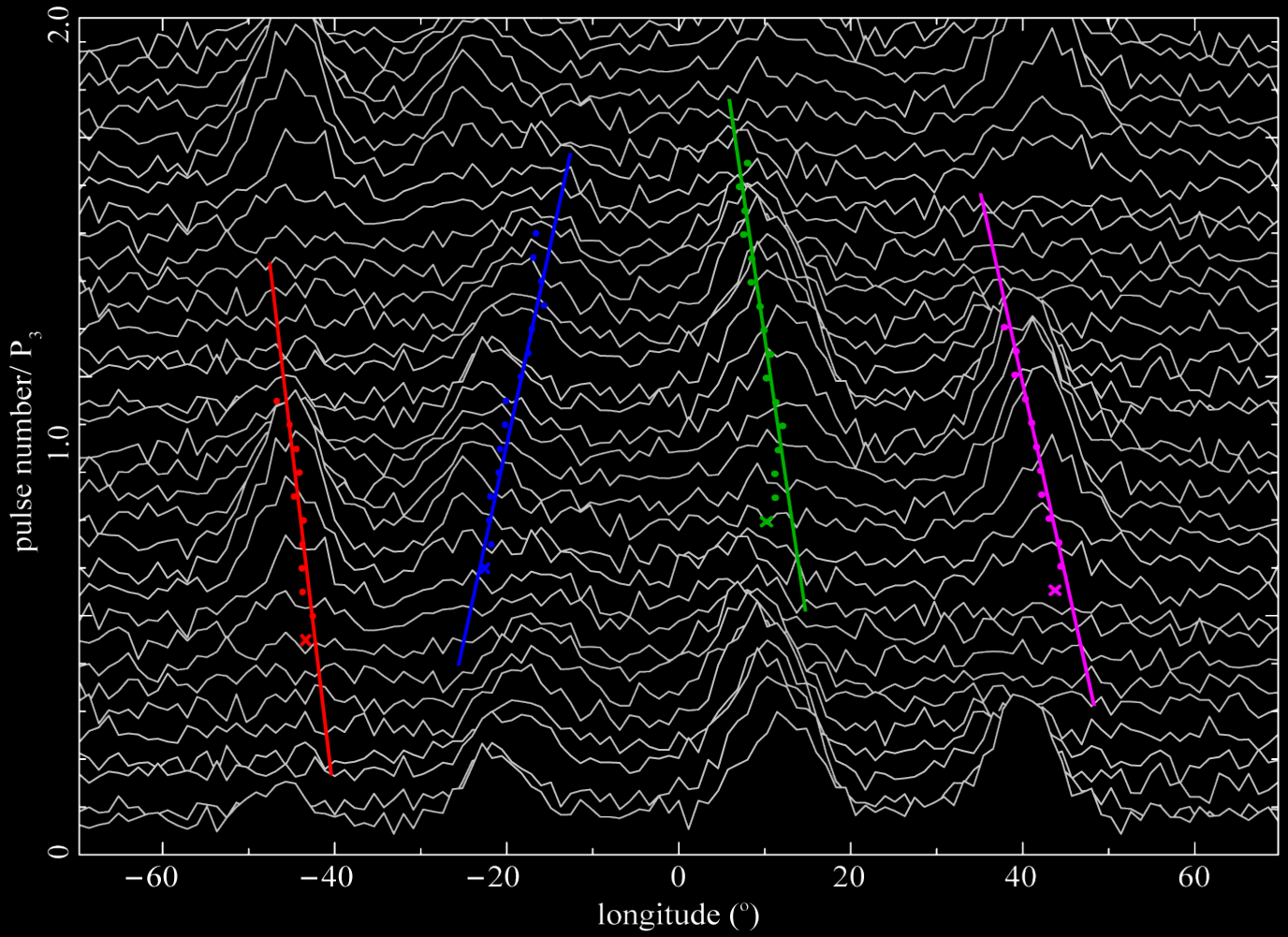
Gil et al. (2006)

A solution: a partially screened gap



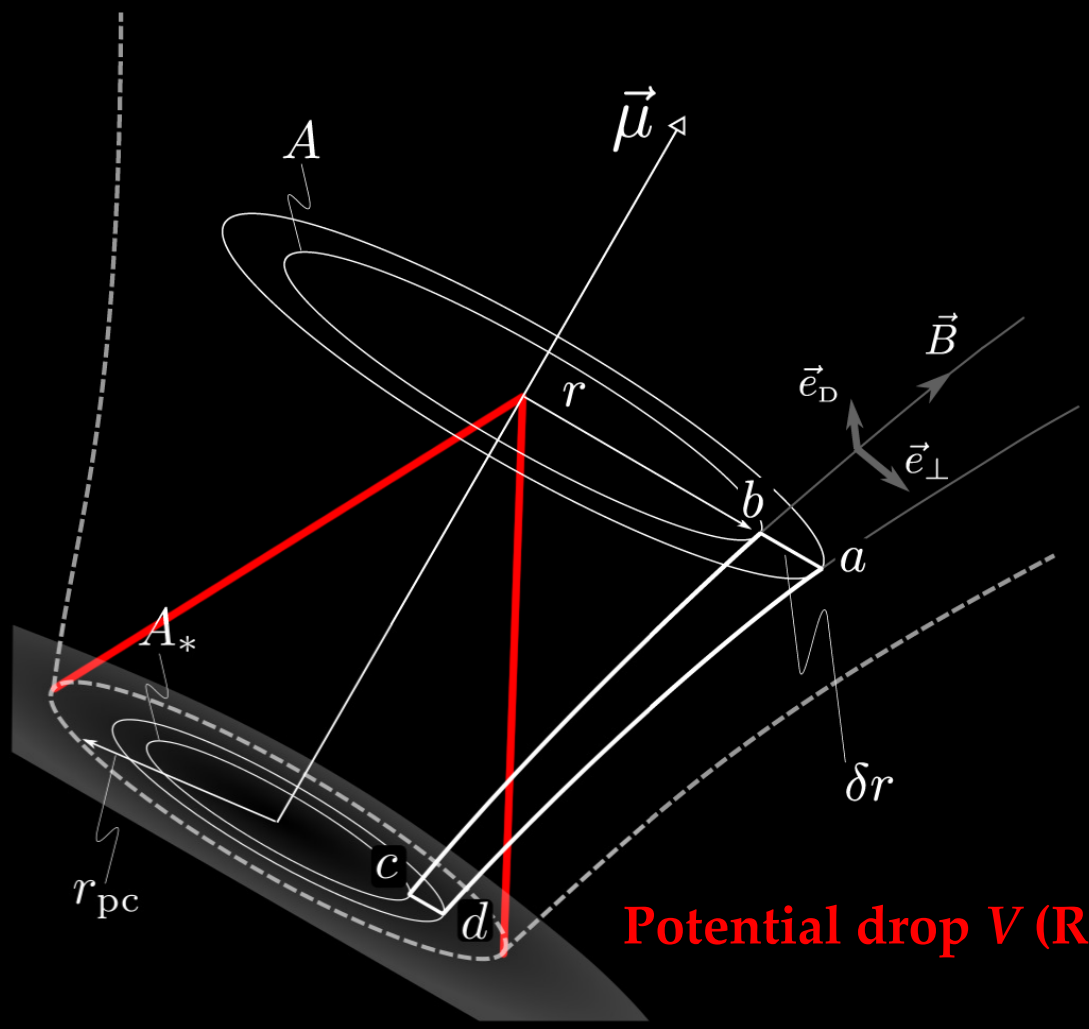
Rankin et al. (2004)

A solution: a partially screened gap – PSR 0815+0393



Szary & van Leeuwen (2016)

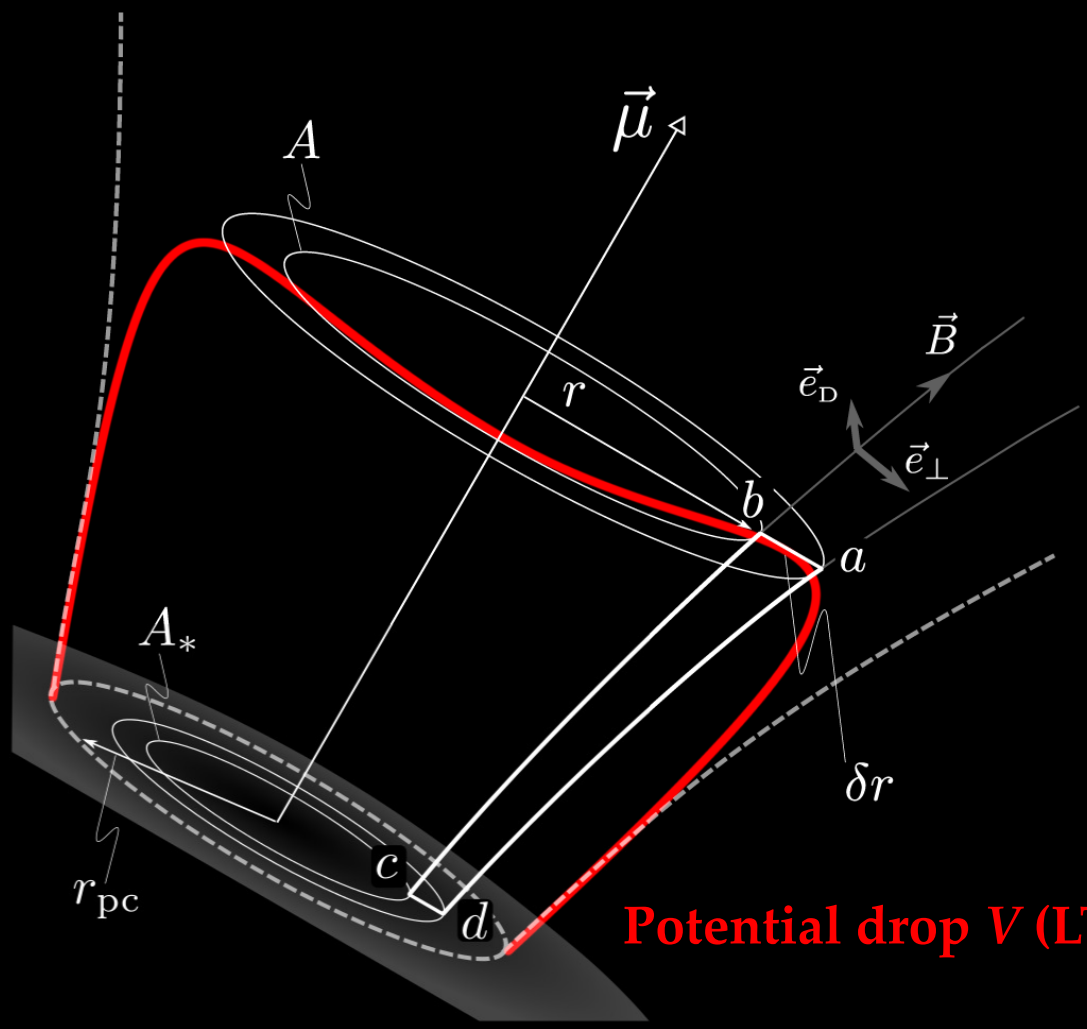
Other solution: use the actual dV/dr



Potential drop V (RS75)

van Leeuwen & Timokhin (2012)

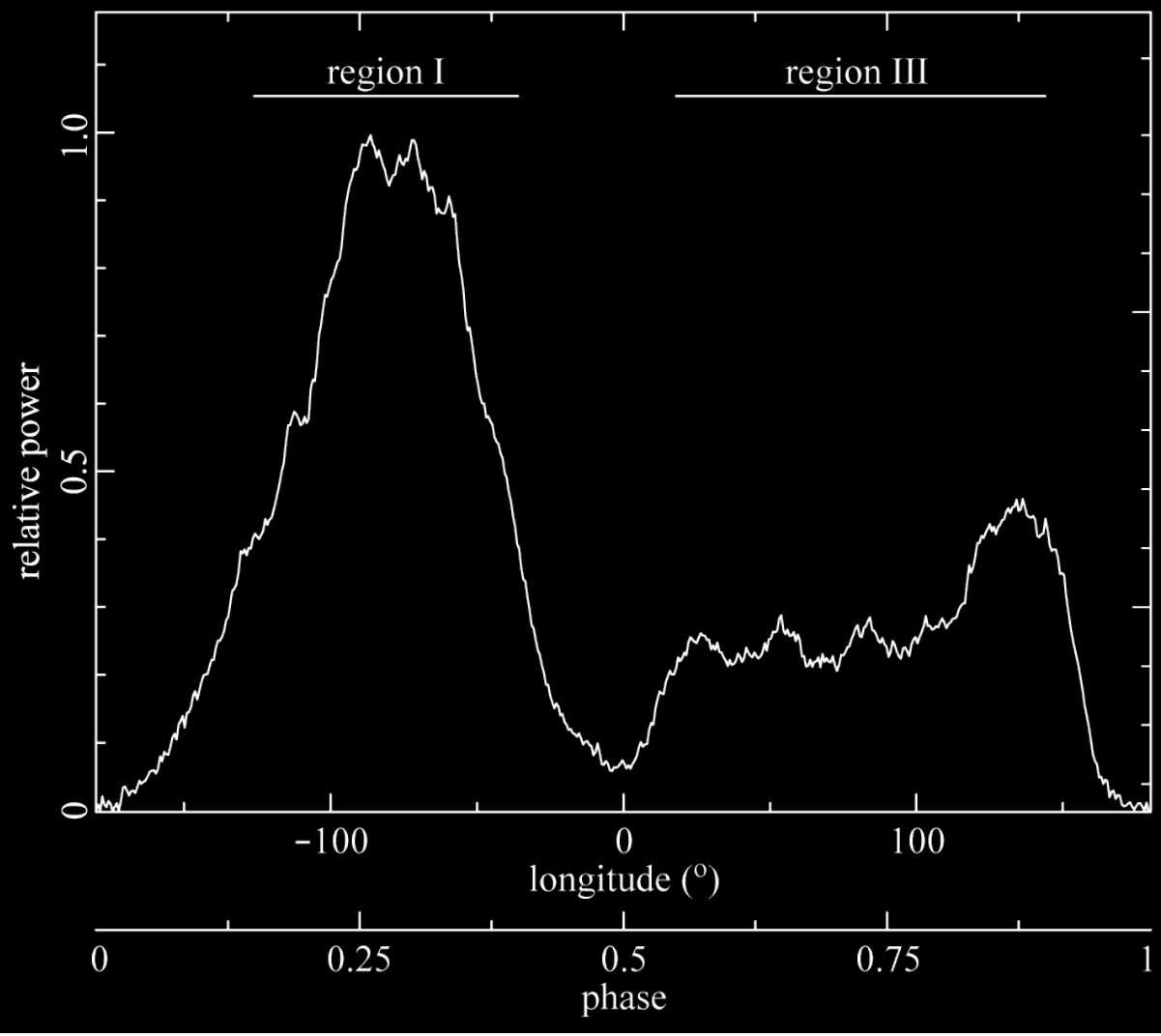
Other solution: use the actual dV/dr



Potential drop V (LT12)

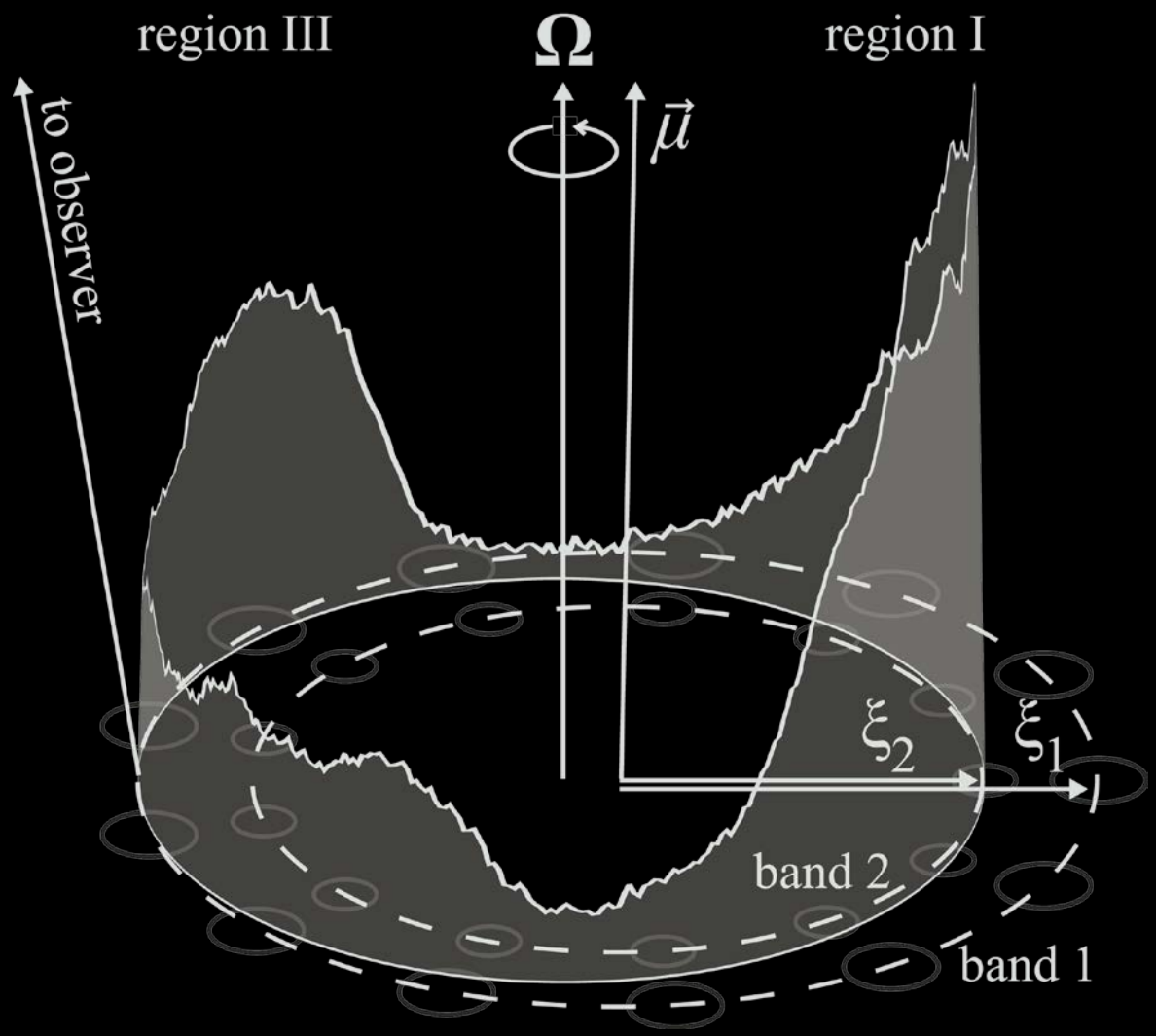
van Leeuwen & Timokhin (2012)

PSR B0826-34: fortuitous geometry



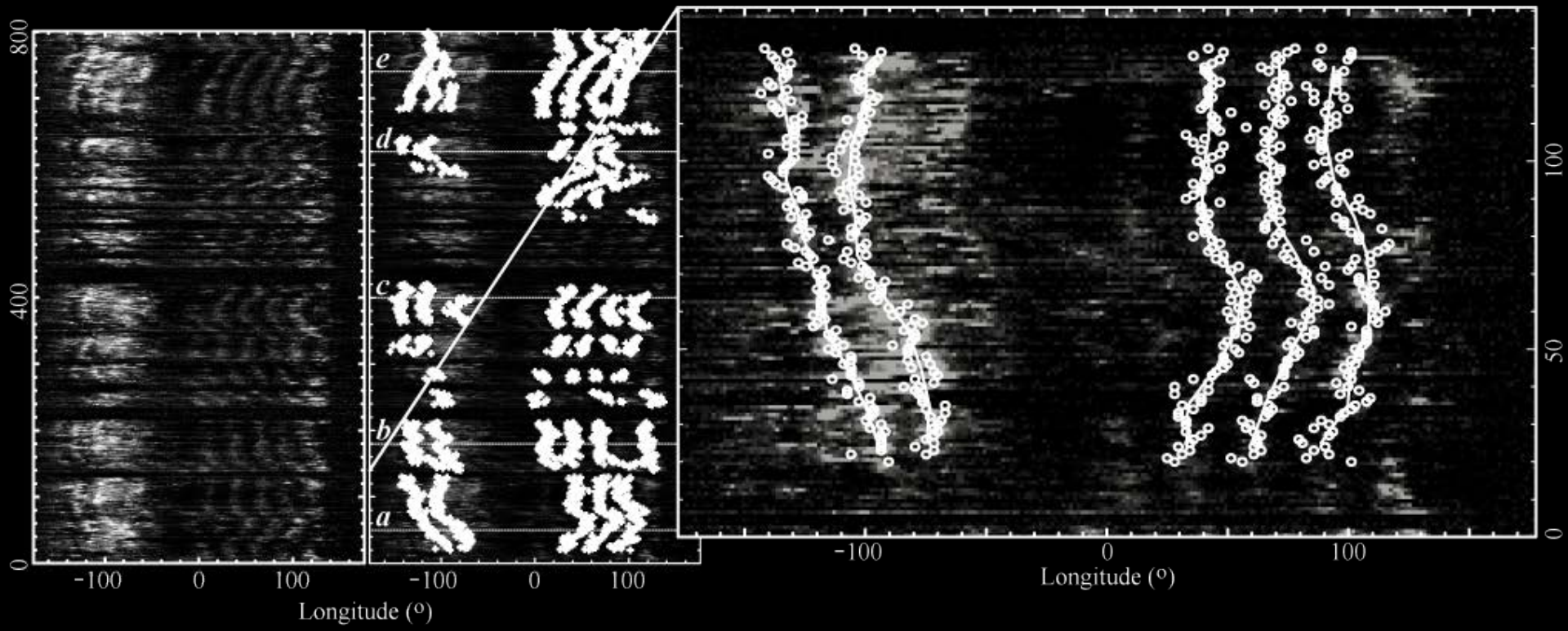
van Leeuwen & Timokhin (2012)

PSR B0826-34: fortuitous geometry



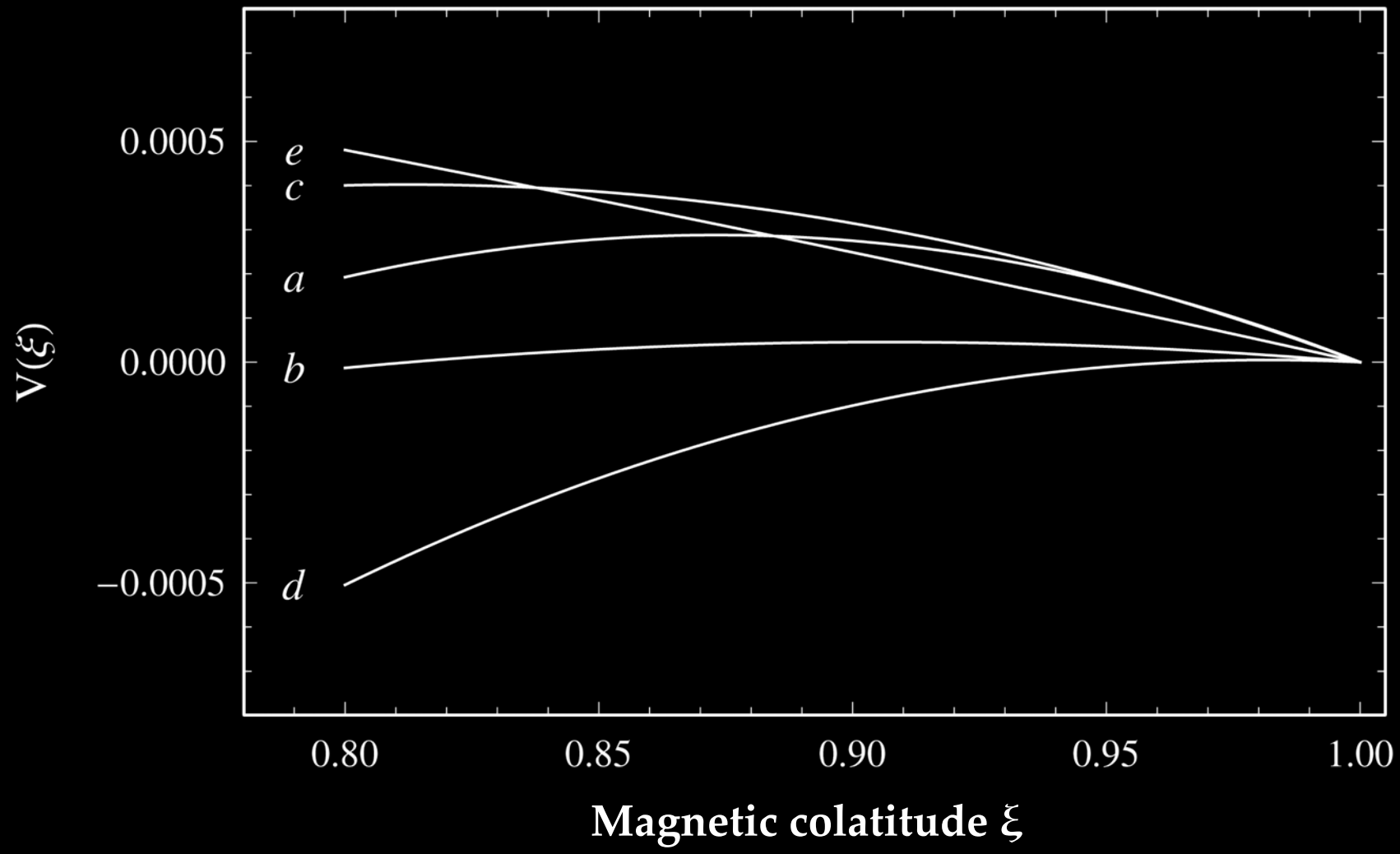
van Leeuwen & Timokhin (2012)

PSR B0826-34: both steady and varying drifting



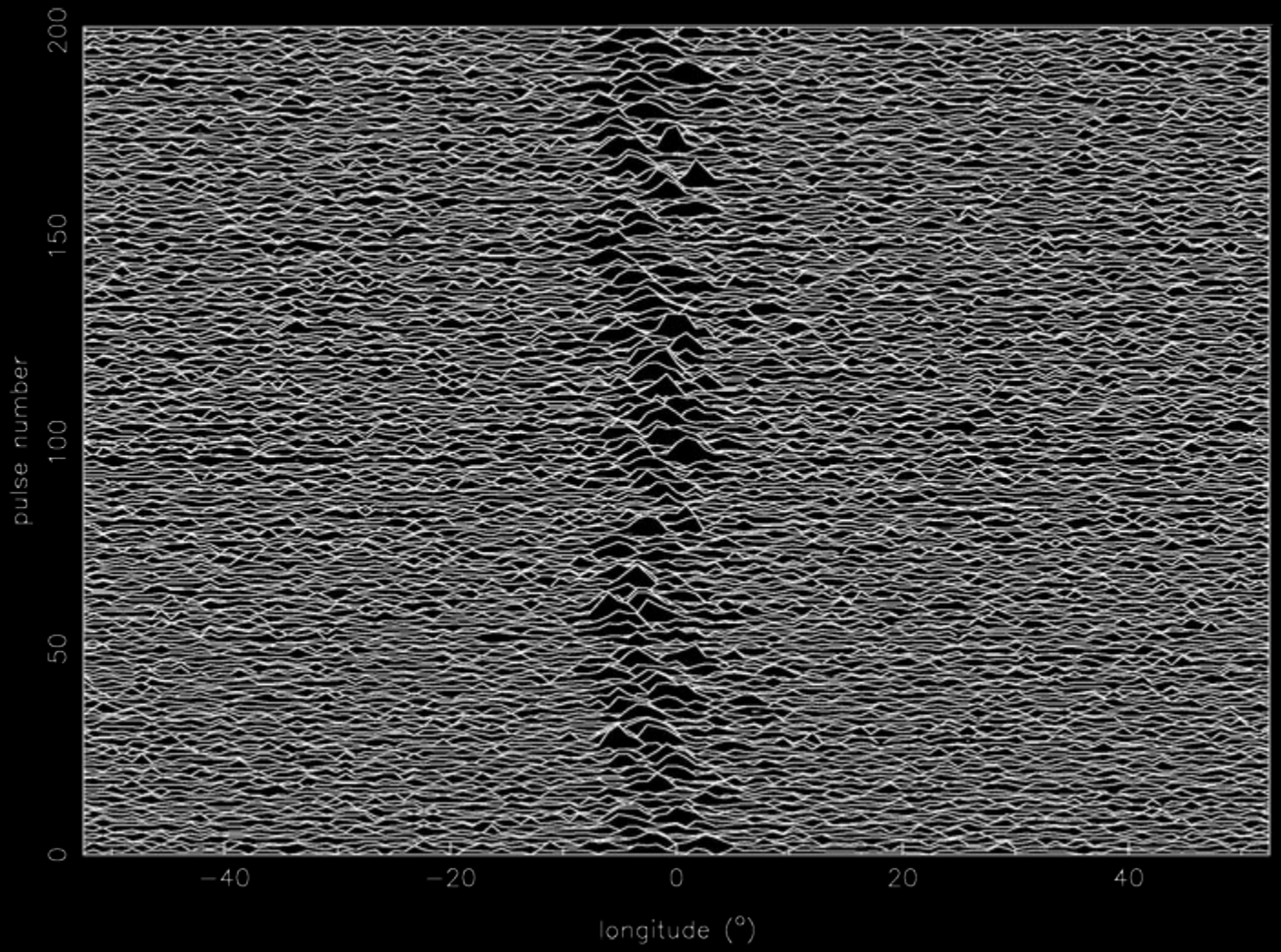
van Leeuwen & Timokhin (2012)

PSR B0826-34: A very *clean machine*



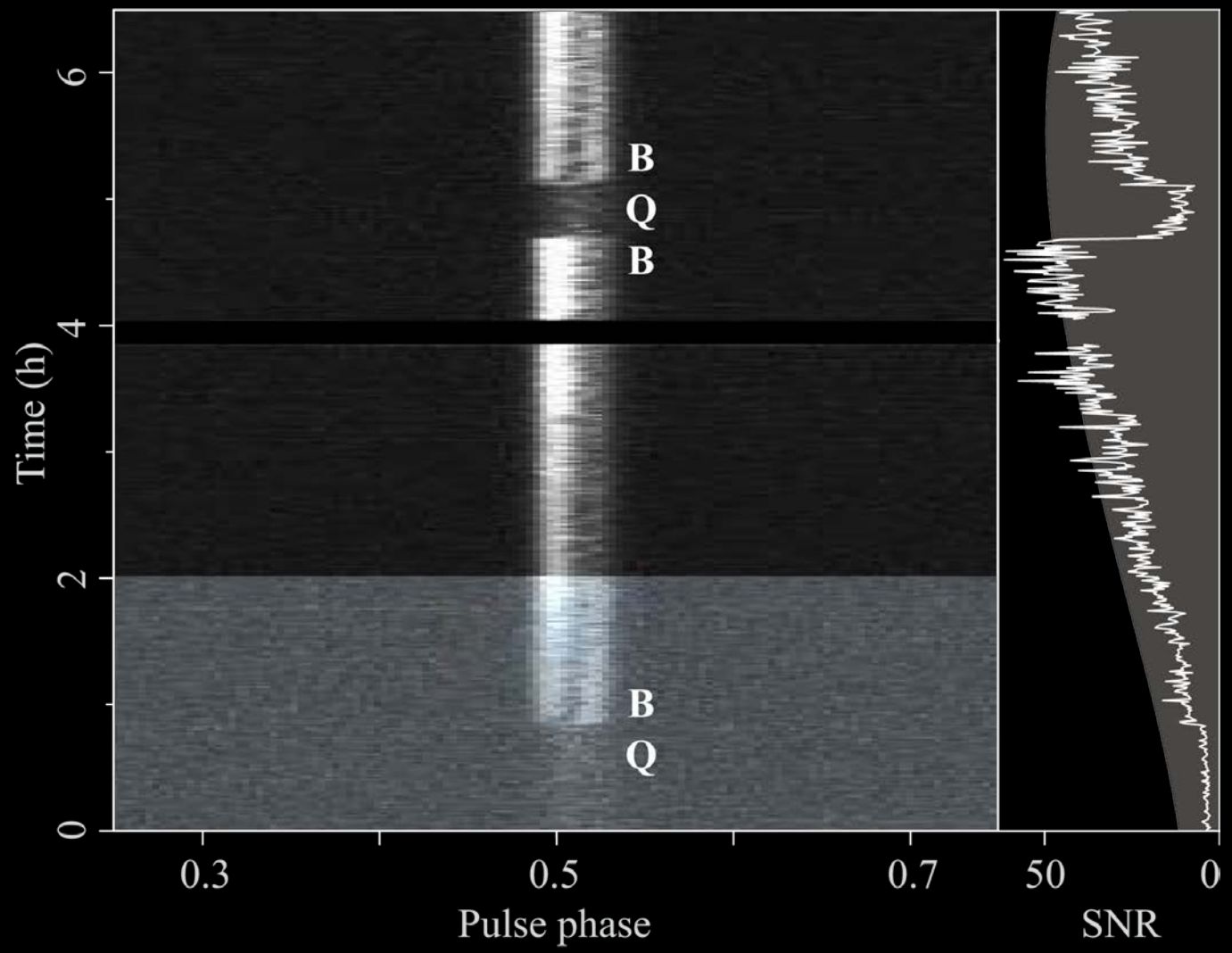
van Leeuwen & Timokhin (2012)

Moding and drifting -- B0943+10 data



van Leeuwen et al. (2016)

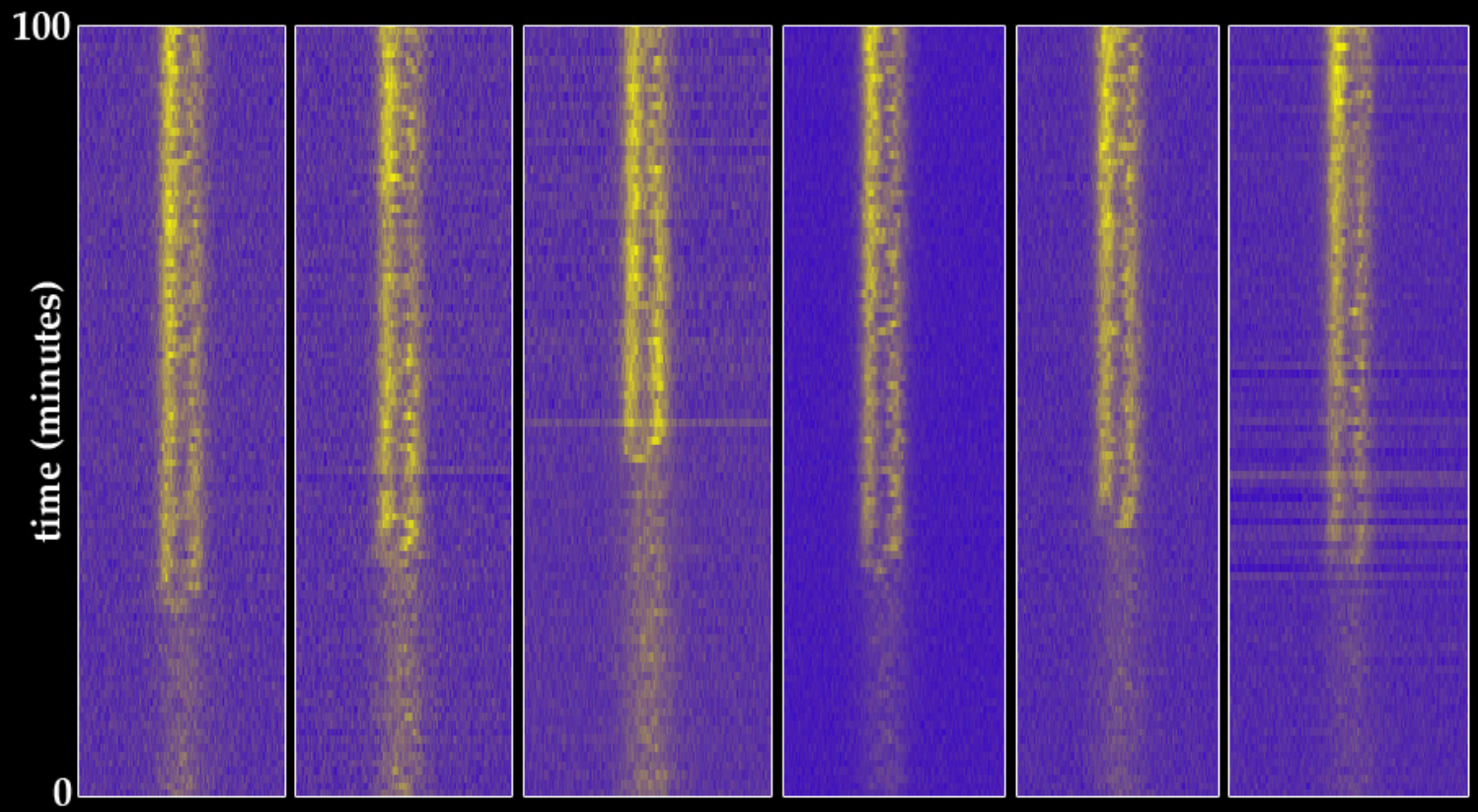
B0943+10 with LOFAR



Hermsen et al. (2013)

Large sample of radio B <-> Q mode transitions

Including high-S/N single pulse / single x-ray photon studies.

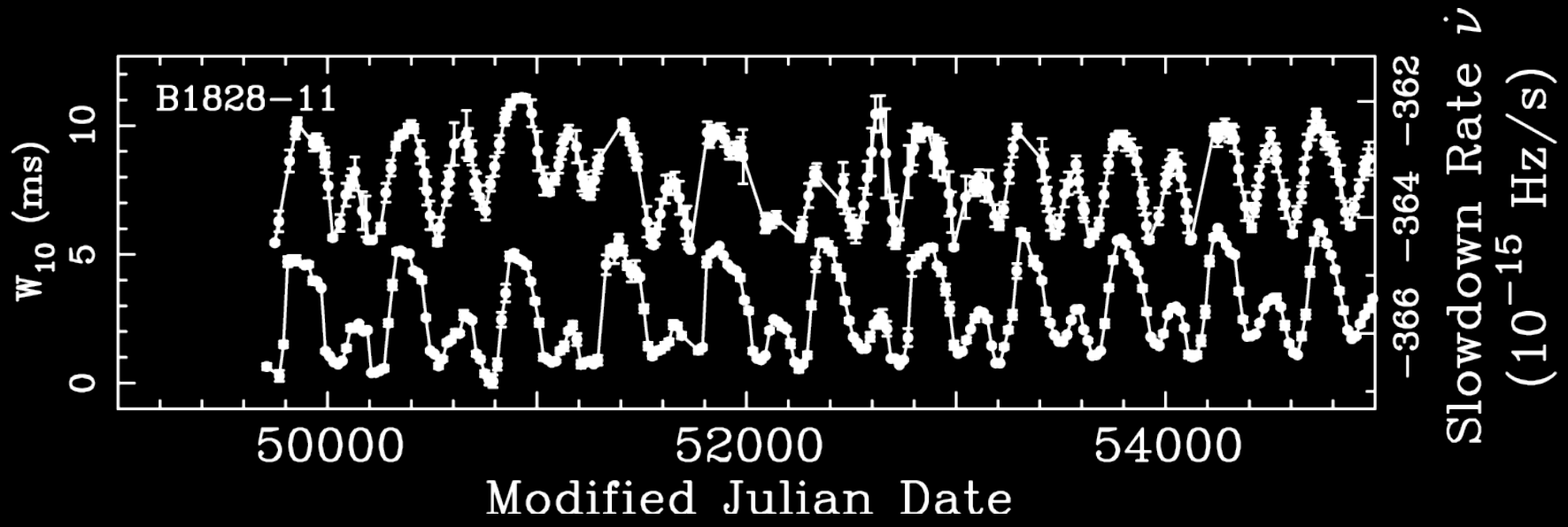


van Leeuwen et al. 2016 (*in prep.*) ; also Bilous et al. 2016 (*in prep.*)

Interest in mode changes

PSR B1931+24 was the first pulsar shown to cease emitting for tens of days, then spin down ~50% less rapidly (Kramer et al. 2006).

Several other pulsars display smaller changes in spin-down rate that correlate with changes in pulse shapes (Lyne et al. 2010).



Conclusions

LOFAR data will dive more in to the 1s – 8hr behavior of B0943+10.

Time variable drifting (including reversals) in B0826-34 can be explained with little variation (~1E-4) of the potential drop over 20% of polar cap.

What causes these variations? And, what determines the drifting 2nd modulation (20 Hz in a 1 Hz pulsar)? Or the nulling / moding time scales 1 s – 100 days ..