Priors can encode information such as the MHD physics, the mean field dynamo equation. Each of these has been fit to data successfully, and yet their morphologies are all very different.

**Parametric Galactic magnetic field models:**
- CRE: GALPROP
- Spiral arms
- Anisotropic turbulence
- In plane only
- NE2001
- 408 MHz total I
- WMAP 23 GHz PI

**Non-parametric Galactic magnetic field models:**
- Note that these are all parametric models where essentially the chosen analytic form encodes prior information. We also hope to eventually explore the magnetic field in a non-parametric way. In this case, the parameters are essentially the field at each position in the 3D simulation. This will be computationally challenging. See, e.g., Enßlin et al., Phys Rev D 80, 105005 (2009) for discussion.

**Our purpose is to join:**
- radio and sub-millimeter astronomers, who have been observing diffuse polarized emission in the Milky Way as well as Faraday rotation measures (RM) of galactic pulsars and extragalactic polarized sources and using them to learn about the Galactic magnetic field (GMF).
- astroparticle physicists who use high-energy data (cosmic rays, or CRs, and gamma-rays) to study the propagation of relativistic particles in the Galaxy as well as the production of secondary particles.
- theorists, who have been attempting to understand the dynamics of the magnetized ISM, how the fields, cosmic rays, and turbulence interact, how the dynamo works, etc., to constrain the model space with MHD physics.
- observers of ultra high energy cosmic rays (UHECRs) who wish to trace these most energetic particles back to their sources to understand their acceleration mechanisms.
- information theorists to build a Bayesian inference engine to take all of the above information and tell us it means.

**Theoretical GMF model (courtesy of S. Mollerach)**

**Likelihood evaluation and model selection:**
Bayesian analysis with “galactic variance” taken into account in computation of P(θ|d,m).

**Simulation engine and sampling:**
Bayesian MCMC (see Steininger et al., in prep):
- Numerical Integration Field Theory (NIFTy3) Steininger et al. 2017
- Hammurabi (integrator) Waelkens et al. 2008 and Wang et al., in prep
- Metropolis-Hastings OR Gibbs sampling OR Hamiltonian sampling

**Likelihoods**
- Marginalized likelihood, P(θ|d,m). example.

**Marginalized likelihood, P(θ|d,m). example.**