Large Scale Alignment of QSO optical Polarizations and Pseudoscalar-Photon mixing

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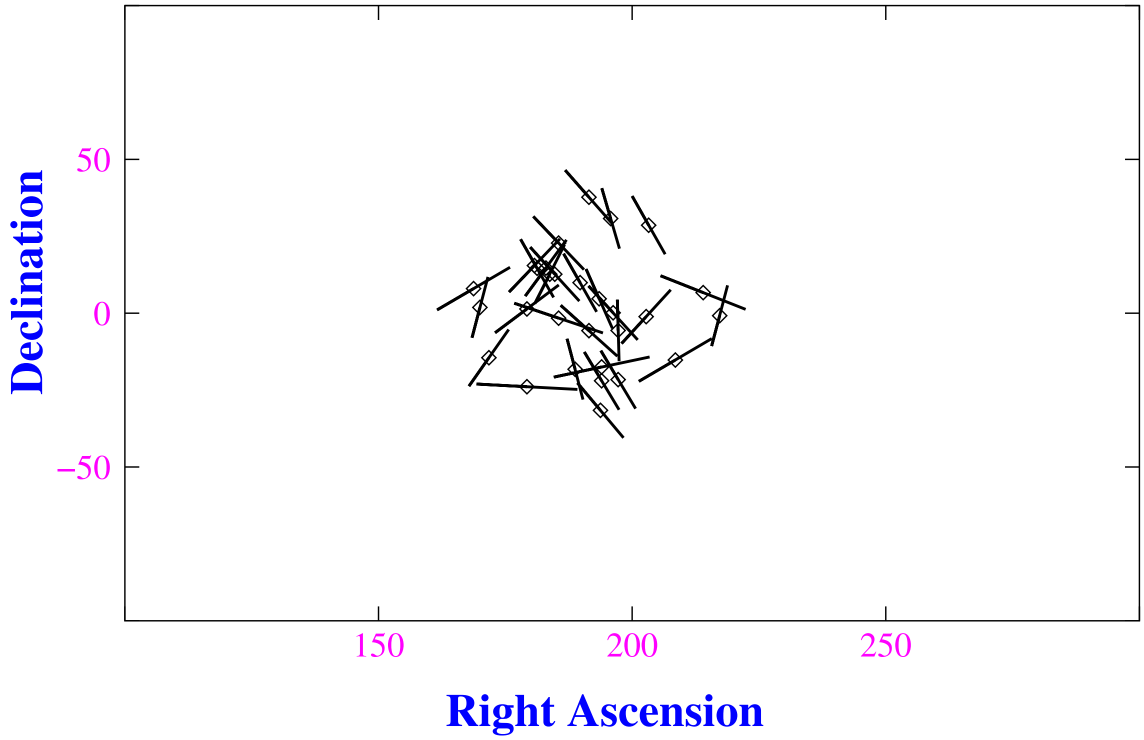
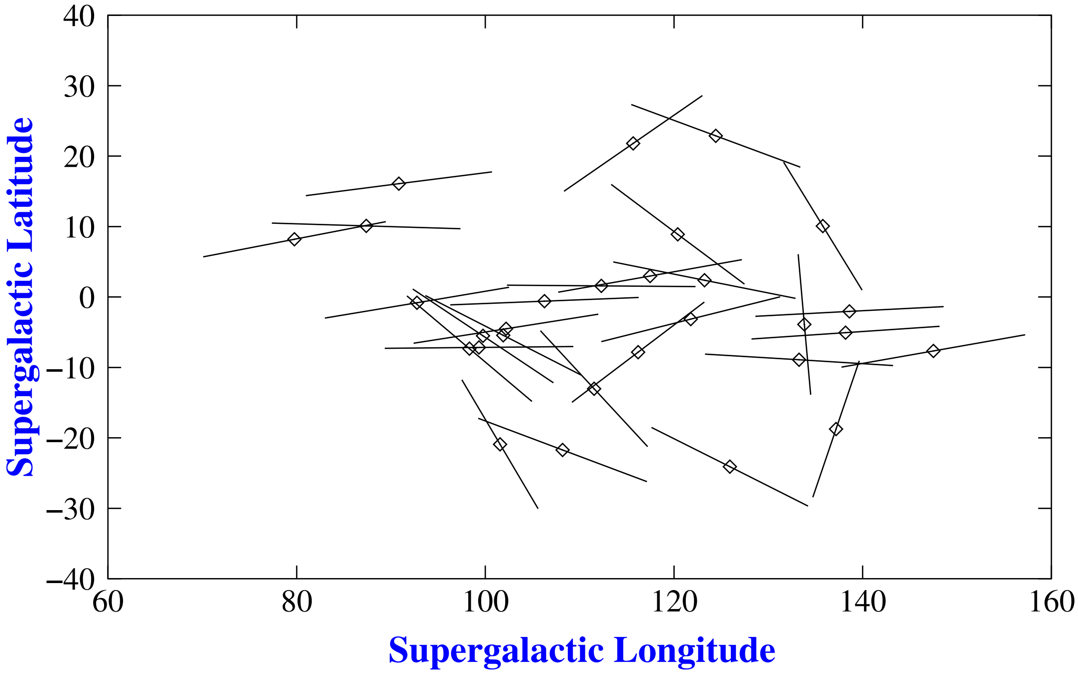
Optical Polarizations of QSOs appear to be locally aligned with one another.

D. Hutsemékers , *A & A* **332**, 410 (1998).

D. Hutsemékers and H. Lamy, *A & A*, **367**, 381 (2001).



$$1.0 \le z \le 2.3$$

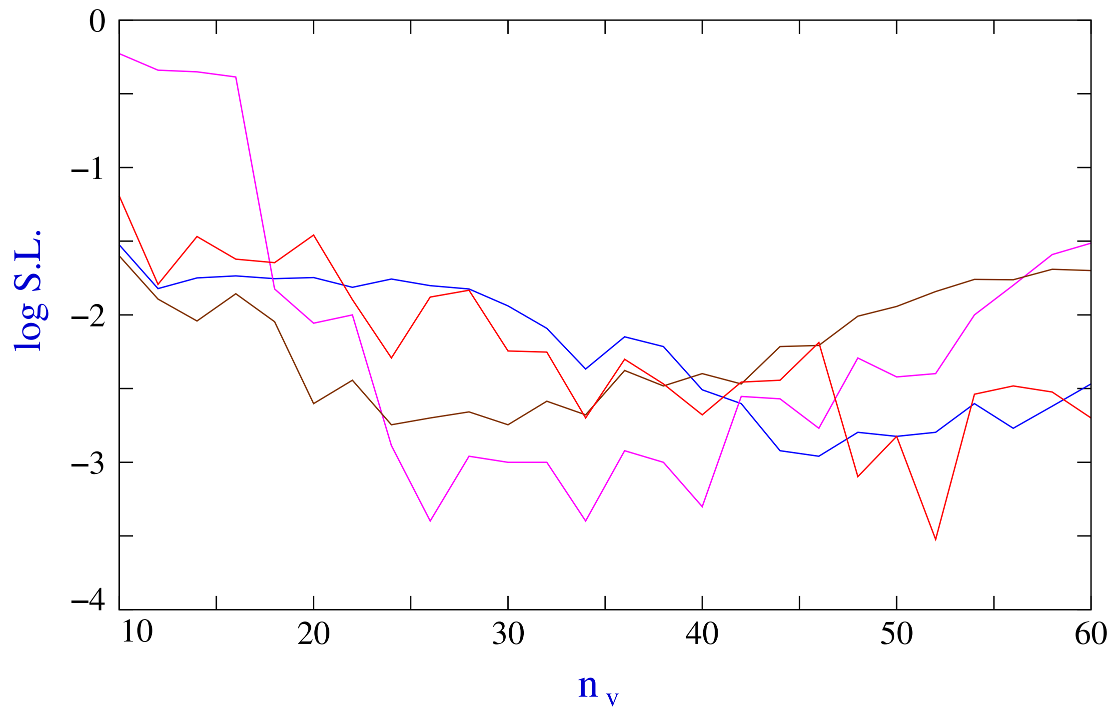

Supergalactic Latitude
Supergalactic Longitude
40
30
20
10
0
−10
−20
−30
−40
60
80
100
120
140
160

$$1.0 \le z \le 2.3$$

- Alignment is seen over very large regions.
- Effect is redshift dependent.
- A very strong alignment is seen in the direction of the Virgo Supercluster ($\approx$ center of the local supercluster.)

$$1.0 \leq z \leq 2.3$$

- Statistically the null hypothesis of Uniform Orientation is ruled out at $\approx 0.1\%$ significance level (S.L.)



Magenta line $\rightarrow S(\Delta\theta_c = 60^o)$

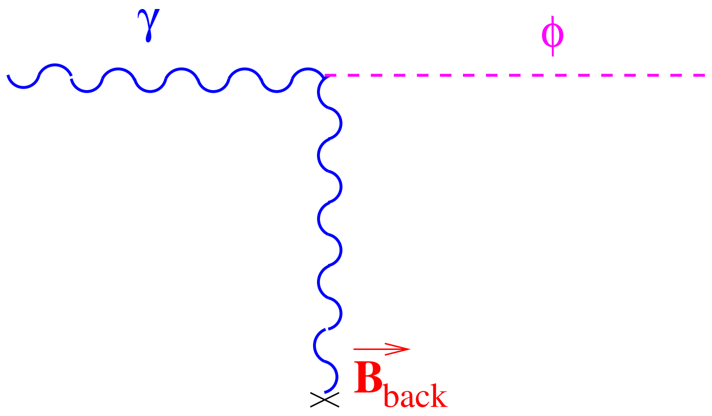
Brown line$\rightarrow S_D$

Red line $\rightarrow Z_c$

Blue line $\rightarrow Z_c^m$

Physical Explanation

- QSOs are not likely to be instrinsically aligned over such large ($\approx$ 1 Gpc) distances.
- The effect may arise due to propagation in a large scale magnetic field.
  - Extinction due to dust
  - Decay of Photons into light pseudoscalar particles.



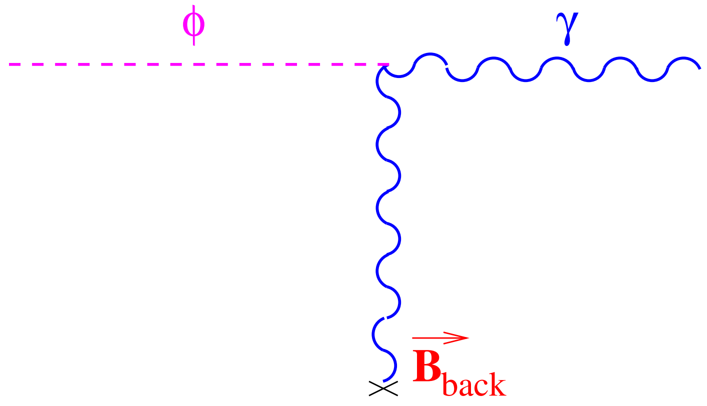
- Photons polarized parallel to $\vec{B}_{back}$ decay into pseudoscalars. Therefore Electromagnetic wave picks up perpendicular polarization.
- Large scale $\vec{B}_{back} \Rightarrow$ Large scale alignment

- However this DOES NOT work!
- We find that Radio Quiet(RQ) + Optically selected(O) QSOs have very low polarizations.
- This low polarization is seen even in the direction of Virgo supercluster.

$\Rightarrow$ strong constraint on the magnitude of the pseudoscalar-photon mixing or extinction due to dust.

- We propose that QSOs also emit a significant flux of pseudoscalars at optical frequencies.

Jain, Panda and Sarala *Phys. Rev.* **D66**, 085007 (2002)



- Decay of pseudoscalar particle (ϕ) into photons in $\vec{B}_{back}$ gives rise to alignment.
- RQ+O QSOs DON'T EMIT significant flux of ϕ

Redshift dependence may be explained if we assume the existence of several superclusters at different redshifts.

Pseudoscalar - Photon mixing Parameters

Virgo Supercluster

- $\vec{B}_{back} \approx 1\mu\text{G}$
- n_e (plasma density) $\approx 10^{-6}\text{cm}^{-3}$
- L $\approx$ 10 Mpc
- $g_{AA\phi} \approx 10^{-11}$ GeV^{-1}
- $P \approx 1\% - 10\%$

Conclusion and Future Work

- Large scale alignment can be explained if we assume the existence of a very light pseudoscalar.
- We are currently making an estimate of the pseudoscalar flux from QSOs in order to determine the viability of this explanation.