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Galactic Compact Objects and Radio Transients

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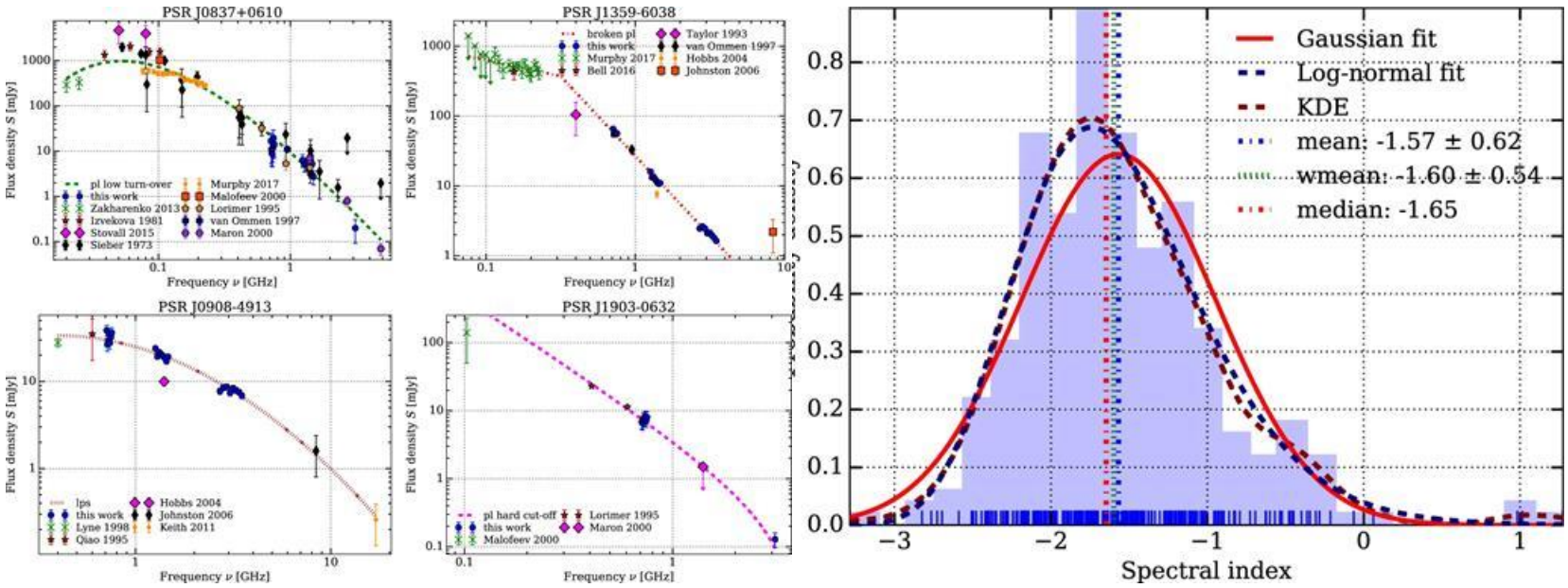
Overview

- Classes of transients and compact objects
  - Pulsars, flare stars, X-ray binaries
- Special advantages and disadvantages of low frequency projects
- What we could do with SWARM that is difficult or impossible now

Pulsars: reasons for interest

- NS-NS/NS-BH mergers (talk by Mike Kavic)
- ISM physics (see e.g. talk by Bansal at this meeting)
- Pulsar timing arrays (talk by Tim Dolch)
- NS masses and EOS, stellar evolution

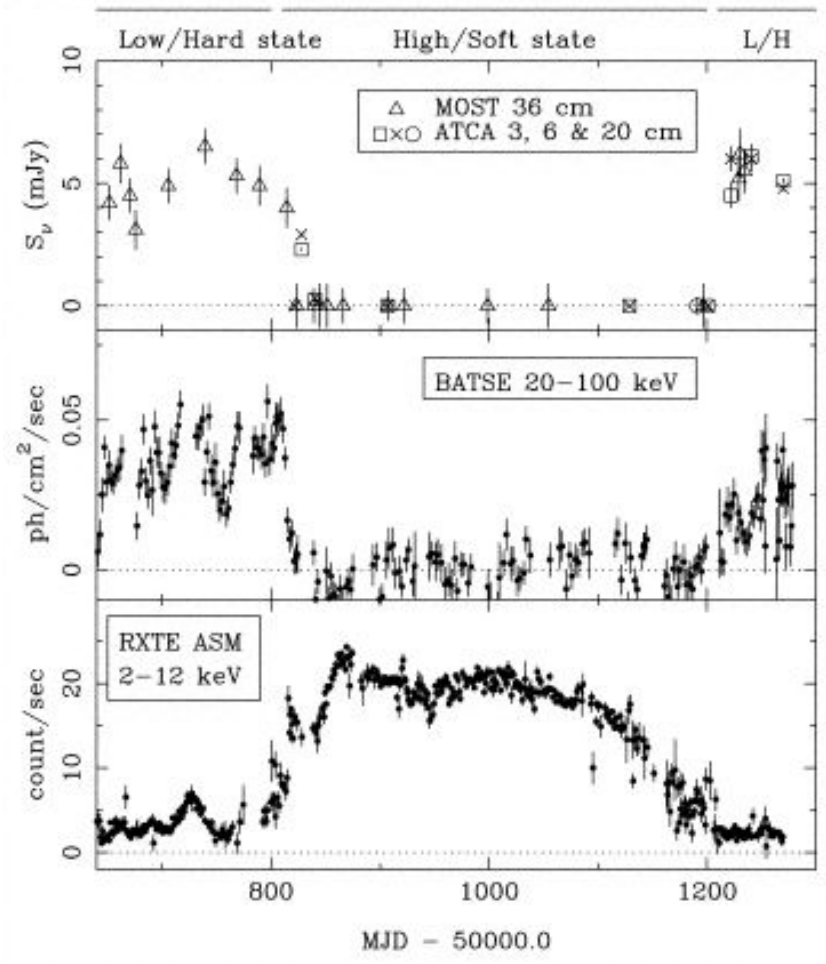
Pulsars have very steep spectra!



Jankowski et al. 2018

X-ray binary jets

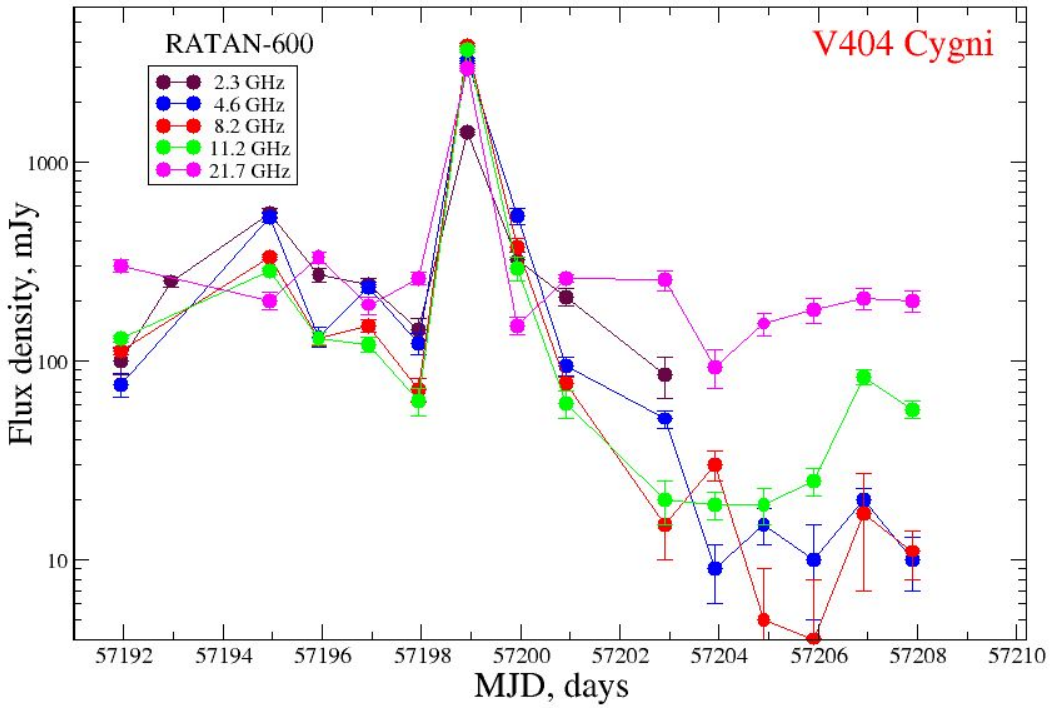
- Precise masses
- Wide range of accretion rates for same source
  - 1 month for XRB~10^8 years for AGN
  - AGN: weather, XRB:climate
- Multiple means to get BH spins
- BH and NS accretors, also WDs



From Fender et al. 1999 for GX 339-4; see also similar discovery in Tananbaum et al. 1972 for Cyg X-1

X-ray binaries: jet ejections

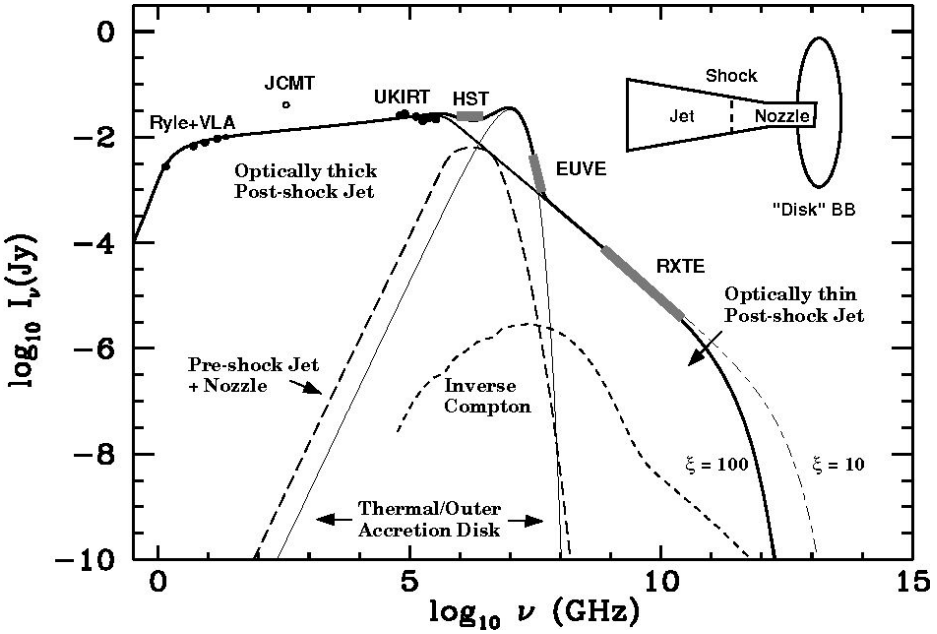
- At X-ray spectral state transitions, can eject large blobs
- LOFAR sampling of V404 Cyg was sparse, but 150 MHz appears delayed and weaker than cm data
- Full understanding of these jet structures can result from good sampling



Trushkin et al. 2015

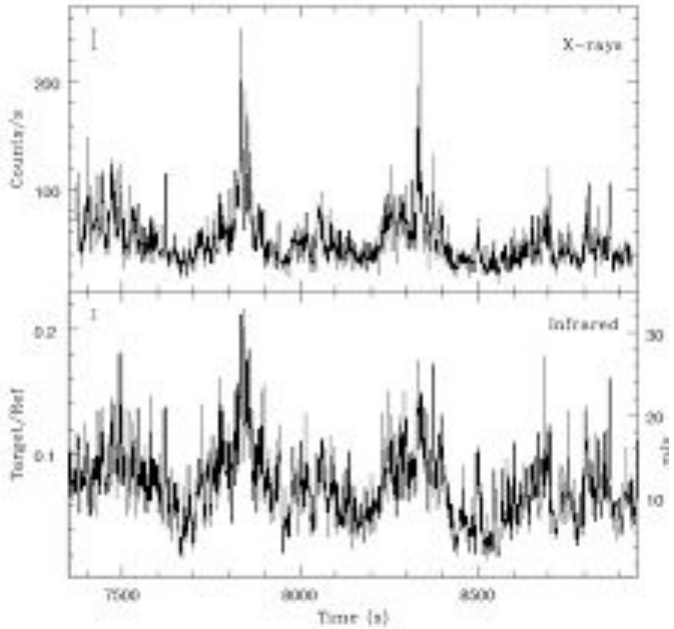
X-ray binaries: “steady” jets

- MAXI 1820+070: flat spectrum jet from 140 MHz-15.5 GHz (Broderick et al. 2019)
  - will there be LF cutoffs?
- Appears to be only “normal” X-ray binary hard state studied by LOFAR
- Most X-ray transients in Galactic Center

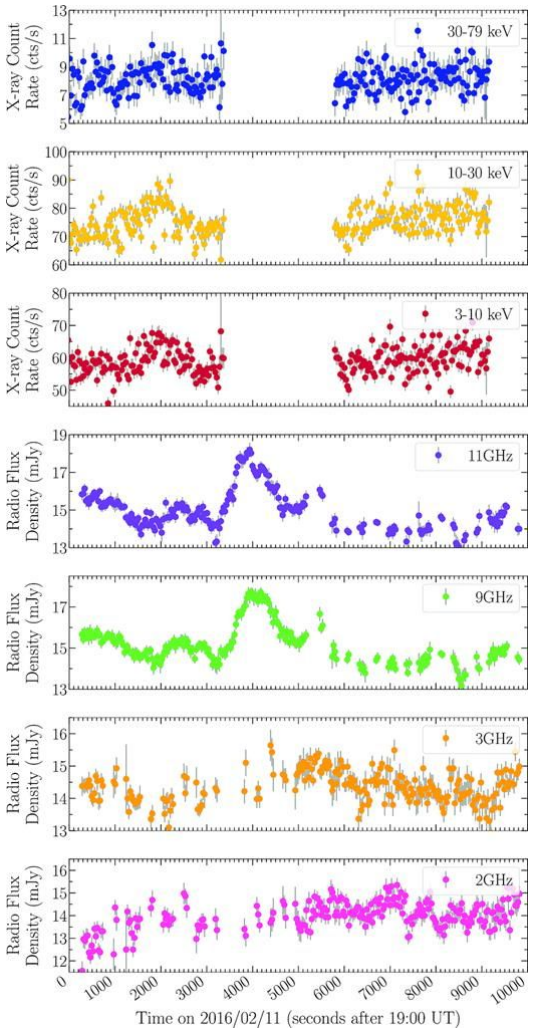


From Markoff et al. 2001

Steady jets are not so steady...



Casella et al. 2010



A. Tetarenko et al. 2019

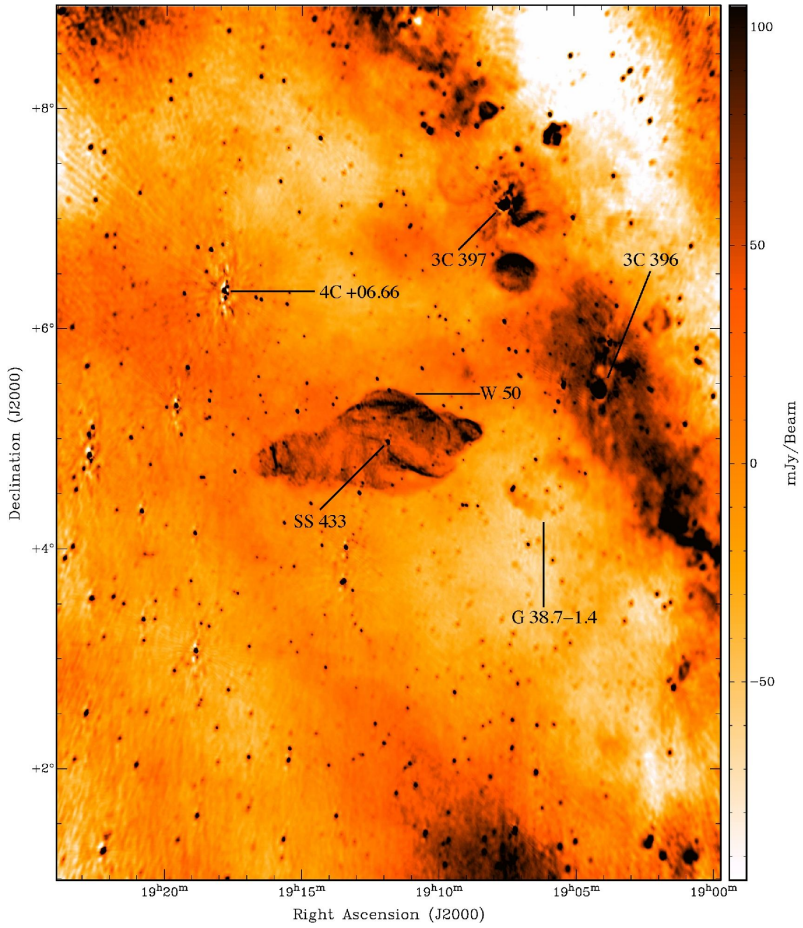
X-ray variability propagates up jets

Can map out jets using variability

X-ray binaries: lobes & SNRs

- SS 433 nebula (Broderick et al. 2018)
- Probably inflated by a powerful outflow from a super-Eddington black hole
- Characteristic barrel-shaped nebula, like ULXs
- Are there old ULXs in the Galactic Plane?

LOFAR, 150 MHz



The LWA niche

MWA - lacks long baselines, is at higher frequencies

LOFAR - too far north, cannot see much of the Galactic Plane, extremely relevant for rare objects

Imaging surveys for pulsars

Pulsars can be hard to detect if they are:

faint

highly dispersed/scattered

in very tight binaries with large accelerations and jerks

Imaging surveys are not affected by the latter two problems

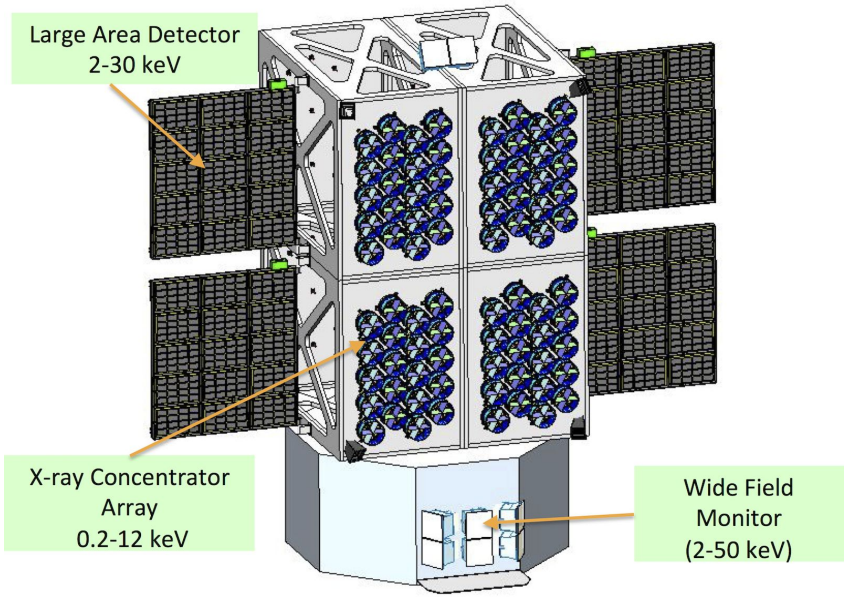
The tight binaries are potentially most interesting!

For pulsars: ~1000 hours would be VLASS by order of magnitude in sensitivity for Galactic Plane -- would be ideal combination

For X-ray binaries: typical “steady jets”

Other facilities to complement long wavelengths

- Multi-wavelength monitoring greatly aids studies of X-ray binaries, pulsars and maybe even exoaurora work
- LSST puts us in good shape for optical, but no clear path to future X-ray wide field instruments
- X-ray timing also valuable for XRBs and pulsars



My favorite example, STROBE-X: see Ray et al. 2019

Summary

- A rich set of exciting projects can be done at low frequencies in the Galactic Plane
- Currently quite limited by confusion, but longer baselines could help immensely
- Most of this is strongly complemented by a wide range of multi-wavelength facilities