MARKUS KLUTE: Hello. Welcome back to 8.701. In this lecture, this little video, we're going to look at reactions and how they relate to cross-sections.

So we start or continue the discussion of how we can relate experimentally measured determined properties to the forces involved. The last lecture, we looked at decay rates and the rates of unstable particles. This time, we're going to look at the reaction rates expressed as cross-sections.

We can start doing this by looking at this simplified picture. So the reaction rate is related to the rate of the beam, so how many particles per second are available for the interactions times the number density of the particle in the target.

So you have your target here. And clearly, the number of reactions depend on how dense your target is, the thickness-- so you go along how the thicker the material the target is, the more likely it is for reactions to occur-- and then by the actual physics-- by the likelihood of a collision to occur. And this likelihood is called a cross-section. And we can think about this cross-section as a geometrical area. All right?

So let's look at this a little bit more. We can stay with a very classical model, a model in which we have two billiard balls-- and light one, a small one, with radius r1, and a larger one with the radius r2. Clearly, a collision occurs when the impact parameter b here between those two billiard balls is smaller than the sum of the radii. OK?

So now we can analyze this reaction a little bit more and look at angular distributions. We find that the cross-section differential distribution is given as a function of sine theta. We can also express this using the azimuth or as a solid angle here. As a reminder, the solid angle theta is equal to sine theta d theta d phi. All right?

So for this specific problem here, we talk about an isotropic reaction, because by definition the cross-section per solid angle is independent of theta and phi. The mapping between sine theta and theta is not trivial. That's why you see this shape of the distribution. Yeah. But the d sigma d cosine theta is [INAUDIBLE] if you look at this as a function of cosine theta.

All right. So this is just a classical picture of what we're going to do later in the class. It's using quantum field theory or Feynman rules in order to calculate cross-sections, or the decay rates. But this classical picture is really something I would like you to keep in mind-- the idea of the likelihood of the collision to occur is in units of an area and can be seen as a geometrical cross-section is kind of a very nice picture to keep in mind. And it also helps estimating orders of magnitude of rates of collisions to occur.