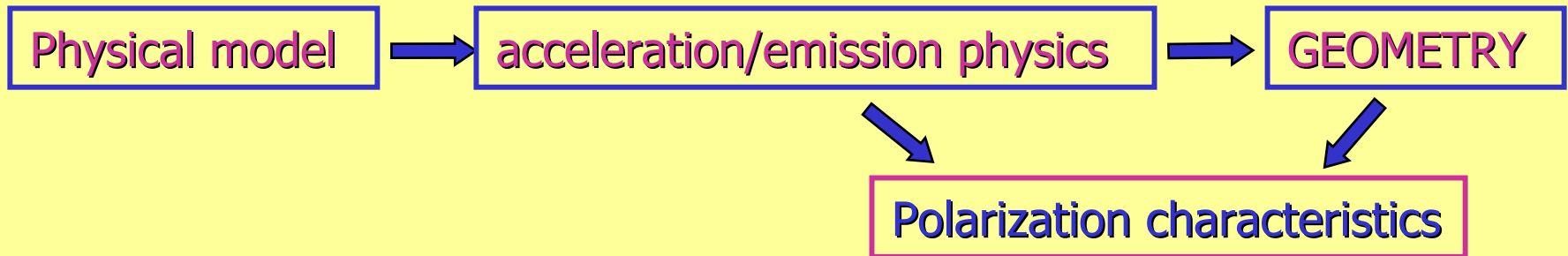


Polarization of Pulsar Emission in Polar Cap Models

Alice K. Harding

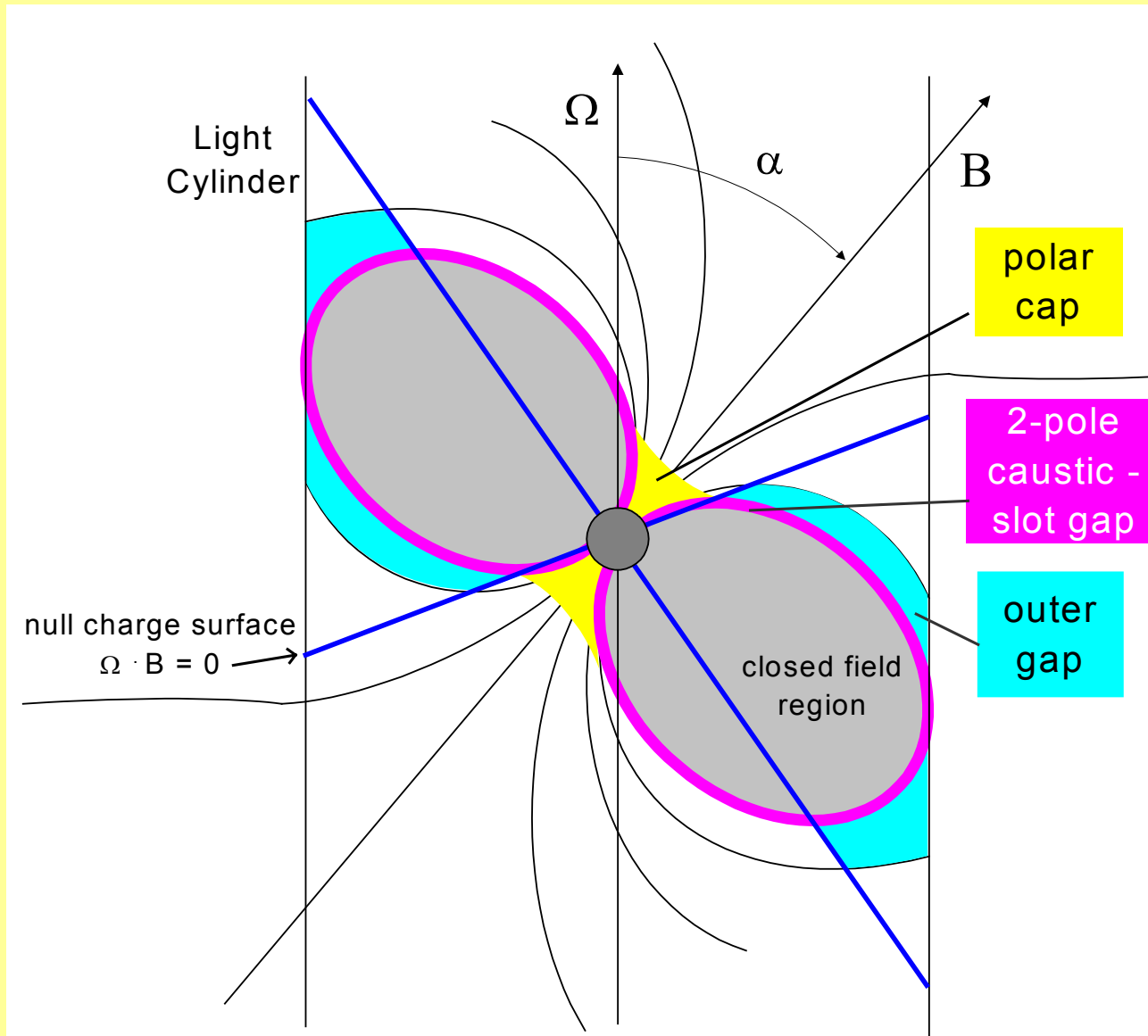
NASA Goddard Space Flight Center

With Collaborators: Jarek Dyks (GSFC) and Bronek Rudak (NCAP-Poland)

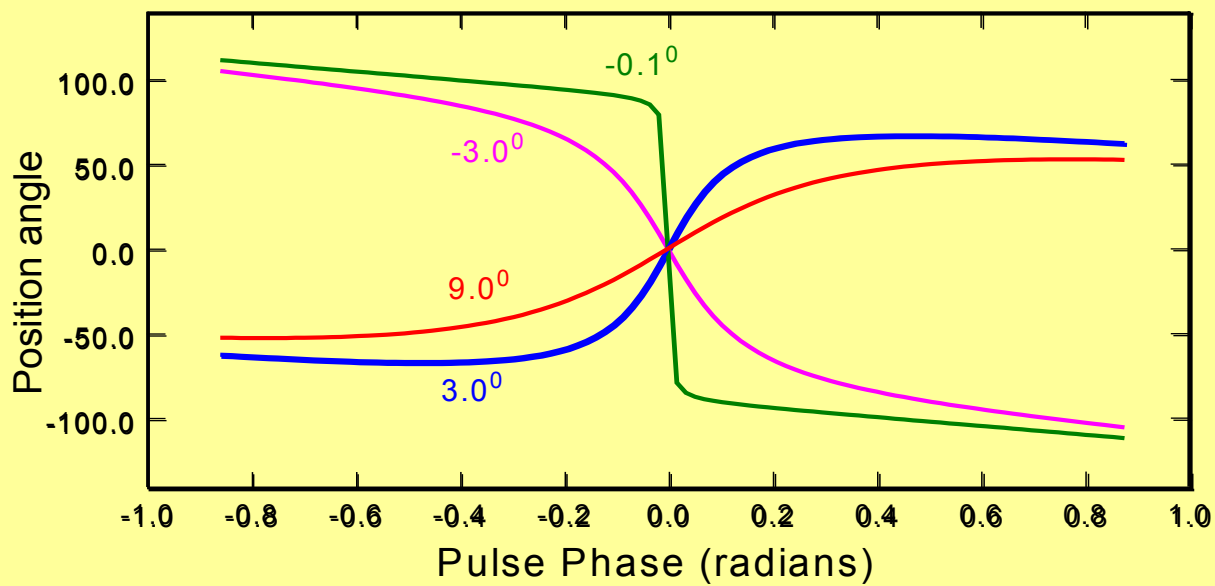
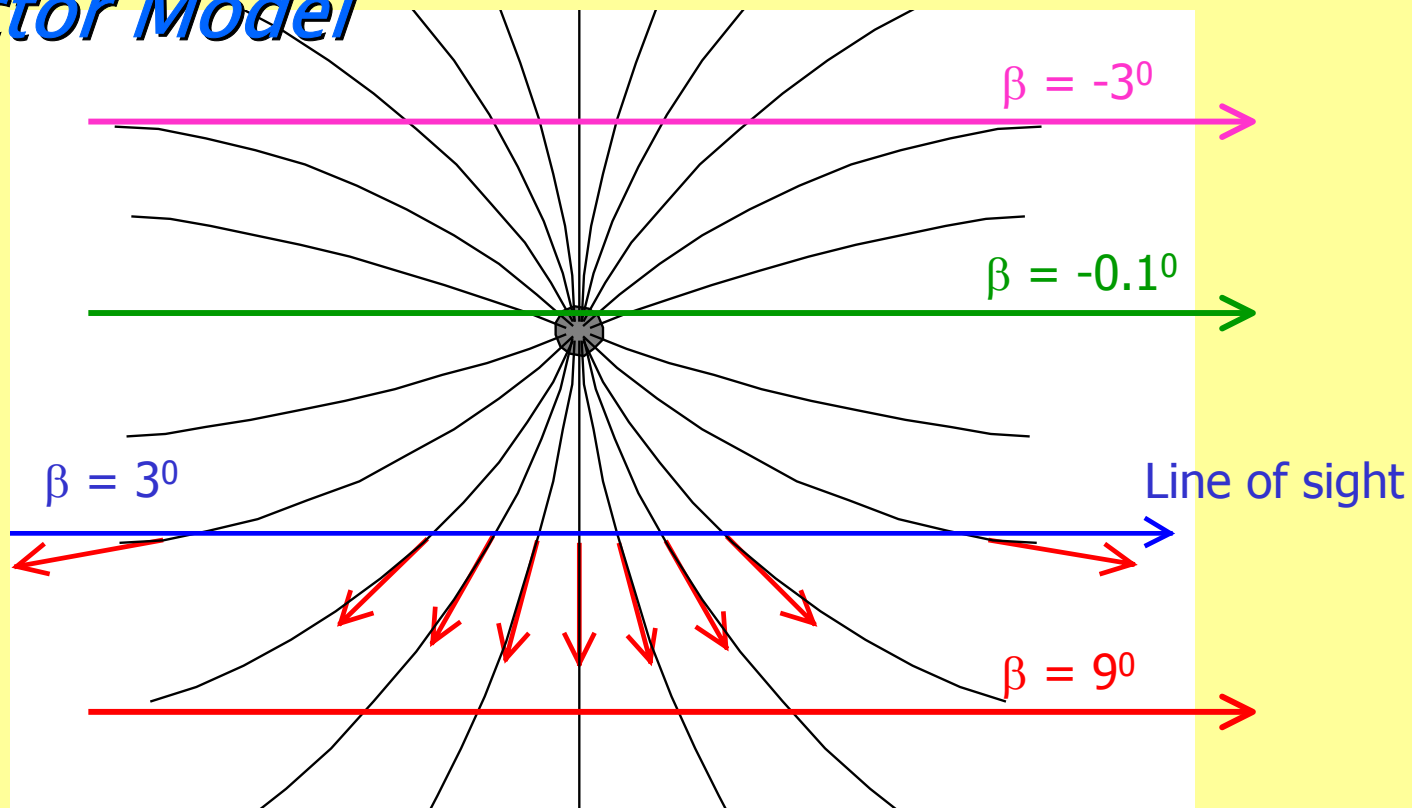
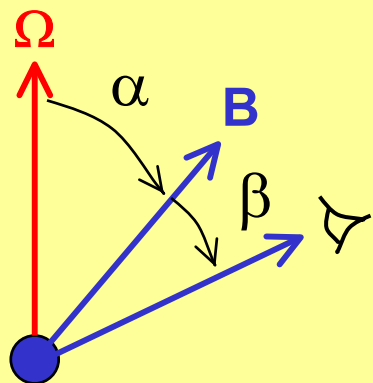


- Polar cap, Slot gap models
- Polarization in simplified geometry

Pulsar high-energy emission models



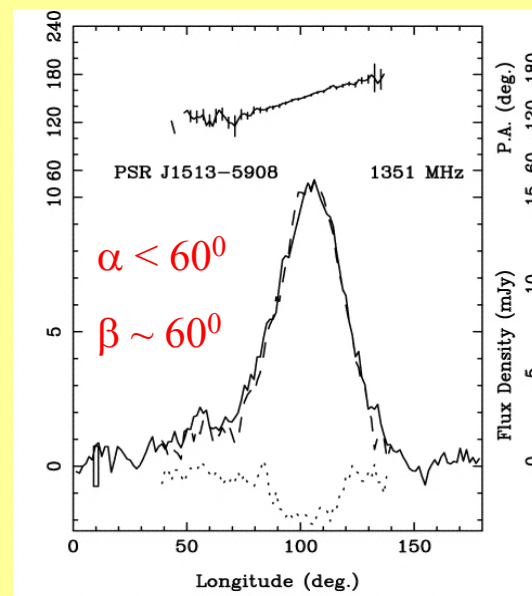
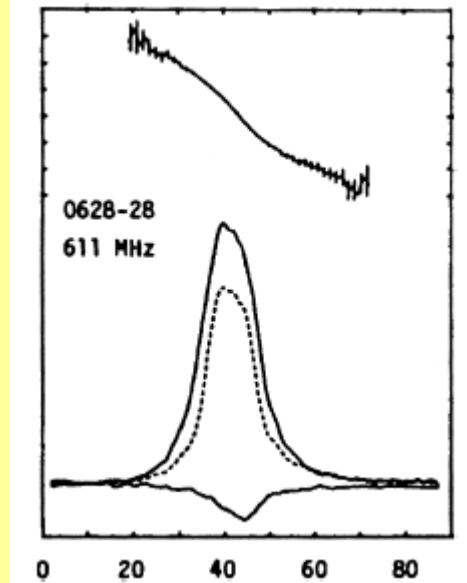
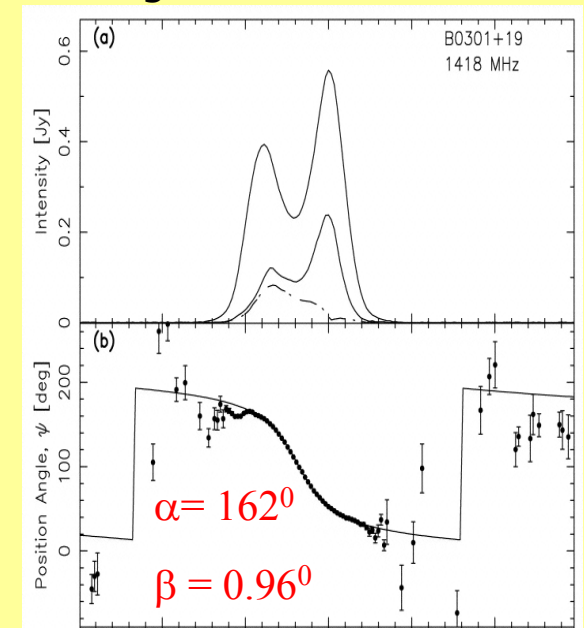
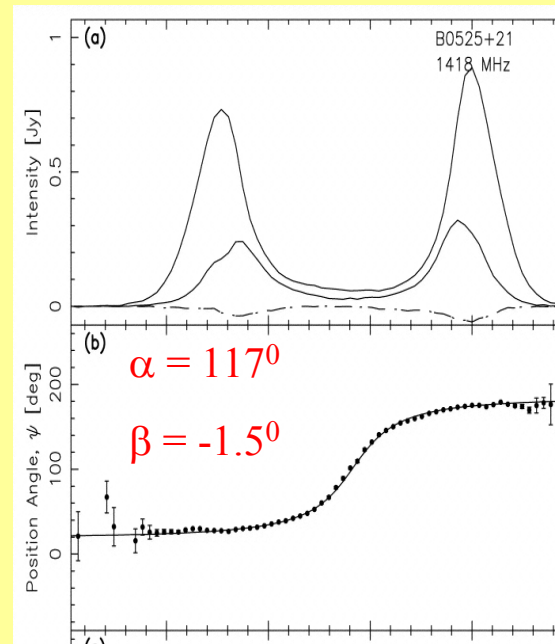
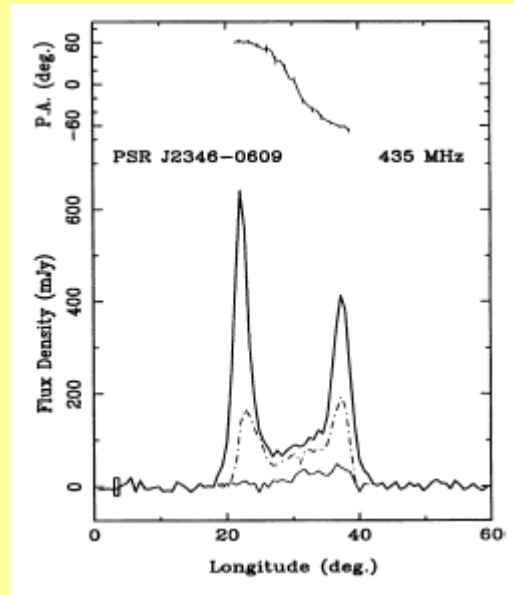
Rotating Vector Model



Polarization of radio pulsars

Everett & Weisberg 2001

Han et al. 1998

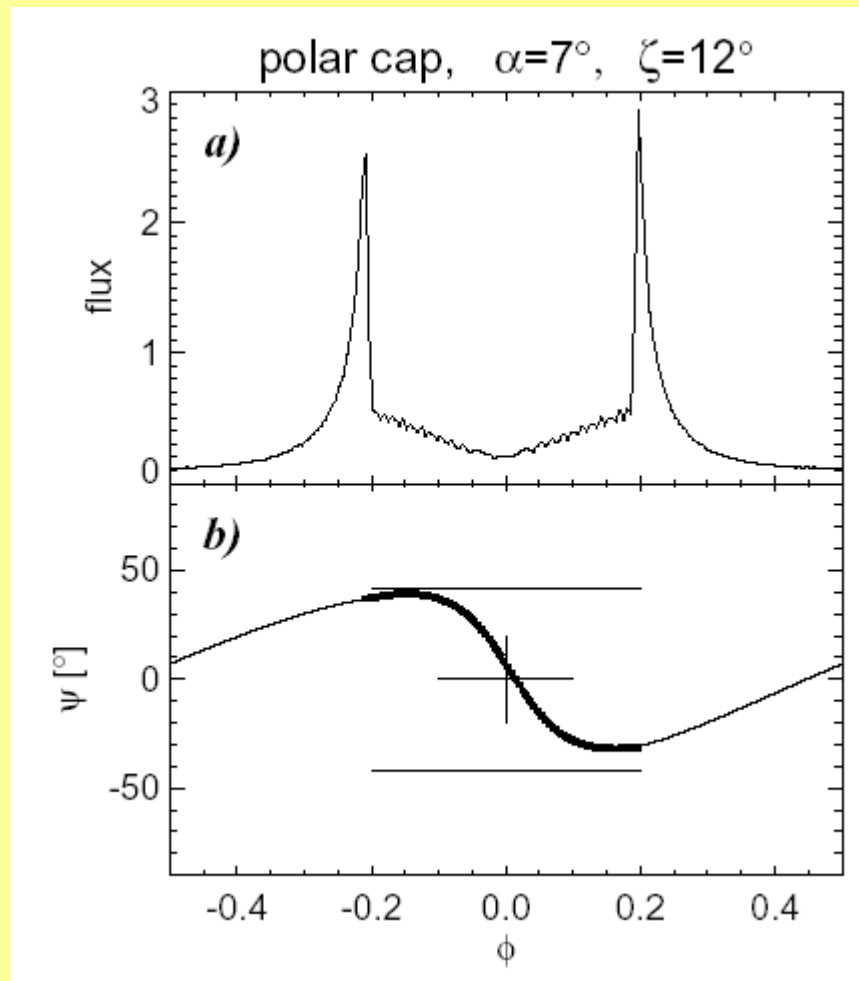


Crawford et al. 2001

Better determination
of β than of α

Polar cap model

Dyks, Harding & Rudak 2004

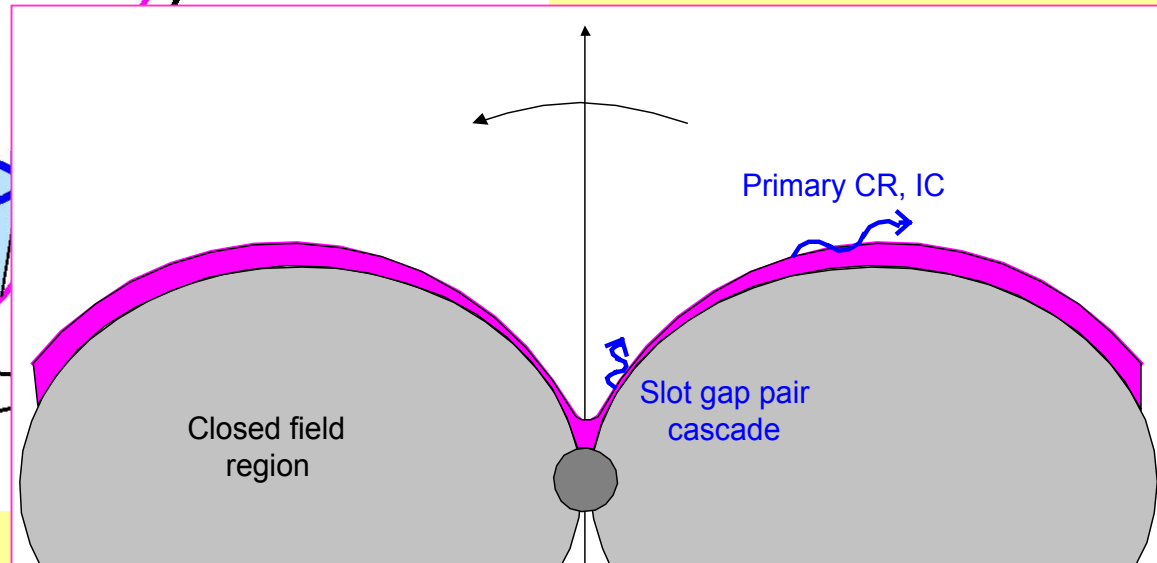
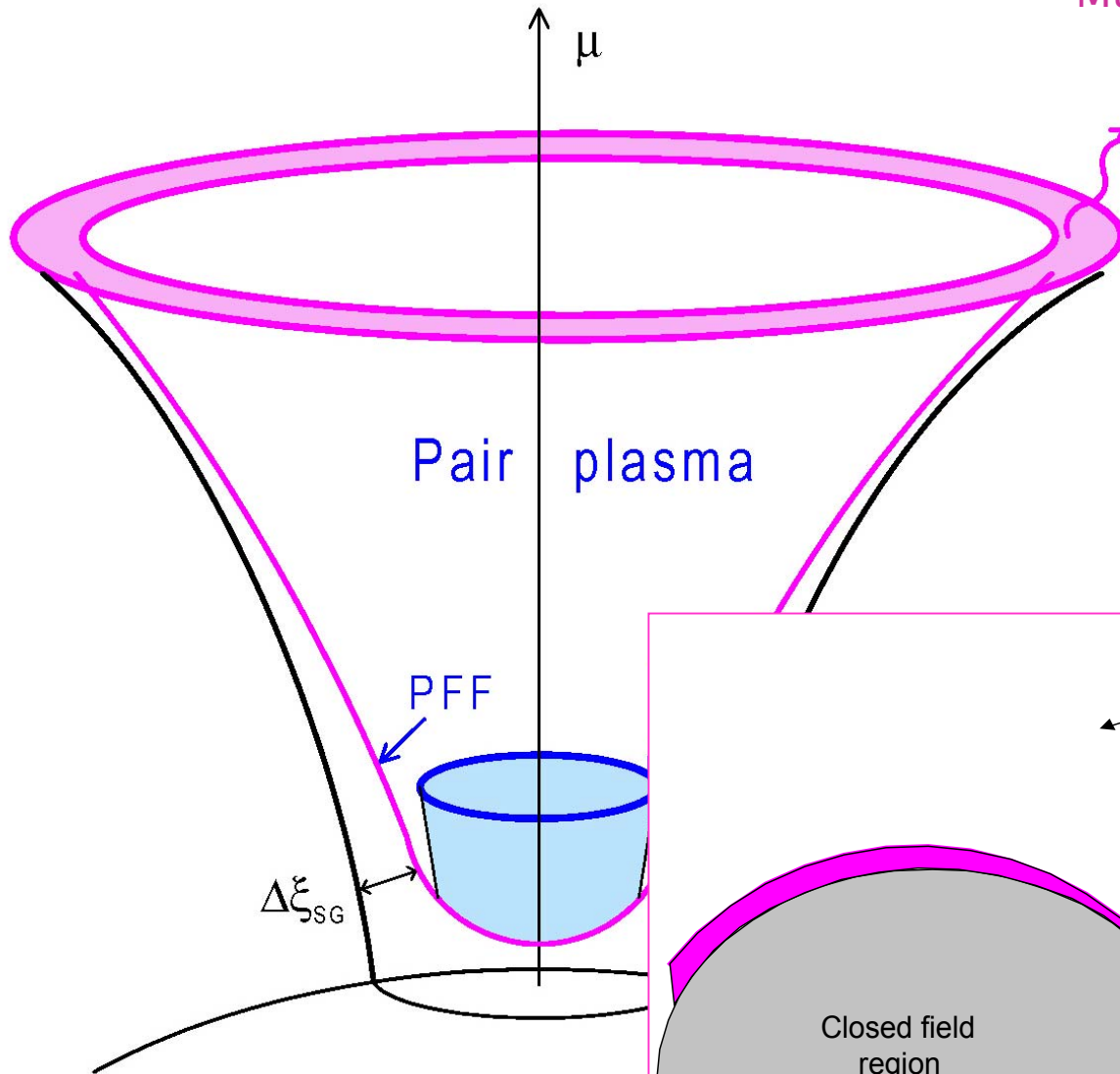


$$\beta = \zeta - \alpha$$

Neither ζ nor α
determined
unambiguously

Polar cap and slot gap models

Muslimov & Harding, 2003, 2004



Relativistic Effects

- Aberration

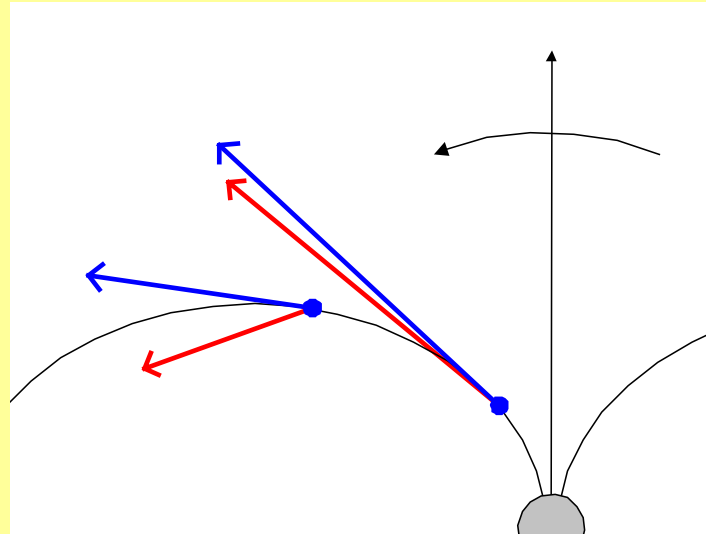
$$\Delta\phi_{ab} \approx -\frac{r_{em}}{R_{LC}}$$

- Time-of-flight delays

$$\Delta\phi_{ret} \approx -\frac{r_{em}}{R_{LC}}$$

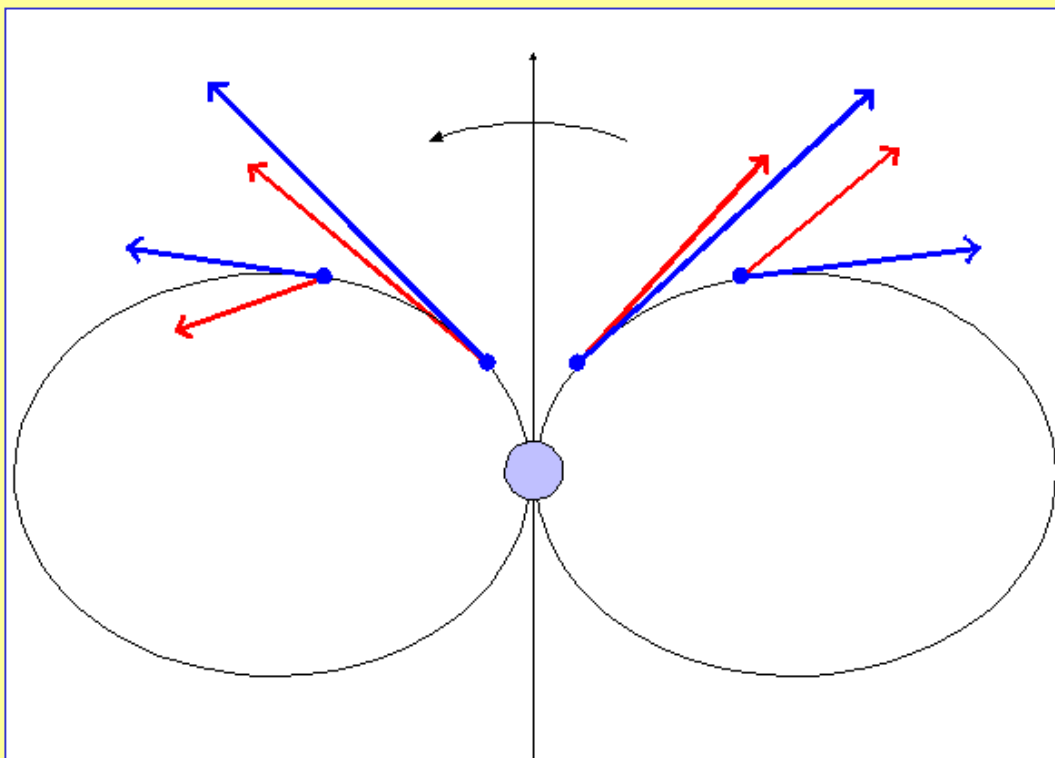
- Magnetic field retardation

➡ need for detailed modeling



Two-Pole Caustic Model *Dyks & Rudak 2003*

- Particles radiate along last open field line from polar cap to light cylinder
- Time-of-flight, aberration and phase delay cancel on trailing edge \longrightarrow emission from many altitudes arrive in phase \longrightarrow **caustic** peaks in light curve



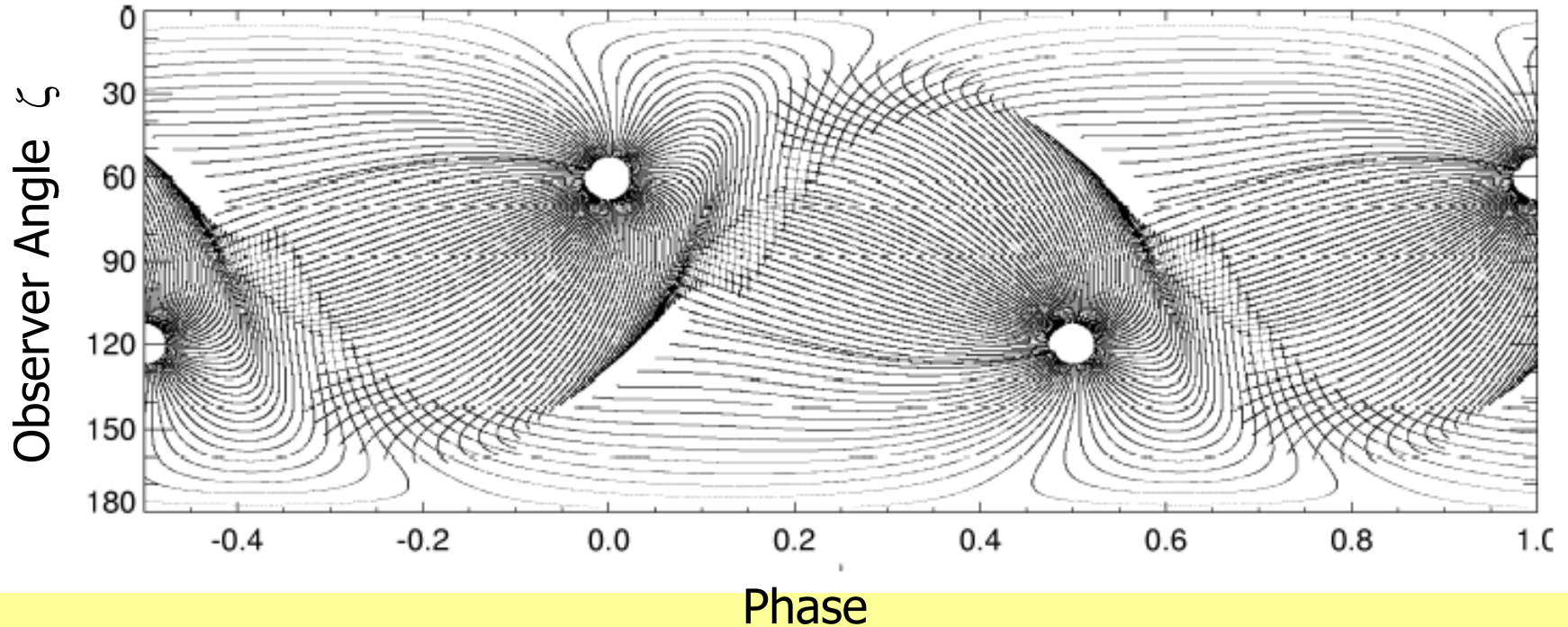
Crab-like pulsars:

- Peaks at all wavelengths are in phase!
- Double-peaks profiles (both poles) with $\Delta\phi < 180^\circ$
- Off-pulse emission

Two-Pole Caustic Model

$$\alpha = 60^\circ$$

Dyks, Harding & Rudak 2004

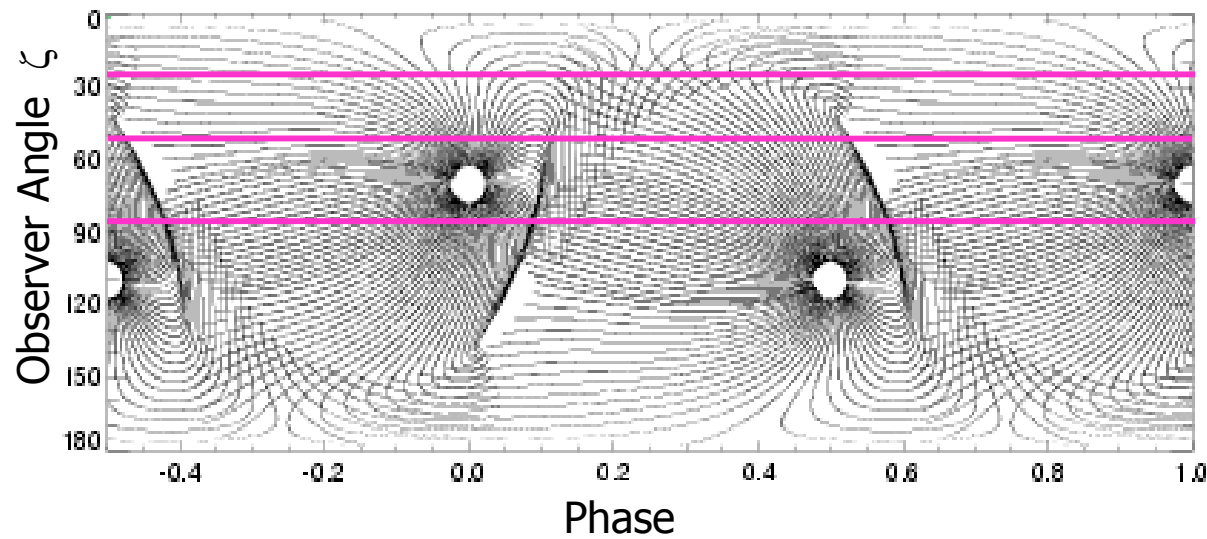


- Retarded vacuum dipole
- Emission radius $< 0.8 R_{LC}$

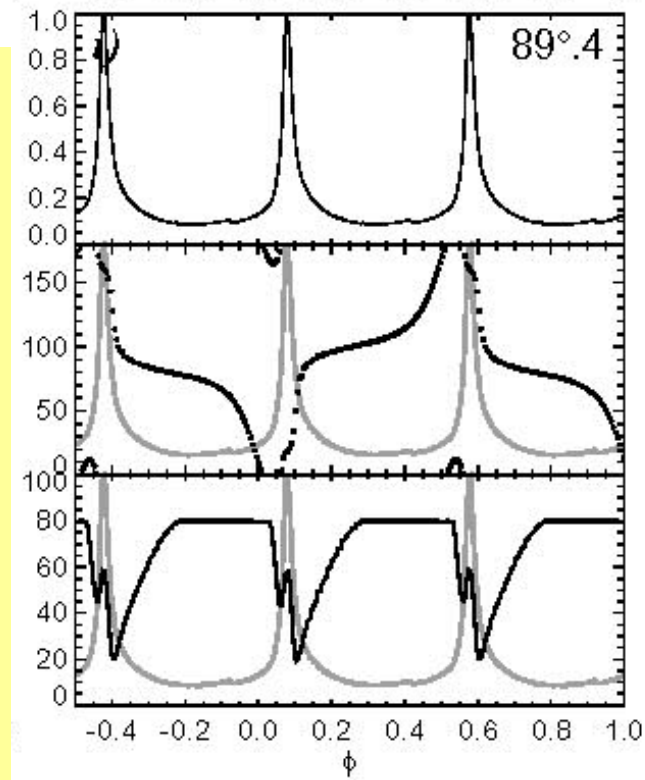
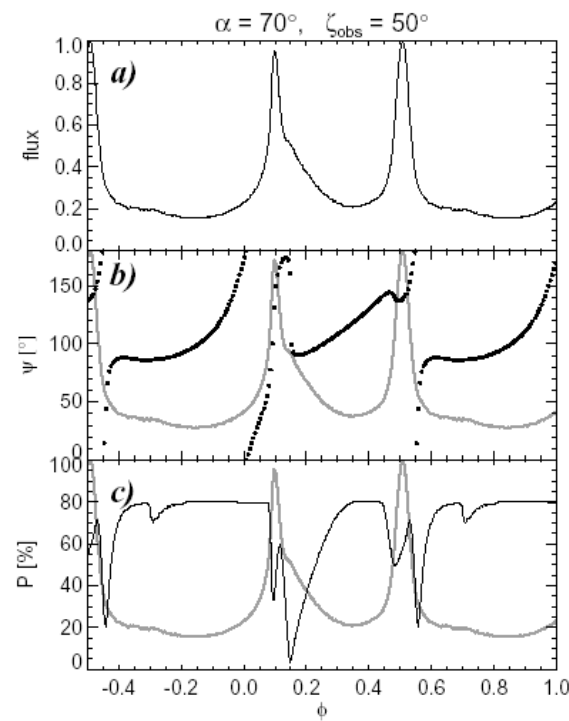
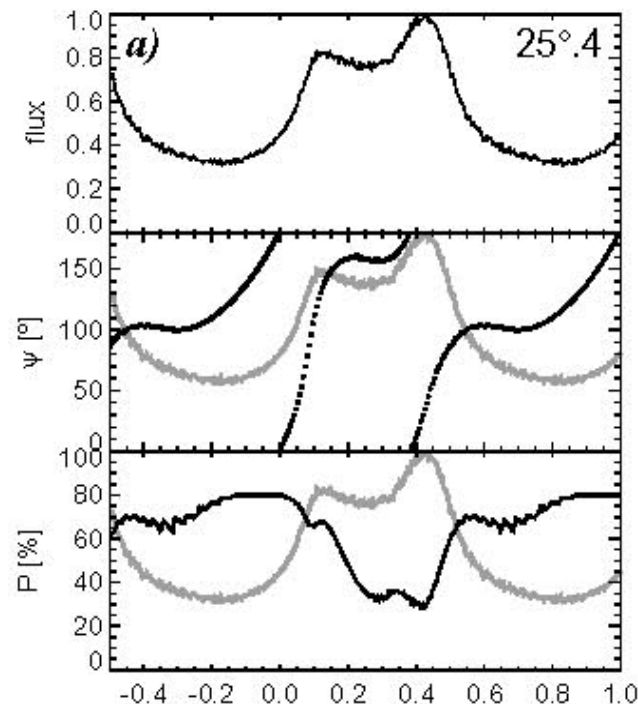
See poster of Dyks et al. for more details

$$\alpha = 70^\circ$$

Profile and polarization



ζ can be determined unambiguously

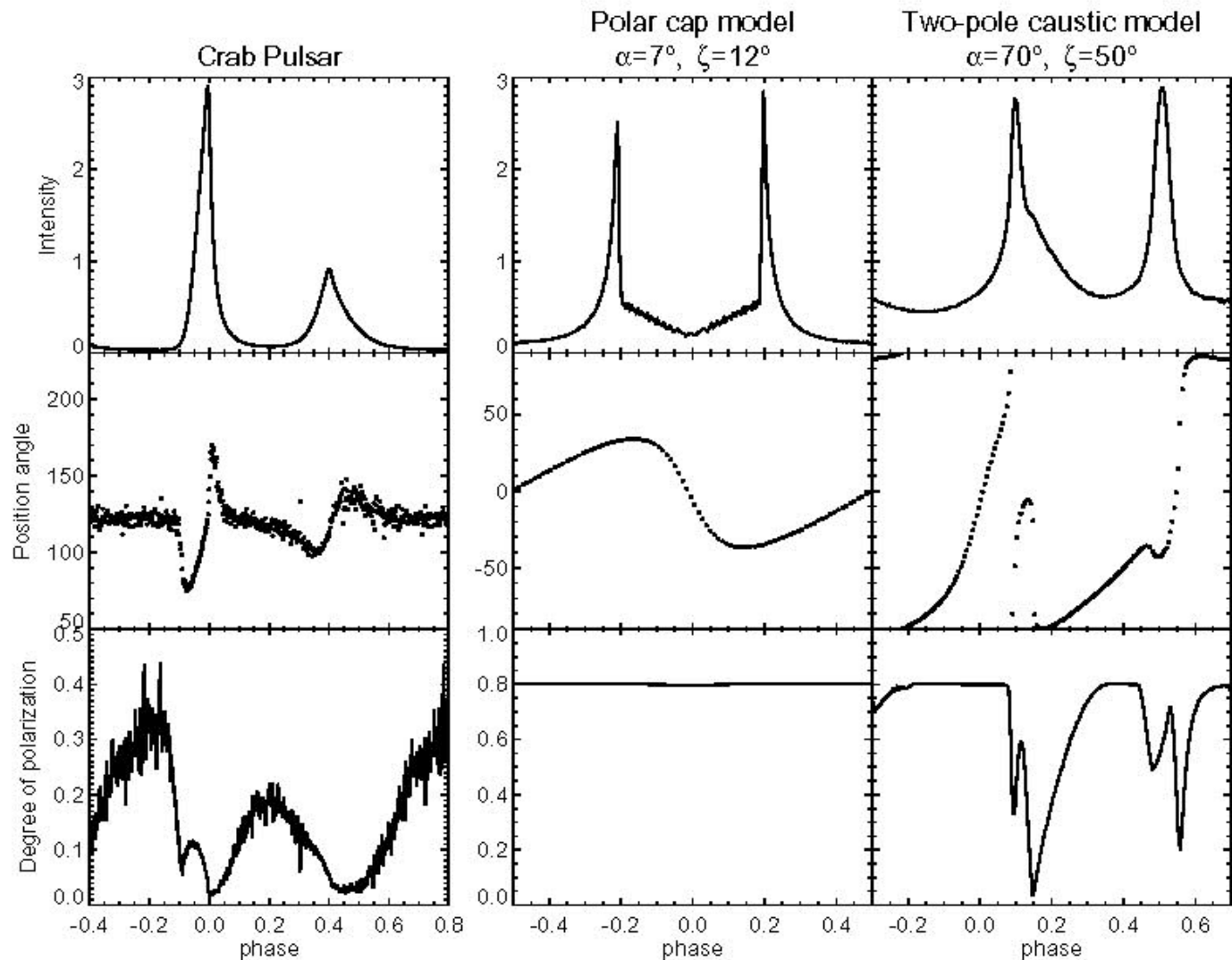


Polarization of Crab Pulsar

OPTIMA

Kellner 2002

Dyks, Harding & Rudak 2004



Polarization of pulsar emission

- Polar cap
 - Emission near magnetic poles
 - Classic 'S-shaped' PA swings of RVP
 - Possible fits to inclination (α) and viewing (β) angles
- Slot gap
 - Emission at high altitudes
 - Relativistic effects dominate
 - Two-pole caustic geometry:
 - Fast sweep of PA at caustic peaks
 - Depolarization at caustic peaks and trailing edges