

## Preface

This book focuses on the convection of *liquid metal* caused by a *Lorentz force* and the convection of fluids such as air and water due to a *magnetizing force*.

The convection of liquid metal due to the Lorentz force has been studied extensively, and here its study was motivated by the desire to clarify the effect of a magnetic field on the convection of *molten Si* in a crucible of the *Czochralski crystal-growing* system. This is because the characteristics of convection of molten silicon have been considered to be responsible for the solidifying processes at the melting temperature and for the final crystal composition and dopant distribution.

On the other hand, study of the convection of *non-electro-conducting fluid* due to the magnetizing force appears to have started since the report by Braithwaite *et al.* in 1991 on the experimental measurement of the heat transfer rates of the *gadolinium nitrate* solution for the configuration of *Rayleigh-Benard* type natural convection in the bore space of a *super-conducting magnet*. The driving force for this convection is the *magnetizing (or magnetization or magnetic) force*, which is proportional to the *magnetic susceptibility* of the fluid and approximately proportional to the gradient of the square of *magnetic induction*. This force has become widely applicable with the development of the super-conducting magnet, and the motivation for this study is due to its vast potential for application, ranging from quasi-non-gravitational or enhanced gravitational acceleration in the bore space of a super-conducting magnet to micro-scale magnetic effects in atomic level processes.

The title of this book, "*magnetic convection*," may not be a familiar or widely employed term, but it is employed herein to mean the convection caused either by a Lorentz force in an electro-conducting fluid or by a magnetizing (or magnetization or magnetic) force in a non-electro-conducting fluid. The origin of this term lies with Professor Shigeo Asai, Nagoya University, who led and chaired a research project, "The new developments in the electro-magnetic-processing", sponsored by the Ministry of Education, Japan from 1999 to 2002. There appears to be no earlier term that covers the convection of fluid caused by magnetic field, either by a Lorentz force or by a magnetizing force. Most of the latter part of this book represents results acquired by my research group in the above research project.

The preparation of this book was proposed by Imperial College Press. Its style is a summary of our research results. Even though the above funded research project has now ended, we have continued to develop our research in line with the contents of this book. Future research results of our group will be listed on our home page.

<http://trans2.cm.kyushu-u.ac.jp/>, <http://www.hiroyuki-ozoe.net> .

Various new findings on the phenomena caused by a strong magnetic field will emerge, and some of them may be employed for developing new industries. I believe this new wave of applications of a strong magnetic field will develop further, and this book may provide an introduction to the current state of this new art.

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in Fukuoka