Evidence for wave-plasma interaction by single pulses

Rapid Rotation of Polarization Orientations in PSR B1919+21's Single Pulses: Implications On Pulsar's Magnetospheric Dynamics (arXiv: 2411.18999)

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Sorry for the topic change…
Please scan this QR code if you want slides for introducing **PSR B0943+10, the original topic**.

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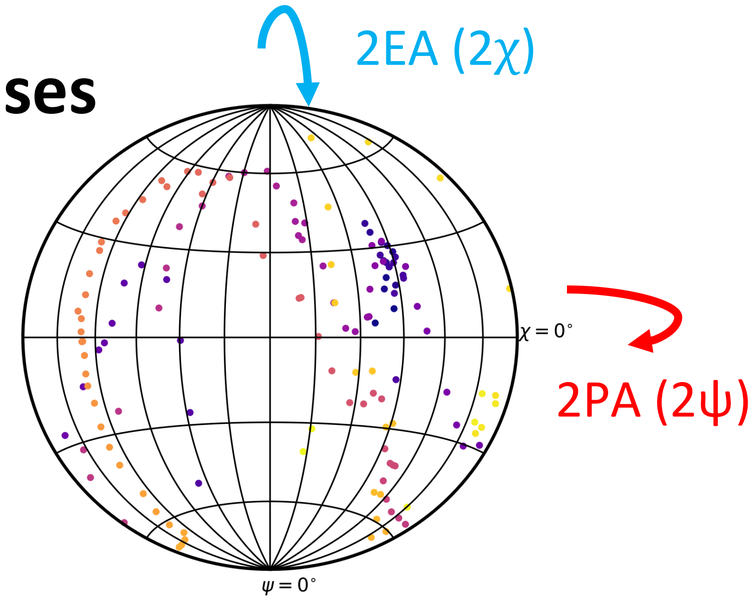
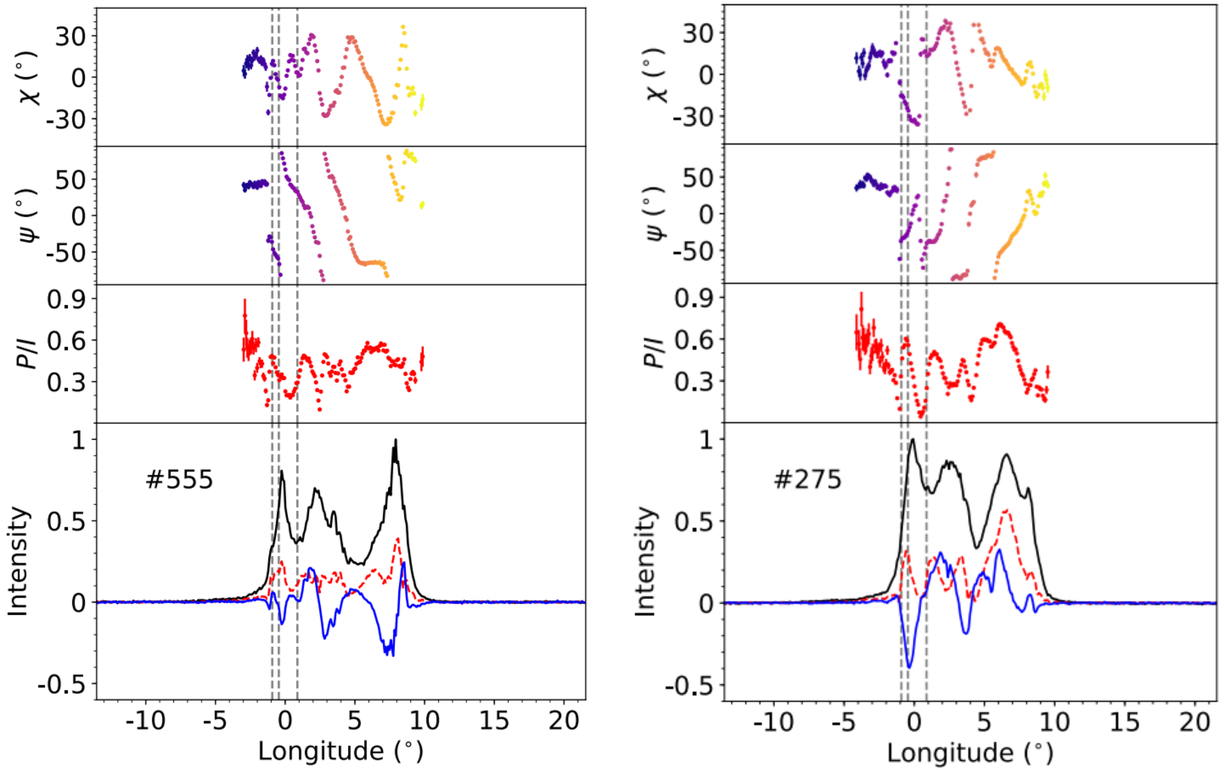
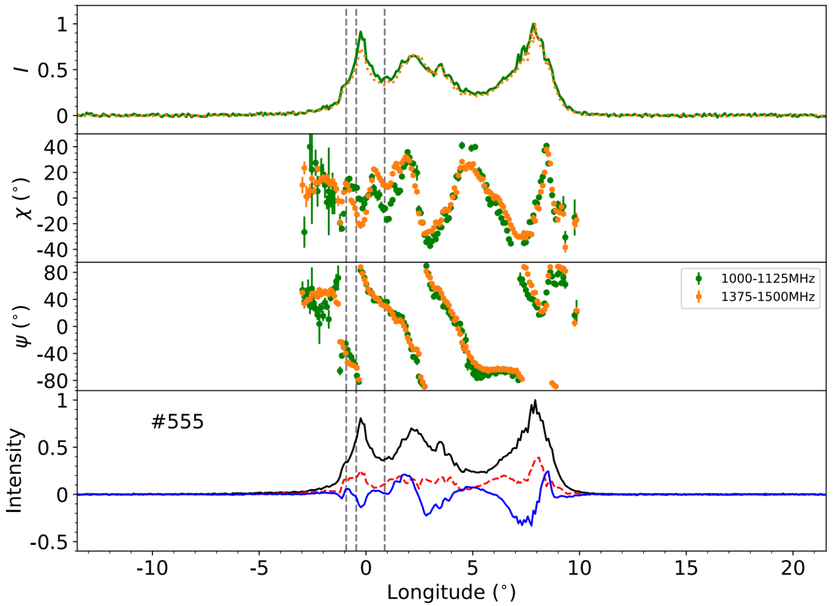
Phenomenon: long polarization rotation in single pulses

>1/3 pulses of B1919+21 have polarization position angle (PA, ψ) **quasi-monotonically rotating** over π or even 2π. Oscillations of circular polarization are accompanied.



Two pulses observed by FAST





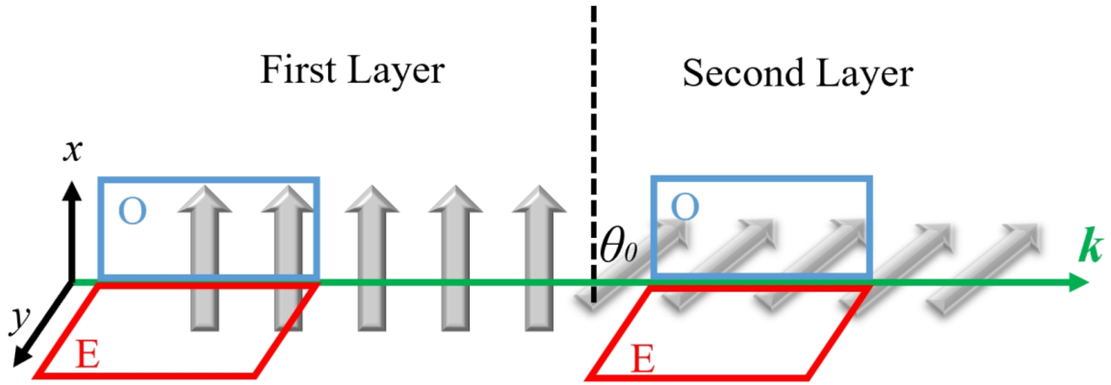
Quasi-monotonic PA curve (versus longitude): **Asymmetry**

negative slope (most) positive slope (very few)

Weak frequency dependence.

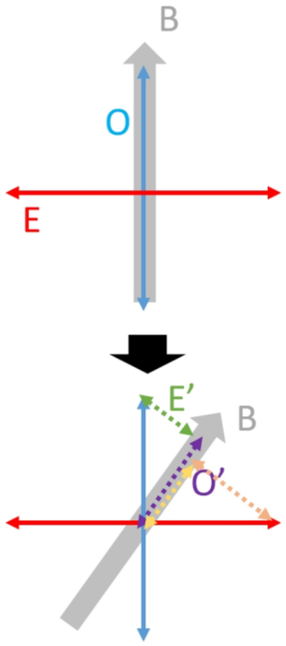
Green (1062 MHz), Orange (1438 MHz)

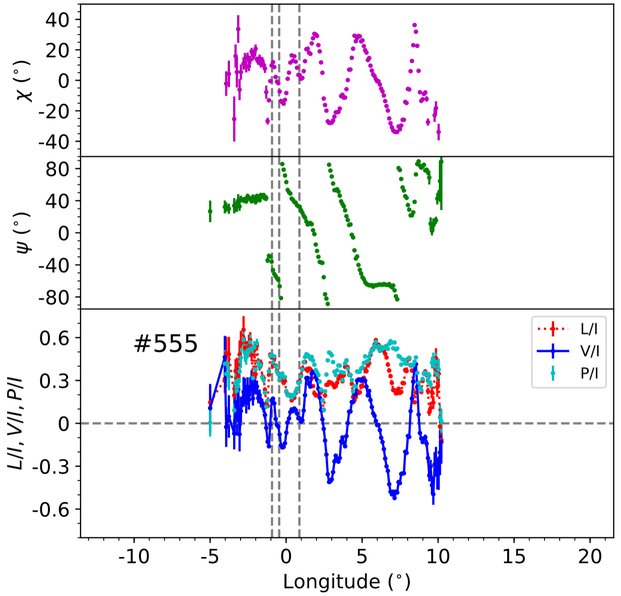
Modeling: orthogonal modes' coherent summation



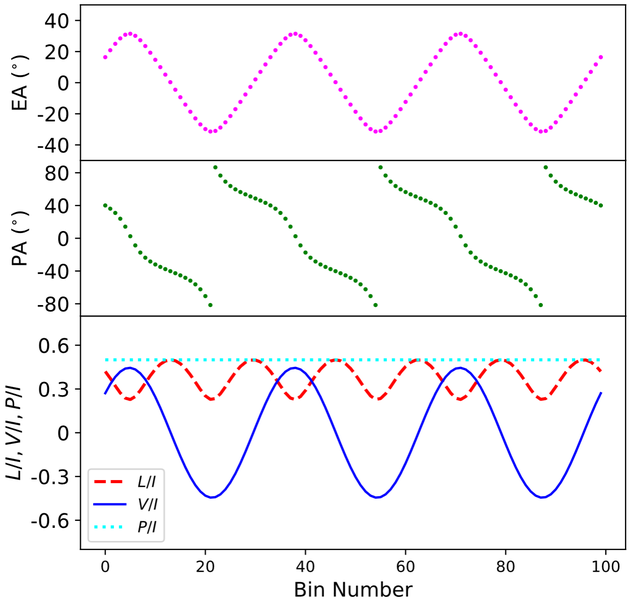
Phase lag (η) between O & E modes changes.

The original O & E modes are factored into new normal modes, with phase lag δ.





Data



Simulation

This polarization rotation could be attributed to quick change of phase lag between normal wave modes within a pulse.

Phase lag is propagation induced.

Inhomogeneous distribution of n_e/γ^3 leads to asymmetry in PA curve slopes' distribution.

Calculation of phase lag: why weak frequency dependence?

Calculation of phase lag between normal wave modes give constraints on magnetospheric dynamics/parameters.

$$(1 - n_{\rm O}^2 \cos^2\theta)\left[1 - \frac{\omega_{\rm p}^2}{\omega^2\gamma^3(1 - n_{\rm O}\beta\cos\theta)^2}\right] - n_{\rm O}^2 \sin^2\theta = 0, \qquad n_{\rm E} = 1$$

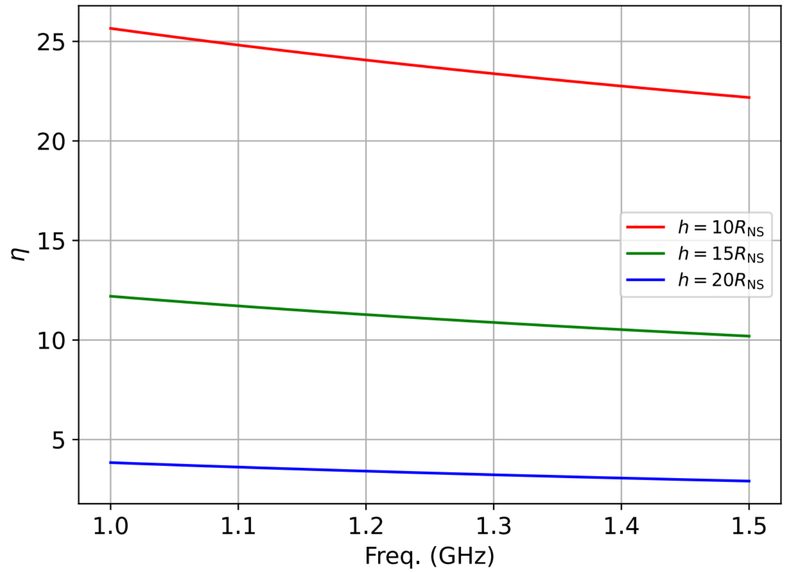
(Melrose & Stoneham 1977, Arons & Barnard 1986)

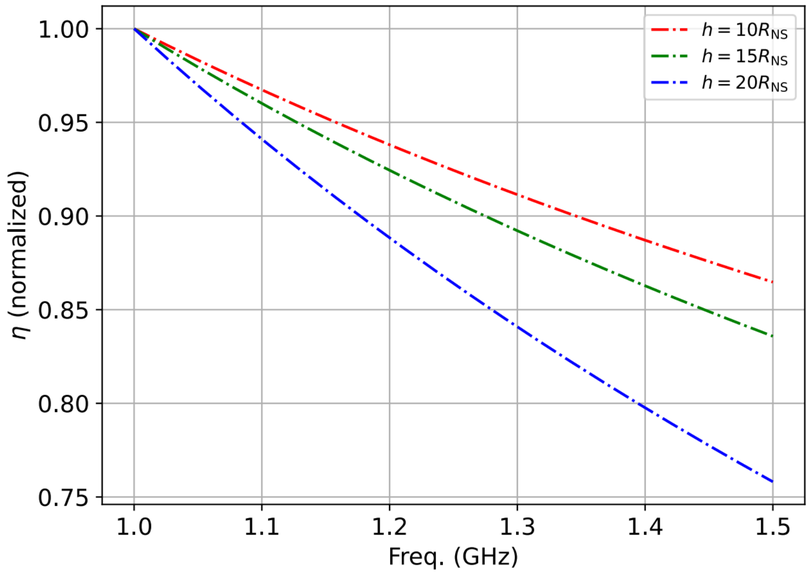
Frequency dependence relies on θ = <***k, B***>, which depends on **emission position**.

$$\eta = \int_L (k_{\rm E} - k_{\rm O})dl = \int_L \frac{\omega}{c}(n_{\rm E} - n_{\rm O})dl$$

Weak frequency dependence ➔ **Low** emission height.

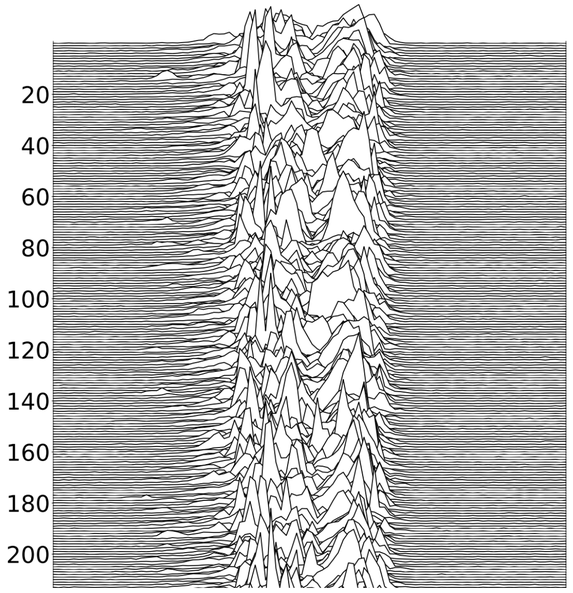
If phase lag η is on the order of 6π, $\kappa/\gamma^3 \sim 10^{-7}$.
(e.g. $\kappa = 10^2, \gamma = 10^3$) ($\kappa$ means $n_e/n_{\rm GJ}$)

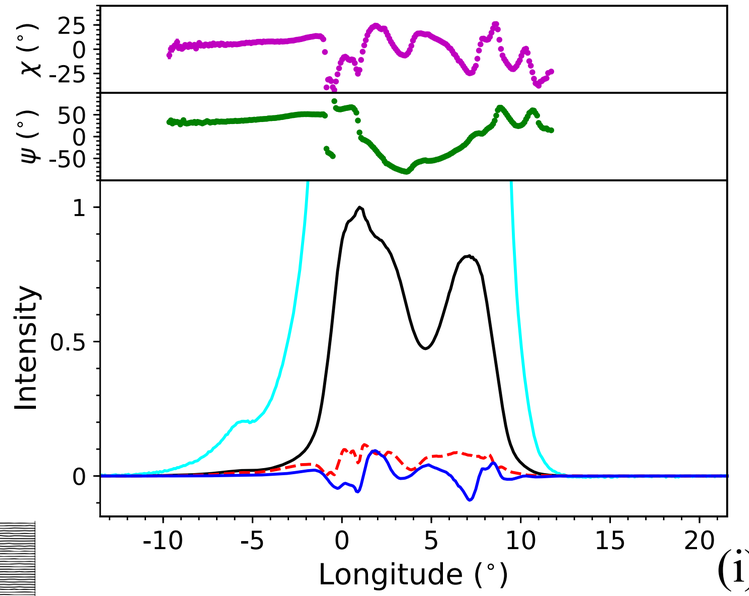


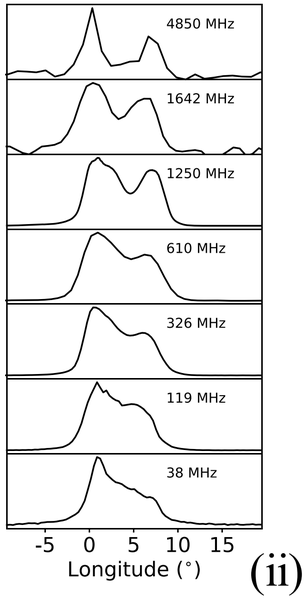


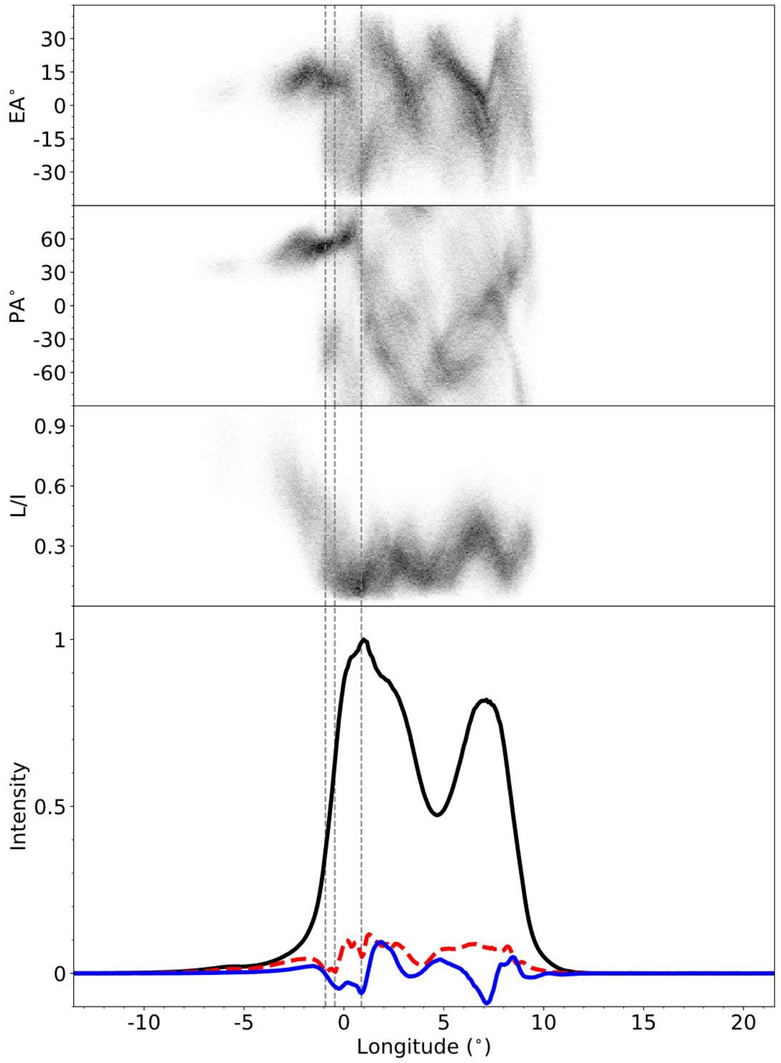
Thanks for listening!

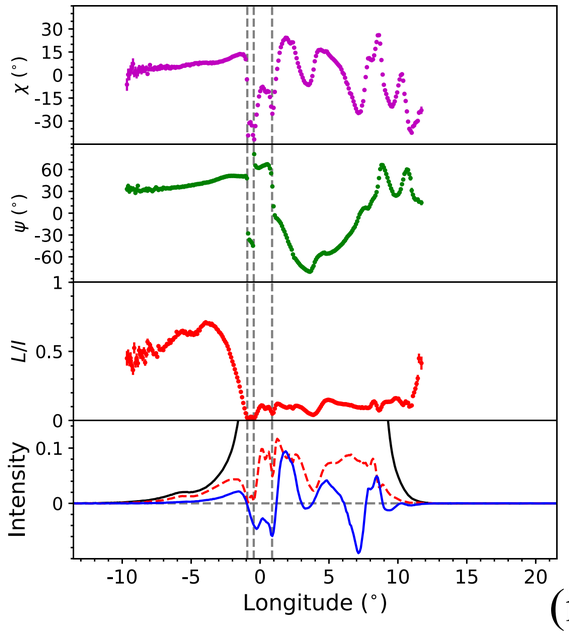
Backup

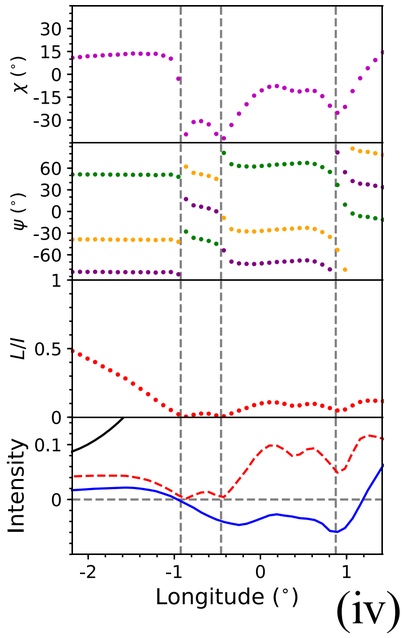

20
40
60
80
100
120
140
160
180
200


χ (°)
ψ (°)
Intensity
Longitude (°)
(i)


4850 MHz
1642 MHz
1250 MHz
610 MHz
326 MHz
119 MHz
38 MHz
Longitude (°)
(ii)


EA°
PA°
L/I
Intensity
Longitude (°)


χ (°)
ψ (°)
L/I
Intensity
Longitude (°)
(iii)


χ (°)
ψ (°)
L/I
Intensity
Longitude (°)
(iv)