

PROFESSOR: We can write, however, J_{left} as $J_{\text{of A}}$, minus $J_{\text{of B}}$. Where $J_{\text{of A}}$ would be $\frac{\hbar k}{m} A^2$. And $J_{\text{of B}}$ would be $\frac{\hbar k}{m} B^2$.

You see the current that exists to the left of the barrier has two components and-- it's very intuitive. It's the current that would have been brought along by the incoming A-wave. Minus the current that would have existed alone from the reflected B-wave. B is the reflected wave.

So that's very nice. There's no interference between these two terms. We can really think of a current that is associated to the incoming wave, and a current that is associated with the reflected wave.

So this suggests how you should define a reflection coefficient. Reflection coefficient R would give me the amount of current I get reflected, compared to the amount of current that there is incident. You see, the incident current is going to be partially reflected and partially transmitted.

So an idea of a reflection is the value of the reflected current divided by the incident current. It's a definition, but it's a reasonable definition.

And then, if it is this ratio-- because of these expressions-- it happens to be B^2 over A^2 . And that's an interesting number. Now, there's some physics in it. It tells me how much of the probability gets reflected as a function of the probability that is incident.

So that's a good measure. If you get a reflection coefficient of $1/10$, then you would expect $1/10$ of the particles to be reflected. Now we don't have particles yet. This is non-normalizable solution. But, still, this will be the intuition very soon.

Now we could have a transmission coefficient, as well. And here is something where we sometimes make a mistake. T is going to be the transmission coefficient. Transmission coefficient.

And how should we define it? There is a temptation to define it-- well, coefficient B over A gives me this. Then maybe it should be C over A . But actually-- while c over a gives you some idea of how big the wave to the right is compared to the wave of the left-- that's not what we should call a reflection coefficient.

And the reason is that-- I will call this current J_C . And that's the amount of probability-- because it's a current associated to the wave C . And that's the amount of probability that is being carried by the transmitted wave. That is the probability. Not necessarily C over A .

So the transmission coefficient will be defined to be J_C divided by J_A . And then J_C divided by J_A -- J_C has an \hbar , k . And J_A has a k . So this is not equal to this ratio, but is actually \hbar over k , C over A .

So it's not just this number. The reflection coefficient-- and transmission coefficients-- really originate from probabilities. And the probabilities for this current. And, therefore, there is no-- it would have been very hand-wavy, and actually wrong to think it's C over A .

These definitions-- because after all, this is a definition-- makes some nice sense. Because you have J_L -- we said is equal to J right, but J_L is J_A minus J_B , is equal to J_C . And therefore R plus T . The reflection coefficient plus the transmission coefficient-- which is J_B over J_A plus J_C over J_A is equal to J_B plus J_C over J_A . And you see here that J_A plus J_C is indeed equal to J_B .

I'm sorry. I got this wrong. Yes. Where is the eraser. I should have passed the B to the other side.

This force implies J_A equals J_B plus J_C . And this ratio is equal to 1, which is something you usually want when you define reflection and transmission coefficients. They should add up to 1.

So now we've got an idea. Yes, with this solution I can understand the reflection and transmission coefficients. But do these apply to particles? Well, the good news is that it roughly applies to particles-- as we will see with the wave packets soon.

If you send the wave packet, it's going to have some uncertainty and momentum. It's going to have some uncertainty and energy. But for some energy-- suppose the wave packet doesn't have that much uncertainty-- basically, the probability that the wave packet bounces is the reflection at that energy, that is the main energy that the wave packet sends.

If your wave packet is very broad over energies, then it's a more complicated thing. But as long as the wave packet is such that it basically has one narrow band of energy, the reflection coefficient associated to this calculation is the reflection coefficient or reflection probability for the wave packet that you're sending in.

