[SQUEAKING] [RUSTLING] [CLICKING] MARKUS KLUTE: Welcome back to 8.701. We're starting a new chapter now, Chapter 9, on nuclear physics. And this video is the first introduction into the topic, where I'm explaining some of the terminology and some of the concepts. We dive in much more detail as we go on.

So given an atom, you can specify the number of neutrons, the number of protons, and the number of electrons, which is equal to the number of protons, for neutral atoms. Atoms of the same element, they have the same atomic number, Z, but they're not all the same. Isotopes of the same element have different numbers of neutrons. So we can have uranium with a number of neutrons varying.

You typically write an isotope by specifying the mass, the number of protons, and the number of neutrons. But that information is redundant. So typically, we simplify this by just writing things like 238 uranium, and that specifies a specific isotope of uranium.

When talking about different nuclei, we sometimes refer to them as nuclide, atom/nucleus with a specific number of neutrons and a specific number of protons. Isobars are nuclides with the same mass, with the same number, same sum of protons and neutrons, but with varying individual number of protons and neutrons.

An isotine is a nuclide with the same number of neutrons, but with varying number of protons, and an isomer is the same nuclide but different [? eigen ?] states, which means that the energy states are-- an energy state. So we can excite nuclides at their component particles. The nuclear radius typically can be extracted from the mass of the nuclide. And it's simply we add little balls to the sum, and it scales with A to the 1/3 the mass of a number of elements in this nuclide.

There's many isotopes. There's many nuclides. And so you typically can look at all of them, if you want, or a subset of them in nuclear charts that's given here, where we plot here the number of protons, and here the number of neutrons. And we look at many more of those charts later.

Here's another representation of the very same thing. You see a nuclear chart again. And here, what's spotted in red are the stable nuclei. We will see that nuclei can decay, and we'll understand why they decay and in what form they decay. It's a core part of this chapter, understanding how nuclei can decay, and what we can learn about them by studying their decays.

One way to look at it, for example, we see that here I plot Z over A, so the number of protons over the sum of the number of protons, Z plus N. And you see that most of the stable nuclei, with the exception of the one with very small mass number, have less protons than neutrons. So there's an excess of neutrons. This can also be seen here. The stable nuclei are typically on or below this axis where Z is equal to A.

Radioactive decays can be characterized, typically, as a parent nuclide, and then a daughter nuclide. And so radioactive decay is a process in which an unstable nucleus spontaneously loses energy by emitting particles, ionization particles and radiation. The decay and the loss of energy results, then, in an atom of one type, the parent particle or parent nuclide, transforming into another type of an atom, or the daughter nuclide. We have already looked at decay rate in the concept of particle physics interactions, but we can define this very similar here, the decay rate, or sometimes it is called decay constant. And then as we did before, we can define the mean lifetime or the half life of a parent nuclide.

So this is it for the introduction. And in the next lecture, we'll start looking in the energy which is used to bind the nuclei, the protons and neutrons together, and how we can understand this from an empirical model.