

List of Suggested Readings for Micromagnetics Course (H. Suhl)
(commentary follows list)

papers & articles:

1. C. Herring and C. Kittel, Phys Rev 81, 869 (1951). (LINKED)
2. Haas and Callen, chapter 10, vol. 1 of the Rado-Suhl series
3. Dillon, chapter 9, vol. 3 of the R-S series.
4. Slavin, in P. Wigen: Nonlinear Phenomena and Chaos in Magnetic Materials.
5. S. Chandrasekhar, Stochastic Problems in Physics and Astronomy, Rev. Mod. Phys. 15, 3, 1943. (LINKED)
6. H. Suhl, IEEE Trans. Magntsm, vol. 34 (1998) (magnetic relaxation caused by coupling to a lossy lattice) (LINKED)
7. Bertram and Safonov, to be published (magnetic relaxation caused by coupling to a simple random field).
8. Safonov and Bertram JAP 87, 5681 (2000). (LINKED)
9. Suhl and Bertram, JAP 82, 6128 (1997). (LINKED)

books:

1. C. Kittel, Introductory Solid State Physics - sections on magnetism.
2. D. Mattis, Theory of Magnetism.
3. Rado-Suhl series, Magnetism and Magnetic Materials, especially vol. 1.
4. Morgan Sparks, Ferromagnetic Relaxation Theory
5. Risken, The Fokker-Planck Equation
6. Coffey, Kolmykov and Waldron, The Langevin Equation.

elaboration & comments:

1. Magnetism in general: Any elementary text; for example the sections in Kittel, Introductory Solid State Physics dealing with magnetism. Students interested in theory at the atomic level might benefit from reading some sections of Mattis, Theory of Magnetism. Students wishing to dig deeper into such topics as the origins of magnetic anisotropy, various types of exchange forces, magnetostriction, optical properties etc. are advised to consult the corresponding chapters in the Rado-Suhl series, Magnetism and Magnetic Materials. particularly volume 1. Although there has been an enormous amount of work since that series was published, there appear to be very few comprehensive review articles.

2. These lectures will mainly deal with magnetic phenomena at the mesoscopic or macroscopic level, a level at which the magnetic moment is treated as a vector field, representing an appropriate average over the individual spin vectors over a region large enough so that the average is meaningful, but still small compared with the region over which normally measured magnetization varies appreciably. The relation between the atomic view and the field-theoretic view is discussed in some detail in a basic paper by Herring and Kittel, Phys Rev 81, 869 (1951). In these lectures, such topics as magnetic domain walls, small excitations (spin waves or magnons), magnetic relaxation processes, magnetization reversal, etc., will be discussed in terms of the magnetization field. A book by Morgan Sparks, Ferromagnetic Relaxation Theory is an excellent guide to small excitation theory, including relaxation by spin wave scattering at

imperfections. Also, the chapter by Haas and Callen in chapter 10 of vol. 1 of the Rado-Suhl series is quite comprehensive.

3. As for device applications, the theory of spin waves is not of much use, since the motion of the magnetization vector is generally very large (for example in magnetic recording, the magnetization is switched from one equilibrium position to a totally different one by the signal field). Most efforts to deal with large motions have so far been mainly confined to computer simulations, sometimes quite massive ones. These lectures will be confined to analytic theory as far as possible. Recommended reading here would cover domain walls and domain wall motion. An excellent article to read is by Dillon, chapter 9, vol 3 of the R-S series. Some articles on the borderline between small signal theory and large motions are found among PR papers by Slavin, which deal with solitons created by spin wave interactions. The same author also has a review type paper in a book edited by P. Wigen: Nonlinear Phenomena and Chaos in Magnetic Materials.

In preparation for these lectures, students should acquire some familiarity with non-equilibrium statistical mechanics at the level of Fokker-Planck and Smoluchowski diffusion equation. These methods are important in the discussion of loss mechanisms induced by the thermal reservoir, as well as in magnetic switching. Some familiarity with the fluctuation-dissipation theorem will be found helpful. Two books are recommended here: One by Risken, The Fokker-Planck Equation, the other by Coffey, Kolmykov and Waldron, The Langevin Equation. Do not go too deeply into the mathematics in these books. In fact, a classic and rather simple overview of this subject is in a 1943 paper by Chandrasekhar, Stochastic Problems in Physics and Astronomy, Reviews of Modern Physics, vol 15, 1943.

An understanding of relaxation mechanisms in magnetically ordered media is important, from both fundamental and applied viewpoints. Aside from the actual atomic-level loss mechanisms, one would like to know how these mechanisms 'map' on the equations of motion of the magnetization vector alone, so that one does not have to carry around the burden of evaluating the mechanism for each problem separately. Papers in this kind are: Suhl, IEEE Trans. Mgntsm vol. 34 (1998) (magnetic relaxation caused by coupling to a lossy lattice) and Bertram and Safonov, to be published (magnetic relaxation caused by coupling to a simple random field).

Theoretical aspects of magnetization reversal are described in many papers (few of them cogniscent of the nonlinear aspects of this problem). Two papers are: Safonov and Bertram JAP 87, 5681 (2000), and Suhl and Bertram, JAP 82, 6128 (1997).