Neutron Star Low Mass X-ray Binaries: a polarimetric view

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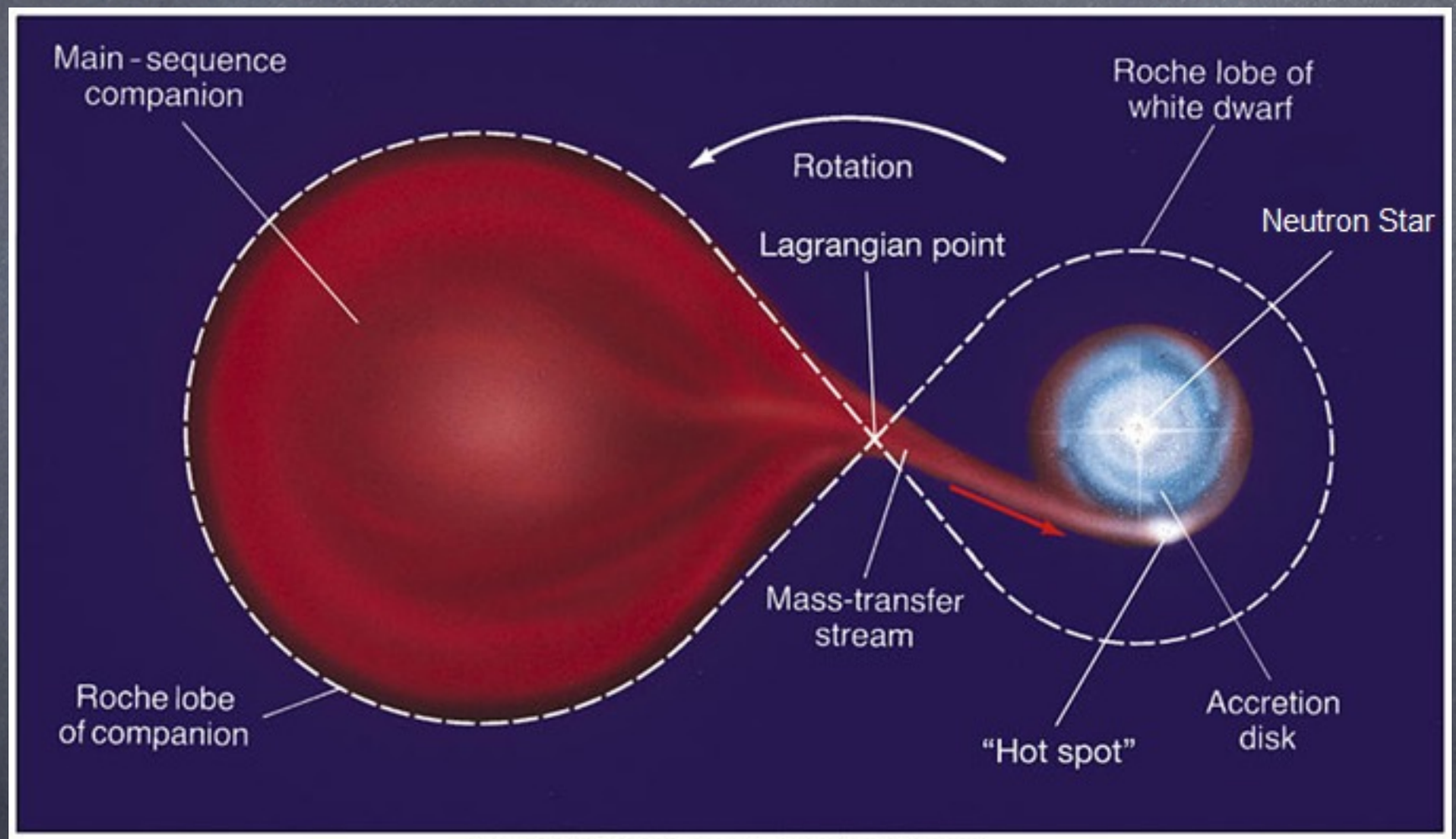
Low mass X-ray binaries



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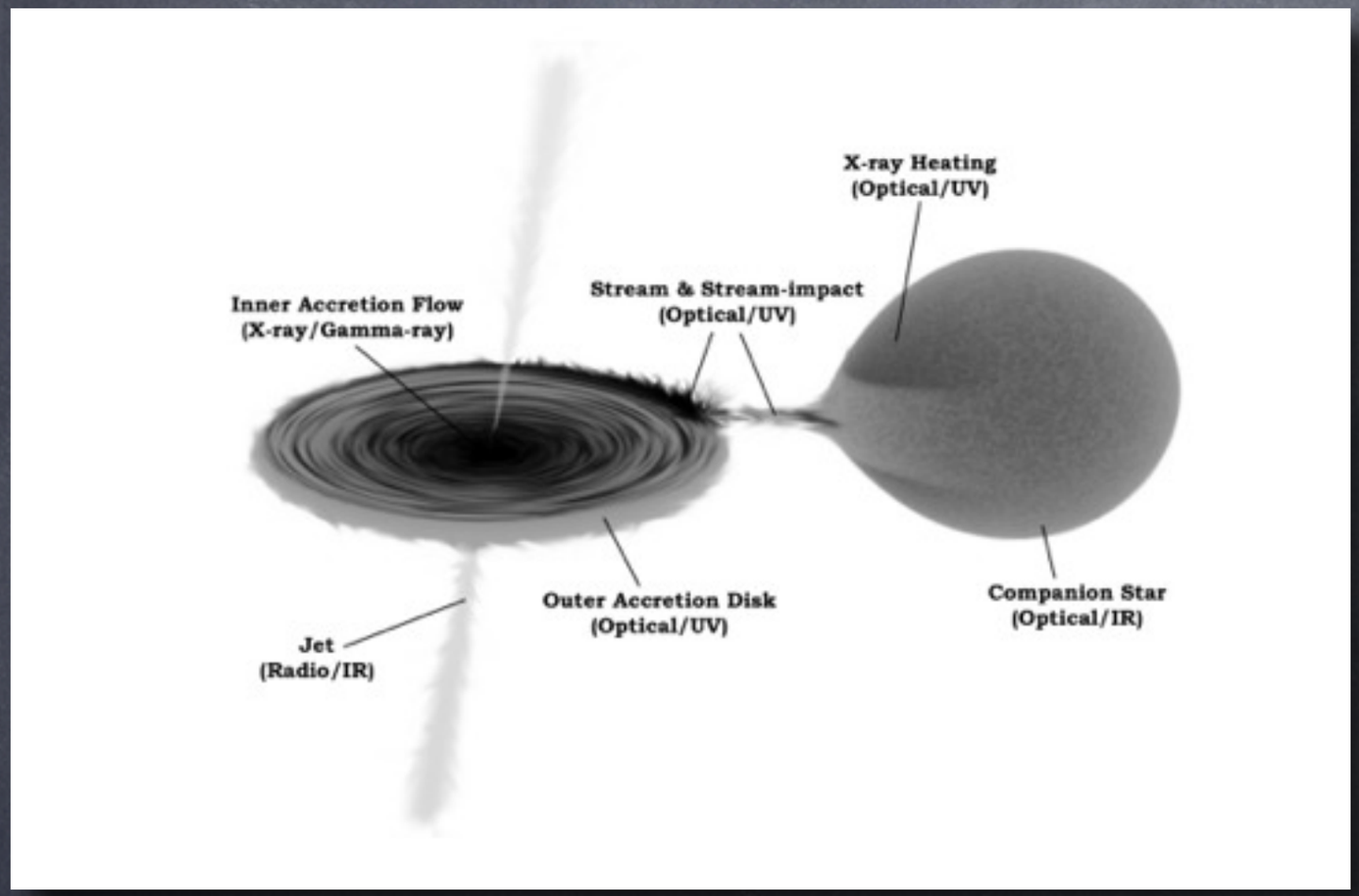

- Persistent systems
- Transient systems (outburst, quiescence)

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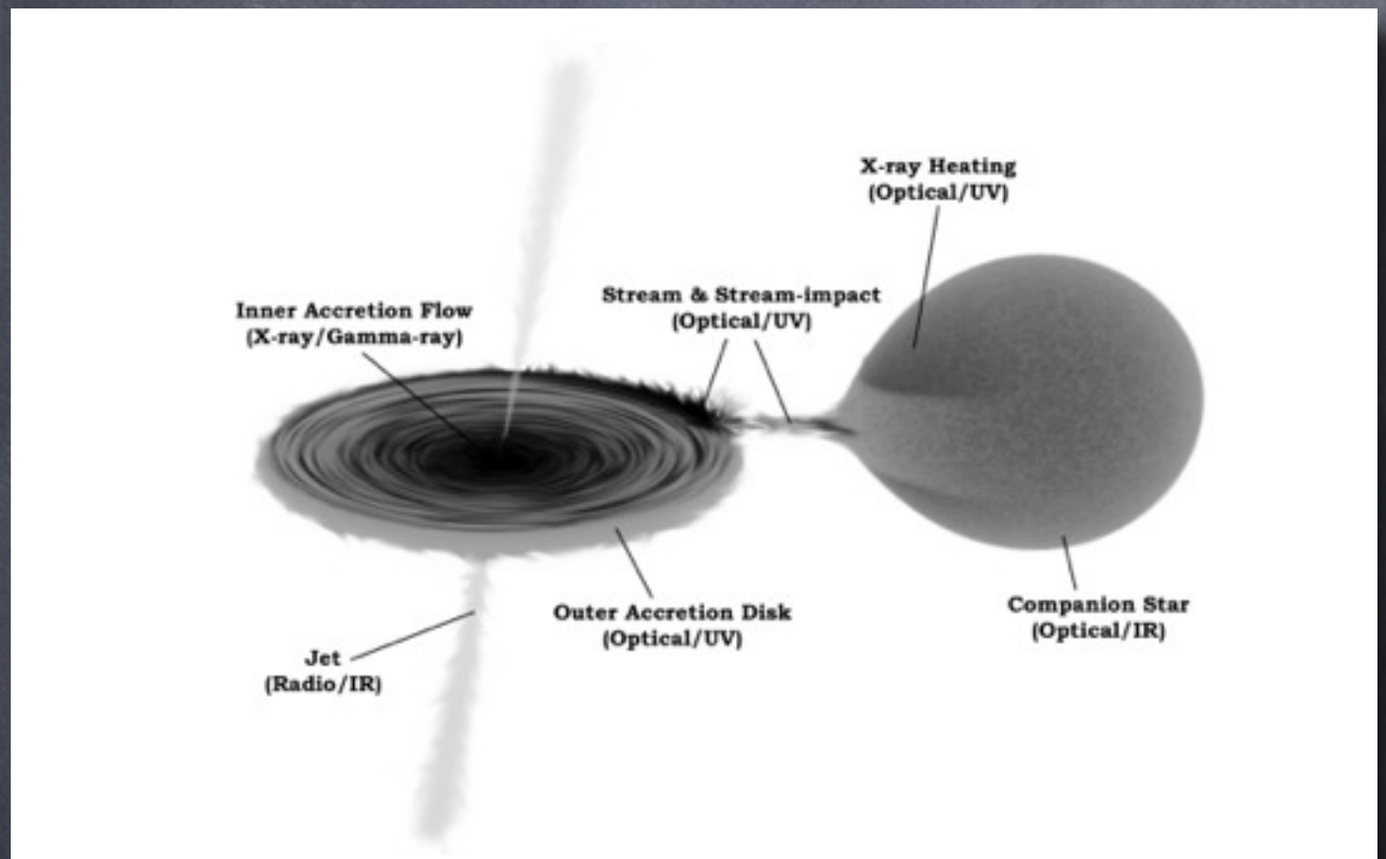


- Persistent systems
- Transient systems (outburst, quiescence)

- X-ray emission: compact object + internal regions of the disc.

- Optical emission: companion star (quiescence), accretion disc (outburst)

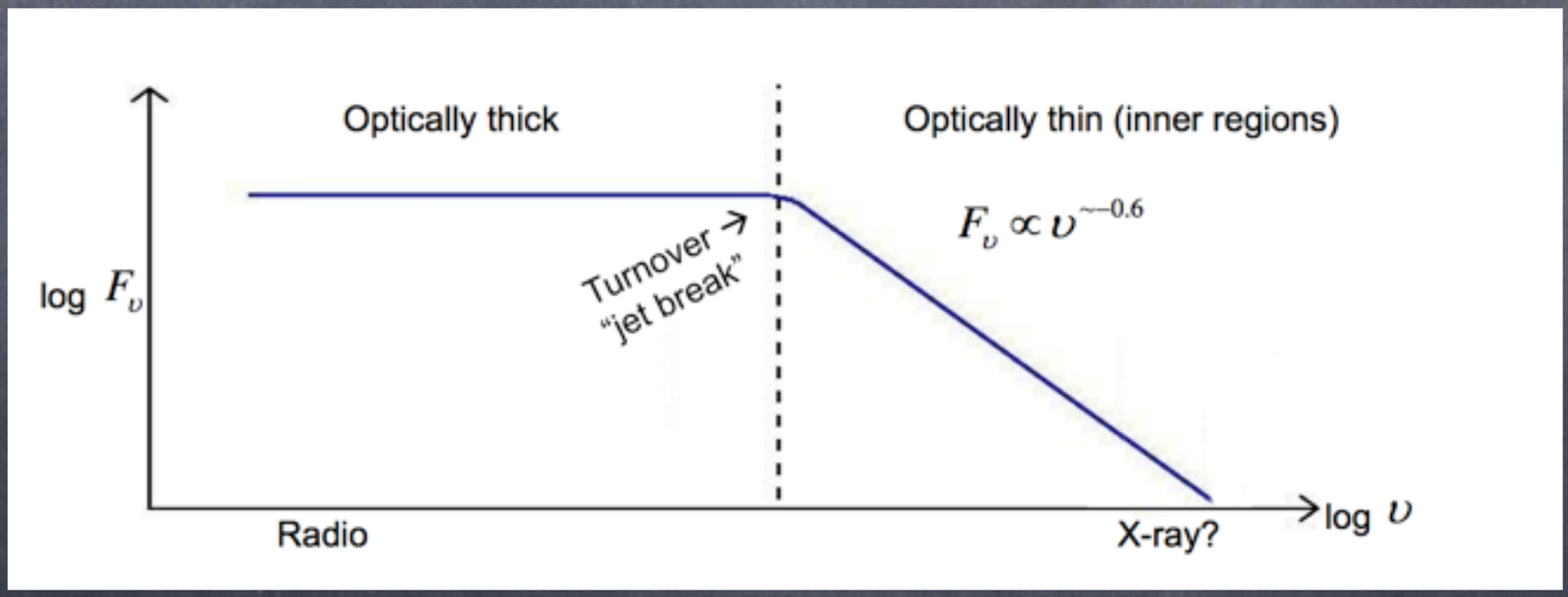
- Lower frequency: relativistic particles jets?

Jets in LMXBs

Jets - accretion: clear coupling in BH LMXBs (Fender et al. 2006).

Accretion states associated with hard X-ray spectra are linked to the emission of jets (Fender et al. 2001).

In the radio band, jets have a flat spectrum that breaks at higher frequencies to an optically thin spectrum (NIR).



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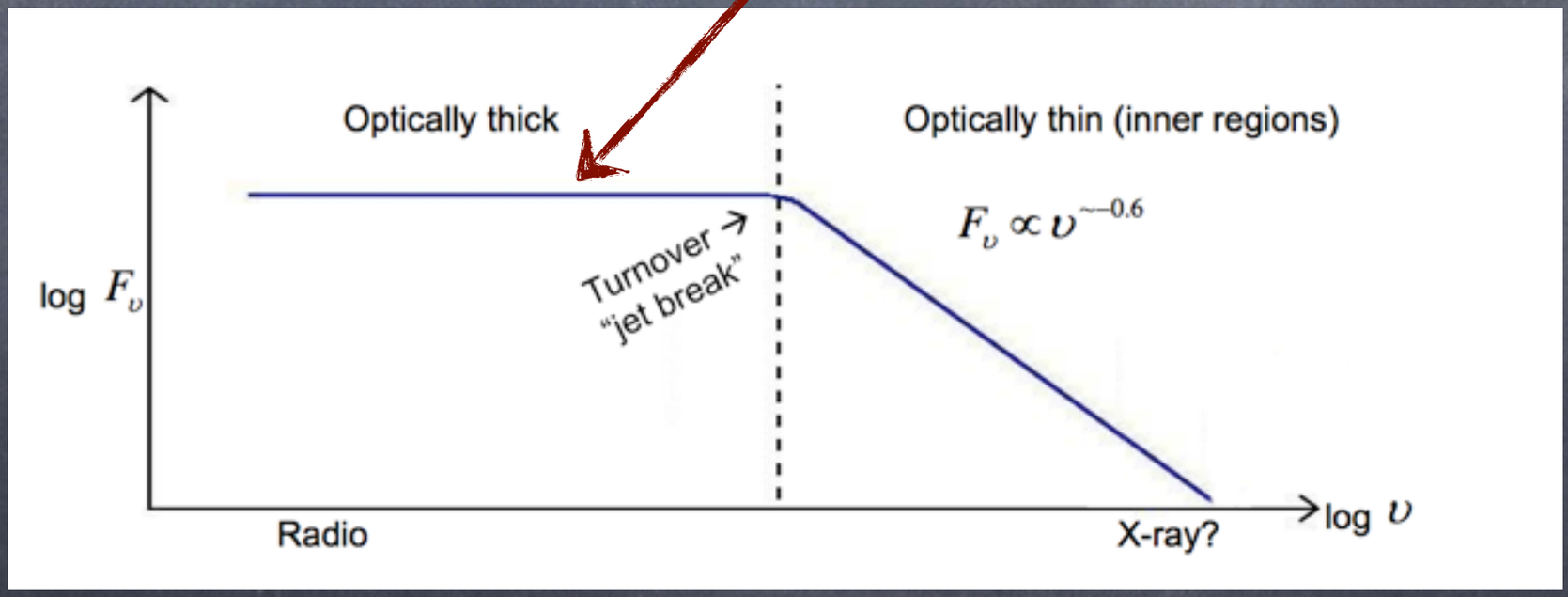

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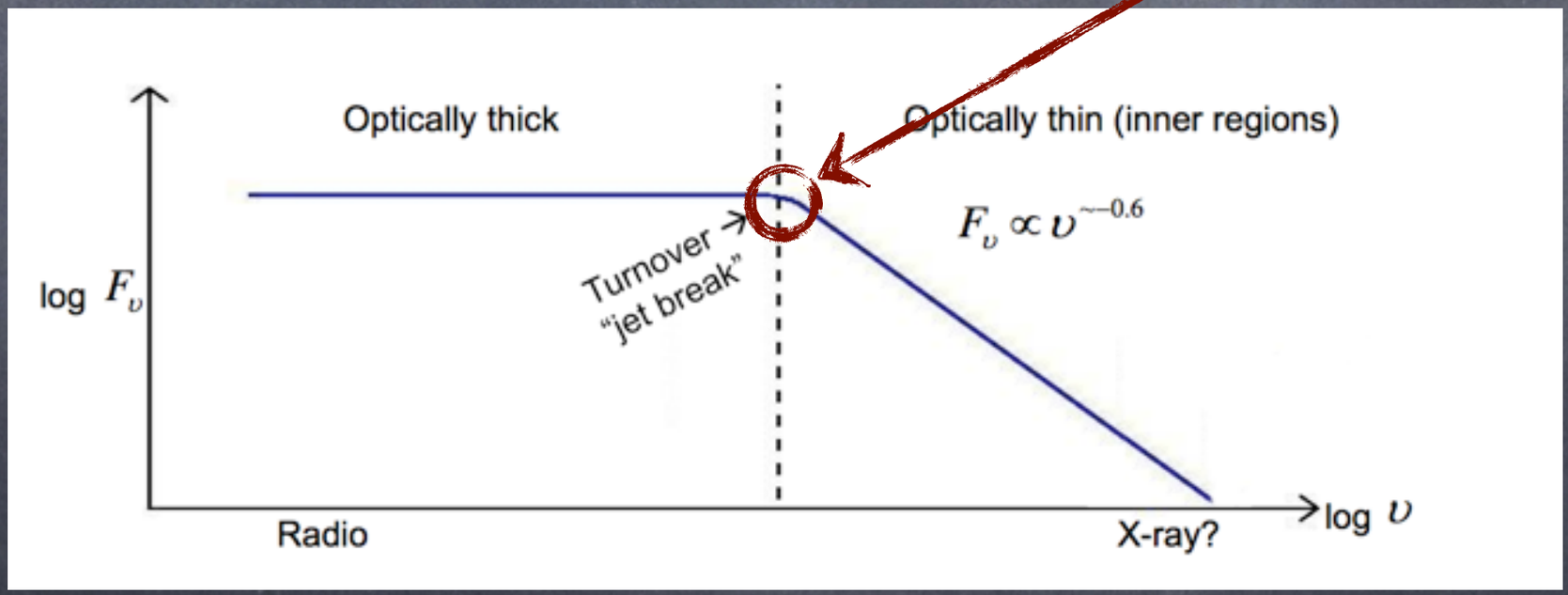


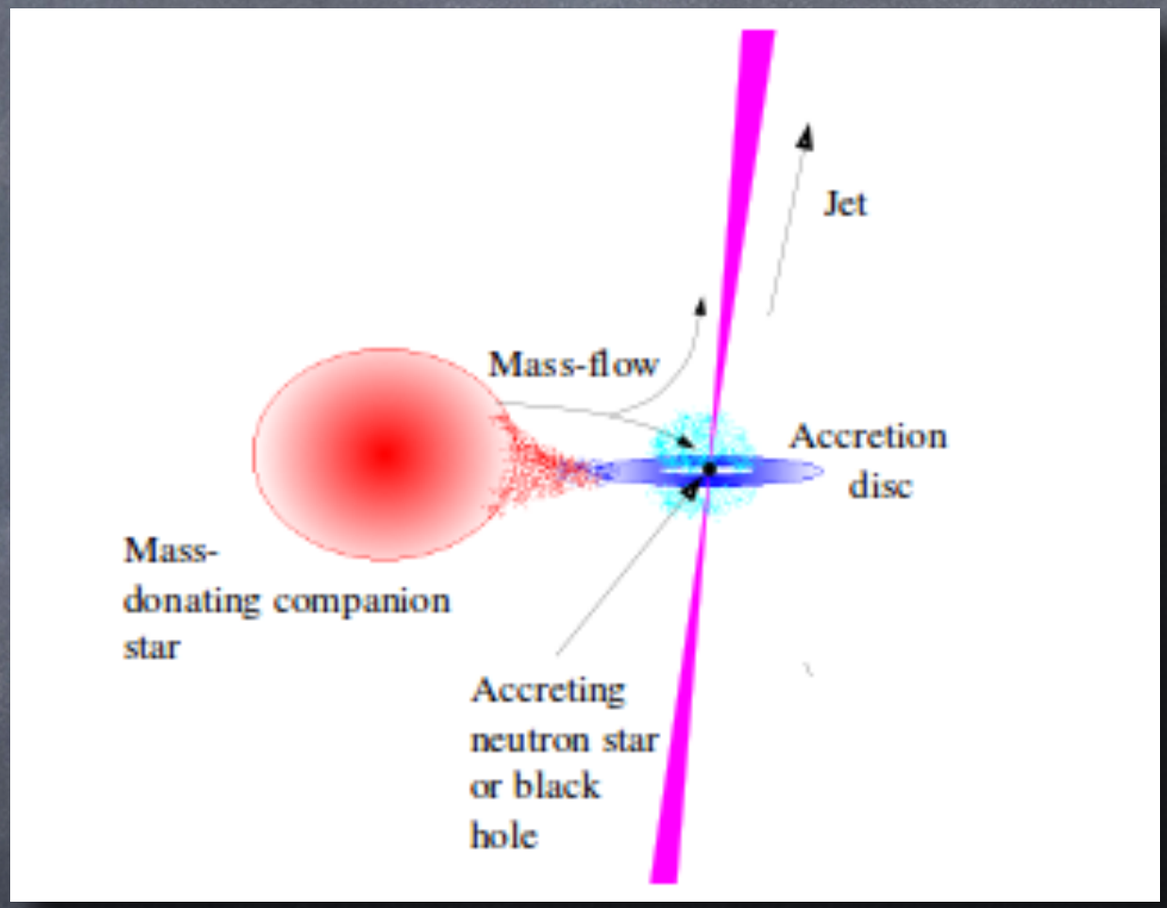
Why can LMXBs be polarized?

Synchrotron emission from relativistic particles jets

Signatures:

NIR-optical polarization P of a few %
(Russell & Fender 2008)

IR excess



Thomson scattering with e^- in an ionized accretion disk
Signatures: P increases with decreasing λ and has a phase-dependent variation.

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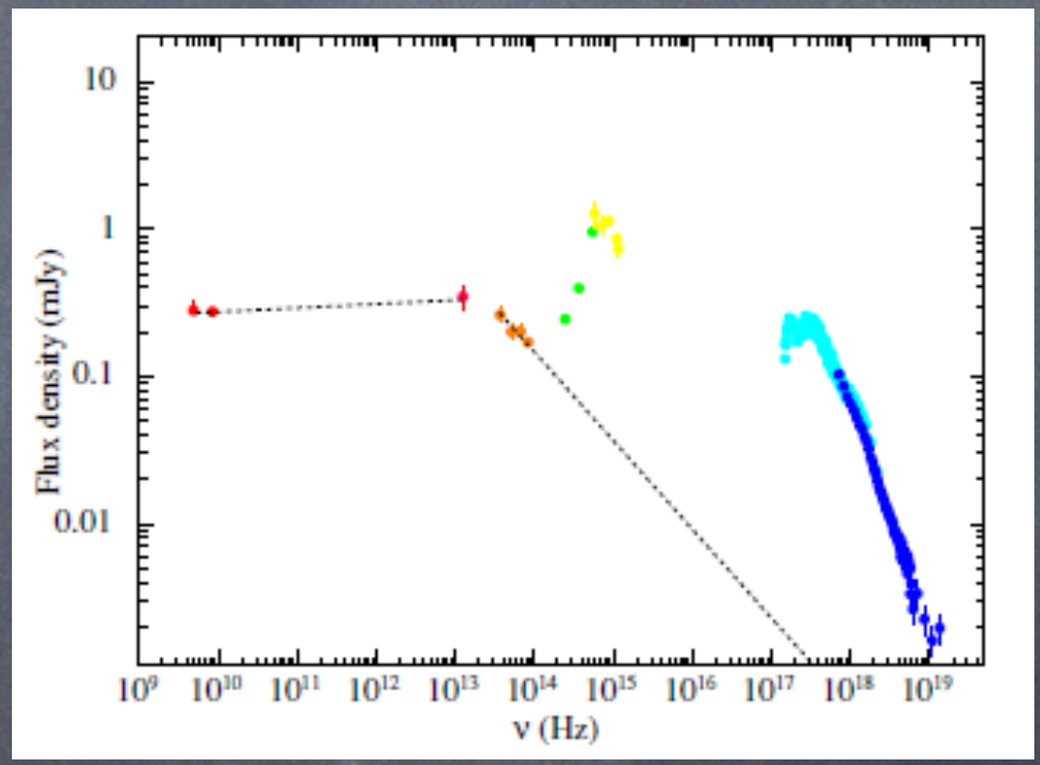

Migliari et al. 2010

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Ultra Compact X-ray Binary (NS + WD)
with unknown orbital period.

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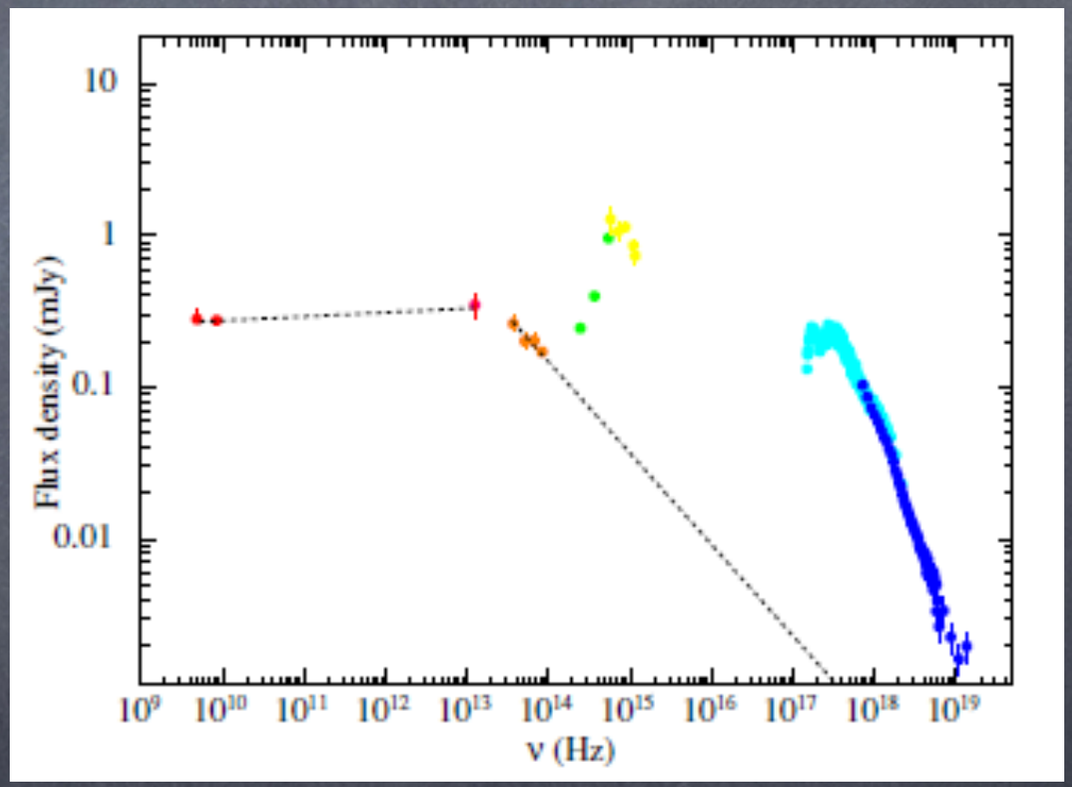

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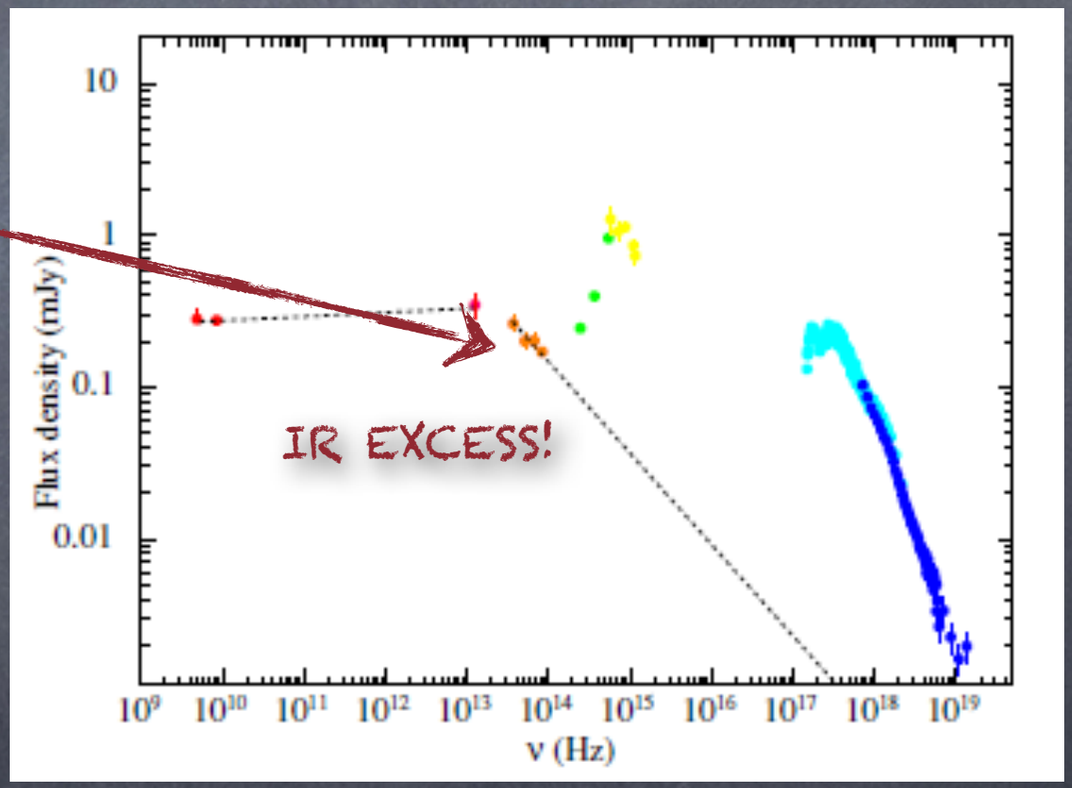

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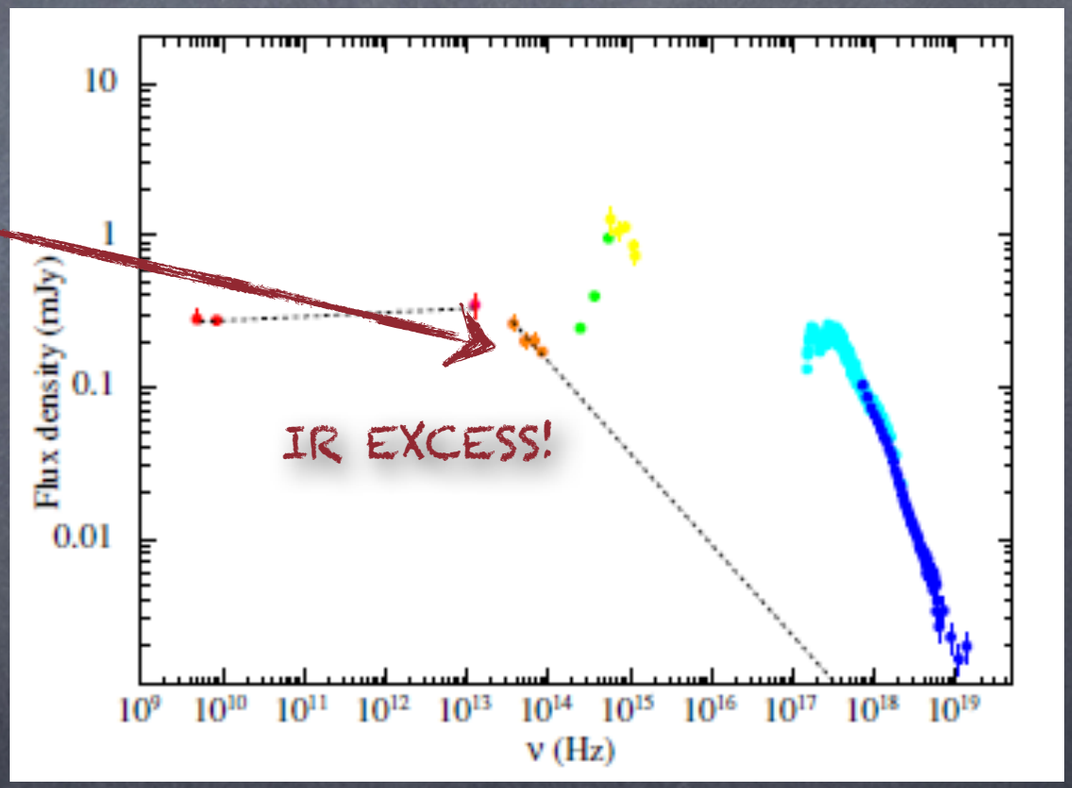
POLARIMETRIC MEASUREMENTS SHOULD SHOW THE PRESENCE OF THE SYNCHROTRON EMISSION FROM THE JET!



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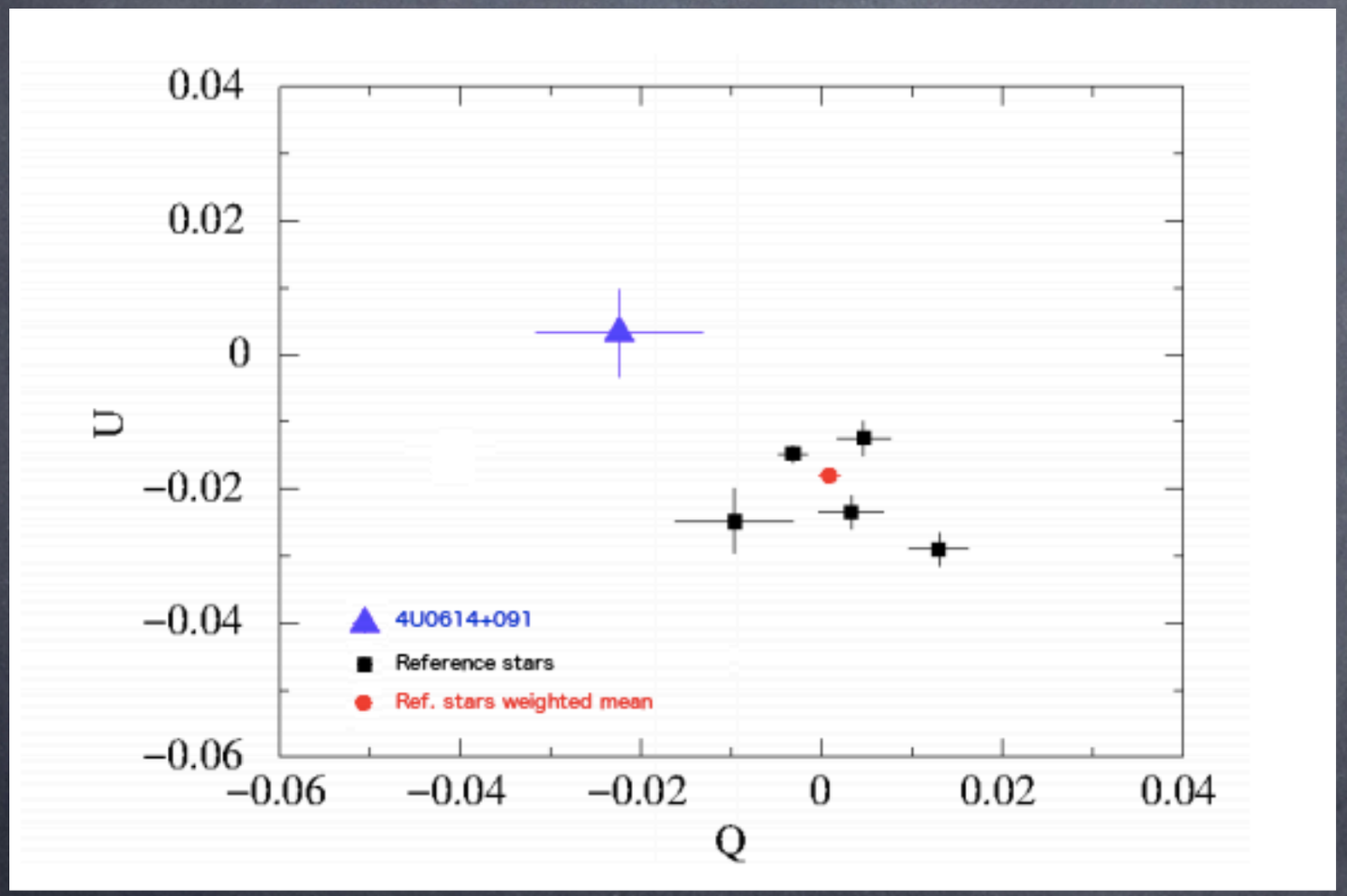
OBSERVATIONS in the r-band:
January 2013, TNG PAOLO polarimeter
March 2014, NOT ALFOSC polarimeter



Baglio et al. 2014, A&A, 572, 99

From the TNG dataset:

$$P = 2.85 \pm 0.96\,\%$$

$$\theta = 85.9^\circ \pm 8.41^\circ$$

Consistent with polarized synchrotron emission from a jet!

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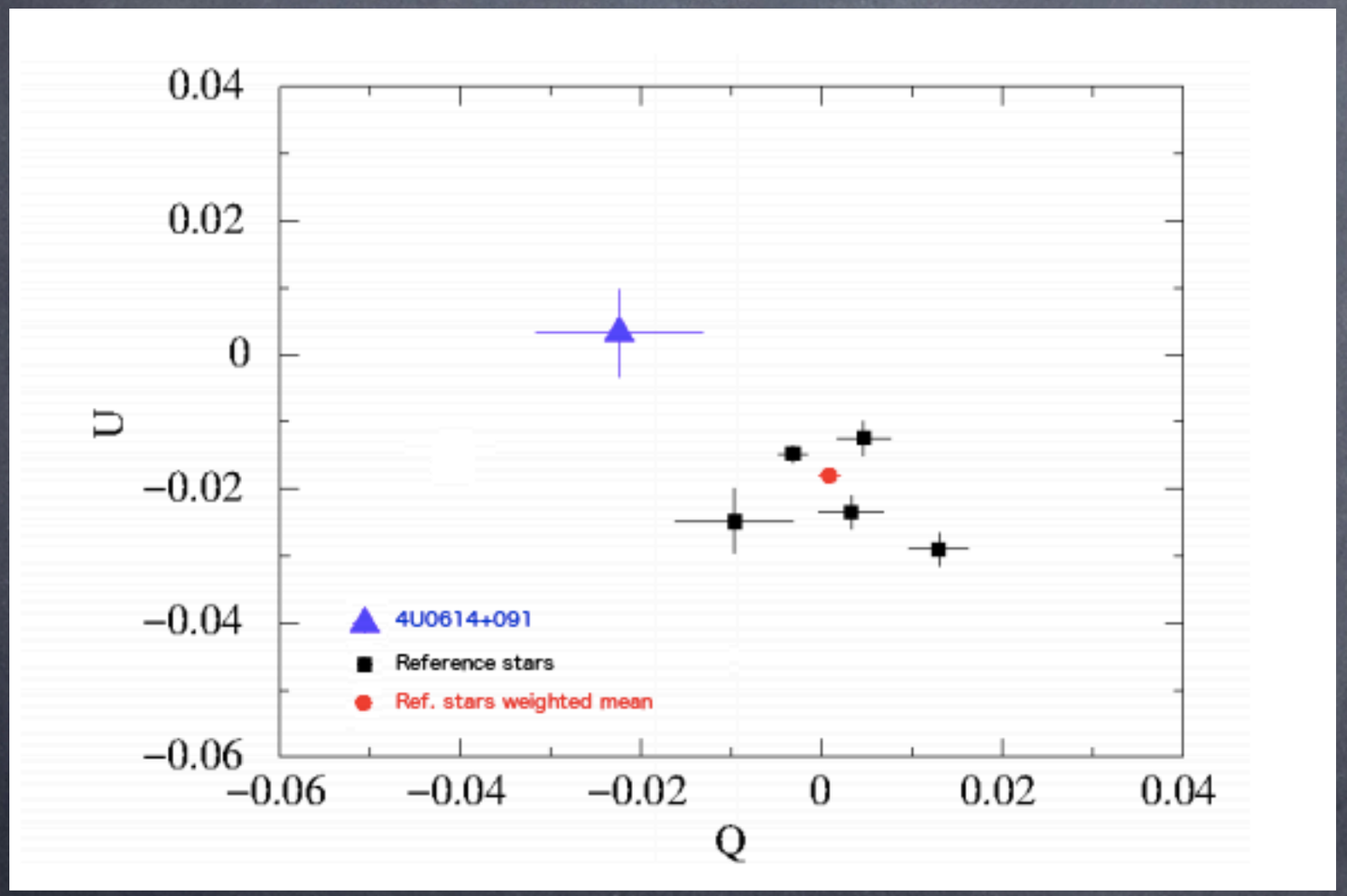

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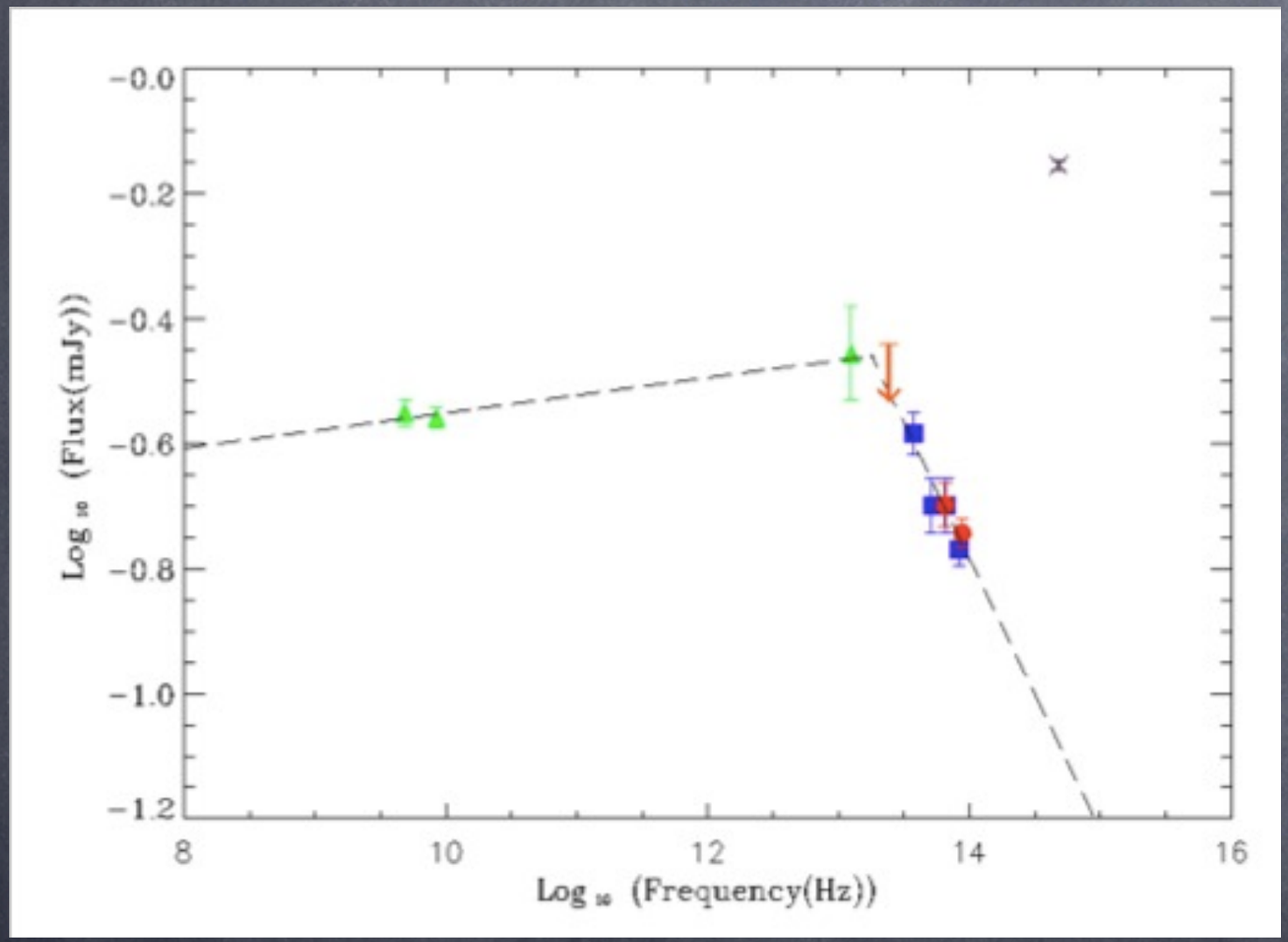
From the NOT dataset:

$$P < 3.4\%$$

(3σ upper limit)



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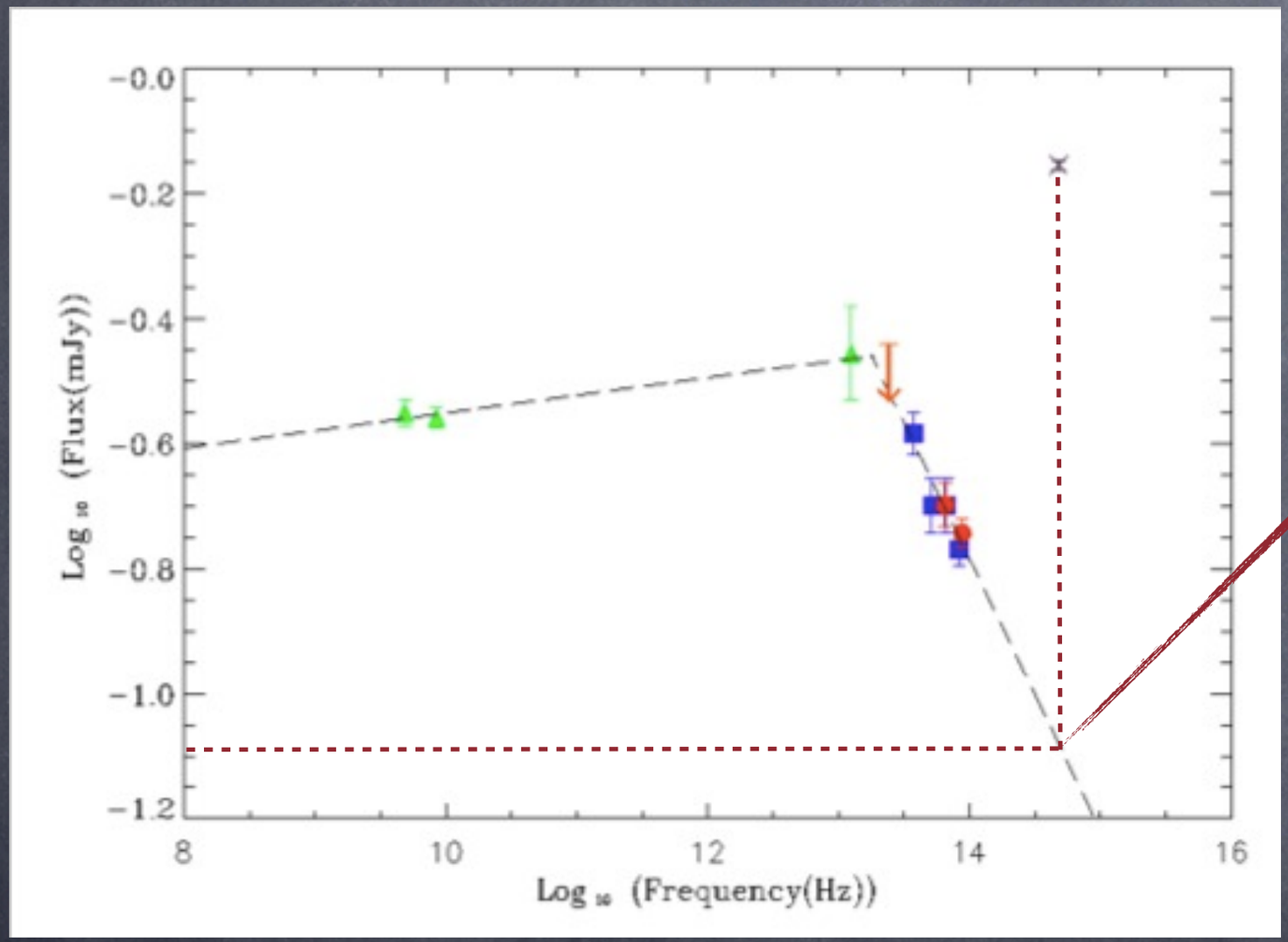

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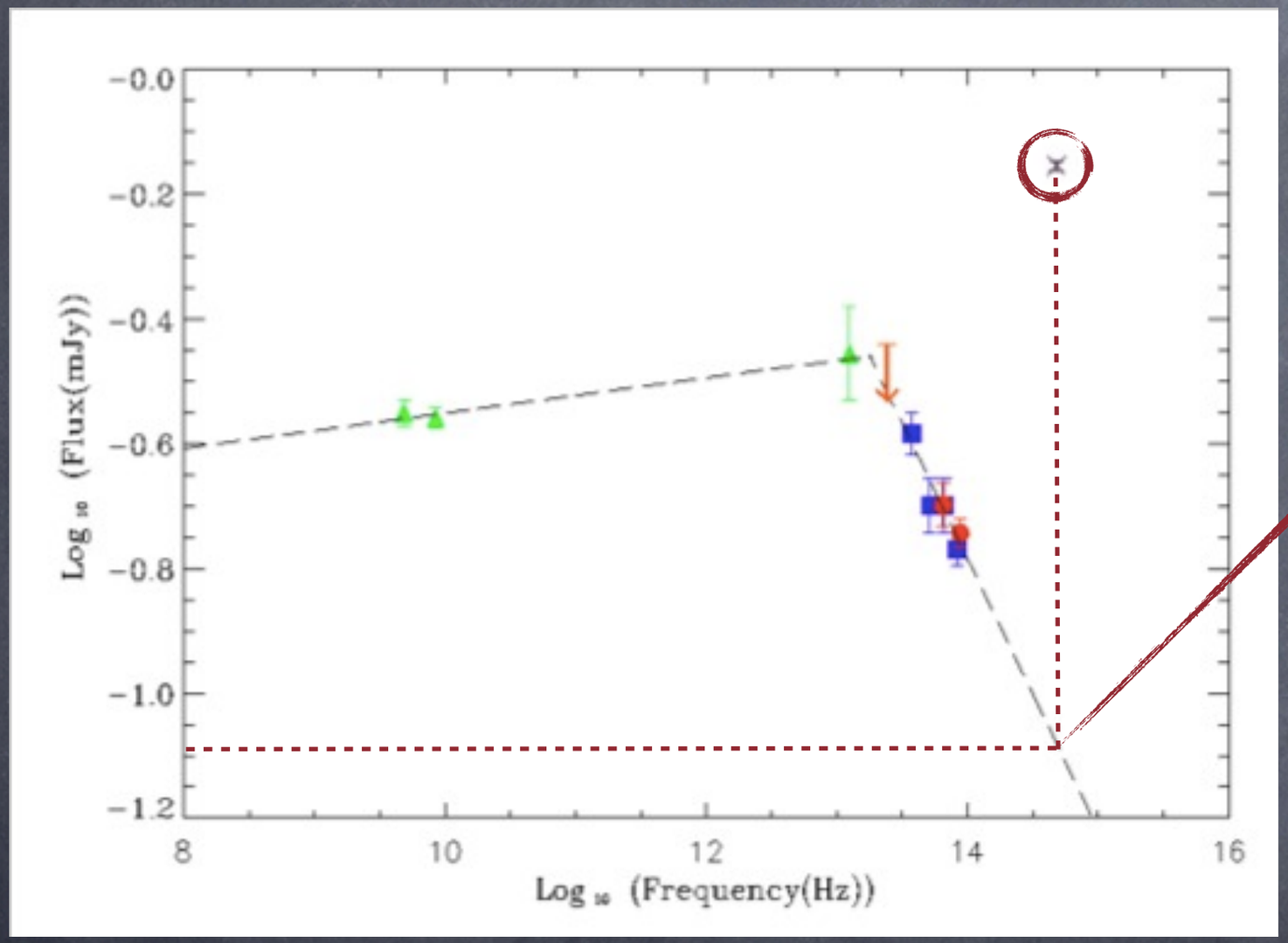
Expected r-band flux due to the jet only:

0.1 mJy



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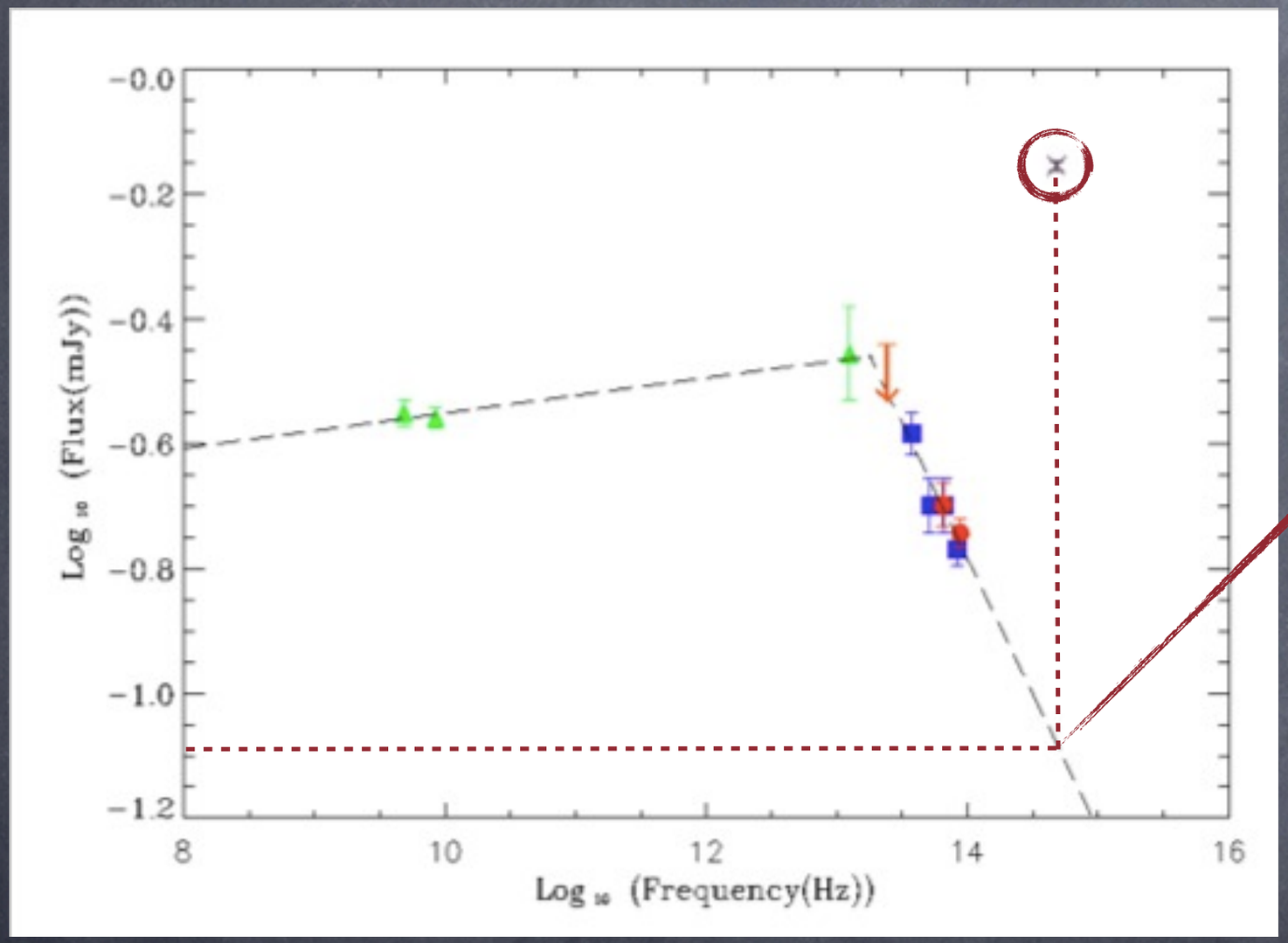

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From F_{jet}/F_r we could estimate an intrinsic polarization of the jet of ~20%.

The "missing link" pulsar PSR J1023+0038

Transitional pulsar: undergoes repeated transitions from an accretion state to a rotation powered state.

The "missing link" pulsar: J1023 showed for the first time that LMXBs can turn on as radio millisecond pulsars (confirming the recycling scenario of pulsars).

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The "missing link" pulsar PSR J1023+0038

OBSERVATIONS:

February 2015, EFOSC2 polarimeter (NTT, La Silla).

Filters: B, V, R, i

We measured a > 4σ average LP in the V and R bands.

Low upper limit in the i-band.

B	*V*	*R*	*i*
	P (%)		
1.17 ± 0.51	1.09 ± 0.27	0.90 ± 0.17	0.55 ± 0.22
	P (3σ upper limit)		
2.7%	–	–	1.21%
	Interstellar/instrumental LP (3σ upper limit)		
1.23%	0.63%	0.48%	0.54%

Baglio et al. 2016, A&A, 591, 101

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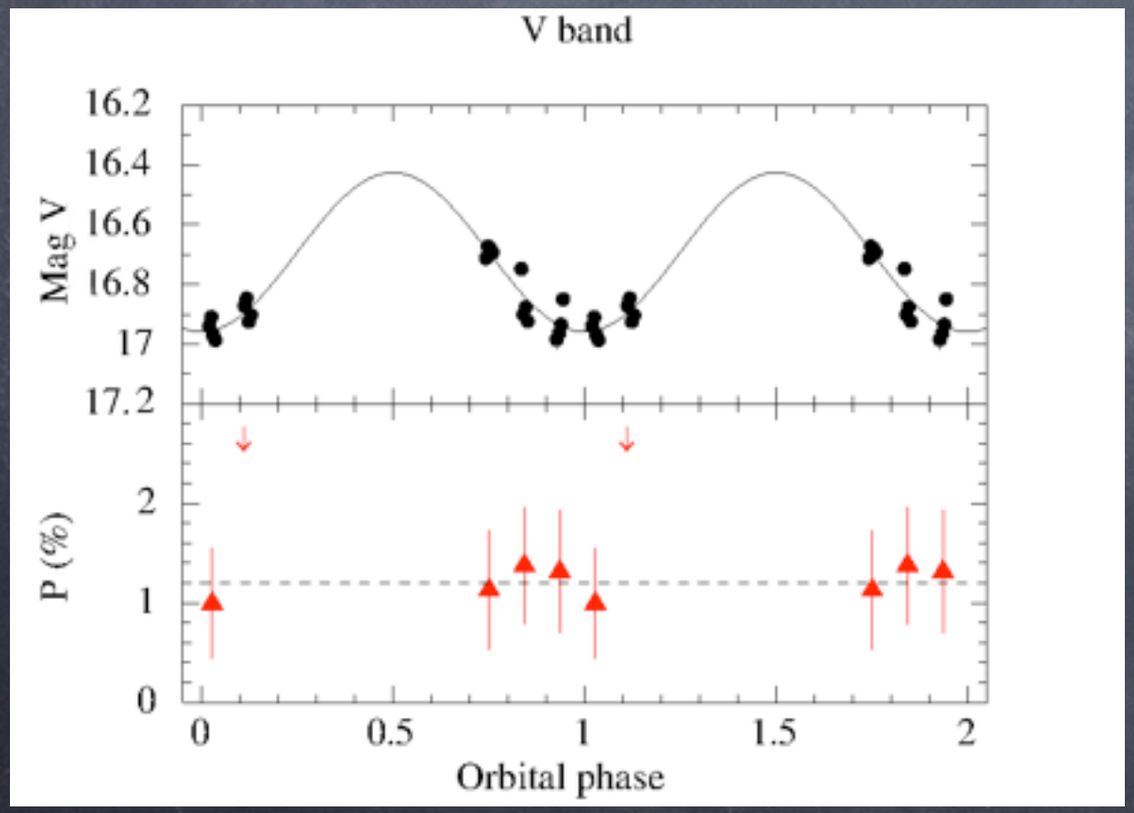
Search for time dependent variability of the LP in V- and R- band



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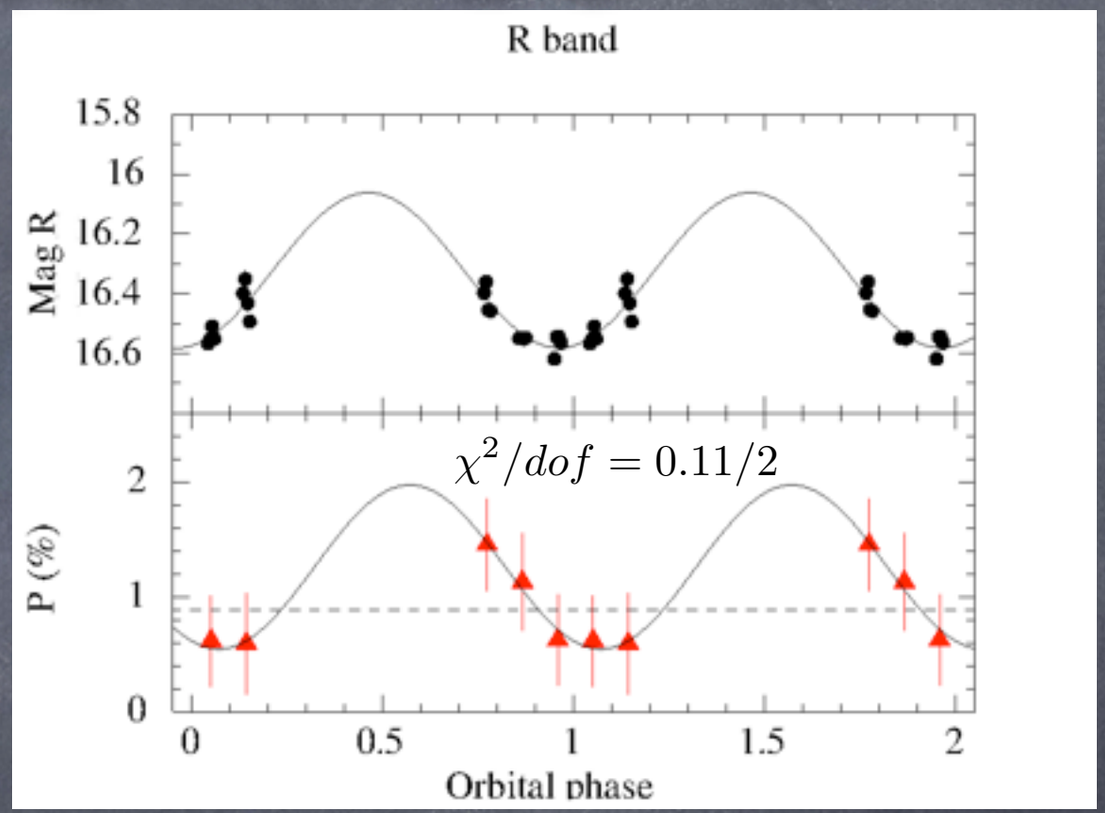

Hint of a sinusoidal modulation at the system orbital period (4.75 hr) in the R-band!

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Thomson scattering?

In favour:

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Low level optical linear polarization

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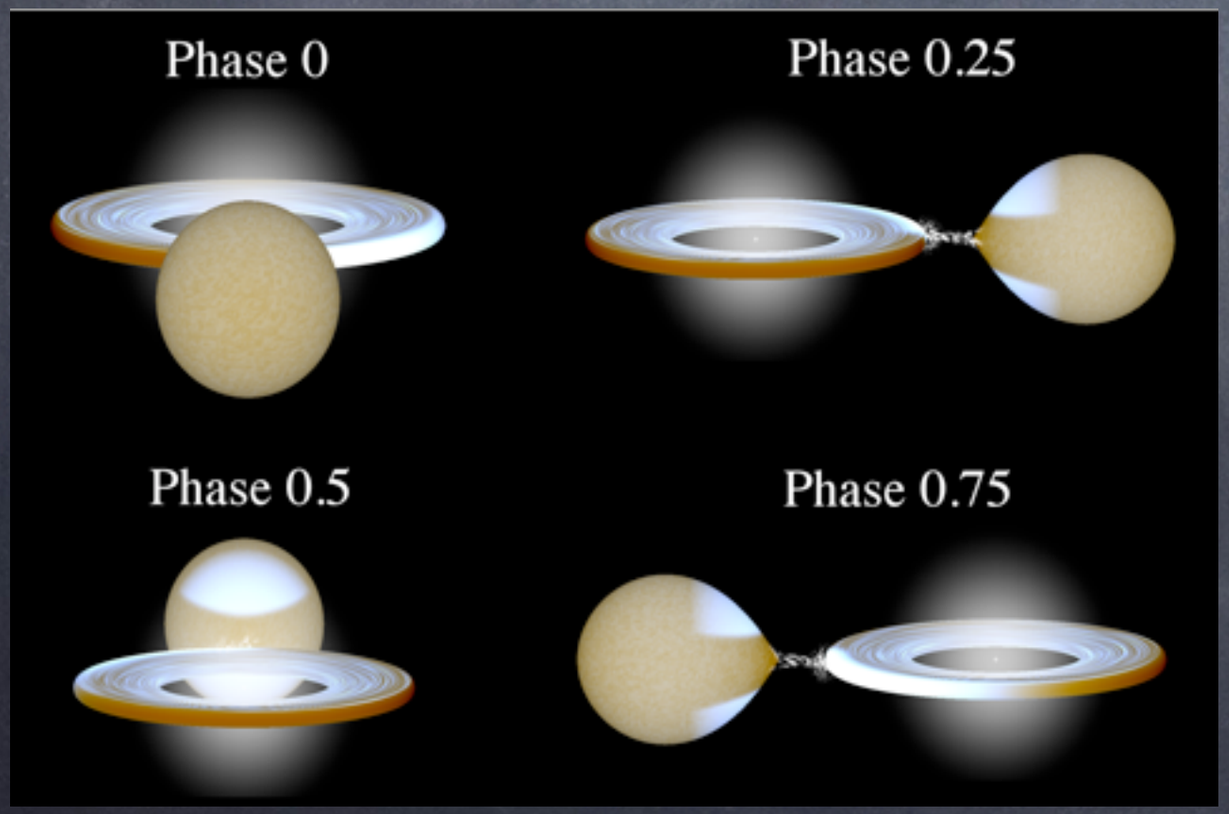

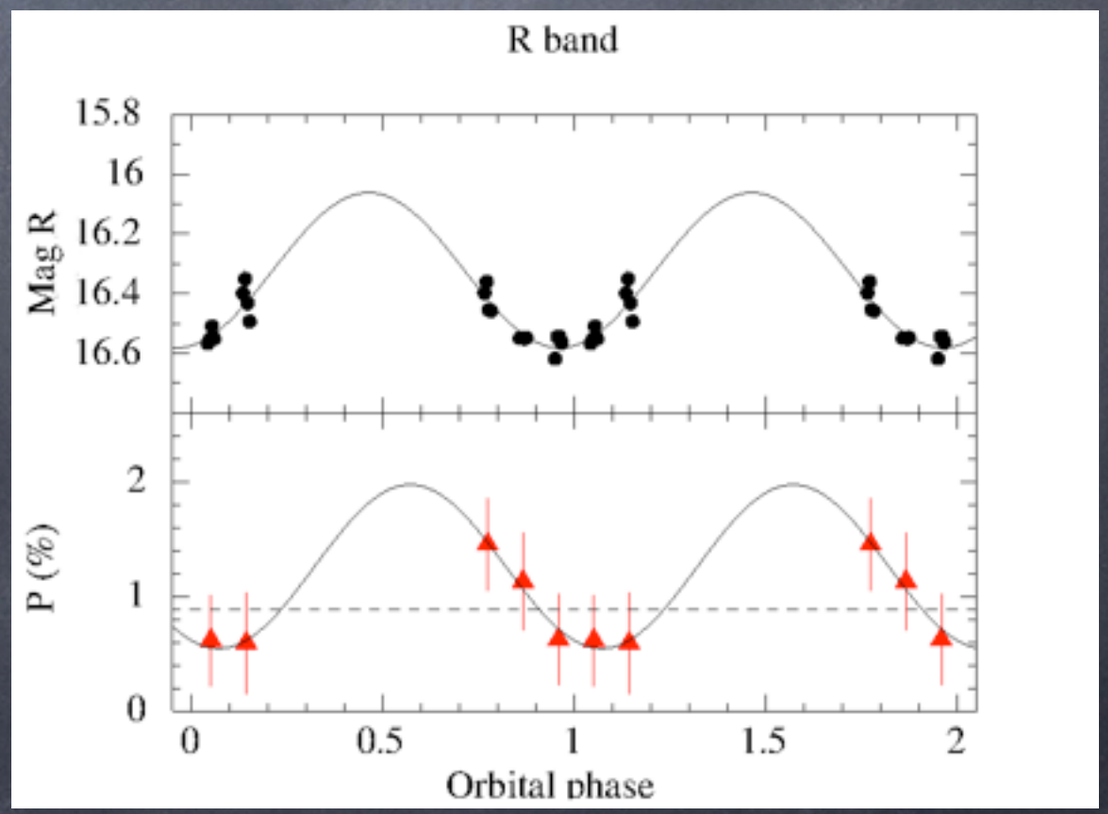

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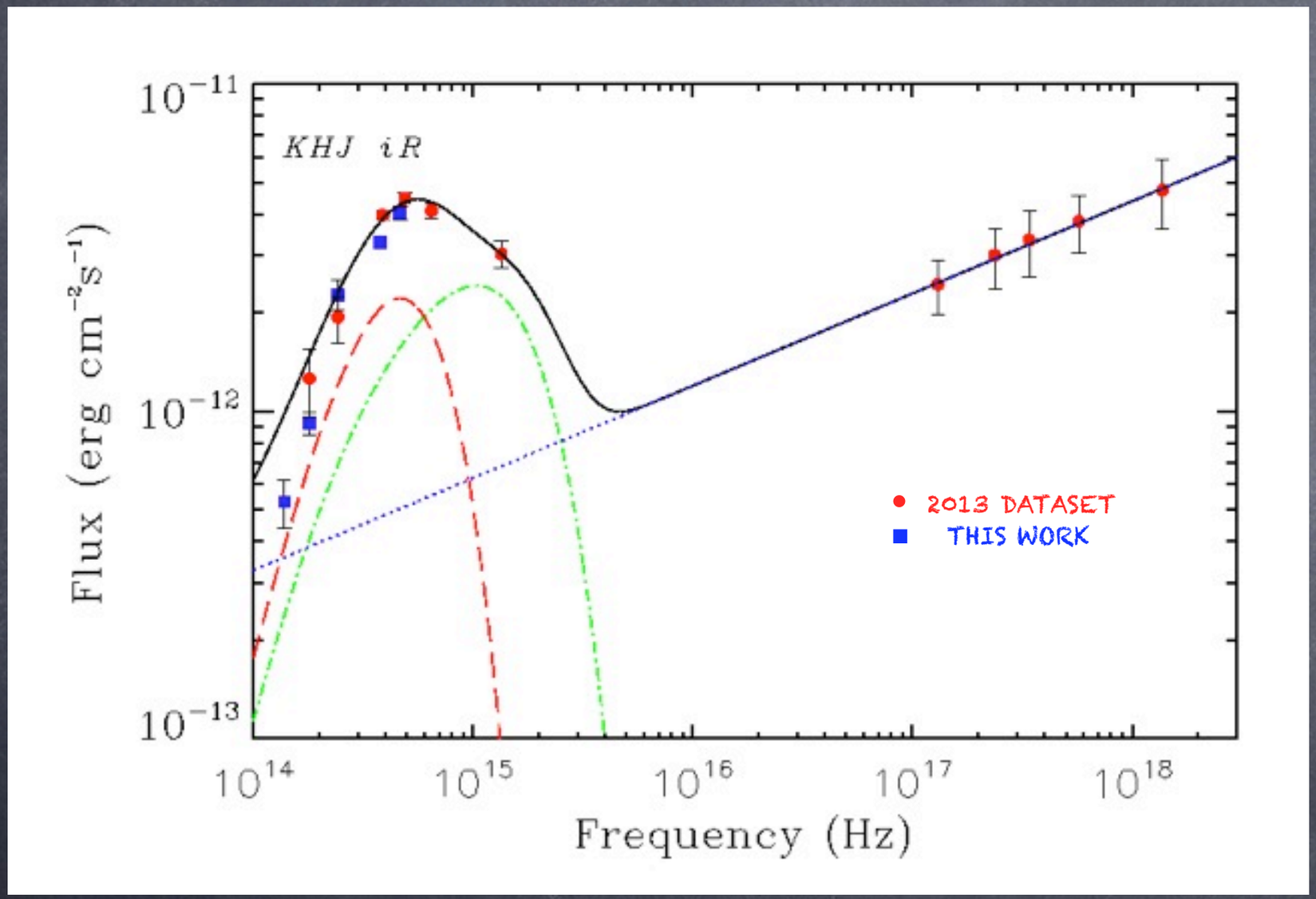
Jets?

Search for non-thermal components in the NIR spectral energy distribution



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The 2013 points fit describes well also the 2015 points.

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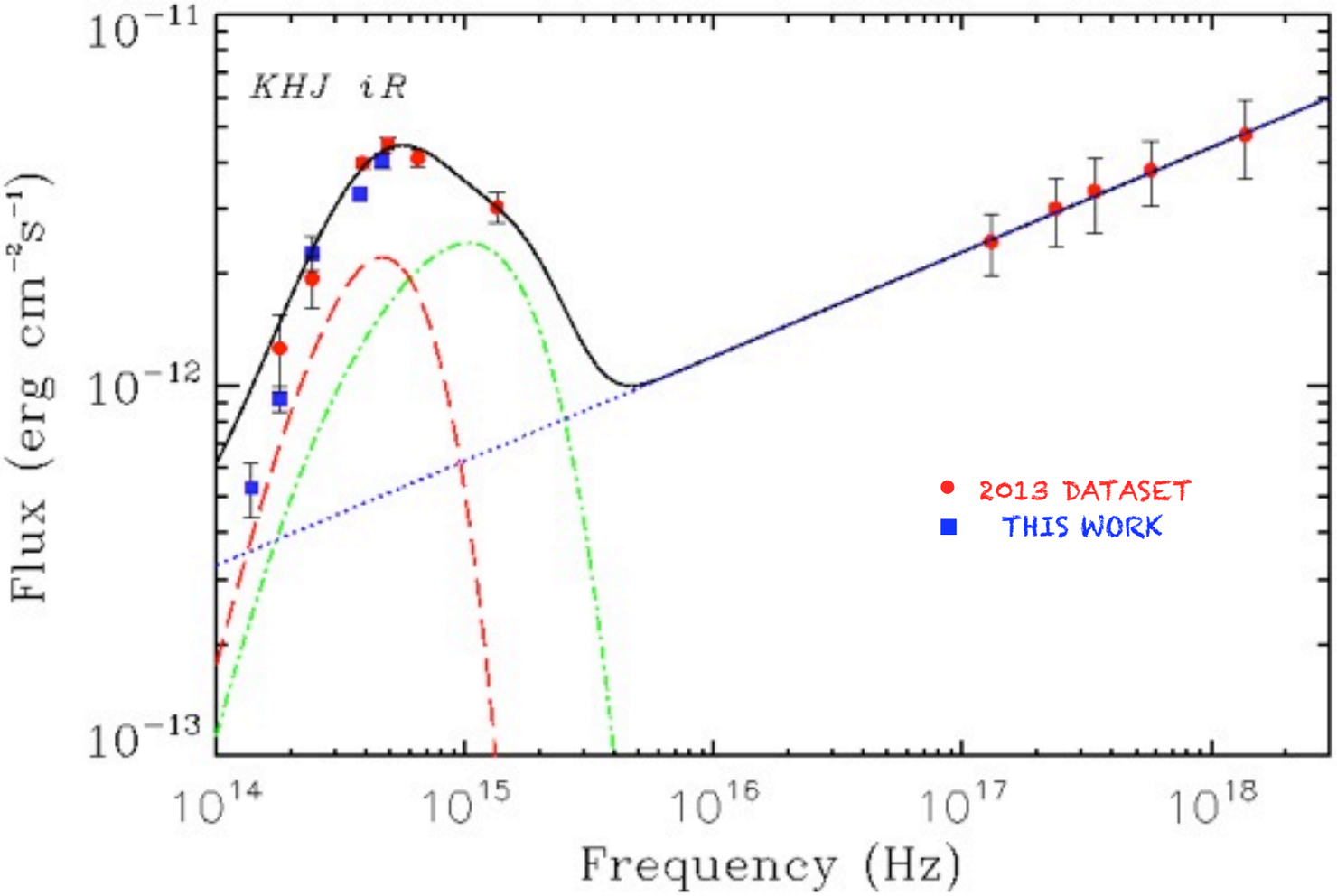

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NO NEED TO INTRODUCE THE EMISSION OF A JET!

CONCLUSIONS

Polarimetry is a great tool that help disentangling the components contributing to the NIR-optical emission of LMXBs. We can investigate the magnetic field ordering in the internal regions of the jet!

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LOW LEVEL OF LP: tangled magnetic fields (as it happens for AGNs)

PSR J1023+0038

We detected low, phase dependent optical LP, higher going to bluer frequencies.

No synchrotron emission detected in the broadband SED.

We interpret our result as due to Thomson scattering of radiation with free electrons in the ionized accretion disc.

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THANK YOU!

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