

物理学教室

物性コロキウム

日時：2015年10月22日(木) 16:30-18:00

場所：理学研究科合同B棟745号室 (745, Science complex B)

講師：Hans-Rainer Trebin 氏

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題目：Fiber bundles and topology for quantum matter

概要：

The sphere S^2 is the simplest example of a nontrivial differential manifold. It is so smooth that at each point a tangent plane can be attached. The basic manifold S^2 plus all its tangent planes form a special case of fiber bundle, a “tangent bundle”. In the general case the “fiber” tangent plane is replaced by an arbitrary vector space upon which a symmetry group is acting.

Parallel transport of fiber vectors along paths in the basic manifold can be defined and leads to the notion of linear connection and curvature. Integrals over certain functions of the curvature tensor yield integer numbers as for example the Euler characteristic of closed two-dimensional surfaces in three-dimensional space.

The concept of fiber bundles has been applied to quantum mechanical particles where the force fields (electric and magnetic field, weak or strong force) turned out to play the role of curvature.

Recently, electronic states of insulators were described by fiber bundles, with the linear connection being identified by the so called “Berry phase”. Integrals over the corresponding curvature again yield integers denoted Chern numbers or “topological quantum numbers”. These numbers are new characteristics of condensed matter systems. When a number is nonzero, exotic physical properties show up.

The first example has been the quantum Hall effect, discovered by Nobel laureate Klaus von Klitzing, where the Hall conductance is an integer multiple of the basic value e^2/h (e : charge of an electron, h : Planck constant). In the meantime, nontrivial topological insulators were identified in HgTe/CdTe quantum wells, BiSb alloys, and Bi_2Te_3 and Bi_2Se_3 crystals. They are insulators in the bulk, but show robust dissipationless surface currents.

Thus the concept of fiber bundles is applicable to a wide range of physical systems and has led to prediction and discovery of new states of quantum matter.

In this talk I shall give an elementary introduction into the most important conceptions connected with topological states of matter.

連絡先：泉田 渉 (795-6475)

☆ 16:15 よりコーヒー、紅茶、お菓子を用意します。カップを持ってお集まり下さい。

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