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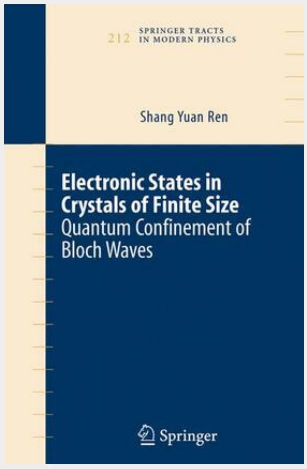
Electronic States in Crystals of Finite Size

Quantum confinement of Bloch waves

The theory of electronic states in crystals is the very basis of modern solid state physics. In traditional solid state physics – based on the Bloch theorem – the theory of electronic states in crystals is essentially a theory of electronic states in crystals of in?nite size. However, that any real crystal always has a ?nite size is a physical reality one has to face. The di?erence between the electronic structure of a real crystal of ?nite size and the electronic structure obtained based on the Bloch theorem becomes more signi?cant as the crystal size decreases. A clear understanding of the properties of electronic states in real crystals of ?nite size has both theoretical and practical signi?cance. Many years ago when the author was a student learning solid state physics at Peking University, he was bothered by a feeling that the general use of the periodic boundary conditions seemed unconvincing. At least the e?ects of such a signi?cant simpli?cation should be clearly understood. Afterward, he learned that many of his school mates had the same feeling. Among many solid state physics books, the author found that only in the classic book Dynamic Theory of Crystal Lattices by Born and Huang was there a more detailed discussion on the e?ects of such a simpli?cation in an Appendix.

The theory of electronic states in the traditionally solid state physics is essentially a theory of electronic states in crystals of infinite size. However, any real crystal always has a finite size. This book presents an analytical theory on the electronic states in ideal low-dimensional systems and finite crystals recently developed by the author based on a differential equation theory approach. It gives some exact and general fundamental understandings on the electronic states in ideal low-dimensional systems and finite crystals and provides new insights on some fundamental problems in low-dimensional systems such as the surface states, quantum confinement effects etc, some of them are quite different from what are traditionally believed in the solid state physics community.



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