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Transport properties of electrons in quasiperiodic magnetic superlattices

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Abstract. We study quantum transport properties in quasiperiodic magnetic superlattices by examining the motion of electrons in Fibonacci and Thue–Morse sequences. It is found that transmission resonances exhibit complicated oscillations and selective suppression. The number of resonant peaks decreases and their distribution becomes less regular in comparison to those of the periodic magnetic superlattice. It is confirmed that both doublet and singlet resonances exist in the quasiperiodic structure. It is also confirmed that complete resonant tunnelling can occur in quasiperiodic systems due to the existence of completely transparent eigenstates. The role played by a local magnetic barrier in the magnetic superlattice is investigated. The results indicate that both the transmission coefficient and the conductance are drastically suppressed with increment of the strength of a local barrier.

1. Introduction

The physical properties of quasiperiodic superlattices have attracted increased interest [1–5] since the discovery of the quasicrystal phase [6, 7] and the actual construction of a Fibonacci superlattice of GaAs/AlAs by Merlin *et al* [8]. Because of the nonperiodicity and self-similarity, competition between localization and delocalization exists in quasiperiodic systems and many intriguing electronic and optical properties have been investigated. Theoretically, for one-dimensional quasiperiodic systems, it has been found that the energy spectrum is singular and continuous and that the wave functions are critical, i.e., neither extended nor localized [9, 10]. This kind of eigenstate was also found in two- and three-dimensional quasicrystals. Quasiperiodic superlattices can be considered as intermediate between periodic crystals which lead to energy bands and disordered materials which cause localization in one-dimensional systems. The Fibonacci and Thue–Morse sequences have usually been adopted as the standard lattices in the study of one-dimensional quasicrystals.

The Fibonacci sequence is constructed by juxtaposing two different building blocks A and B arranged in a Fibonacci sequence which is formed according to the rule

$$S_{l+1} = \{S_l S_{l-1}\} \qquad (l \geqslant 1) \tag{1}$$

with $S_0 = \{\mathrm{B}\}$, $S_1 = \{\mathrm{A}\}$. The Fibonacci integer F_l is the total number of building blocks A and B in S_l, and obeys the recursion relation $F_{l+1} = F_{l-1} + F_l$ for $l \geqslant 1$ with

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$F_0 = F_1 = 1$. It is easy to obtain that in the limit $n \longrightarrow \infty$, the ratio F_n/F_{n-1} tends to the golden mean $\nu = (1+\sqrt{5})/2$.

The Thue–Morse sequence is a different type of aperiodic system, with a very different kind of aperiodicity from that of the Fibonacci sequence. The Thue–Morse sequence is obtained from the recursion relation

$$M_{l+1} = \{M_l M_l^*\} \qquad (l \geqslant 0) \tag{2}$$

with $M_0 = \{\mathrm{A}, \mathrm{B}\}$ and where M_l^* is the complement of M_l, obtained by interchanging A and B. The Thue–Morse integer (the total number of building blocks A and B in M_l) is $N_l = 2^{l+1}$.

Recently, the motion of a two-dimensional electron gas (2DEG) subjected to an inhomogeneous lateral magnetic field on the nanometre scale has caused tremendous interest. Experimentally, this kind of field has been realized with the creation of magnetic dots [11], the patterning of ferromagnetic materials [12] and the deposition of superconducting materials on conventional heterostructures [13]. Transport of electrons in a unidirectional weak magnetic field modulation has been realized by several research groups [14]. They observed oscillatory magnetoresistance due to an effect of commensurability between the classical cyclotron diameter and the period of the magnetic modulation. These experimental techniques open up the way to experiments in alternating magnetic fields with periods in the nanometre region. Theoretically, the properties of the tunnelling through a thick potential barrier under the influence of a local magnetic field were investigated by Ramaglia *et al* [15] and they found that the magnetic field was localized strictly within the potential barrier, which led to resonances that were centred within the barrier. The motion of a 2DEG in an infinite strip which a magnetic field varies linearly across [16], in a smooth magnetic barrier geometry of different shape [17] and in a curved 2DEG system were also studied [18]. Most recently, studies on electron tunnelling through symmetric magnetic barriers [19] and asymmetric magnetic barriers [20] showed that magnetic barriers possess wave-vector-filtering properties and that the asymmetric double-barrier magnetic structure possesses stronger filtering properties. The electronic and quantum transport properties of periodically arranged magnetic barriers [21] and magnetic superlattices [22, 23] have also been studied in depth. The latter study found that the energy spectrum consists of magnetic minibands.

The question that we raise here is that of what happens in the quasiperiodic magnetic superlattice. By using electron beam lithography and standard lift-off techniques, it is possible to fabricate magnetic superlattices with randomly distributed heights or thicknesses of the magnetic barrier and well layers [14]. In a random sequence of magnetic barriers and wells, quantum tunnelling is drastically affected by the randomness. Azbel [24] has suggested the idea of resonant tunnelling in a random electric system. It may be interesting to investigate electronic transport properties through a random sequence of multiple magnetic barriers. Our numerically calculated results given in this work show that there are several interesting and novel features of electronic transport in the quasiperiodic magnetic superlattice. Selective suppression and complicated oscillations of transmission resonances are found. It is confirmed that both the doublet resonance and the singlet resonance exist in the tunnelling transmission spectrum. Moreover, the role played by a local magnetic barrier is examined and a strong suppression effect of both the transmission coefficient and the conductance is found in the case where the strength of a local barrier is larger than others in the magnetic superlattice. The results obtained in this work shed new light on the electronic transport through the periodic and quasiperiodic magnetic superlattices.

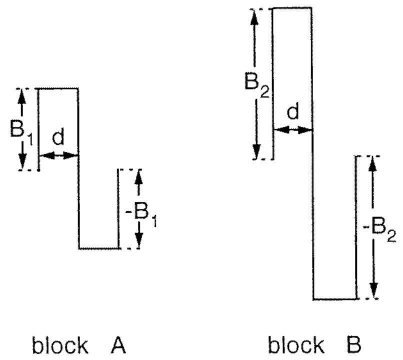

Figure 1. A schematic representations of building blocks A and B.

2. Theory

We consider the motion of two-dimensional electrons (in the (x, y) plane) in a finite quasiperiodic magnetic superlattice which is obtained by juxtaposing two different building blocks A and B arranged in a Fibonacci sequence or in a Thue–Morse sequence. Schematic representations of building blocks A and B are depicted in figure 1. Each building block is made up of two types of term, i.e., a magnetic barrier (of amplitude B_i $(i = 1, 2)$) and a magnetic well (of amplitude $-B_i$ $(i = 1, 2)$). Throughout this paper the thicknesses for all of the magnetic barriers and magnetic wells are set to take the same value, namely d. The total magnetic field over the whole 2DEG plane is zero. The Schrödinger equation is written in the framework of the effective-mass approximation in each magnetic barrier and well region as

$$\frac{1}{2m^*}[\boldsymbol{P} + e\boldsymbol{A}_i]^2\psi(x, y) = E\psi(x, y) \tag{3}$$

where m^* is the effective mass of an electron and $\boldsymbol{A}_i$ the vector potential which is taken in the Landau gauge, $\boldsymbol{A}_i = (0, A_i(x), 0)$.

For convenience, we express all of the quantities in dimensionless units by using the cyclotron frequency $\omega_c = eB_0/m^*$ and the magnetic length $l_B = \sqrt{\hbar/eB_0}$ (B_0 is set to be 0.1 T which is an estimated value [19, 20]). For GaAs, m^* can be taken as $0.067m_e$ (m_e is the free-electron mass). The coordinate $\boldsymbol{r}$ is in units of l_B, A_i in units of $B_0 l_B$ and the energy E in units of $\hbar\omega_c$. Since the y-component of the electron momentum operator commutes with the Hamiltonian, the wave function can be written as a product $\psi(x, y) = \mathrm{e}^{\mathrm{i}k_y y}\psi(x)$, where k_y is the wave vector of the electron in the y-direction. Accordingly, we obtain the following 1D Schrödinger equation:

$$\left\{\frac{\mathrm{d}^2}{\mathrm{d}^2 x} - [A_i(x) + k_y]^2 + 2E\right\}\psi(x) = 0. \tag{4}$$

The function $V(x) = [A_i(x) + k_y]^2/2$ can be interpreted as a k_y-dependent electric potential [19, 20]. In the left-hand and right-hand regions, the wave functions are the free-electron wave function, which can be written as $\psi_l(x) = \mathrm{e}^{\mathrm{i}k_l x} + r\mathrm{e}^{ik_l x}$, and $\Psi_r(x) = \tau\mathrm{e}^{\mathrm{i}k_r x}$, where $k_i = \sqrt{2E - [A_i(x) + k_y]^2}$ $(i = l, r)$; τ and r are transmission and reflection amplitudes, respectively.

In the magnetic barrier and well regions, the wave function $\psi_i(x)$ can be written as a linear combination of Hermitian functions [20]:

$$\Psi_i(x) = \exp\left(-\frac{\xi_i^2}{2}\right)[C_i U_i^1(\xi_i) + D_i U_i^2(\xi_i)] \tag{5}$$

where $\xi_i = \sqrt{m^*\omega_i/\hbar}(x - x_i^0)$, $\omega_i = eB_i/m^*$, C_i and D_i are arbitrary constants, U_i^1 and U_i^2 in equation (5) are Hermitian functions. Matching the wave functions at the edges of the magnetic barriers and magnetic wells, the transmission amplitude τ and the reflection amplitude r are obtained. Then, the transmission coefficient of electron transport through the finite quasiperiodic magnetic superlattice is given by

$$T(E, k_y) = \frac{k_r}{k_l}|\tau|^2. \tag{6}$$

In the ballistic regime, the conductance can be derived as the electron flow averaged over half of the Fermi surface [19, 25]:

$$G = G_0 \int_{-\pi/2}^{\pi/2} T(E_F, \sqrt{2E_F}\sin\phi)\cos\phi \, \mathrm{d}\phi \tag{7}$$

where ϕ is the angle of incidence relative to the x-direction, E_F is the Fermi energy, $G_0 = e^2 m^* v_F l/\hbar^2$ with l the length of the structure in the y-direction and v_F is the Fermi velocity.

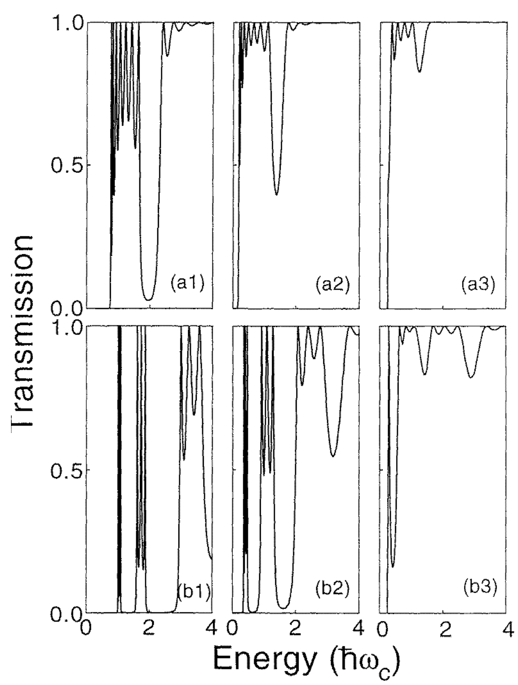

Figure 2. The transmission coefficient for electrons tunnelling through two finite periodic magnetic superlattices. (a1), (a2) and (a3) are for ones which are periodic arrangements of block A (with $B_1 = 0.1$ T and $d = 1$); (b1), (b2) and (b3) are for the other case, which is a periodic juxtaposition of two different blocks A (with $B_1 = 0.1$ T and $d = 1$) and B (with $B_2 = 0.2$ T and $d = 1$).

3. Results and discussion

In order to achieve a better understanding of the electronic transport properties in the quasiperiodic magnetic superlattice, first of all, in figures 2(a) and 2(b) we present our model numerical results for the transmission coefficient for electrons tunnelling through two finite periodic magnetic superlattices. One is a periodic arrangement of building block A, while the other is a periodic juxtaposition of two building blocks, A and B. The total number of blocks in the two cases is set to be eight. (a1) and (b1) correspond to $k_y = 0.7$; (a2) and (b2) correspond to $k_y = 0.0$; (a3) and (b3) correspond to $k_y = -0.7$. Throughout this paper, we have set $d = 1$ (in units of l_B), $B_1 = 0.1$ T for building block A and $B_2 = 0.2$ T for building block B. There are a few interesting features exhibited in figure 2 that we would like to summarize here.

(1) There exist resonant domains which are separated by non-resonant domains. Each resonant domain consists of several resonant peaks of peak value unity.

(2) The transmission spectrum is very different for the $k_y < 0$ case to those for the $k_y \geqslant 0$ case. This feature reflects the strong wave-vector dependence of the transport in the magnetic structure.

(3) One resonant domain in the superlattice which is a periodic arrangement of blocks A splits into two resonant domains in the magnetic superlattice which is a periodic arrangement of two different blocks A and B. In the latter case, the total width of resonant domains narrows and the total number of resonance peaks decreases.

For semiconductor superlattices, the resonance splitting effect was investigated [26] and $(n-1)$-fold splitting for n identical barriers is obtained. Moreover, we found that one resonant domain in semiconductor superlattices which consists of identical barriers splits into two resonant domains in semiconductor superlattices in which two different barriers (i.e., with different widths or heights) are periodically juxtaposed. In the latter case, each time two new barriers are added to the existing ones, splitting will occur [27]. The detailed results are given elsewhere. Since resonant domains in the transmission spectrum versus incident energy reflect the formation of minibands of energy, all of the above-stated results obtained for semiconductor superlattices are reasonably described by the miniband structure of the corresponding superlattice. By extension, it is reasonable to attribute the formation of resonant domains and non-resonant domains and the splitting features obtained in the magnetic superlattice to its k_y-dependent magnetic miniband structures. For a finite magnetic superlattice, there is no continuous energy band. In each magnetic miniband only some discrete and k_y-dependent energy is to be expected. In comparison to the magnetic miniband of the periodic magnetic superlattice which consists of identical building blocks, minibands split into sub-minibands in the magnetic superlattice which is a periodic juxtaposition of two different blocks. Energy minibands are ones in which allowed energy bands are separated by forbidden gaps [22]. The total number of discrete energy levels, the widths of the bands and those of the gaps between them depend strongly on the wave vector k_y. The necessary condition for the transmission resonance to occur is that the energy of the incident electron falls completely inside allowed minibands. Therefore, in the transmission spectrum one can see not only resonant domains separated by non-resonant domains, but also rich k_y-dependent and structure-induced resonance splitting phenomena.

Figure 3 shows the numerical results for the transmission coefficient for electron transport through two periodic approximants of the Fibonacci magnetic superlattice for different incident wave vectors k_y. For the curves from top to bottom, the corresponding periodic approximants are of orders $l = 5$ and $l = 6$, for which the total numbers of

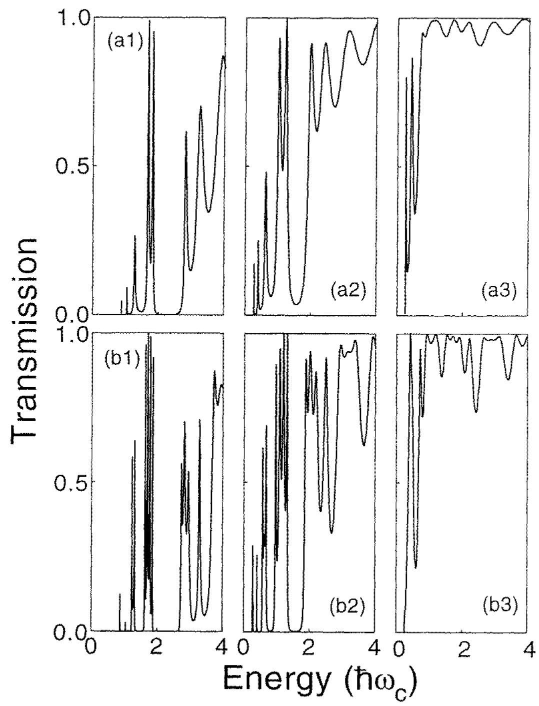

Figure 3. The transmission coefficient for electrons tunnelling through two periodic approximants of the Fibonacci magnetic superlattice which are obtained by arranging block A (with $B_1 = 0.1$ T and $d = 1$) and block B (with $B_2 = 0.2$ T and $d = 1$) in the Fibonacci sequence. (a1), (a2) and (a3): $l = 5$; (b1), (b2) and (b3): $l = 6$.

building blocks are 8 and 13, respectively. (a1) and (b1) correspond to the $k_y = 0.7$ case; (a2) and (b2) correspond to the $k_y = 0$ case; (a3) and (b3) correspond to the $k_y = -0.7$ case. It is evident that there are several resonant peaks in the transmission spectrum, and with increment of the order of the Fibonacci sequence, more peaks appear and peaks become sharper. In comparison to that for the perfect periodic case (see figure 2), the total number of resonant peaks decreases and their distribution becomes less regular. Another noticeable feature is that transmission resonances show selective suppression and markedly complicated oscillations between unity and very small values. These features are associated with wave-vector-dependent hierarchical miniband structures of the corresponding quasiperiodic magnetic superlattice. Through different eigenstates, electrons with very different transmission coefficients tunnel through the corresponding structure due to the disorder of the quasiperiodic system. When the degree of order of the sequence is high, the number of minibands becomes large and the width of each miniband narrows. Moreover, there are still several resonant peaks of peak value unity due to the existence of completely transparent eigenstates [24].

Figure 4 indicates the results for the transmission coefficients for electron transport through two periodic approximants of the Thue–Morse magnetic superlattice. (ai) and (bi) ($i = 1, 2$) are for $l = 2, 3$ for which the unit cells are 8 and 16, respectively. Like those in figure 3, panels (a1) and (b1) correspond to the $k_y = 0.7$ case; (a2) and (b2) correspond to the $k_y = 0$ case; (a3) and (b3) correspond to the $k_y = -0.7$ case. We can see that in the Thue–Morse sequence, transmission resonances exhibit complicated

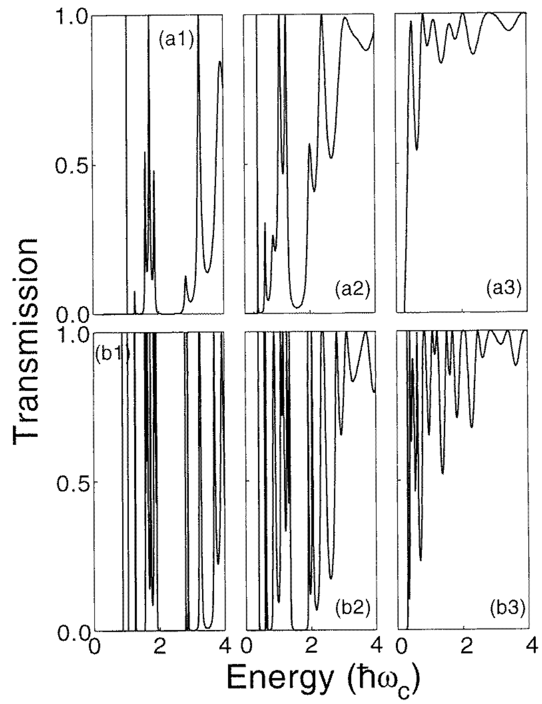

Figure 4. The transmission coefficient for electrons tunnelling through two periodic approximants of the Thue–Morse superlattice which are obtained by arranging block A (with $B_1 = 0.1$ T and $d = 1$) and block B (with $B_2 = 0.2$ T and $d = 1$) in the Thue–Morse sequence. (a1), (a2) and (a3): $l = 2$; (b1), (b2) and (b3): $l = 3$.

oscillations and selective suppression somewhat like the transmission features exhibited in the Fibonacci magnetic superlattice. However, the feature of selective suppression is very different from that in the Fibonacci sequence, especially for the Thue–Morse sequence of higher order. The extent of the suppression of the transmission peaks in the Thue–Morse case is weaker than that in the Fibonacci sequence. In the $l = 3$ case where the total number of building blocks is equal to 16, one can see that there are many transmission peaks of peak value unity. This indicates that more electrons can tunnel through the structure without suffering any scattering. As a general trend, it can be seen that with increment of the order of the sequence, the total number of minibands becomes large and the total width of the minibands narrows in comparison to those of perfect periodic superlattices with equal numbers of building blocks. We can also see that the distribution of resonant peaks becomes relatively more regular in the Thue–Morse sequence than that in the Fibonacci sequence. This feature can be seen clearly for the quasiperiodic sequences of higher order. Here we would like to offer some discussion concerning the degree of regularity of the Thue–Morse and the Fibonacci sequences. There exist contradictory results on the degree of regularity of Thue–Morse systems and Fibonacci systems. In reference [1] (1995), the average value of the transmission coefficient was calculated for both kinds of quasiperiodic system, and numerical results indicated that the Fibonacci system behaves more regularly than the Thue–Morse system; however, in reference [5] it was claimed that the Thue–Morse system is a link between the Fibonacci sequence and the periodic sequence as far

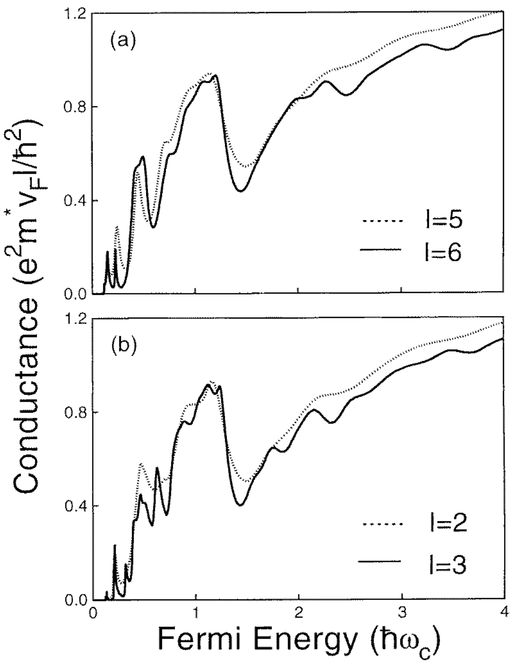

Figure 5. The conductance for electrons tunnelling through (a) two Fibonacci sequences and (b) two Thue–Morse sequences. The parameters of the sequences in (a) and (b) are exactly the same as those in figures 3 and 4, respectively.

as the eigenstates are concerned. From figure 3 and figure 4 one can see that as far as the feature of selective suppression of transmission resonances and that of the distribution of transmission peaks are concerned, the Thue–Morse sequence can be considered as an intermediate between periodic and Fibonacci systems and the Fibonacci sequence is a system intermediate between quasiperiodic and disordered systems. Our results tend to agree with the claim made in reference [5]. However, how can one measure the degree of regularity of an aperiodic system? What is the standard that should be adopted? These questions need further investigation, which is beyond the scope of our consideration in the present work. From figure 4 one can once again see that for electron transport through quasiperiodic magnetic superlattices with different wave vectors k_y, the features of the tunnelling are drastically different. In the $k_y \geqslant 0$ case, more very much sharper peaks can be seen than in the $k_y < 0$ case, especially in the low-incident-energy range. This renders the transmission through magnetic structures an inherently 2D process, since the transmission coefficient depends not only on the electron's momentum perpendicular to the tunnelling barrier, but also on its momentum parallel to the barrier.

Another noticeable result obtained in this work is that there exist doublet resonances (the resonant tunnelling with a doublet) and singlet resonances (the resonant tunnelling with a singlet) in the transmission spectrum of the quasiperiodic superlattice. More doublet resonances appear in the higher-order approximants of the Thue–Morse sequence (see (b1), (b2) and (b3) of figure 4). The doublet resonances were also confirmed as existing in symmetric n-fold barrier structures ($n \geqslant 3$) [28] and in a double-antidot system [29]. You *et al* [4] found isolated peaks of magnetoresistance by studying longitudinal

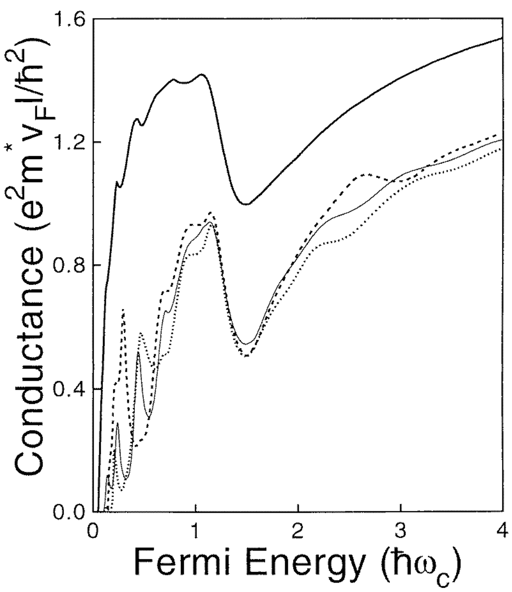

Figure 6. Comparison of the conductances among periodic and quasiperiodic magnetic superlattices. The thick solid, dashed, thin solid and dotted curves correspond to a periodic superlattice that is an arrangement of blocks A (with $B_1 = 0.1$ T and $d = 1$), a periodic superlattice that is a juxtaposition of block A (with $B_1 = 0.1$ T and $d = 1$) and block B (with $B_2 = 0.2$ T and $d = 1$), a Fibonacci superlattice and a Thue–Morse superlattice, respectively. The total number of building blocks in all the four cases is set to be 8.

resistance oscillations in the Fibonacci semiconductor superlattice. In quasiperiodic semiconductor superlattices, we also found that there exist doublet and singlet resonances in the transmission spectrum. More detailed discussion of the physics of quasiperiodic semiconductor superlattices is given elsewhere [27]. In all of the above work, some degree of disorder is introduced into the system. The existence of the doublet resonance and isolated peaks in this work is driven by the hierarchical splitting of the bands into subbands of the quasiperiodic magnetic superlattice. It is known that a Thue–Morse sequence can be considered as built up of four different kinds of constructing element: A, B, AA and BB, while a Fibonacci one can be considered as built up of isolated As and Bs and AA clusters [5]. Similarly to the case in which the periodic superlattice is arranged as two different blocks, A and B, splitting of the energy bands occurs in the quasiperiodic case. However, in this case the splitting is too complicated for obtaining a simple rule to generalize its main features. Its features are not only determined by the parameters of the building blocks but also determined by the wave vector k_y. Since the four or three aperiodically alternating clusters constitute the main construction pattern, the one that splits more is the dominating hierarchical structure in the higher hierarchies which yield the occurrence of singlet and doublet resonances.

As for measurable quantities, in figure 5 we show the numerical results for the conductance for both the Fibonacci sequence (see figure 5(a)) and the Thue–Morse sequence (see figure 5(b)). The comparison with the conductance of the periodic magnetic superlattice is given in figure 6, where the total number of building blocks in four structures is set to be 8. In figure 5 one can see that there are a few sharp peaks despite the averaging of the transmission coefficient $T(E, k_y)$ over half of the Fermi surface, especially in the low-Fermi-energy range. With increment of the order of the Fibonacci sequence or that of the Thue–Morse sequence, more peaks appear and the conductance exhibits complicated oscillations. For higher-order approximants of quasiperiodic superlattices, on the whole the conductance decreases. In figure 6 one can clearly see the main discrepancy in the conductance between the periodic magnetic superlattice and the quasiperiodic superlattice. The splitting characteristics exhibited by the transmission coefficient can also be seen clearly in the conductance. One broad resonant domain of the conductance in the periodic magnetic superlattice which is an arrangement of identical blocks (see the thick solid curve) splits into two narrower resonant domains in the periodic superlattice which is a periodic juxtaposition of two different building blocks (see the dashed curve). There are a few isolated peaks and a relatively narrow domain for the quasiperiodic Fibonacci sequence (see the thin solid curve) and the Thue–Morse sequence (see the dotted curve) in the low-Fermi-energy range. Morever, in the wide-Fermi-energy range, the conductance for the quasiperiodic superlattices decreases even in comparison to that for the periodic superlattice which is obtained by periodically juxtaposing two different blocks. The reduction of the conductance is due to the suppression of the transmission coefficient in the quasiperiodic superlattices.

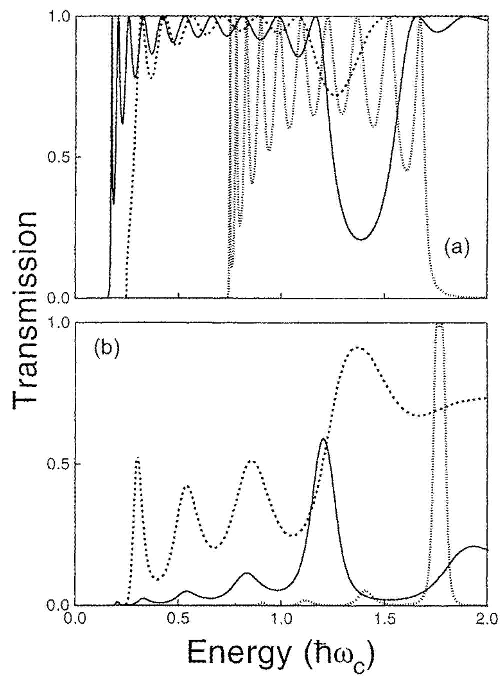

Figure 7. The transmission coefficient for electrons tunnelling through (a) a perfect periodic superlattice that is an arrangement of blocks A (with $B_1 = 0.1$ T and $d = 1$) and (b) a superlattice in which the parameters of the middle block are set to be $B_2 = 0.3$ T and $d = 1$ and all of the other blocks are exactly same as those in (a).

Finally, we examine the role played by a local magnetic barrier in the magnetic superlattice. If there exists one special barrier with larger strength (i.e., larger height or width, or both), will the transport motion of electrons be greatly changed or not? As an example, in figure 7 and figure 8 we present our numerical results for the transmission

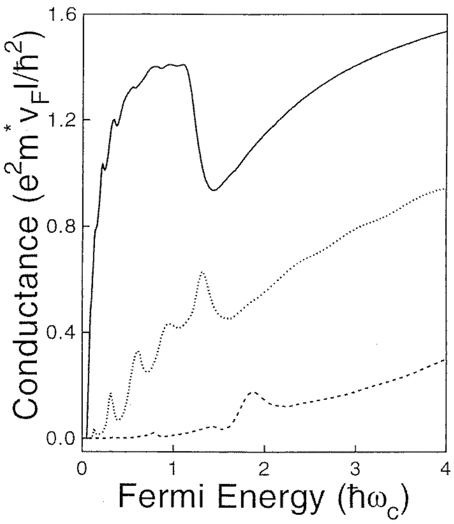

Figure 8. The conductance for electrons tunnelling through a perfect periodic superlattice that is an arrangement of building blocks A with $B_1 = 0.1$ T and $d = 1$ (see the solid curve), one superlattice in which the parameters of the middle block are set to be $B_2 = 0.3$ T and $d = 1$ (see the dotted curve) and one superlattice in which the parameters of the middle block are set to be $B_2 = 0.5$ T and $d = 1$ (see the dashed curve). The parameters of all of the other blocks in the two latter cases are set to be $B_1 = 0.1$ T and $d = 1$. The total number of blocks in each of the three structures is equal to 11.

coefficient and the conductance for one periodic superlattice and two aperiodic magnetic superlattices in which the strength of the middle block is larger. The total number of building blocks in the three structures is set to be 11. Figure 7(a) shows the results for a perfect periodic superlattice in which all of the magnetic barriers are identical ($d = 1$ and $B_1 = 0.1$ T). Figure 7(b) shows the results for a magnetic superlattice in which the height of the middle barrier is set to 0.3 T and all of the other ten building blocks are exactly same as those in figure 7(a). In each of subplots, dotted, solid and dashed curves correspond to $k_y = 0.7$, $k_y = 0.0$ and $k_y = -0.7$, respectively. In comparison to the transmission coefficient for electrons tunnelling through the perfect superlattice (see figure 7(a)), it is evident that, except a few transmission peaks at resonance of peak value unity, most of them are drastically suppressed, especially in the low-energy range for the $k_y \geqslant 0$ cases. The total number of resonant peaks greatly decreases, and the interval between adjacent peaks is enhanced (see figure 7(b)). If we change the position of the special building block from the middle position to the side positions, similar results can be obtained. Here, in order to avoid unnecessary repetition, we do not present the numerical results again. Drastic suppression can also be seen clearly in the conductance (see figure 8) due to the drastic reduction of the transmission coefficient. Physically, the variation of the strength of a local magnetic barrier in the magnetic superlattice substantially disrupts the periodicity of the structure, and thus the motion of the electrons is greatly changed, which results in the reduction of both the transmission coefficient and the conductance.

4. Summary

In summary, we have systematically investigated electronic tunnelling properties in the quasiperiodic magnetic superlattice. One prominent feature is that the transmission coefficient exhibits selective suppression and complicated oscillations. The total number of resonant peaks decreases and the total width of the resonant domains narrows. To some extent the distribution of resonant peaks becomes irregular in comparison to that of the periodic superlattice. Another prominent feature is that there exist singlet and doublet resonances; in particular, there are more cases of resonant tunnelling with doublets existing in higher-order approximants of the Thue–Morse sequence. Disorder of the quasiperiodic system destroys the regularity of the structure; however, with certain incident energies and wave vectors, electrons can tunnel through the whole structure completely without suffering any scattering. In the quasiperiodic magnetic superlattice, on the whole the conductance is decreased. However, one can get several sharp conductance peaks in the low-Fermi-energy range which cannot be obtained in the perfect periodic magnetic superlattice. It is confirmed that a local magnetic barrier plays a dominant role in electron transport through the magnetic superlattice. The increment of the strength of a local magnetic barrier yields drastic suppression of both the transmission coefficient and the conductance of tunnelling electrons.

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