MAGNETIC FIELD IN A TURBULENT GALACTIC DISK.

K.Otmianowska-Mazur
Astronomical Observatory
Jagiellonian University
Orla 171
30-244 Cracow
Poland

ABSTRACT.A numerical model of magnetic field structure in the presence of turbulent motions of the interstellar gas has been made.We solved the kinematic equation of magnetic field transport in a limited volume of ISM.Diffusion effects smoothing out small-scale structure are allowed as well.A permanent helical configuration of field lines has been found.This justifies,at least partly,searching solutions in the dynamo theory in the form of field modes. The presence of diffusion appears essential for the time evolution of magnetic field and magnetic energy density.

1. Introduction

The analysis of observational data (particularly polarization of galaxies having various inclination) indicates the presence of a significant,three-dimensional random component with the scale<<1kpc. One of principal mechanisms which could be responsible for the small-scale magnetic field distortions is interstellar turbulence.It also plays a fundamental role in the galactic dynamo process.
In this work we tried to answer the following questions:
1.What structures of magnetic field could be expected in the presence of permanent turbulent activity in interstellar medium?
2.Does the action of turbulence change in any systematic way the magnetic field energy density?

2. Method.

Calculations were performed in a limited volume of interstellar gas(40pcx40pcx40pc),in which the magnetic lines of force were permanently distorted by a large number of turbulences.The magnetic field was assumed to be perfectly frozen into the gas. The initial magnetic field was taken as purely azimuthal,its strength being 10 G.The calculations were performed in a rectangular grid with spacing of 0.9pc.Diffusion effects smoothing out field structures smaller than a given scale were approximated by convolving the field values with a Gaussian function, the half-power width of which

R. Beck et al. (eds.), Galactic and Intergalactic Magnetic Fields, 157–158.

played a role of diffusion scale.This operation was performed after each individual turbulence action.The diffusion scale was varied in order to investigate its effect on the resulting field structure and evolution.

3. Results.

We computed the magnetic field structure in the volume perturbed by a large number of randomly entering turbulent cells.Such a configuration of magnetic field after 50 turbulences can be seen at Fig.1. We found that the helical structures,especially loops in the XZ plane appeared (Fig.2).The radial and the poloidal magnetic field components are very important for the dynamo process, as well as for the random component of the large-scale magnetic field.Such helical structures constitute a good aproximation of those component.

4. Conclusions.

1.We found that the action of multiple turbulences in the ISM led to a permanent helical structure of magnetic field lines of force.This justifies, at least partly, searching solutions in the dynamo theory in the form of field modes.
2.The field deformations were systematically larger and grow faster for greater values of diffusion scale.The presence of diffusion was thus essential for the time evolution of magnetic field structure and magnetic energy density.
3.Without large-scale field gradient it is extremely difficult to obtain any systematic field amplification.If turbulences enter the given ISM volume in a random manner ,the energy input from turbulences and its losses by diffusion compensate each other if a certain degree of general field helicity is attained.At present the role of gradients and differential rotation in further field amplifications remains beyond the scope of the present model and is not yet well determined.A more realistic model is now being developed.

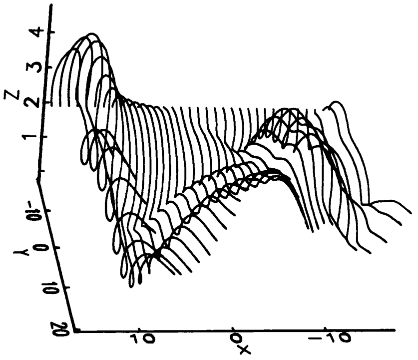

Fig. 1

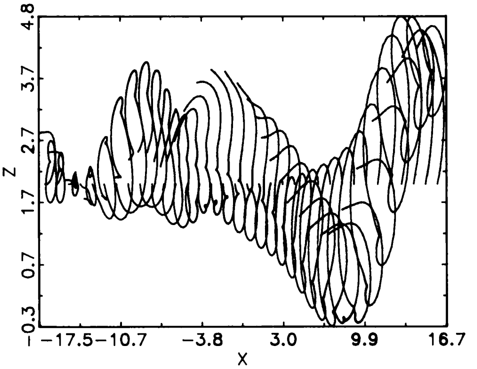

Fig. 2

https://doi.org/10.1017/S0074180900189831 Published online by Cambridge University Press