Abstract: Magnetic fields and turbulence are ubiquitous in the universe. Here we review the turbulent dynamo generation of astrophysical magnetic fields focusing on galactic and galaxy cluster magnetism. Turbulence generically leads to fluctuation or small-scale dynamos, which are crucial to understand magnetic fields in clusters and young galaxies. The degree of coherence of the generated fields is a major concern. Some form of mirror-asymmetry is required to generate fields on scales larger than turbulent eddy scales, as inferred in present day disk galaxies. However such mean-field dynamos need to operate in the presence of strongly growing fluctuations and also shed small scale helicity to avoid quenching. The present status of these ideas is elucidated.

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