Primordial Origin of Composite Magnetic Configurations in Spiral Galaxies

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Abstract

Observations indicate composite magnetic fields in galaxy disks, comprising S (BSS), A (ASS) , R (Ring), GPR(Gal. plane reversal) in disks, and V (Vertical) in the center. These are explained as the fossil of large scale primordial field wound up during galaxy formation, and are well reproduced by MHD simulations. SKA High-resolution and sensitive Faraday RM mapping will clarify the detailed S, A, R, GPR and V field configurations, which gives constraints on the seed cosmological magnetic field.

1 Introduction

Figure 1 shows observed magnetic configurations in near spiral galaxies and that in the Galactic Center. Fields in the disk are mostly bisymmetric spiral (BSS=S or ASS=A) or ring (R). The central fields are vertical (V) to the galactic plane. These different configurations often co-exist in the same galaxy.

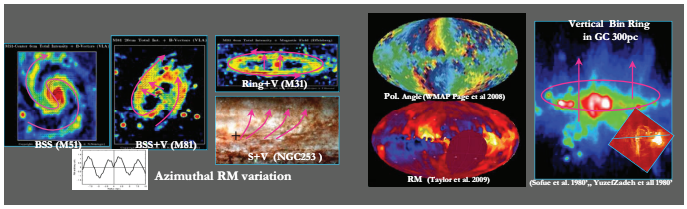

Fig. 1: Observed S, A, R and V magnetic configurations in nearby galaxies and V field in the Galactic Center. See the literature in Sofue et al. (2010)

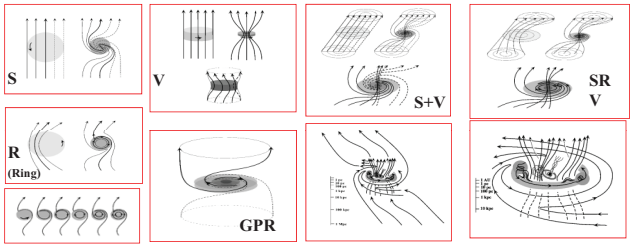

Fig. 2: Hypothetical scenario of galactic magnetic field from uniform, tilted cosmological field (Sofue et al. (2010).

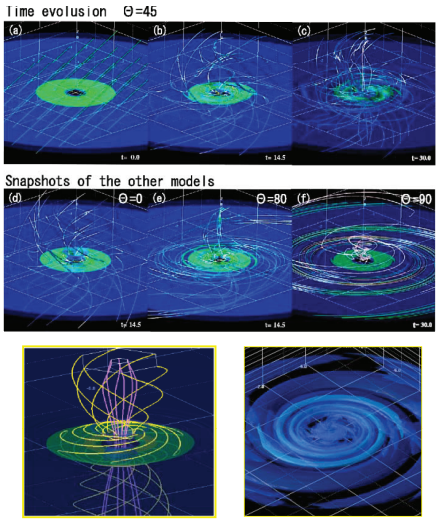

Fig. 3: MHD simulation of magnetic field evolution in a disk galaxy (Sofue et al. (2010).

2 Primordial Origin Hypothesis

Figure 2 illustrates the origin of magnetic topology in spiral galaxies. Tilted uniform field is wound up into a rotating gas disk, forming an S, A or R fields in the disk. ASS field shows reversal with respect to the galactic plane (GPR). The vertical component is accumulated to the center to form twisted V field. Ring field is created from reconnection of a part of the spiral, stimulated by mode-1 asymmetry in the initial field.

3 Result of MHD Simulation

Figure 3 shows the result of MHD simulations. The gas is rotating in a disk potential (Sofue et al 2010). In several rotations, S (BSS), A with GPR, and central V fields are indeed created. R field is not created, because no mode-1 asymmetry exists in the initial condition, which would be a subject for the future.

4 SKA Faraday-RM Synthesis for Galactic Magnetic Field Origin

High-resolution RM mapping of nearby spiral galaxies is crucial to understand the magnetic field origin. Detailed comparison of the observations with MHD simulations may used to clarify the primordial magnetic condition in spiral galaxies.

References

[1] ofue, Y., Machida, M., Kudoh, T. 2010 PASJ 62, 1191.