

Neutron Star **Pulsars** and **Polarization**

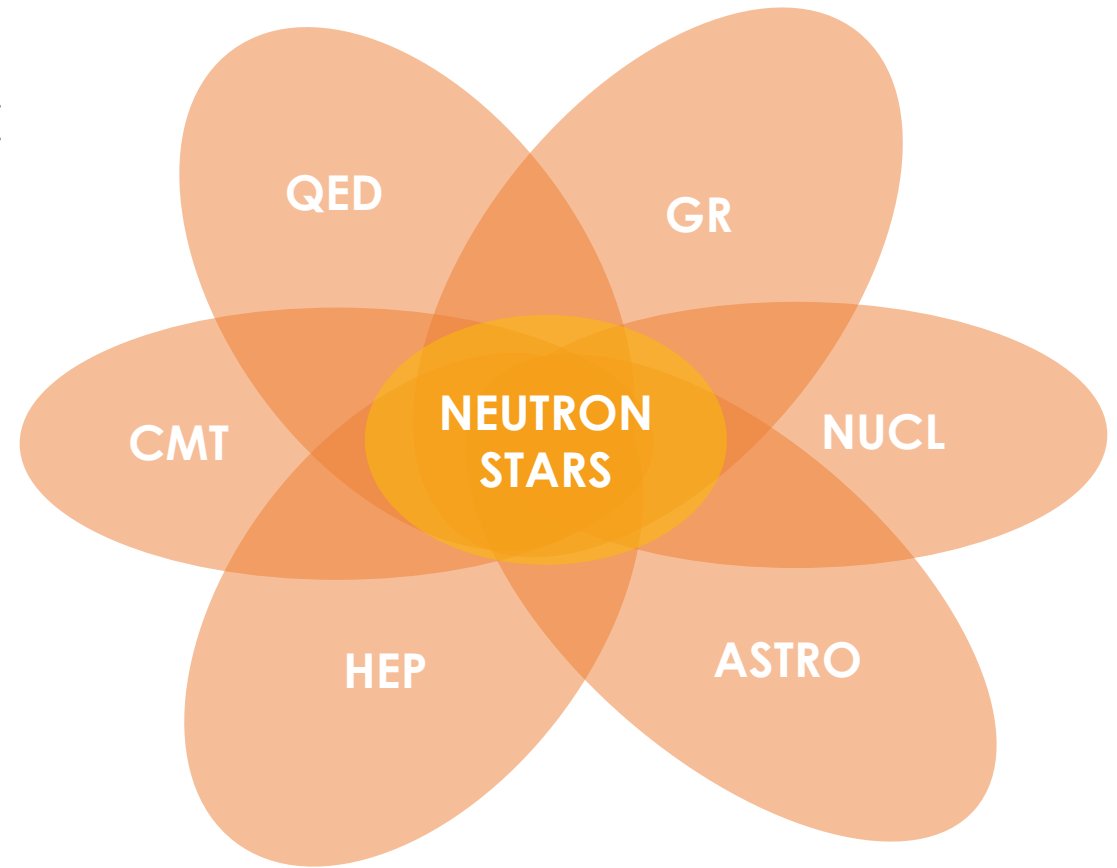
Kartik Tiwari, Ashoka University (India)

Exotic Astrophysical Laboratories:

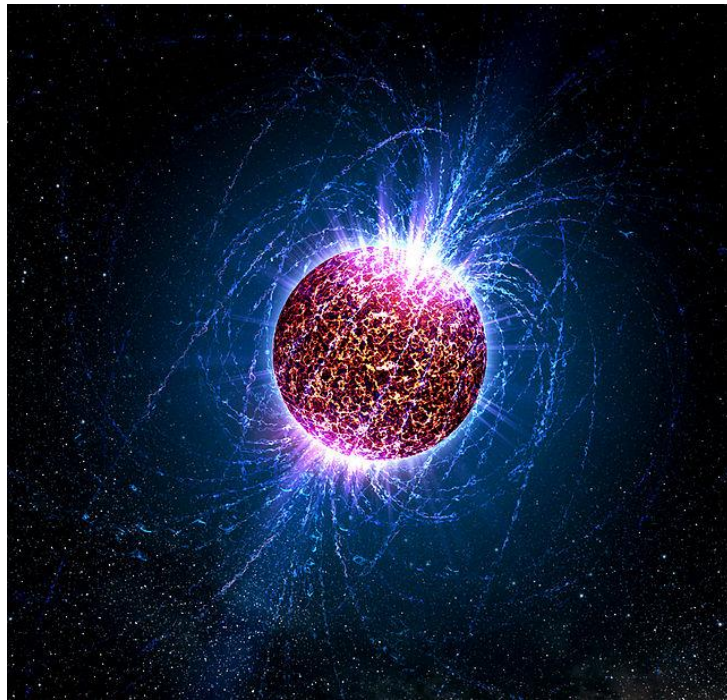
Densities $\sim 10^{17} \text{ kg/m}^3$

Magnetic Fields $\sim 10^{12} - 10^{13} \text{ G}$

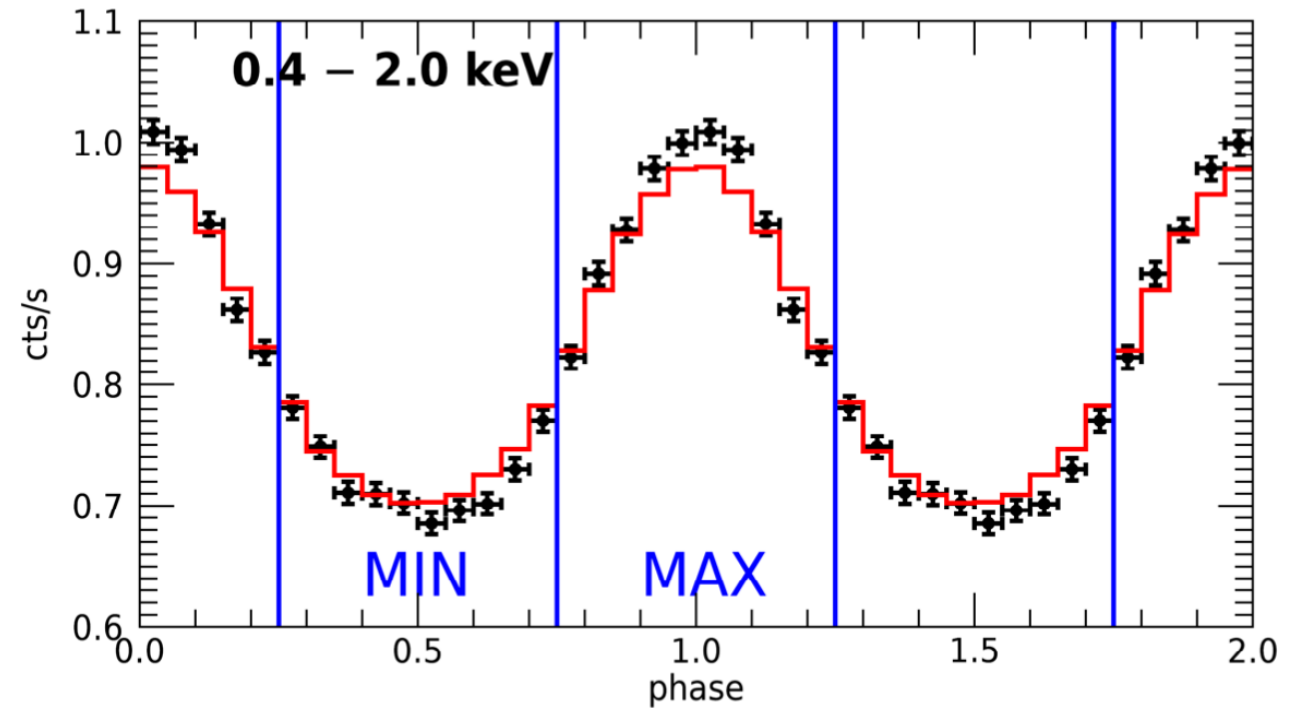
Drivers for **multi-physics** developments



Polarization carries information about mechanisms of radiation
but
what is emitted is not exactly what we see



Artist's Impression

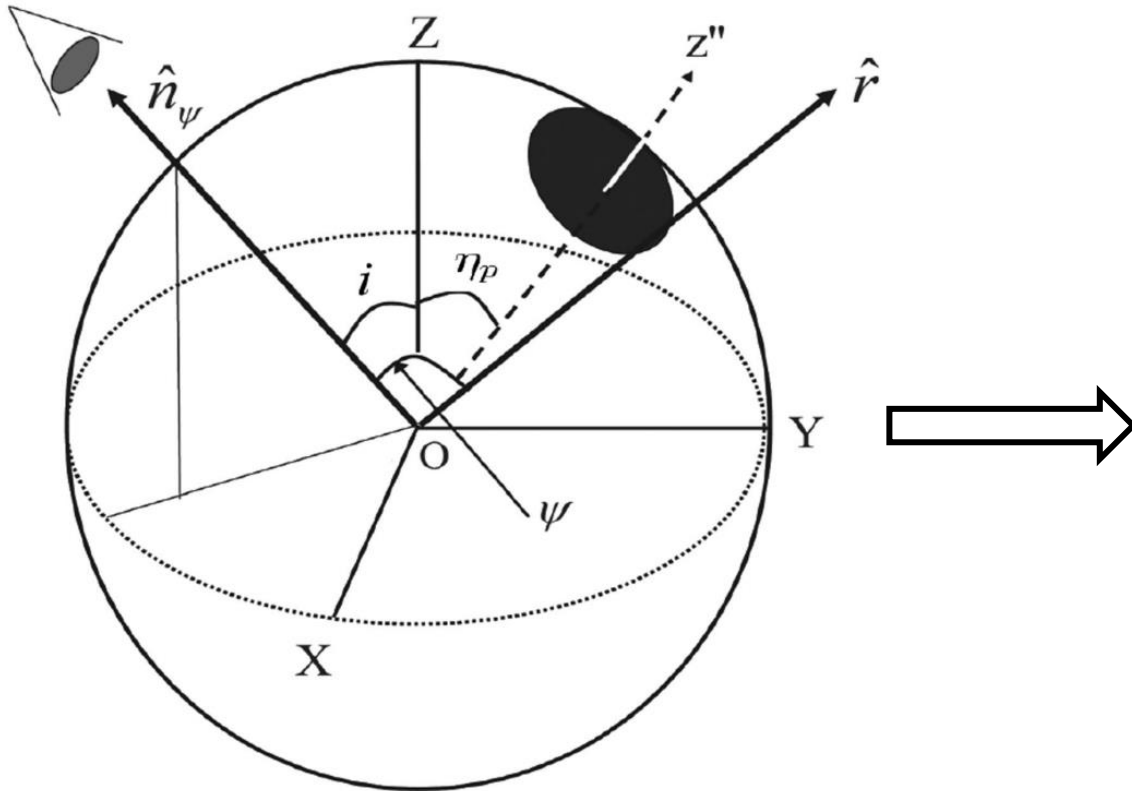


Calvera Observations (Mereghetti et al 2021)

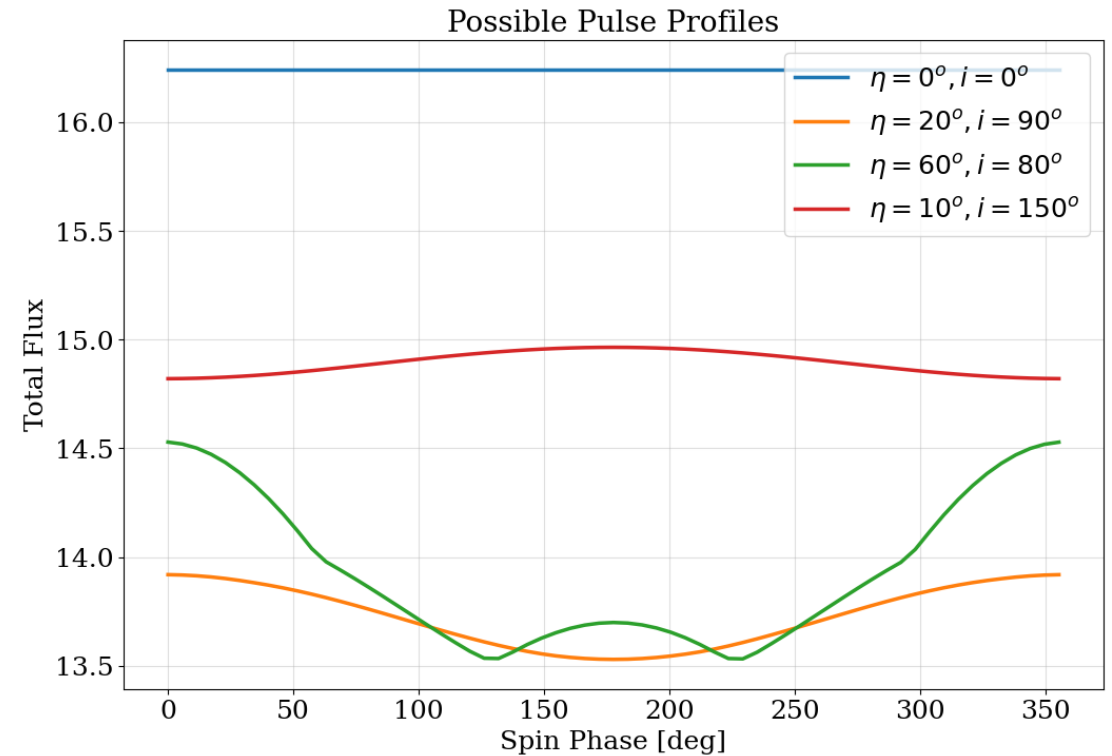
QUESTION

Given a pulsar configuration, what polarization data should we expect (and vice versa)?

Neutron Star **attributes** affect **pulse profiles**

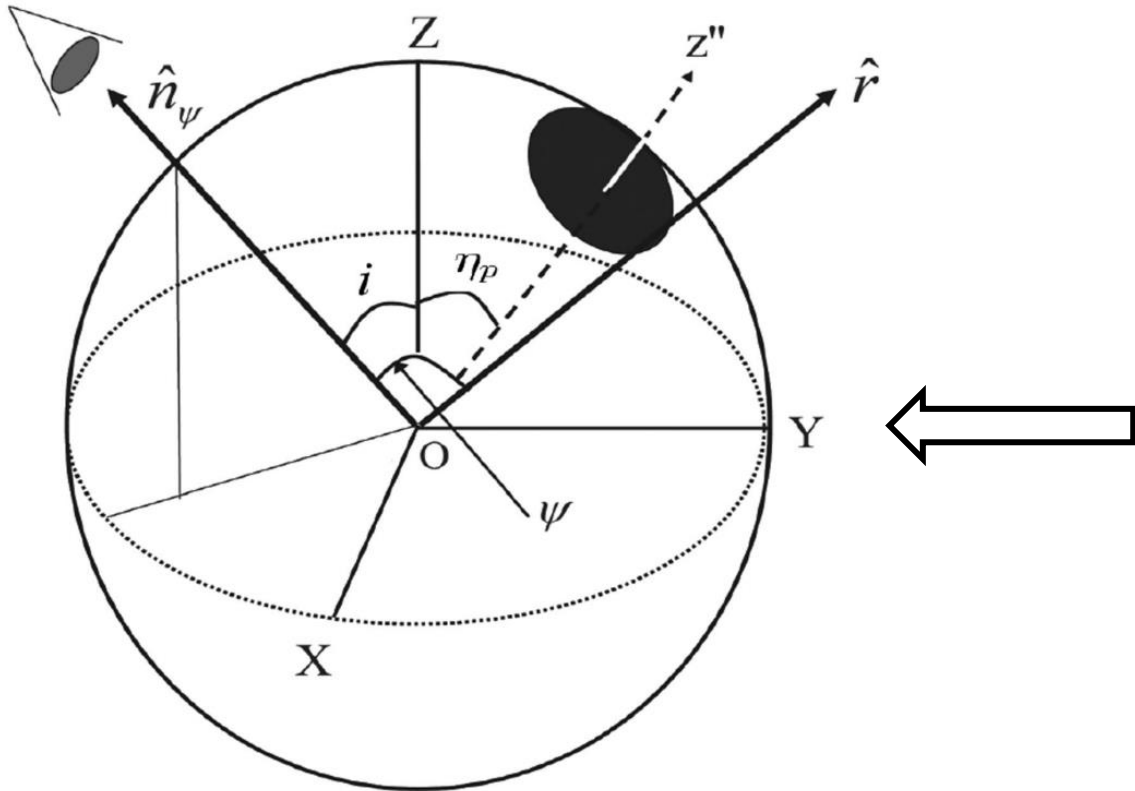


Mukherjee and Bhattacharya (2011)

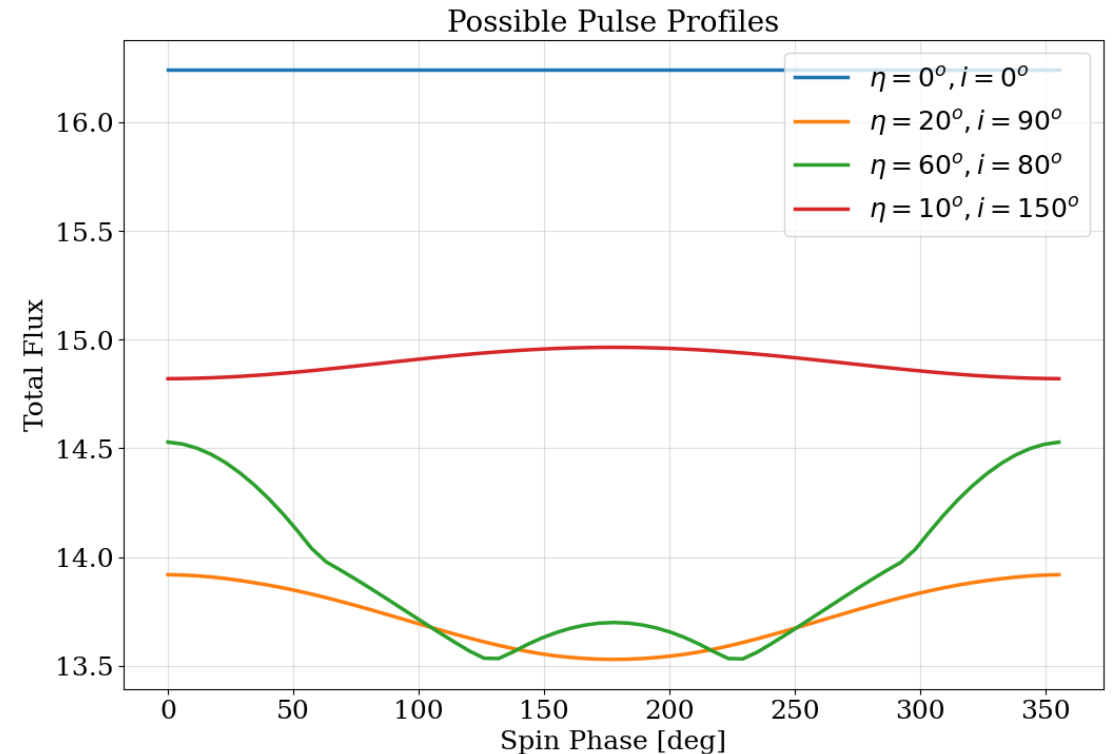


All figure generating code at
github.com/krtktwri/comp-astro-asp

Dependency **Simulations** + Bayesian **Inference** extracts Neutron Star attributes from pulse profiles



Mukherjee and Bhattacharya (2011)

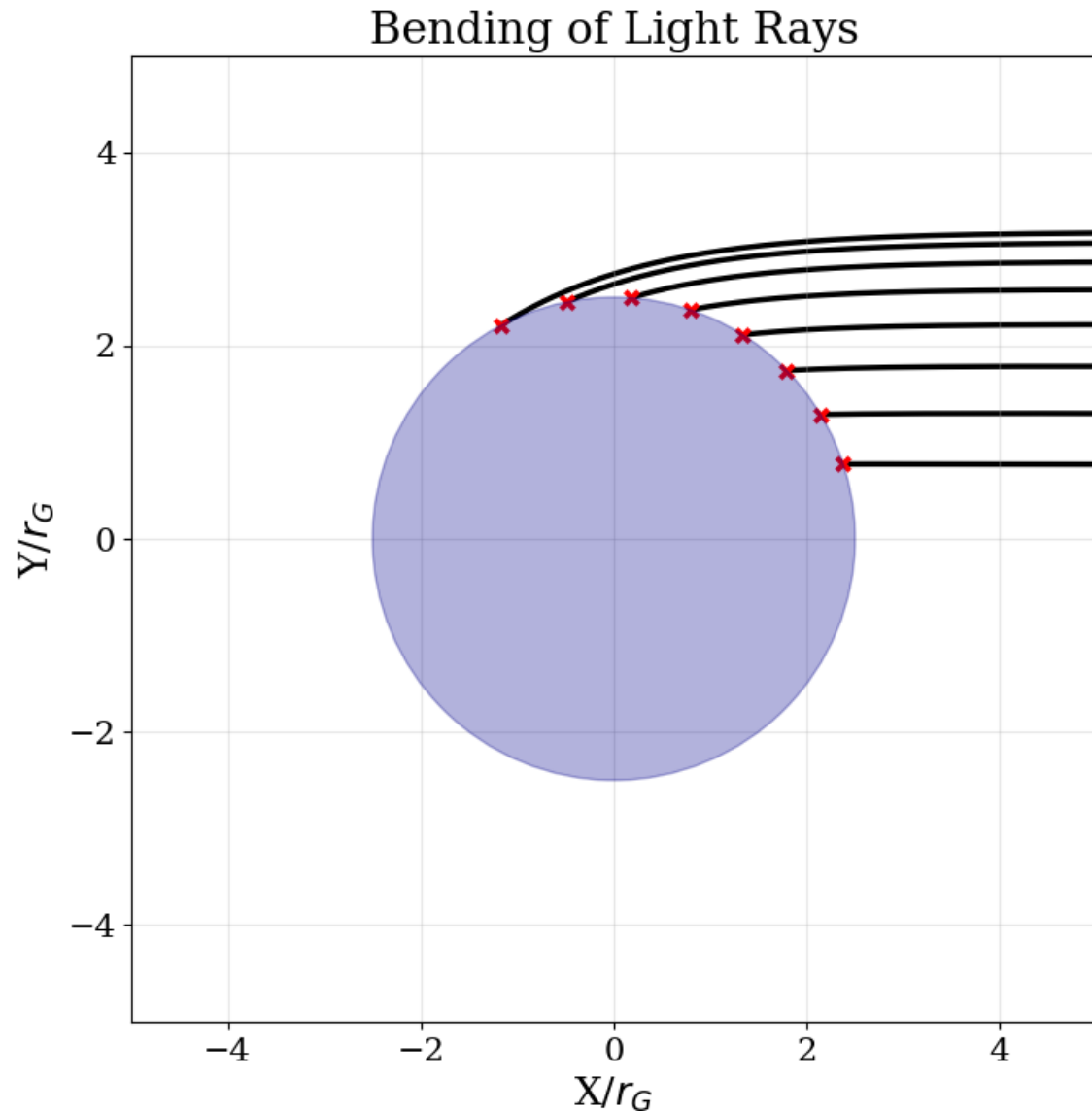


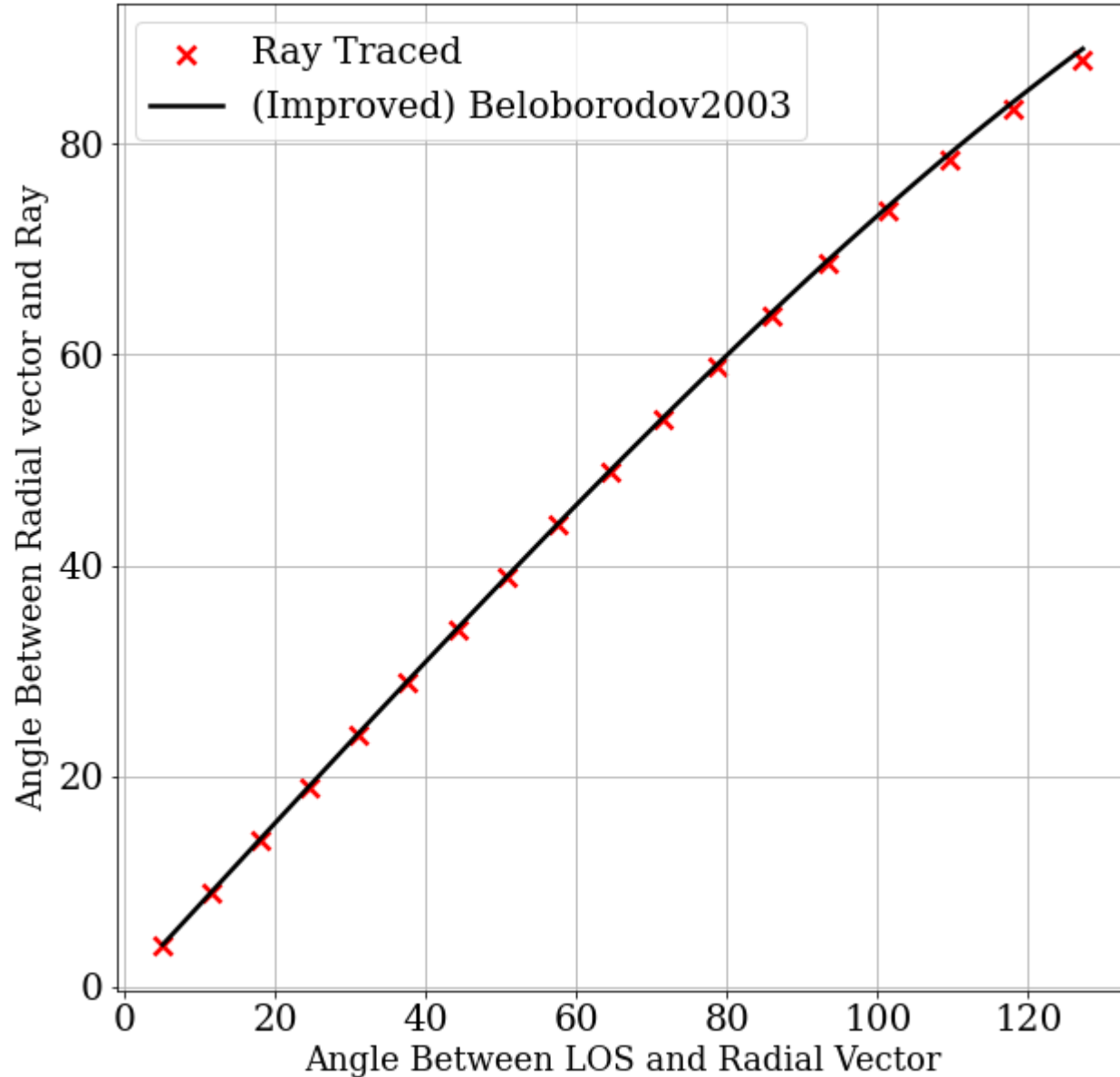
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Gravitational lensing affects observed surface projection and polarization.

Photon propagation in Schwarzschild is well understood.

Explicit ray-tracing is very slow with horrible scaling.

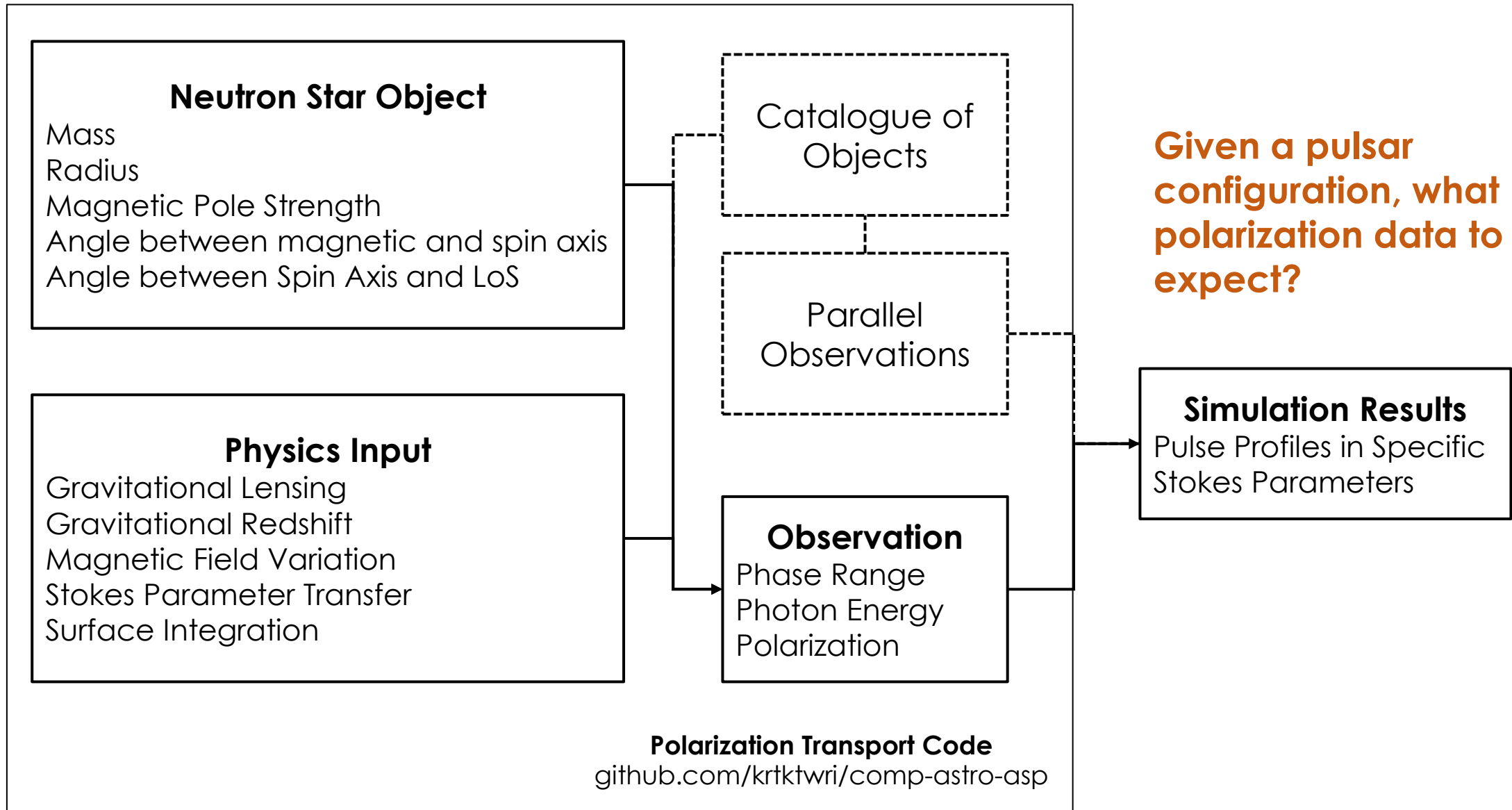




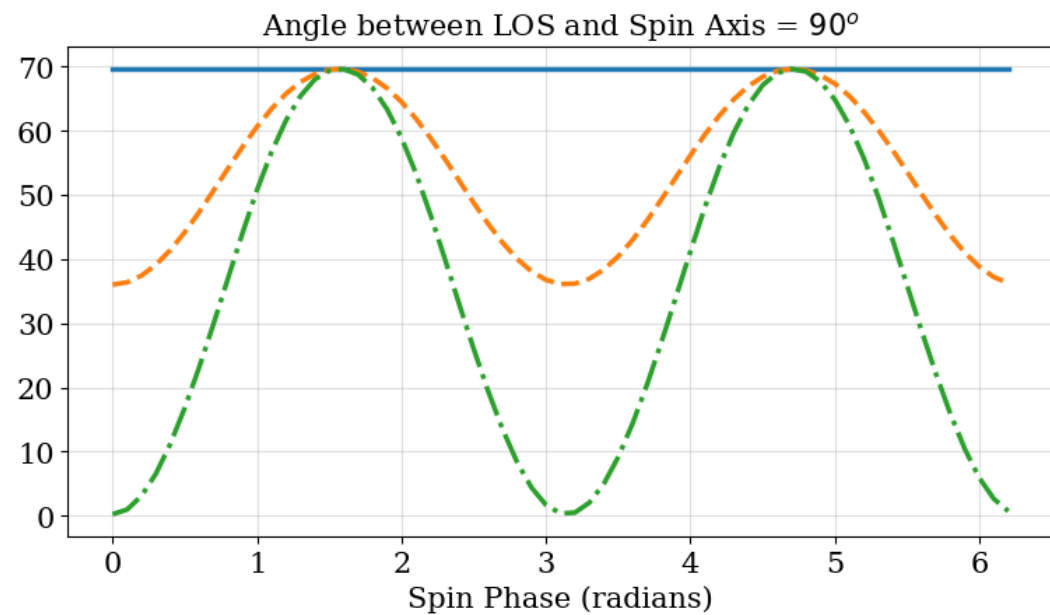
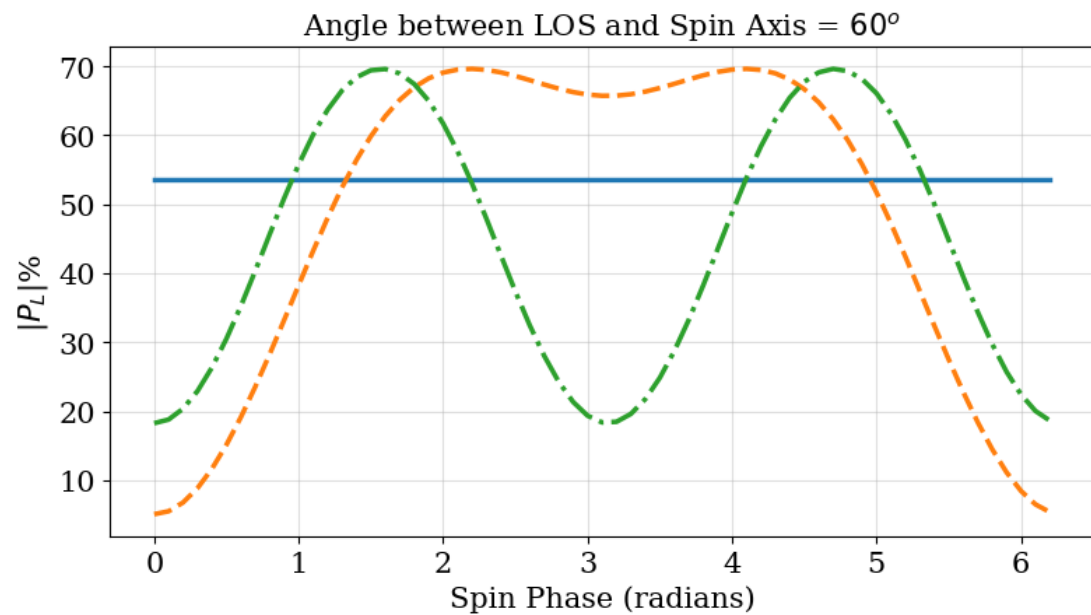
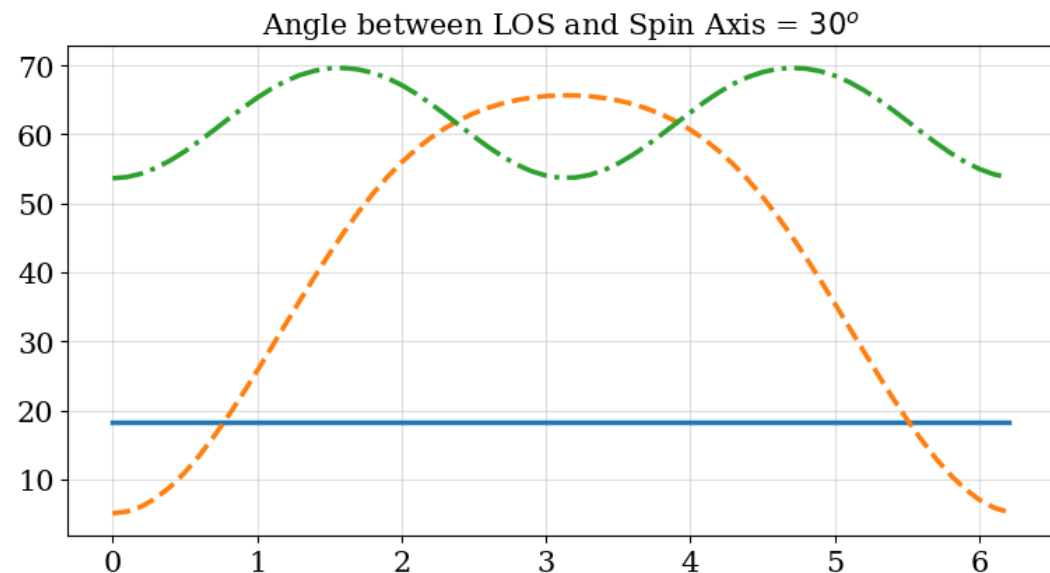
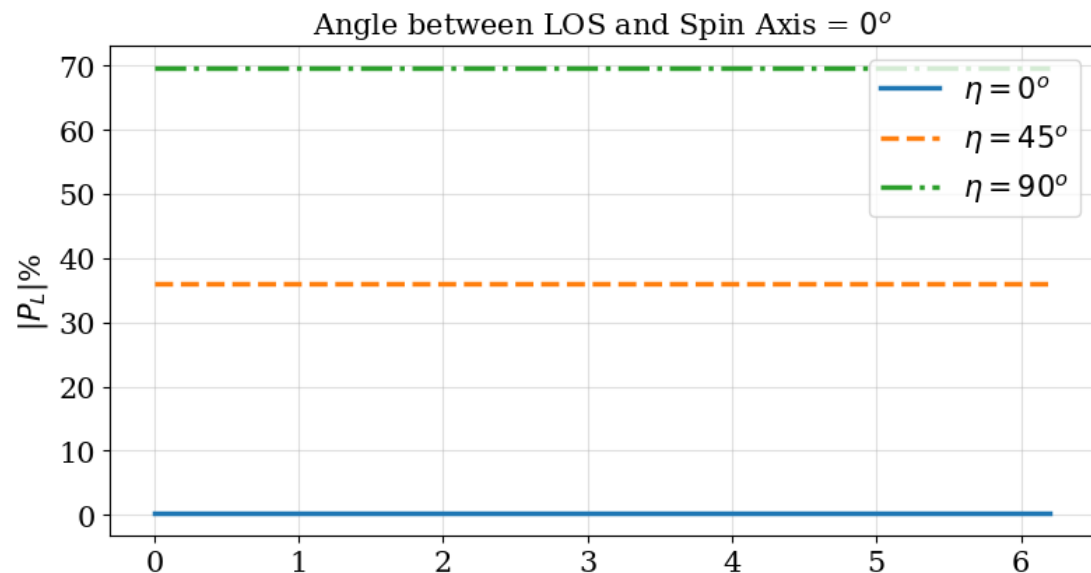
Belobordov's approximation (2003) relates location on the surface with the angle from the normal required to reach observer.

Ray-tracing not required.

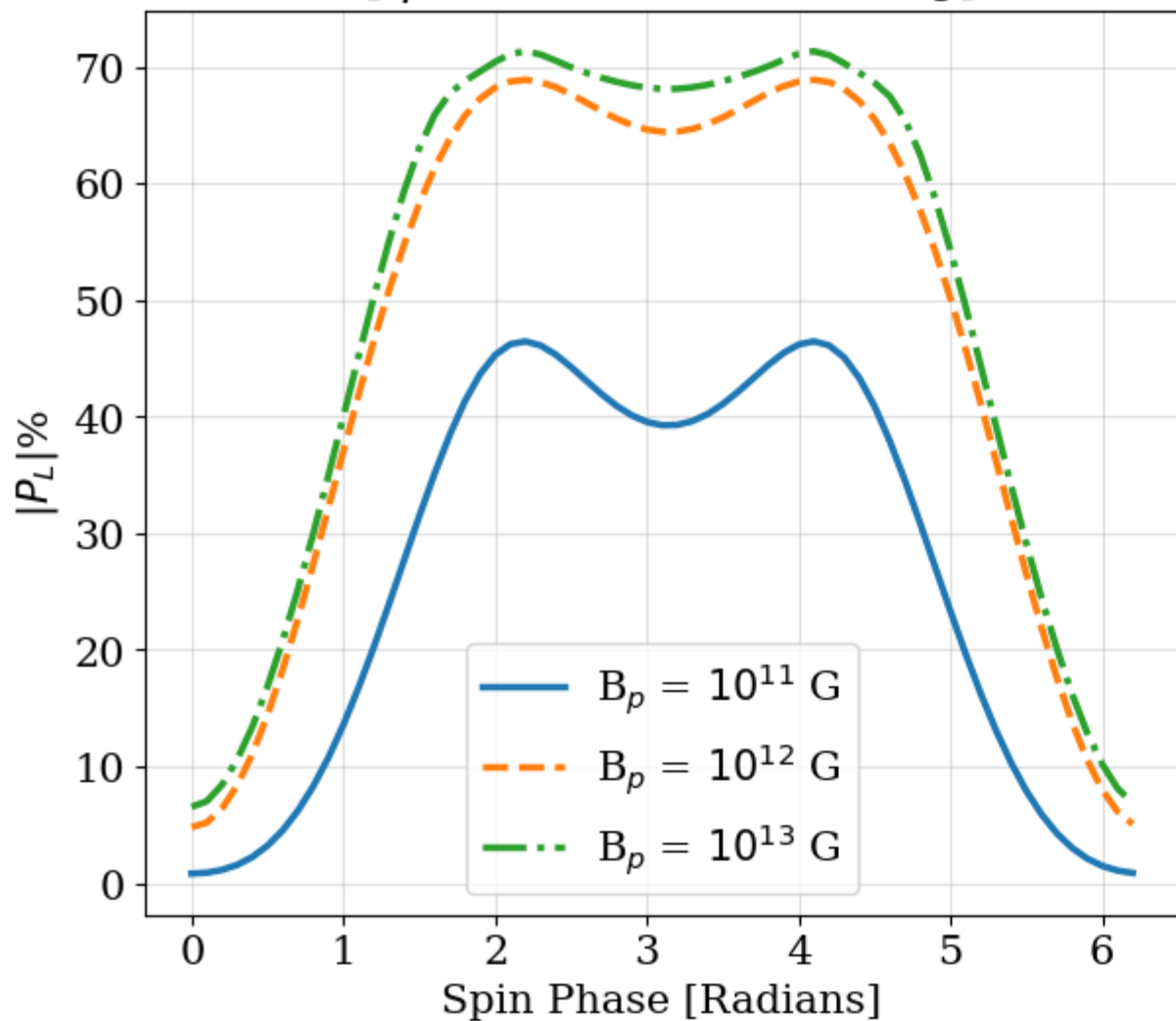
With an additional improvement, errors remain under 1%.



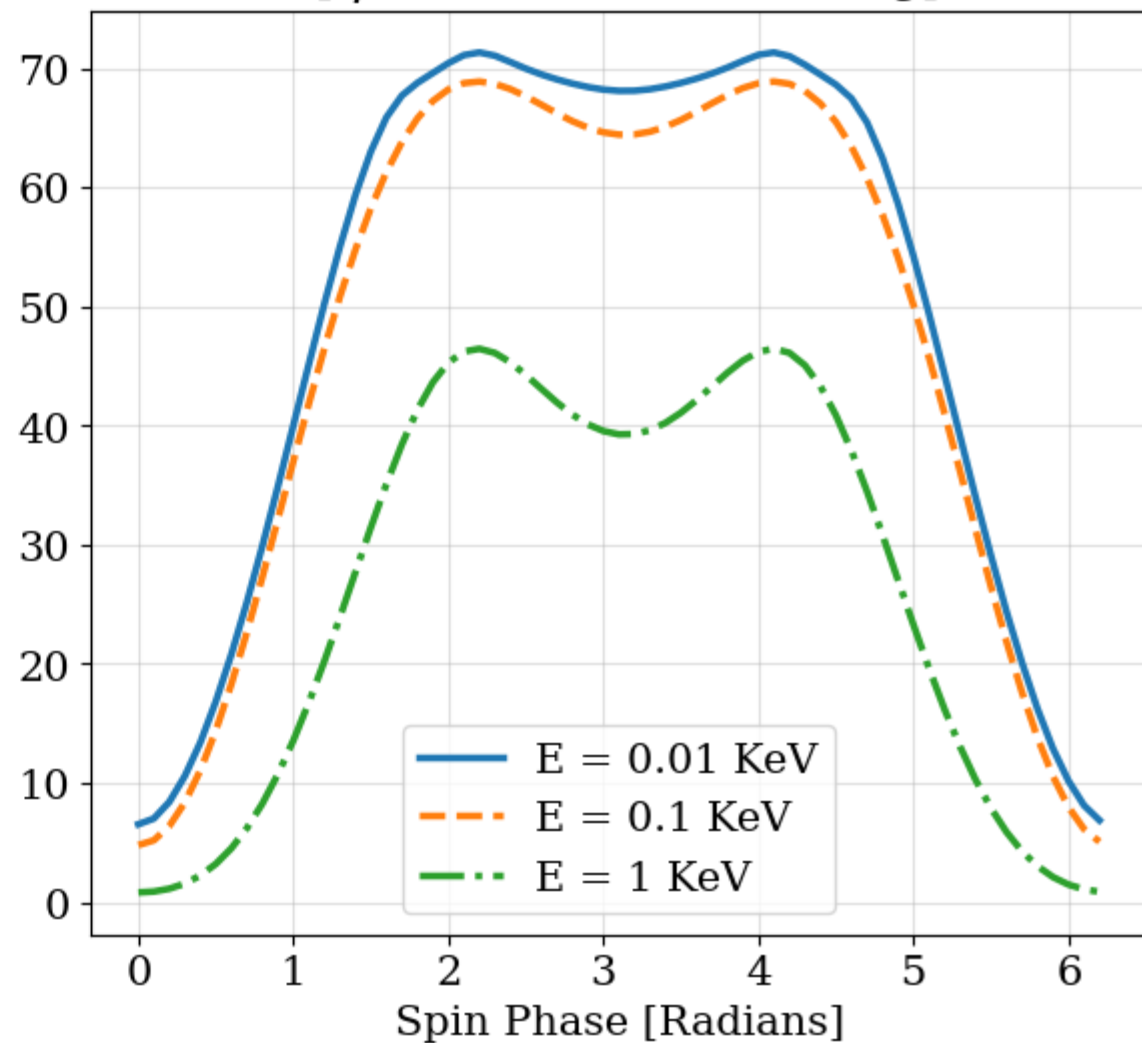
Pulse Profiles [Radius = $3R_G$]
at $E = 1$ MeV

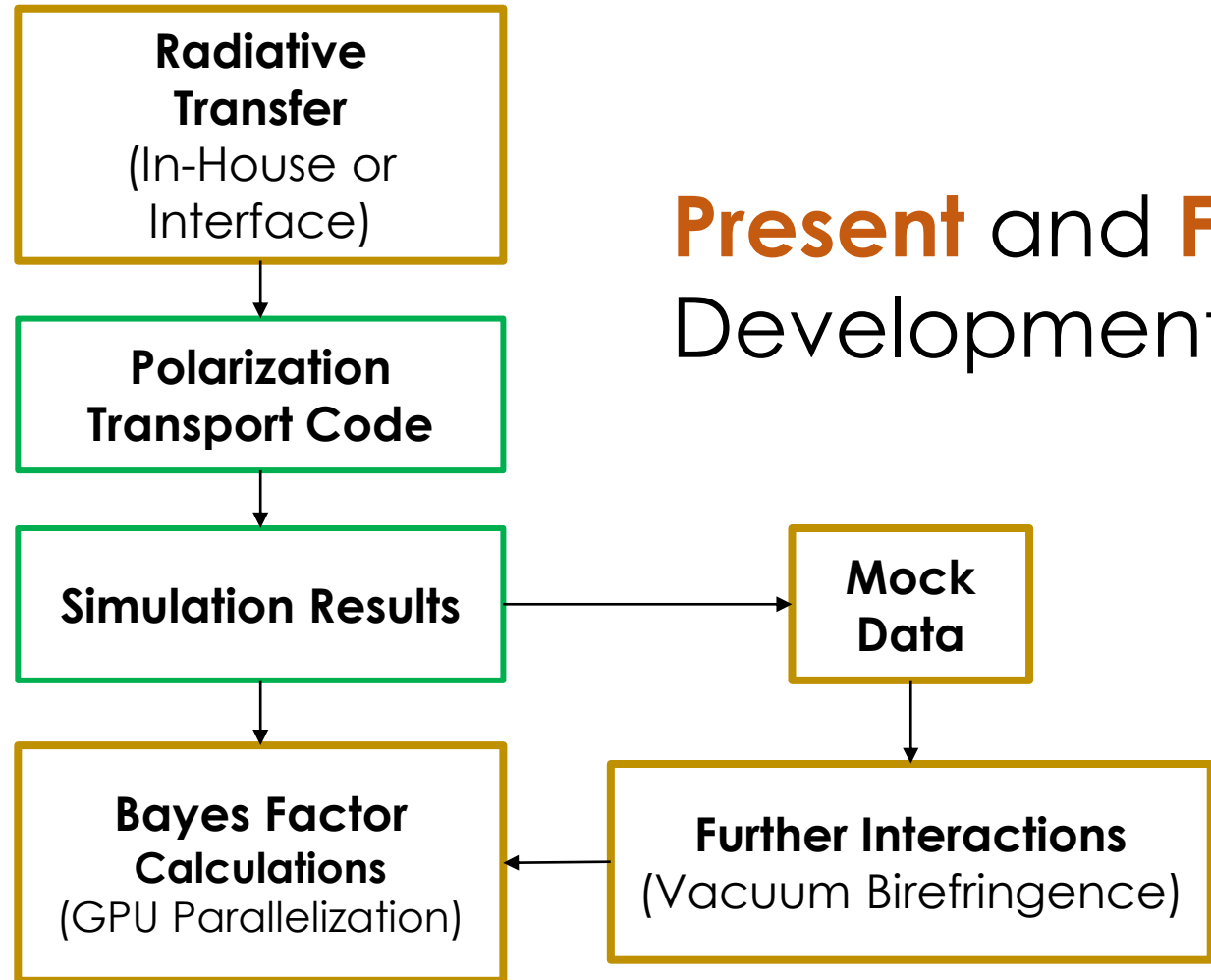


Magnetic Pole Field Strength
 $[\eta = 45^\circ, i = 60^\circ, R = 3R_G]$



Observation Energy Spectra
 $[\eta = 45^\circ, i = 60^\circ, R = 3R_G]$





Present and Future Developments