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On the resonances and eigenvalues for a 1D half-crystal with localised impurity

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We consider the Schr\"odinger operator H on the half-line with a periodic potential p plus a compactly supported potential q. For generic p, its essential spectrum has an infinite sequence of open gaps. We determine the asymptotics of the resonance counting function and show that, for sufficiently high energy, each non-degenerate gap contains exactly one eigenvalue or antibound state, giving asymptotics for their positions. Conversely, for any potential q and for any sequences $(\s_n)_{1}^\iy, \s_n\in \{0,1\}$, and $(\vk_n)_1^\iy\in \ell^2, \vk_n\ge 0$, there exists a potential p such that $\vk_n$ is the length of the n-th gap, $n\in\N$, and H has exactly $\s_n$ eigenvalues and $1-\s_n$ antibound state in each high-energy gap. Moreover, we show that between any two eigenvalues in a gap, there is an odd number of antibound states, and hence deduce an asymptotic lower bound on the number of antibound states in an adiabatic limit.

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