Magnetohydrodynamic Turbulence

Dieter Biskamp, Cambridge University Press, New York, 2003, 297 pp., $95.00

Once upon a time, long, long ago (possibly before you were born), magnetohydrodynamic (MHD) turbulence was a matter of some interest to the fluid dynamics community. It looked as though there might be some money for research, and Batchelor and others were predicting the forms of the velocity spectra in liquid metals. Kraichnan was developing his direct interaction theory with support from an MHD program (though most of his work was done with $B = 0$). This was in the late 1950s, and CalTech set up a mercury tunnel for MHD turbulence research. Unfortunately, the tunnel overflowed during filling, and hundreds of pounds of mercury dripped through cracks in the floor. A senior experimentalist on the floor directly below ground zero was seen leaving his lab stark naked and holding an umbrella over his head. Everyone went to the hospital to be chelated, and the hapless graduate student responsible for the flood was assigned to other duties.

At about the same time, the National Bureau of Standards planned a NaK tunnel, using as a working fluid a sodium–potassium eutectic. The tunnel was never built, which is probably just as well—a mixture with greater potential for disaster is hard to imagine.

Suddenly the money dried up. The only people still concerned were the plasma physicists, who found MHD turbulence in fusion reactors, and astrophysicists, who found it in stars. The turbulence in fusion reactors at first was referred to as "weak" turbulence, which consisted of random Alfvén waves. Turbulence people said firmly that this was not proper turbulence. Later the plasma physicists found "strong" turbulence, which was proper turbulence.

There was a brief resurgence of interest when it seemed possible that a hypersonic transport, the Orient Express, would be built. Design required models of plasma turbulent boundary layers and presented the possibility of their control using magnetic fields. Retired hypersonic types began to sit up and take nourishment again. Unfortunately, our ability to design this aircraft had been very much overhyped, and the project quietly died.

So, now MHD turbulence is primarily of interest again to plasma physicists and astrophysicists. Dieter Biskamp has worked in both areas. This is a serious, clear, and well-written book. After an introduction to MHD in general, Biskamp treats the various instabilities that are possible. He gives enough of an introduction to hydrodynamic turbulence probably to permit a physicist with not much background in fluid mechanics to come up to speed. The author goes relatively light on models, dealing primarily with the quasi-normal and EDQNM (eddy-damped quasi-normal Markovian) approximations. He does cover the various applicable similarity theories and several phenomenological models for intermittency.

Biskamp makes generous use of the results of direct numerical simulations. He covers two-dimensional turbulence, compressible turbulence, turbulent convection, turbulence in the solar wind, accretion disks, and interstellar turbulence, all with MHD fluctuations where appropriate. Thirty years ago, I could find relatively little in the literature on astrophysical turbulence. It is gratifying to have at hand such a useful guide to these fascinating areas.

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