MARKUS KLUTE: Welcome back to 8.20. So this section is a preview or maybe a review of 8.02 depending on whether or not you have listened to electromagnetism [? already. ?] So first I just want to remind you how we relate electric and magnetic fields and how we can describe them from a different moving reference [? point. ?] So if the reference point moving in x direction, then the x component of the fields do not change. But the transverse components do change, as we have discussed before.

The core of this section is about how the fields-- the electric and magnetic fields are actually generated by charges and their distributions. And this relation is described by Maxwell's equation. The entirety of 8.02 are classes on electromagnetism is about how to understand Maxwell's equations.

So I'll do this here in a very short and brief manner. So you can write Maxwell equations in four different equations. The first one is called Gauss's law. And if you read the equation, it just says that the divergence of an electric field gives the density of the source or the charge density of the source.

You can also read this equation by saying a charge density generates an electric field. So charges generate electric fields. Similarly, Gauss's law for magnetism can be read as magnetic charges generate magnetic fields. Or the diversion of the magnetic field is the density of the magnetic source.

However in nature, we haven't observed magnetic monopoles or at least not yet. And so therefore, there's no such thing. There's no magnetic density. You can read this equation also saying that all magnetic field lines need to be closed. And so that's another way to look at this.

And we have Faraday's law, which means that we can induce electric fields in a coil equal to negative change of the magnetic field. In other way, if you want to create an electric field, you can do this with a charge. Or you can do this by changing, as a function of time, the magnetic field. Changing magnetic fields generate electric fields.

And very similarly, we can look at Ampere's law and saying that changing electric fields generate magnetic fields. And you can also generate magnetic fields with a current, as we have seen in the previous [? section. ?] So this is how we can understand [INAUDIBLE] Maxwell's equations.

The difficulty now, 8.02, is often to understand the concept of fields, the fact that there is a [? vector ?] describing the strengths of this abstract thing, of an electric or magnetic field somewhere in space or [INAUDIBLE] are changing this time. That's [? complicated. ?]

And then there is also a little bit of functional analysis needed in order to understand and how to apply the electric field by a specific charge. Those cases can often be simplified by having symmetric configurations, like a charged atmosphere, or a point charge, or a cylinder, or charges along the line. In those cases, those integrals or those divergences can be calculated in a straightforward manner.

OK, so then there's another aspect which is relating [? charge/discharge ?] distributions or fields to forces. And that's done by Lorentz force. So the force of the charged particles which is moving in electromagnetic field is given by the strength of the charge itself times the electric field, plus the velocity of the charge, plus the strength of the magnetic field.

OK, what that means is I can-- if I put a charge in an electric field, it's being pulled. It's being accelerated. If I have a moving charge in a magnetic field, it's being bend around or the force bending it around. And then I can have this relativistic equation of motion, which uses our relativistic equation of motion and sets it equal to our Lorentz force.