Magnetic fields of galaxies

Introduction

Magnetic fields in the interstellar media of nearby spiral galaxies are in approximate energy equipartition with thermal motions, turbulence and cosmic rays, making them dynamically important. The most basic features of these fields can be understood in the context of dynamo models. However, quantitative comparison between theory and observation needed to validate or reject theoretical models is still lacking.

Proposed research

I propose to review the literature in this field to map out current observational and theoretical knowledge about galactic magnetic fields, as well as the existing comparisons between them. This may assist the community in understanding what aspects need more study.

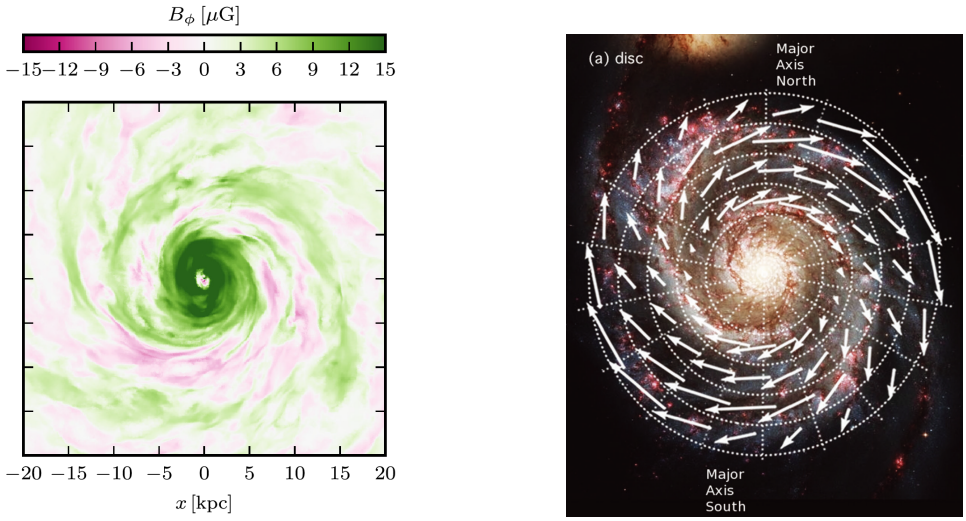

Figure 1: Azimuthal component of the magnetic field in a simulated spiral galaxy, from Pakmor et al. (2018) (left), along with a global magnetic field model for the disc in the galaxy M51 made using observations of synchrotron emission, from Fletcher et al. (2011) (right). Large-scale field reversals are present in the simulated galaxy, but absent in the observational model.

Methods

I will synthesize research from multiple sources, including a recent textbook on the subject (Shukurov & Subramanian, 2021), which contains detailed explanations of magnetic field observations and dynamo theory. Moreover, I will make use of a recent review which compiled recent observational data (Beck et al., 2019), and will refer to the references therein, as needed. These sources do not discuss direct numerical simulations in detail, but these have become a crucial tool for understanding magnetic fields. Therefore, I will consult some recent literature on this topic (e.g. Pakmor et al., 2018; Gent et al., 2021). An image of the magnetic field of a spiral galaxy from a zoom-cosmological simulation simulation, along with an observational model is shown in Fig. 1.

Research output

The work will be submitted to *Monthly Notices of the Royal Astronomical Society*.

Timeline

The work will require 10 weeks in total. I will first spend two weeks learning the basics of dynamo theory, followed by two weeks learning the basics of magnetic field observational techniques. The next three weeks will be spent studying observational and theoretical results from the literature. The final three weeks will be spent writing the report, while continuing to consult the literature.

Summary

I propose to review the current status of research on magnetic fields in galaxies in order to synthesize knowledge and identify gaps in our current understanding, and drive the field forward.

References

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