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Examples of exact solutions of charged particle motion in magnetic fields and their applications.

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There are very few exact solutions for the motion of a charged particle in specified magnetic field. These solutions have considerable theoretical as well as pedagogical value. In this talk I will briefly describe several known analytical solutions, such as motion in the equatorial plane of a dipole and in a constant gradient field. Particular attention will be given to a relatively unknown solution corresponding to magnetic field inversely proportional to the radius. This case leads to relatively simple expressions involving only elementary functions. I will discuss applications of this solution to validation of numerical methods of particle tracing, such as symplectic integration. Another interesting use of this solution is comparison with the adiabatic drift theory. Finally, this solution can be used as a building block for developing new numerical integration schemes for particle tracing.

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