Outline

- Motivation
- Probing the Galactic Magnetic Field
- Puzzles and Potential Solutions
Magnetic fields are an integral part of the ISM. They...
- Contribute to the vertical support of gas in the Galaxy.
- Are essential in star formation.
- Influence galaxy formation and evolution.

There remains many questions about our Galactic field:
- What is its source?
- How is it maintained?
- How does it connect with the Inter-Galactic Medium?

To answer these questions, we have to know what it looks like now!
Galactic Magnetic Field Basics

- Two components: large, small
- Concentrated in the disk
- Follows the spiral arms (?)
- Local field is cw
- Sagittarius field is ccw
- Determining the existence and location of additional reversals will help us understand the origin and evolution of the field — and possibly of the Galaxy itself!
Faraday Rotation

\[ \tau = \tau_0 + \lambda^2 \psi \]

\[ \psi = \lambda^2 0.812 \int n_e \mathbf{B} \cdot d\mathbf{l} = \lambda^2 \text{RM} \]

\[ \tau = \tau_0 + \lambda^2 \text{RM} \]
Comparing Pulsars to External Galaxies
~800 EGS + 1075 CGPS + 150 SGPS = 2025 EGS
~555 Pulsars
~120 EGS + 870 CGPS + 150 SGPS = 1140 EGS
~390 Pulsars
Arecibo is necessary to fill critical regions of Q1, Q3 and high latitudes.
Galactic Arecibo L-band Feed Array Continuum Transit Survey

GALFACTS
22 pulsars, 24 previous EGS and +1075 new RM sources in the CGPS region so far

SGPS RM sources:

120 pulsars, 1 previous EGS, 150 SGPS EGS

Current GALFACTS RM sources:

36 pulsars; 20 EGS (2 CGPS EGS so far)
Anticipated GALFACTS RM sources:

Conservative estimate for GALFACTS sources in this region: +2000!
Key Observational Questions
*(ie. The Puzzles)*

*Can we identify...*

- ...the number and location of reversals?
- ...the alignment of the field with the spiral arms?
- ...what the disk-halo transition looks like?
- ...what sort of cross-scale coupling exists?
Identifying Magnetic Field Reversals
A reversal in the Sagittarius arm is demonstrated.

Thompson et al. 1980

Simard-Normandin & Kronberg 1980
Reversals in the Inner Galaxy

Reversal assumed to continue into the Carina arm.

Rand and Lyne 1994

Frick et al. 2001
Interpreting the SGPS Data
Interpreting the SGPS Data
Important Lines-of-Sight

IN Q4:
- Carina arm: Clockwise
- Crux arm: Counter-Clockwise

IN Q1 (expect):
- local arm: Clockwise
- Sagittarius arm: Counter-Clockwise

GALFACTS

IN Q4:
- Carina arm: Clockwise
- Crux arm: Counter-Clockwise
Field Alignment with the Spiral Arms
Weisberg et al. 2004

Field is assumed to follow the spiral arms, consistent with external galaxy observations.

Han et al. 2006
Field Alignment: Recent Proposals

Vallée (2005) proposed a circular field model.
Predicted RM Nulls

RM null: $l \sim 165^\circ$

RM null: $l \sim 180^\circ$
New High-Longitude CGPS RMs

Observed Null is at $l > 175^\circ$, suggesting a circular field!
Both CGPS and GALFACTS will detect the Null... ...but GALFACTS will solidify the location.
Available Data in the Fourth Quadrant

Physical reversal transition occurs at $l \sim 304^\circ$. 
Available Data in the First Quadrant

Transition occurs at $l \sim 360^\circ - 304^\circ = 56^\circ$?
Symmetry Between Q1 and Q4?
Symmetry Between Q1 and Q4?

CGPS might detect RM transition...
Symmetry Between Q1 and Q4?

CGPS might detect RM transition...

GALFACTS will detect RM transition.
Halo Field & Disk-Halo Transition
Vertical Symmetry and Reconnection

Quadrupolar (even symmetry)

“Dipolar” (odd symmetry)
High Latitude CGPS Region in RM
Exploring Regions out of the Disk
Cross-Scale Coupling
Scale Sizes of the Magnetic Field
Scale Sizes of the Magnetic Field
Isotropy of the Random Field
Correlation between $\overline{\text{RM}}$ and $\sigma_{\text{RM}}$

From analysis of CGPS data
Anisotropy of the Random Field

- What is (are) the source(s) of the perturbations?
- How does the large-scale field couple to the small-scale field?

The expected source density from Arecibo will allow better probing of these questions.
The complete geometry of the Galactic Magnetic Field is far from being conclusively determined.

Unanswered Questions:
- How many reversals are in the inner Galaxy?
- What is the field alignment w.r.t. the spiral arms?
- What is the halo field geometry?
- How does the field transition from the disk to halo?
- How does cross-scale coupling occur?

Obtaining answers requires Arecibo.
We’re not done yet...
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...but we’re getting closer!