# Reconnection in magnetic and vorticity fields

Gunnar HORNIG

*Theoretische Physik IV,*
*Fakultät für Physik und Astronomie,*
*Ruhr-Universität Bochum, 44780 Bochum, Germany*
gh@tp4.ruhr-uni-bochum.de

**Abstract** Reconnection is an important process of structure formation in fluid dynamics. It occurs in form of vortex reconnection in hydrodynamics as well as in form of magnetic reconnection in plasmas. Two basic types of reconnection are known. The planar two-dimensional reconnection and the more generic, but more complicated three-dimensional case. These two types differ for example with respect to their production of helicity in reconnection.

Simple analytic examples of vortex reconnection are given and compared with corresponding solutions of magnetic reconnection. It is shown that, while for magnetic reconnection two-dimensional stationary solutions exist, vortex reconnection always requires a time-dependent velocity field. This explains why vortex reconnection in spite of all similarities often has a more complicated geometry than magnetic reconnection.

---

*The process of line reconnection*
*Results from diffusion-advection;*
*With a flick of the wrist*
*I can generate twist,*
*And this for your greater delection!*

## 1. Introduction

Reconnection is an important process both in magnetohydrodynamics (MHD) and hydrodynamics (HD). It describes a change in the topology of field lines of a divergence-free field, i.e. the vorticity field in HD or the magnetic field in MHD. The equation which determines the evolution of the divergence-free field is in the case of vorticity the curl of the Navier-Stokes equation and for the magnetic field the curl of Ohm's law. We can summarize both in

$$\partial_t \mathbf{G} - \nabla \times (\mathbf{v} \times \mathbf{G}) = \nabla \times \mathbf{N} \ , \tag{1}$$