Knots, links and braids in magnetic fields

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4PM, Friday, 8th March, Room 5215, JCMB

The relation between knot theory and magnetic fields can be traced back to Gauss' linking integral, which is used to calculate the linking number between two closed curves (knots). The linking integral can be generalised to measure the average linking number of pairs of field lines in a magnetic field – see the 1974 paper of V.I. Arnold http://www.maths.ed.ac.uk/~aar/papers/arnoldhopf.pdf and the 2005 survey article of B.Khesin http://www.maths.ed.ac.uk/~aar/papers/khesin.pdf This integral, called magnetic helicity, plays an important role in technical and astrophysical plasmas.

We will explain the properties of magnetic helicity and give an overview of the attempts to generalise further notions of knot theory to magnetic fields. In particular we will present integrals for higher order linking numbers in three and four dimensions and discuss their relevance for magnetic fields in plasmas.