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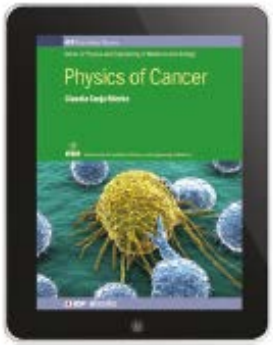

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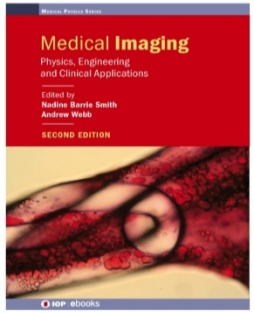

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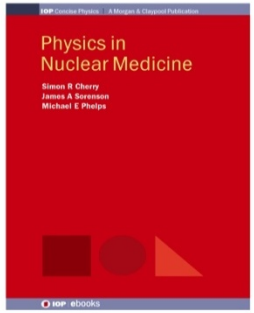

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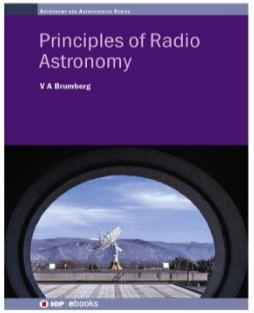

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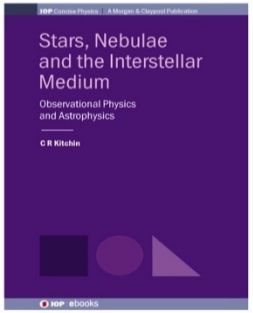

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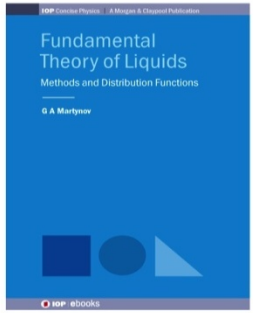

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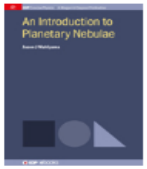

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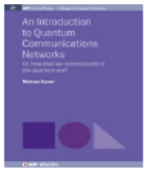

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CHAPTER 1 • FREE TO READ

The world of nanoelectronics

David K Ferry

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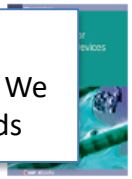
Abstract

It generally is regarded as being true that nanostructures may be considered as ideal systems for the study of the physics of electronic transport. Perhaps this is a self-fulfilling statement, as I have been involved in the field for my entire career. In the late 1970s, this area of research was called 'ultra-small electronics research', and the description as one of nanoscale was not applied for a few decades after that. But, it was interesting that we pursued the use of electron-beam lithography to make things small. Unfortunately, this endeavor was ended by the success of the microelectronics industry. For instance, we worked hard in the university environment to make small transistors with gate lengths on the scale of 25–50 nm. For the past decade or so, Intel (and others, of course) has made a number something like a thousand times the population of the Earth of such devices each day, so this area of research is gone from the universities.



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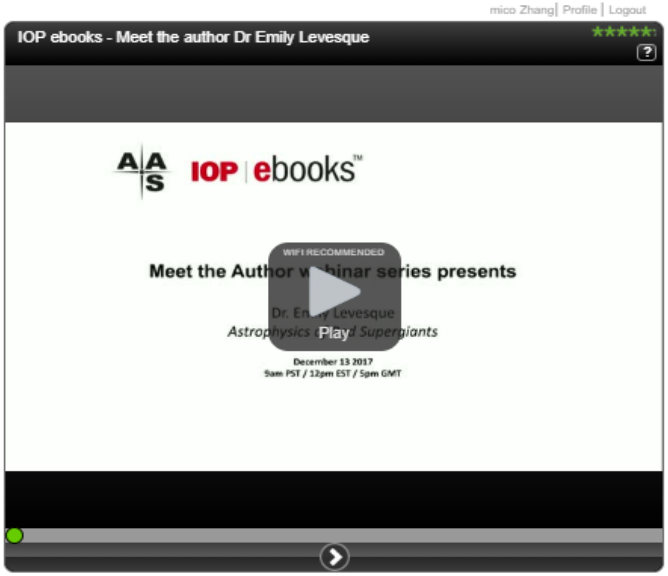

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processing that has given us this high technology life. This is nicely illustrated by Professor Jesper Nygård in the video of figure 1.1. Several research technologies are discussed in this video, and we will treat many of them in the following chapters of this book.

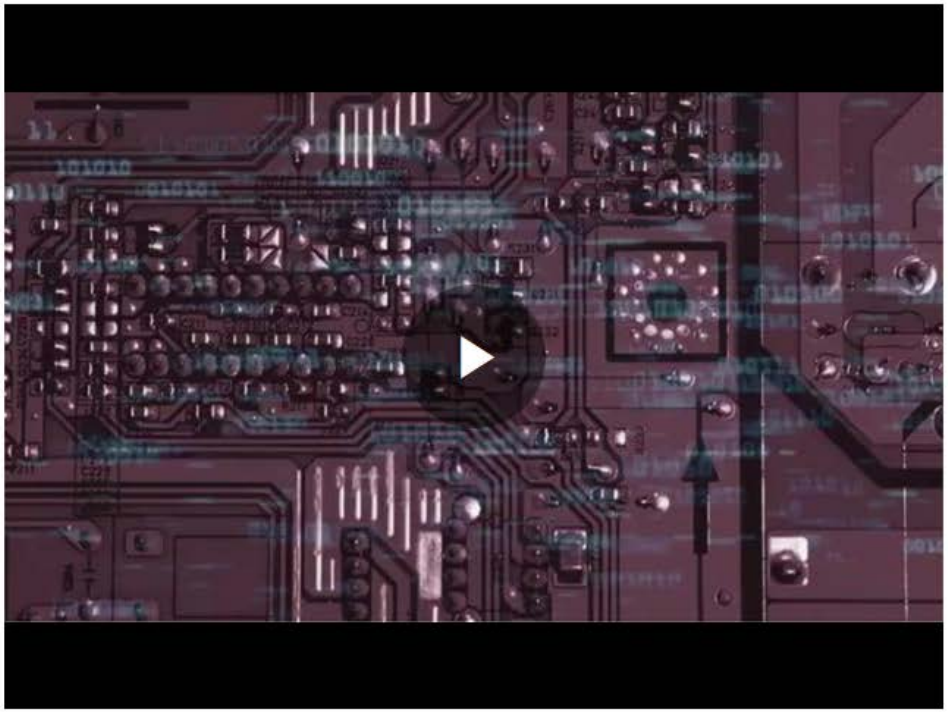

Figure 1.1. Jesper Nygård on nanotechnology, artificial atoms, and the future of computing. (Video hosted by Professor Jesper Nygård, Neils Bohr Institute, and produced by the Compound for Neils Bohr Institute, included here with their permission.)

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self-consistent manner. Before addressing this, let us talk about the phrase 'transverse mass'. Silicon has a complicated band structure. The minimum of the conduction band lies along the line from Γ to X in the Brillouin zone, and is located about 85% of the way to X. Because of the symmetry of the Brillouin zone, there are six equivalent minima, as shown in figure 1.4. Each of the six ellipsoids has a longitudinal axis and two transverse axes, and corresponding values for the mass. In Si, it is generally felt that the effective mass values are $m_L = 0.91m_0$, $m_T = 0.19m_0$.

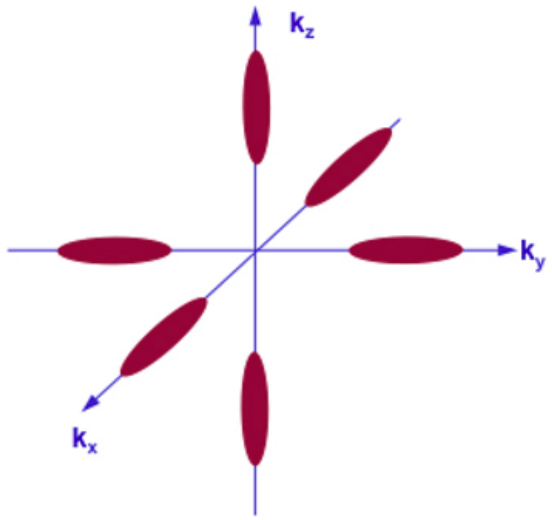

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Figure 1.4. A constant energy surface near the minima of the conduction band in silicon consists of six equivalent ellipsoids oriented along the lines from Γ to X.

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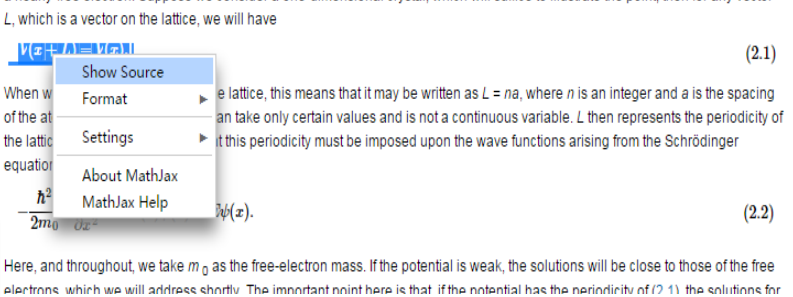

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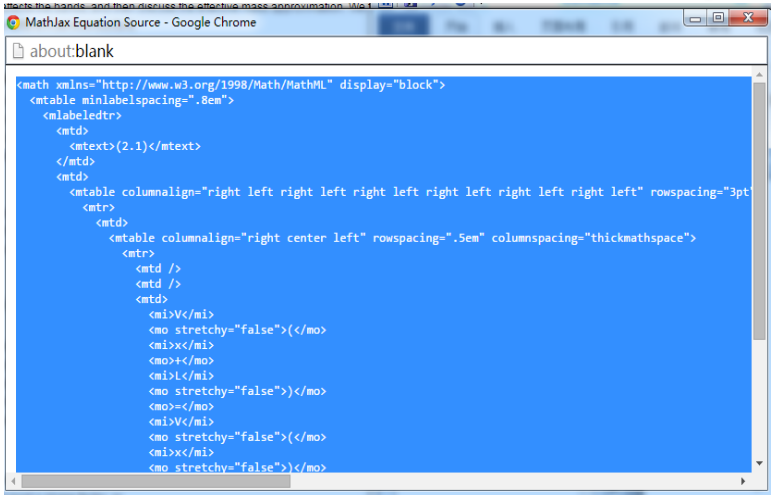

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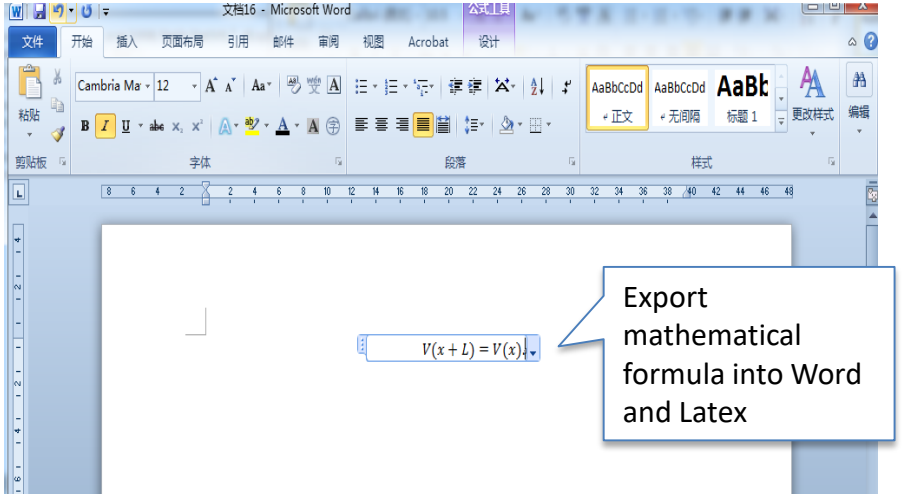

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