Robopol: optical polarization monitoring of an unbiased sample of blazars

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gamma-ray loud:

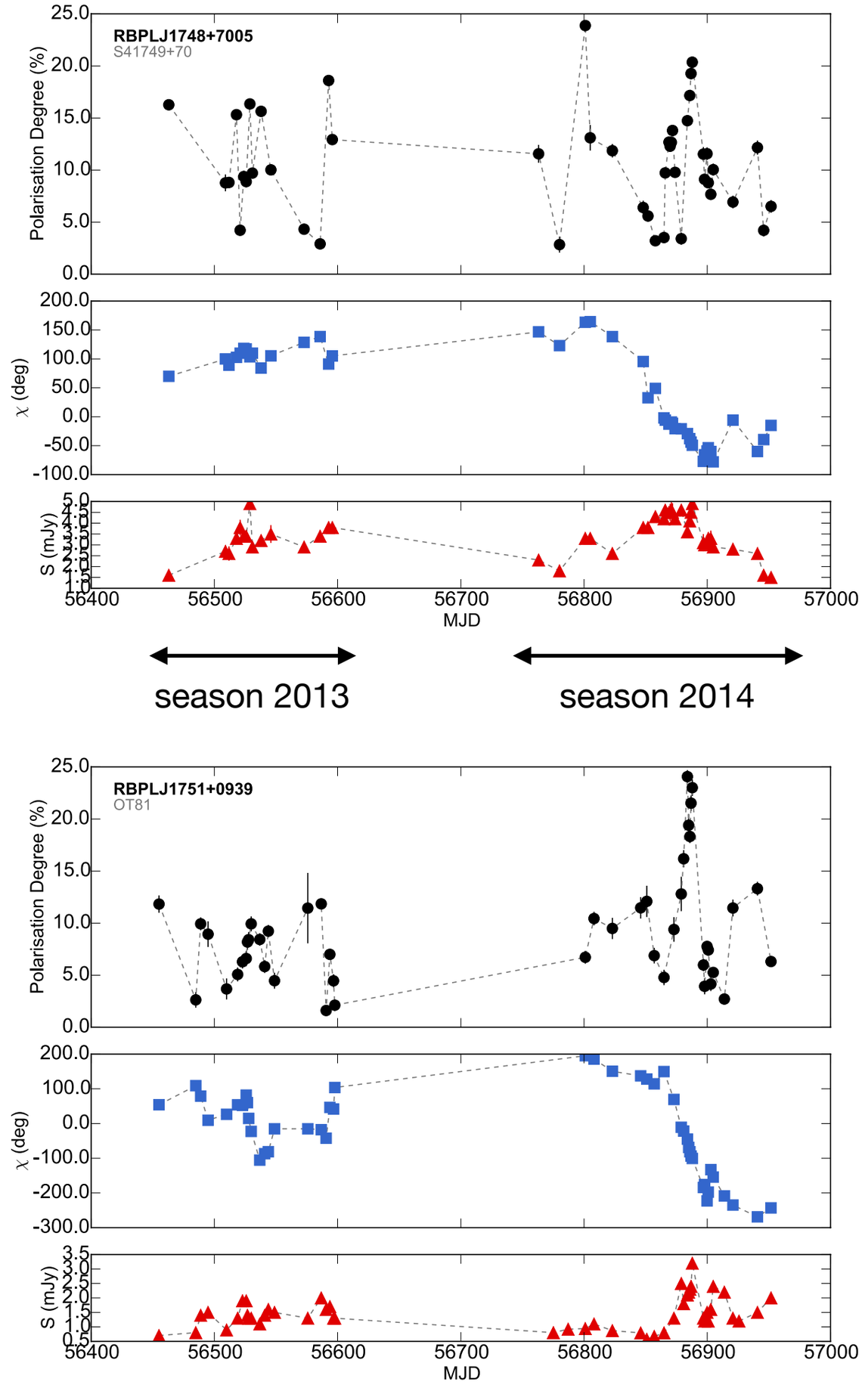
2FGL:

- integrated photon flux $F\ (> 100\ \mathrm{MeV})$
- $F\ (> 100\ \mathrm{MeV}) > 2 \times 10^{-8}\ \mathrm{cm}^{-2}\ \mathrm{s}^{-1}$,
- we exclude the galactic plane: |b| 10◦
- non-biasing cuts: 62 GL sources

gamma-ray quiet:

OVRO monitoring:

- intrinsic modulation, $m >= 0.05$
- mean flux density, $S >= 0.06\ \mathrm{Jy}$
- non-biasing cuts: 15 GQ sources



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$$\mathrm{PDF}\,(p;\alpha,\beta) = \frac{p^{\alpha-1}\,(1-p)^{\beta-1}}{B\,(\alpha,\beta)}$$

$$p_0 = \frac{\alpha}{\alpha+\beta}$$

and

$$m_p = \frac{\sqrt{\mathrm{Var}}}{p_0} = \frac{\alpha+\beta}{\alpha}\cdot\sqrt{\frac{\alpha\beta}{(\alpha+\beta)^2\,(\alpha+\beta+1)}}.$$

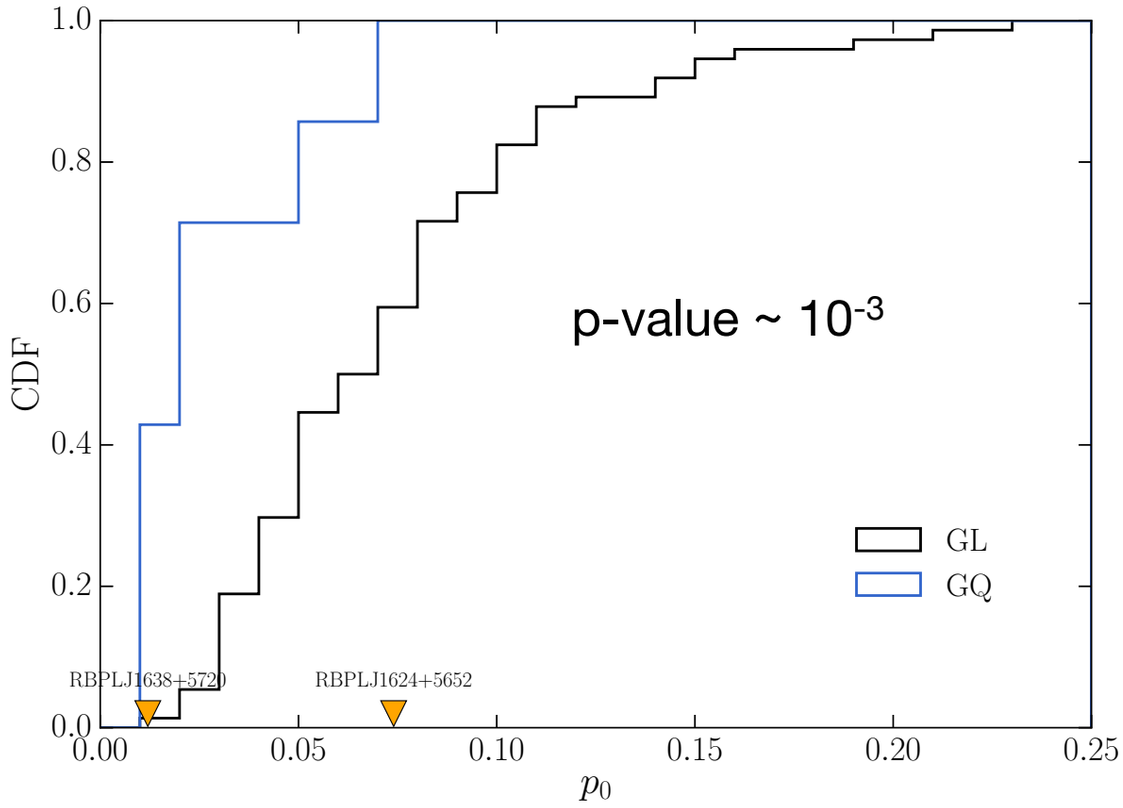
assuming a power law distribution:

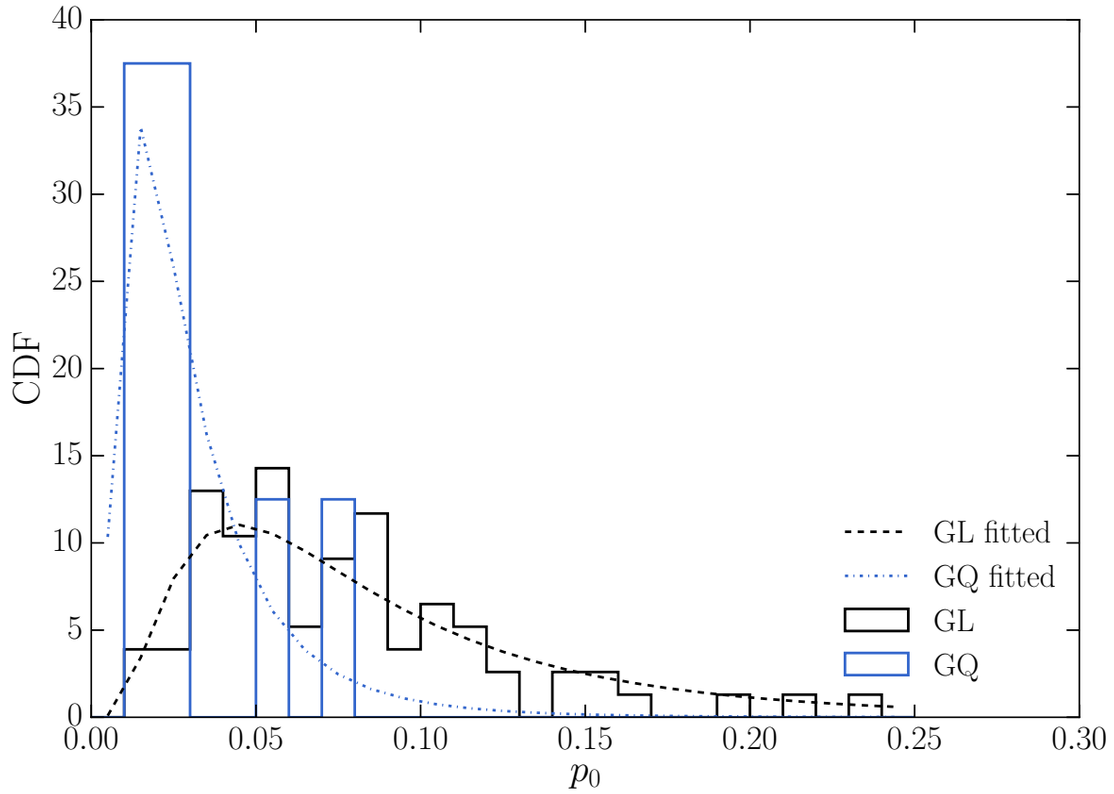
- **GL**: $\langle p_0 \rangle$ ~ 0.092 ± 0.008
- **GQ**: $\langle p_0 \rangle$ ~ 0.031 ± 0.008

from June 2013 survey

- **GL**: 0.064 (+0.009-0.008)
- **GQ**: 0.032(+0.02-0.011)

Pavlidou et al. 2014, MNRAS.442.1693P





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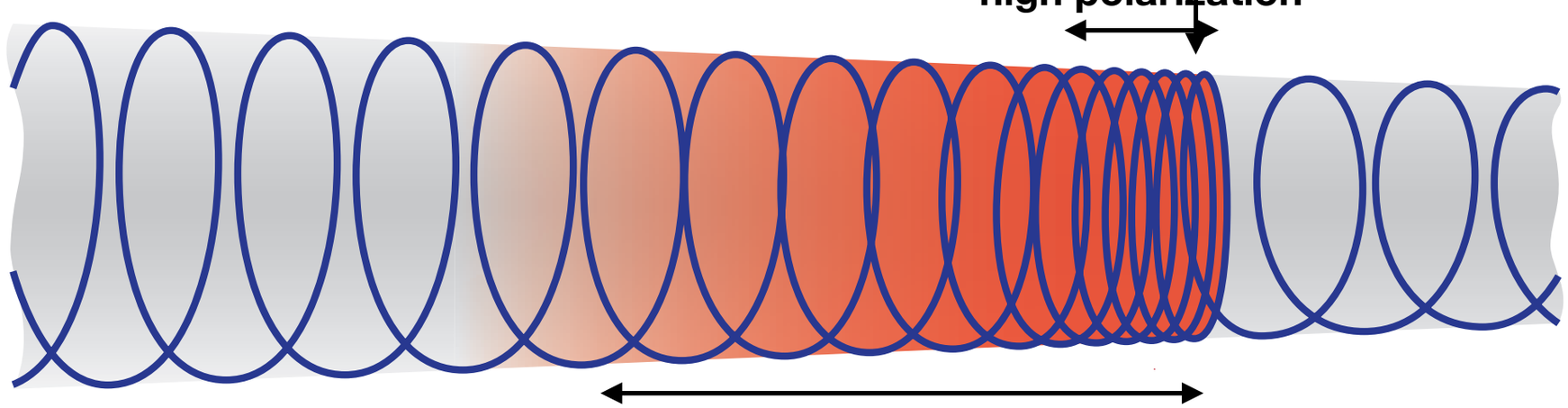
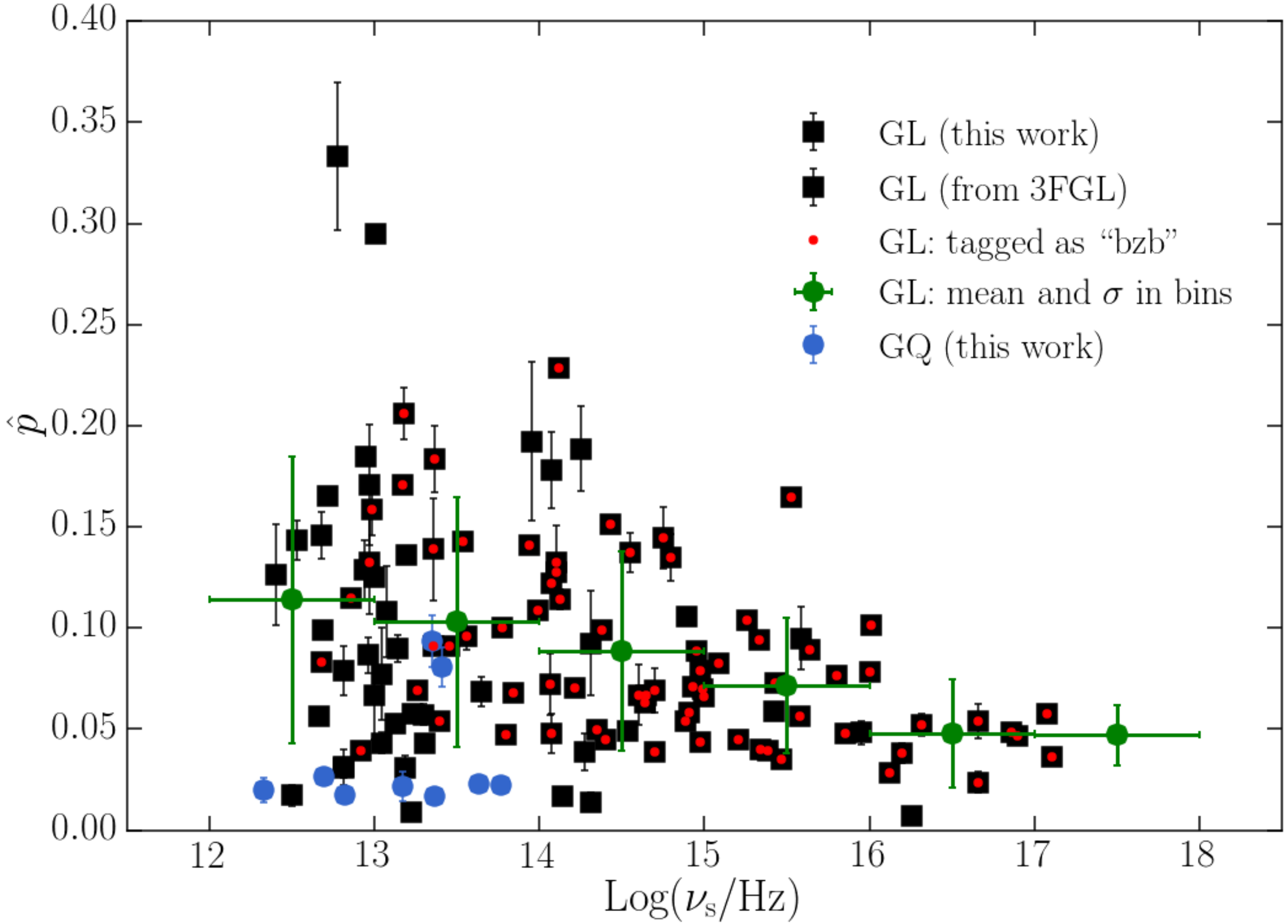
GL:

- highly variable, strong jet dominance due to:
  - high degree of Doppler boosting (*e.g. Savolainen et al. 2010; Lister et al. 2015*)
  - frequent occurrence of impulsive events of particle acceleration
- optical from **smaller volumes** hence **higher polarization**



GQ:

- objects with:
  - less extreme Doppler boosting or
  - impulsive episodes less efficient,
- optical from **larger volumes** hence **lower polarization**



for BL Lac GL only : ϱ = –0.5 (p-value: $7*10^{-6}$)

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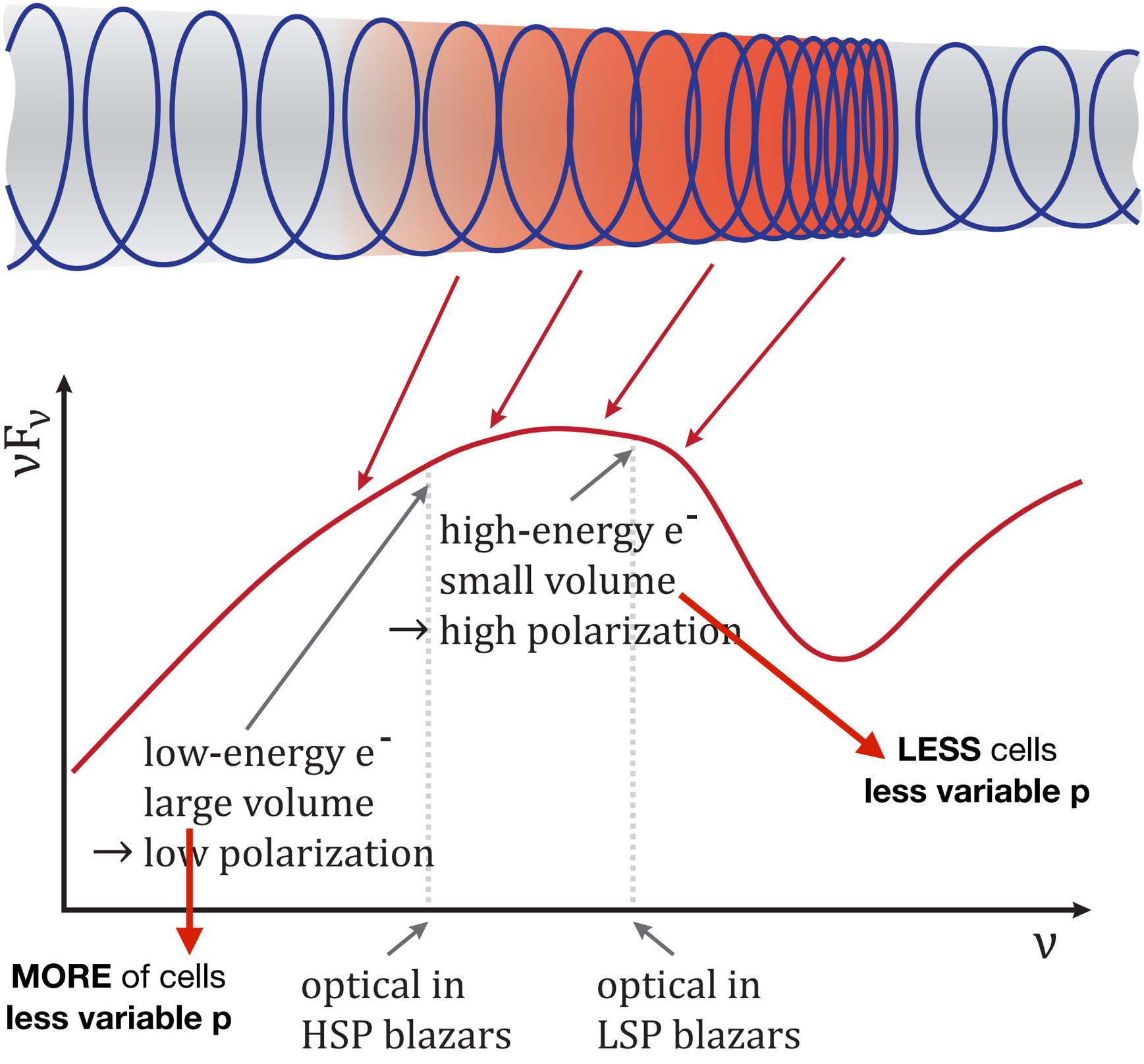
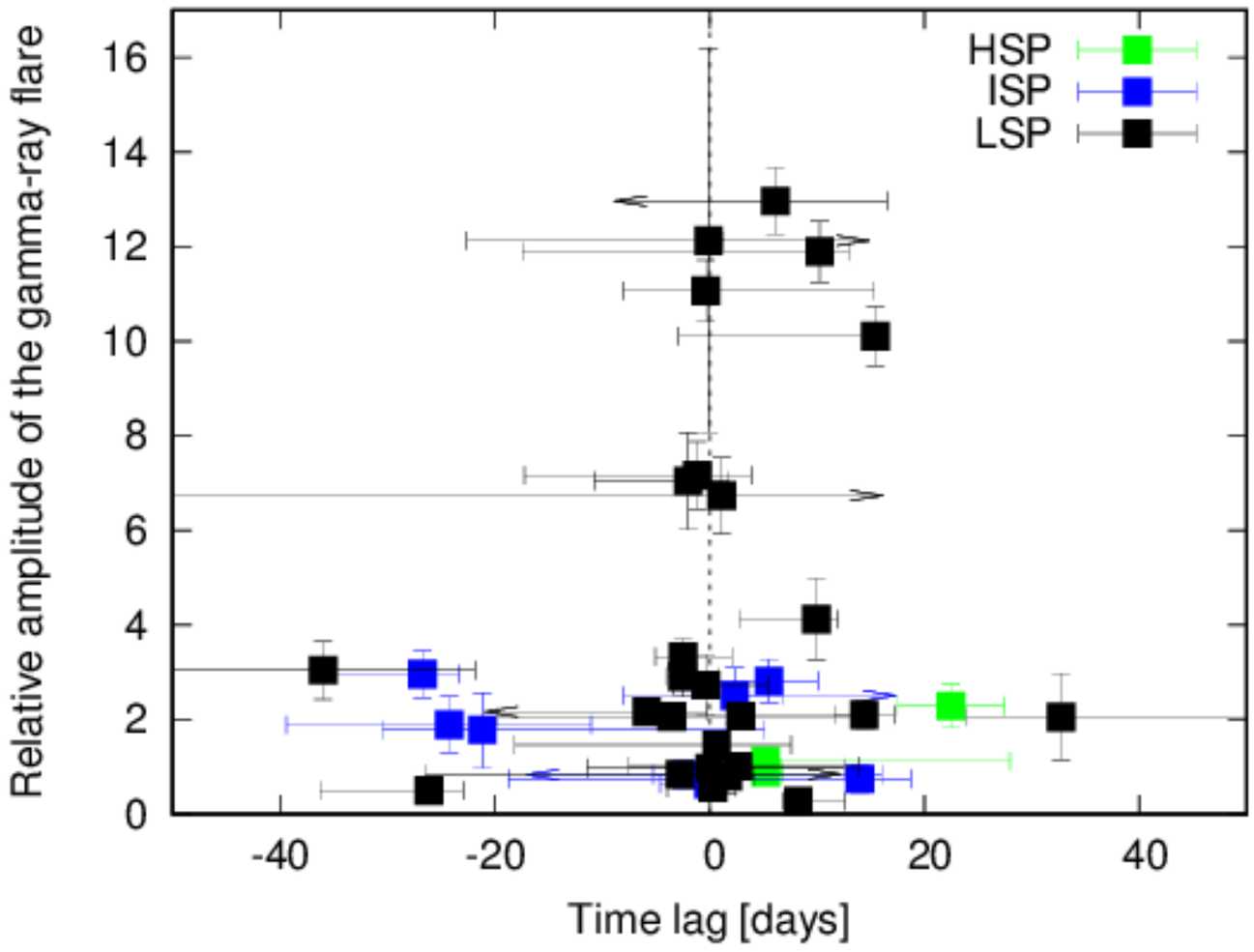

νF_ν
high-energy e⁻
small volume
→ high polarization
low-energy e⁻
large volume
→ low polarization
LESS cells
less variable p
MORE of cells
less variable p
optical in
HSP blazars
optical in
LSP blazars
ν



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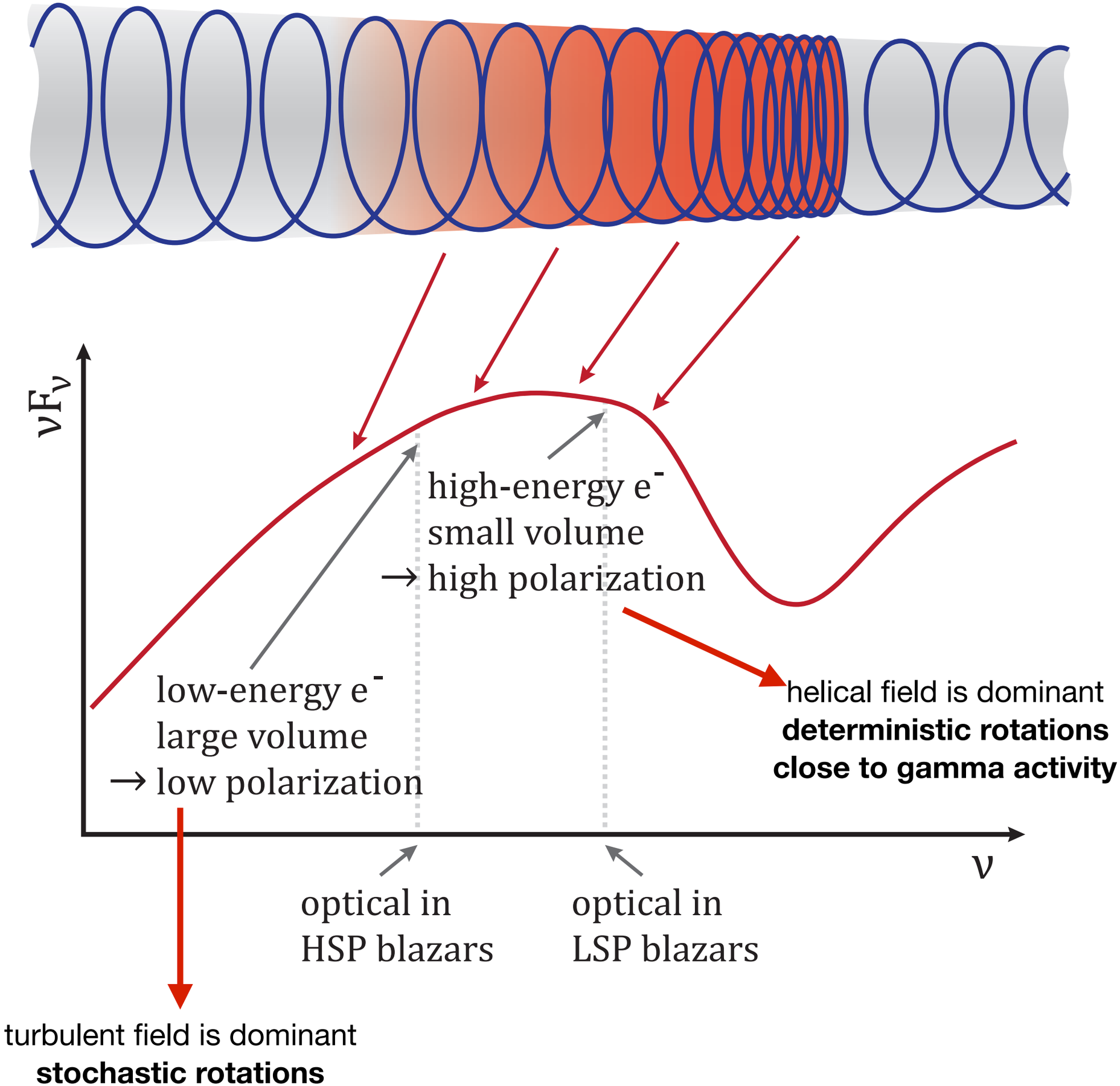
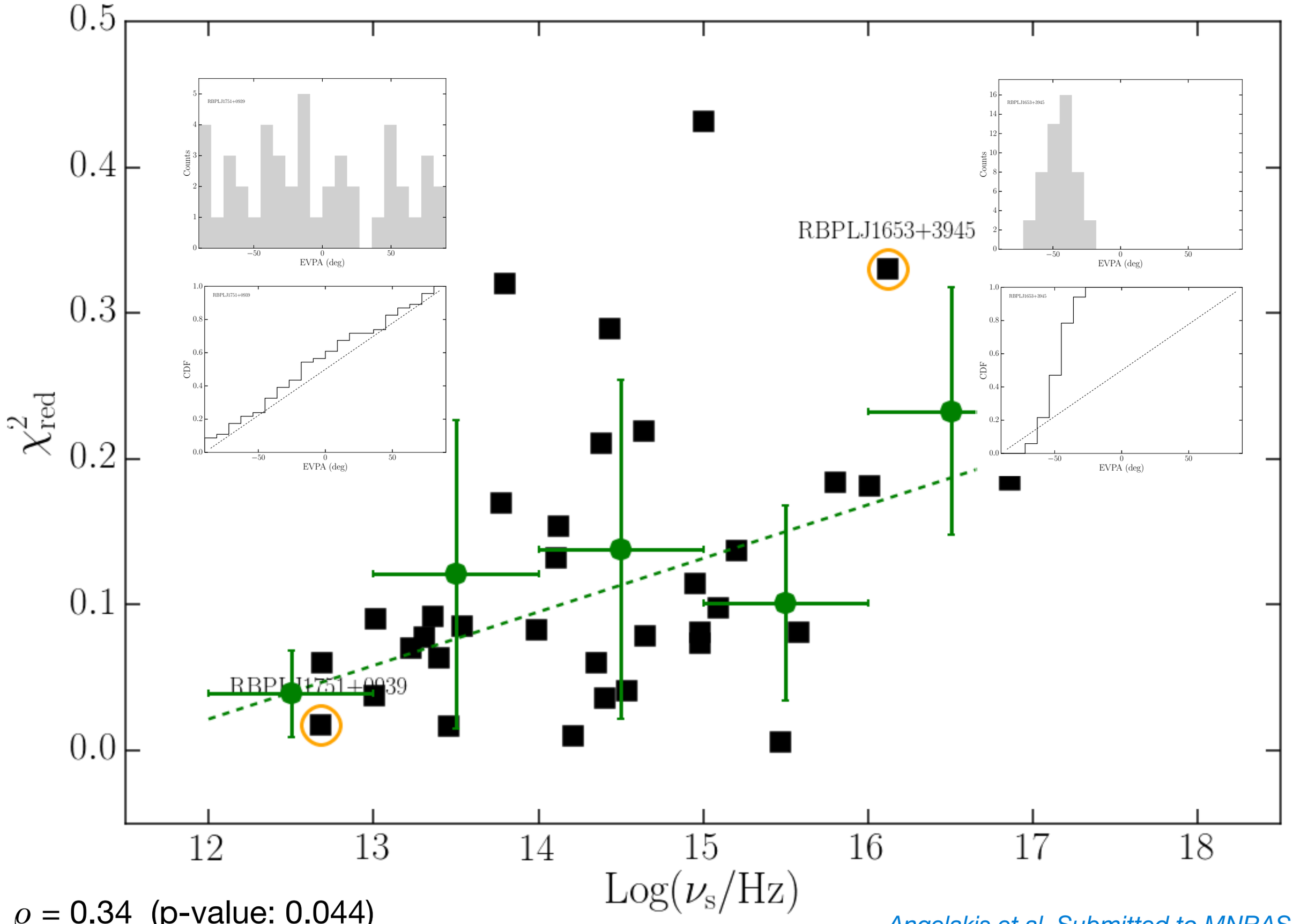
Blinov et al. MNRAS 453, 1669
Blinov et al. in preparation


νF_ν
high-energy e⁻
small volume
→ high polarization
low-energy e⁻
large volume
→ low polarization
helical field is dominant
deterministic rotations
close to gamma activity
turbulent field is dominant
stochastic rotations
optical in
HSP blazars
optical in
LSP blazars
ν



ϱ = 0.34 (p-value: 0.044)

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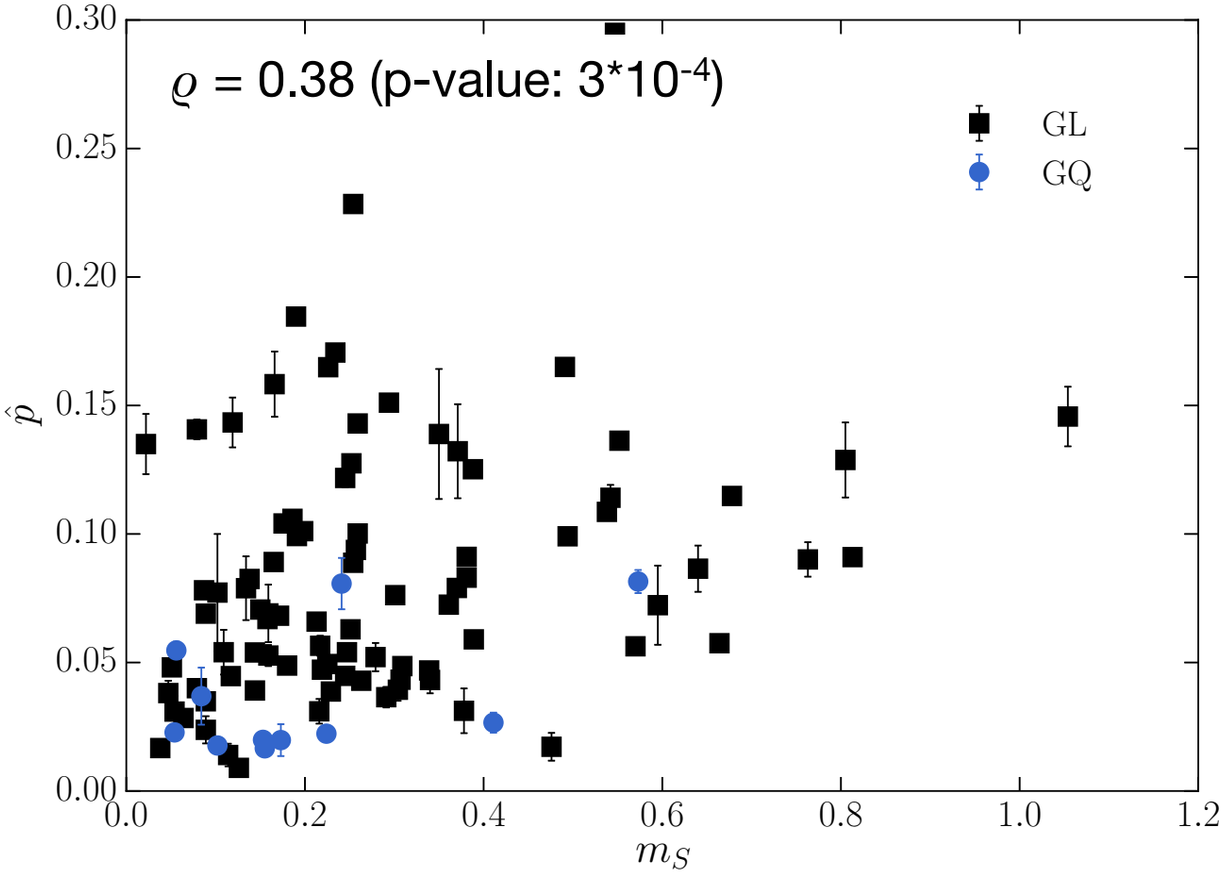

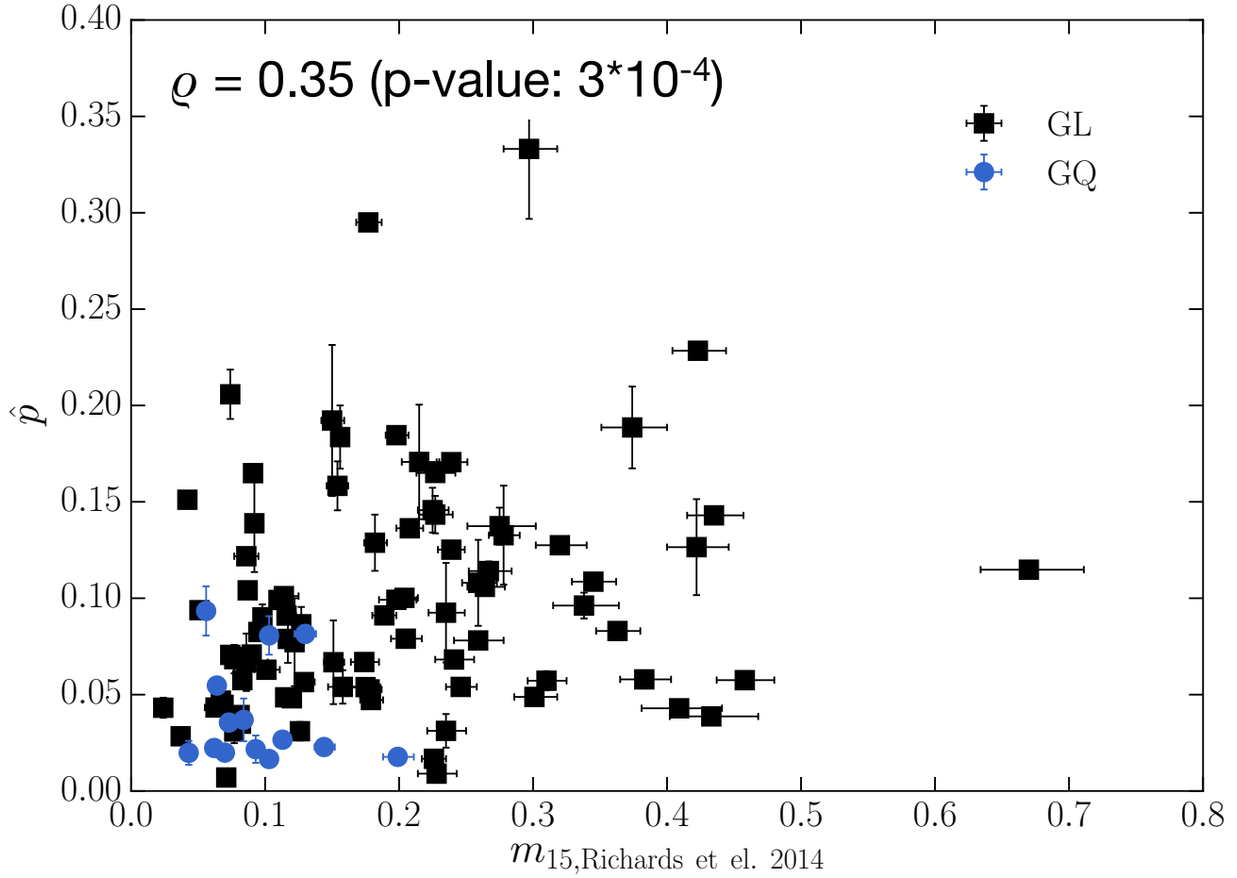

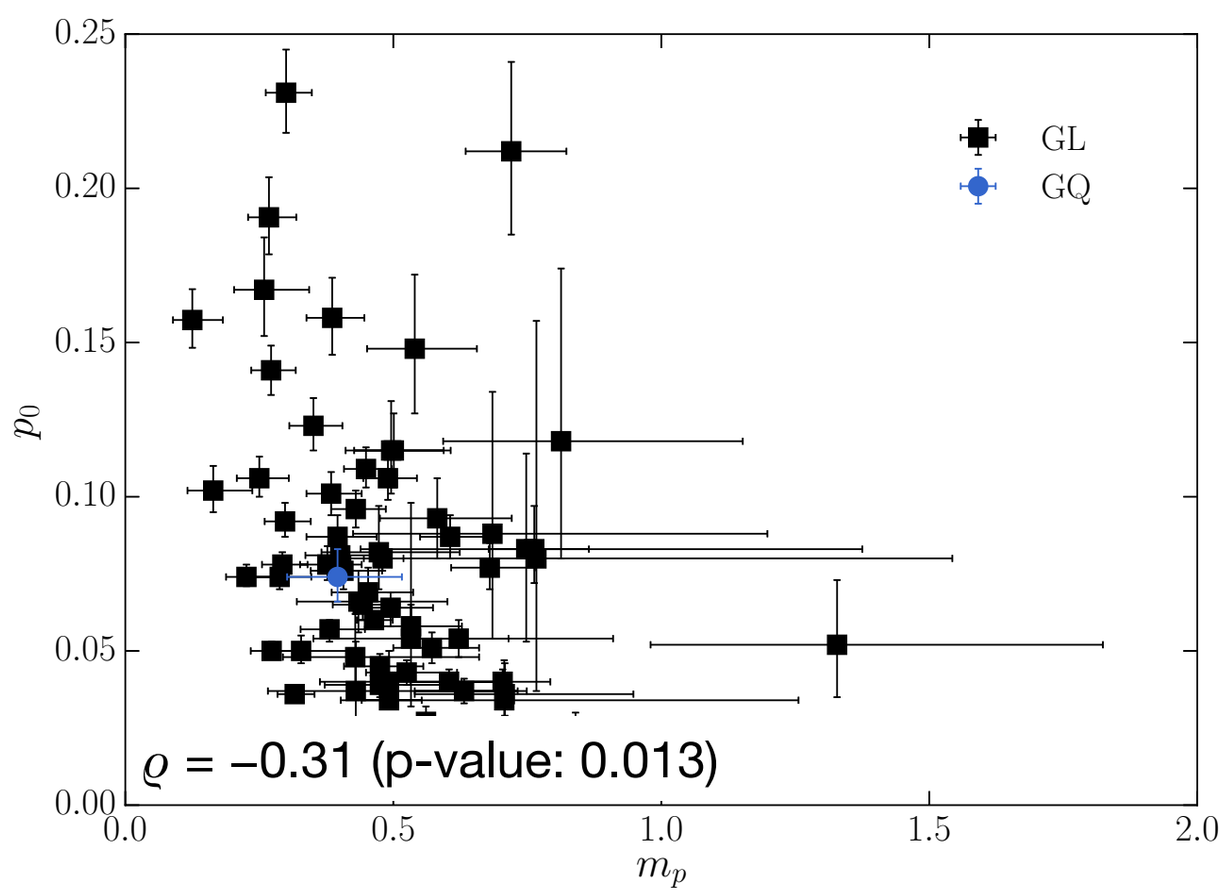

- stronger variability causes higher polarization
- the more variable sources are less polarized

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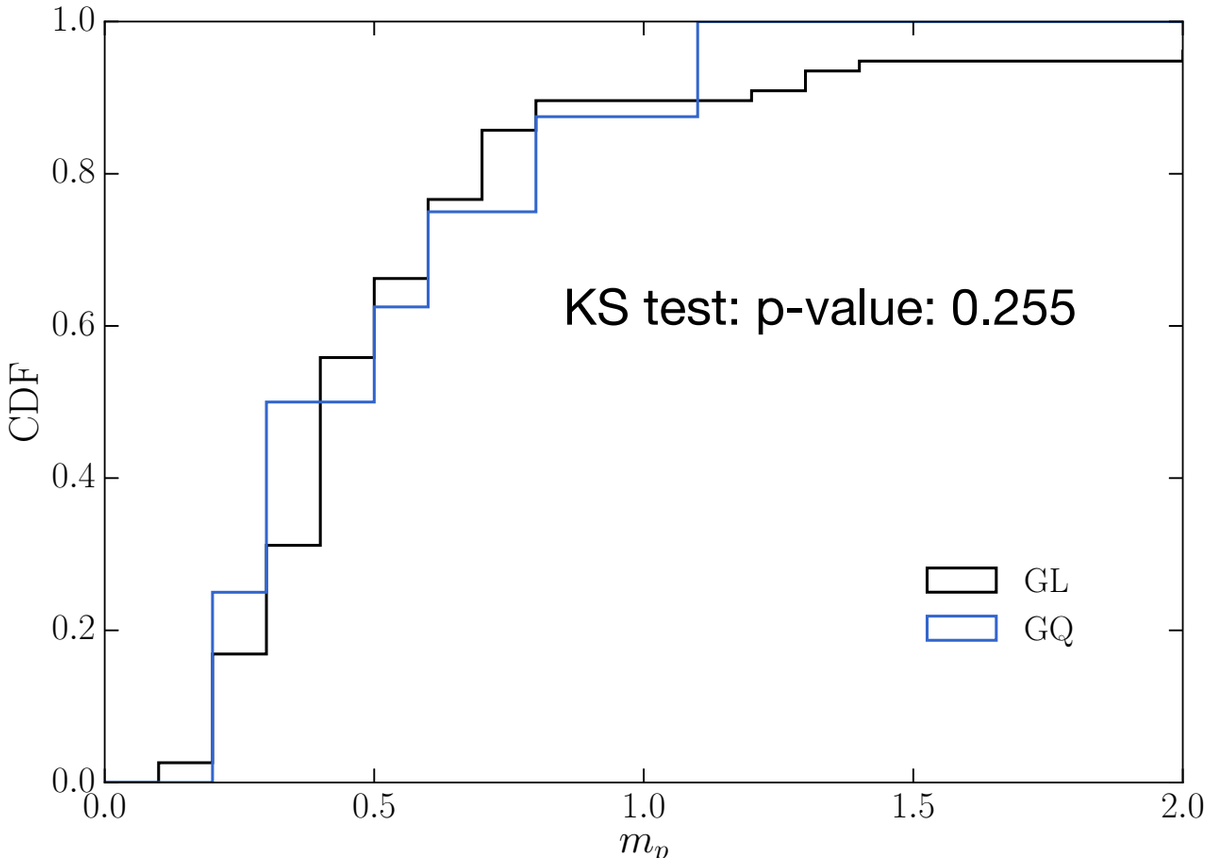
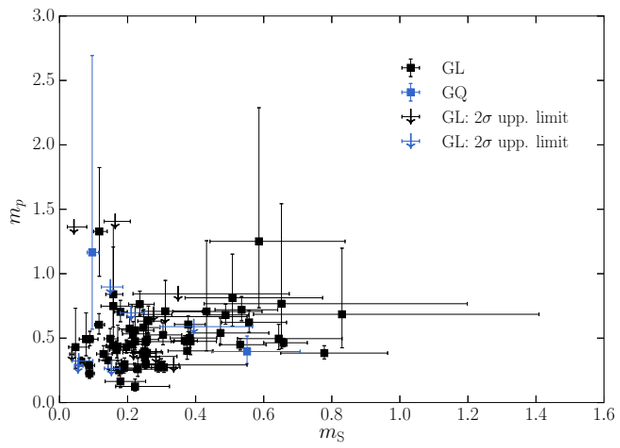
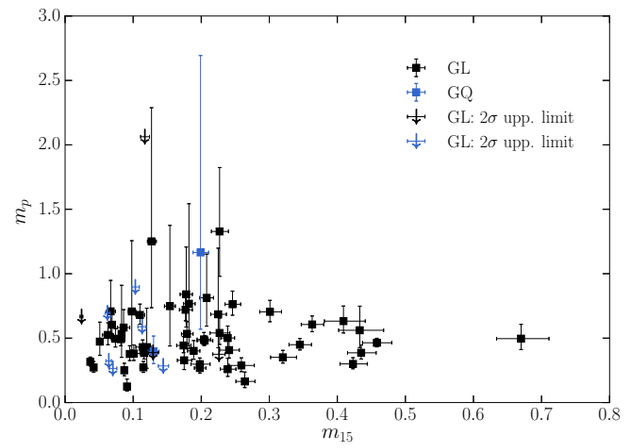


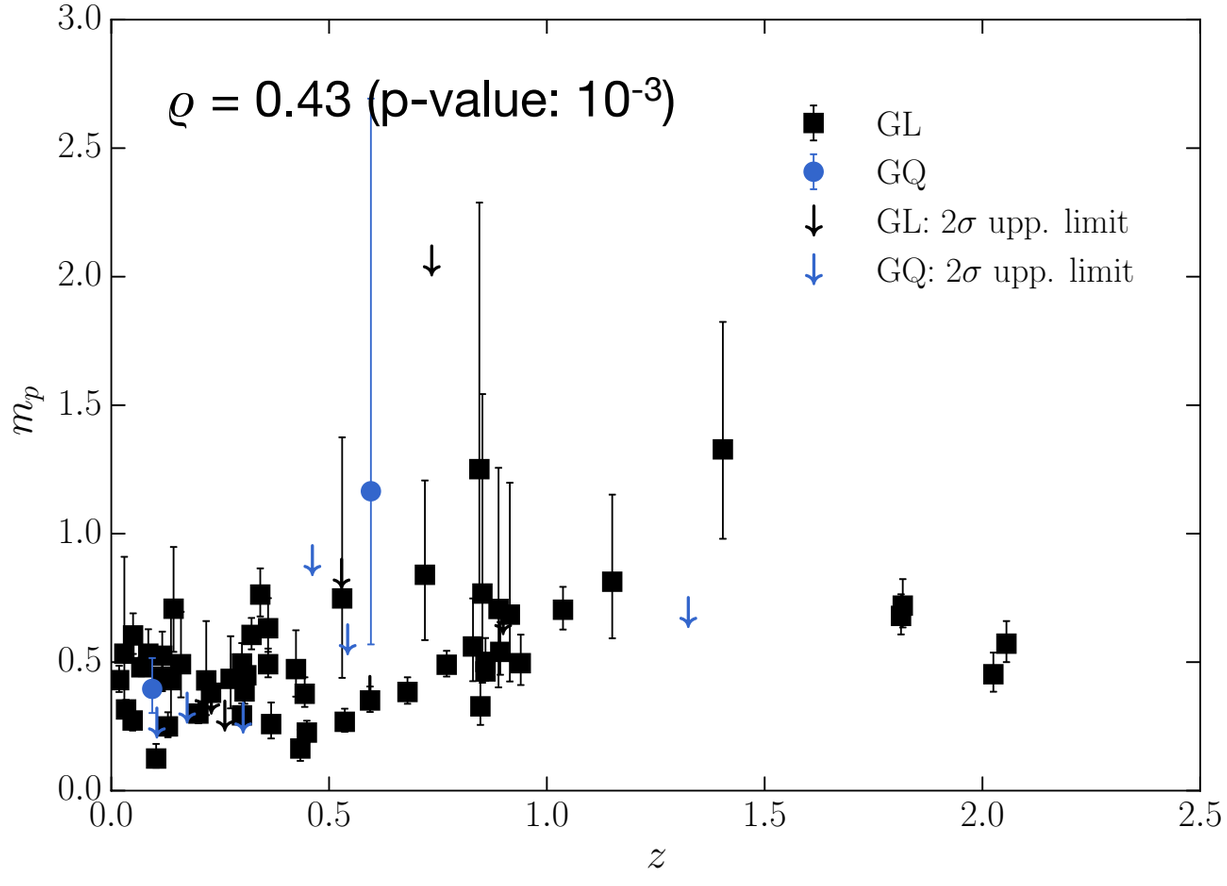
weak indication:

ϱ = 0.3 (p-value: 0.016 ~ 2.5σ)





no correlation



- GL and GQ are indistinguishable for m_p
- the polarization variability amplitude m_p increase with cosmic distance
- weak dependence of polarization variability in optical variability and no in radio

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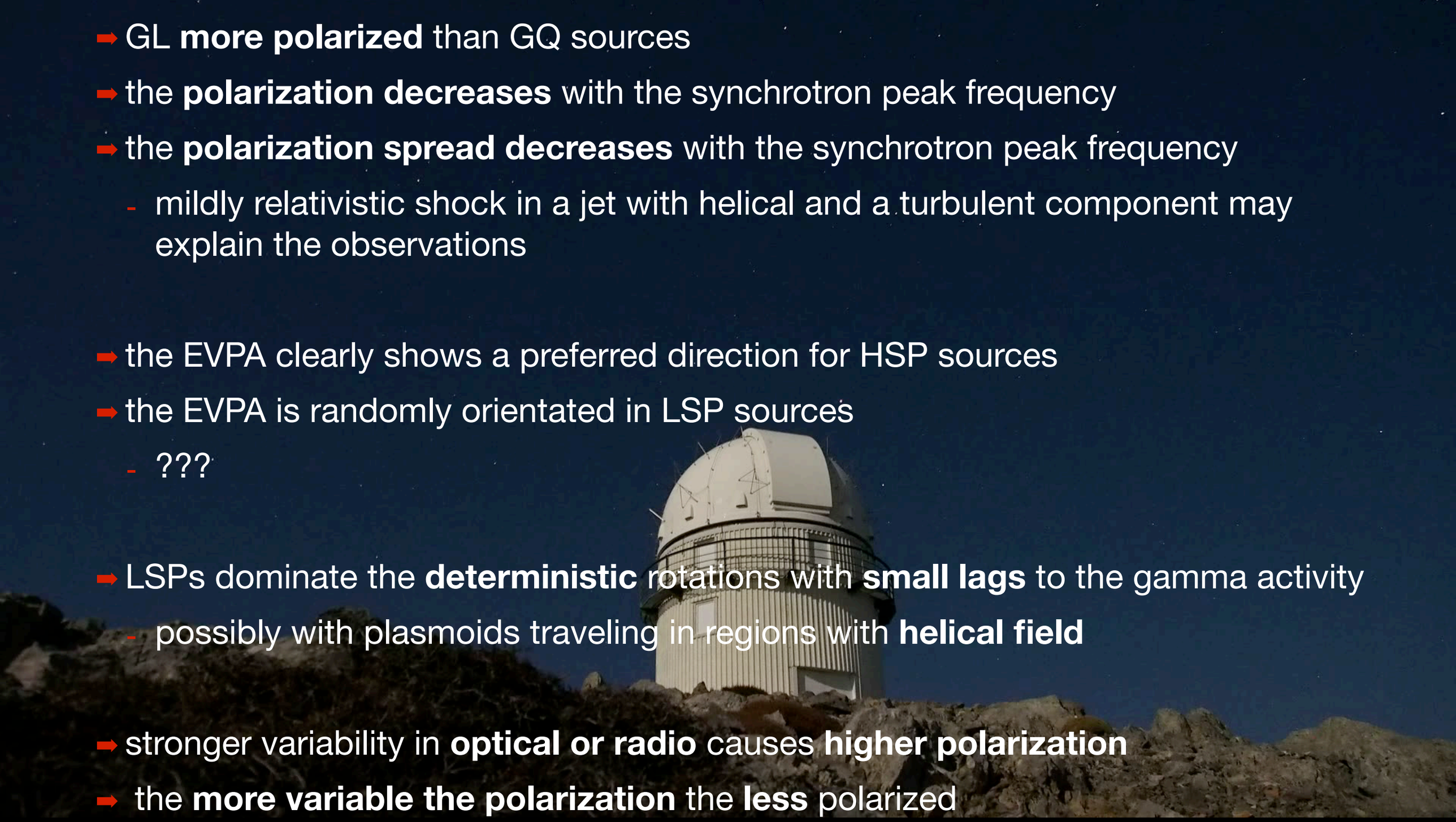
- GL **more polarized** than GQ sources
- the **polarization decreases** with the synchrotron peak frequency
- the **polarization spread decreases** with the synchrotron peak frequency
  - mildly relativistic shock in a jet with helical and a turbulent component may explain the observations

- the EVPA clearly shows a preferred direction for HSP sources
- the EVPA is randomly orientated in LSP sources
  - ???



- LSPs dominate the **deterministic** rotations with **small lags** to the gamma activity
  - possibly with plasmoids traveling in regions with **helical field**

- stronger variability in **optical or radio** causes **higher polarization**
- the **more variable the polarization** the **less** polarized

- GL and GQ are indistinguishable for m_p