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The interstellar magnetic field: plasma problems[1]

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I will discuss a number of unsolved plasma problems whose solution will help in understanding the origin and evolution of the interstellar magnetic field. The prevailing theory of the origin of this field from a weak primordial seed field is the alpha-omega dynamo driven by interstellar turbulence. During the operation of this dynamo it is necessary for some flux to be expelled from the disc, and this has to happen without removing the interstellar medium as well. How this happens is an important astrophysical problem involving plasma physics. Furthermore, the turbulence initially produces small scale fields on scales below the inner scale of the turbulence. When the interstellar magnetic field is extremely weak the bulk plasma is still controlled by the orbits of the particles in the weak field. During this phase there are strong parallel and perpendicular pressure instabilities whose saturation has not been successfully worked out, and whose consequences are not understood. These instabilities can control the initial buildup of the interstellar magnetic field and impact its origin. The role of magnetic reconnection, in these early phases as well as later times when the field is strong, is not understood. Finally, the actual physics of magnetic reconnection itself is not understood. I will discuss the astrophysical importance of all these plasma problems.

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