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FROM DEFORMED SURFACES WITH PRESCRIBED QUANTUM PROPERTIES TO NEW TWO-DIMENSIONAL QUANTUM DEVICES

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Abstract. We propose a problem in differential geometry, i.e., which deformed surfaces produce prescribed curvature induced quantum potentials. We solve this inverse problem in the case of surfaces of revolution. We also show that there exist rotational surfaces in the form of a circular strip around the axis of symmetry which allow particles with generic angular momentum to bind. The quantum physics of a collection of circular strips of curved surfaces glued together is discussed in the conclusion in view of the possibility to engineer devices based on thin films.

1. Introduction

It is possible to produce very narrow two-dimensional conducting surfaces which allow electrons to propagate in the channel formed by their boundaries, but require the electron wave function to vanish on these boundaries. In this paper, we study the possibility of creating an effective one dimensional quantum problem by confining a particle to move in a collection of simple rotationally invariant surfaces in the form of ribbons glued together. The interaction between quantum particles and curvature in such a construction induces possible physical applications. Furthermore, curvature leads to surprising effects in quantum systems, for example, in [5] it was shown that a charged quantum particle trapped in a potential of quantum nature due to bending of an elastically deformable thin tube travels without dissipation like a soliton. Surprisingly, the twist of a strip plays a role of a magnetic field and is responsible for the appearance of localized states and an effective transverse electric field thus reminisce the quantum Hall effect [6].