[MUSIC PLAYING]

**ANNA FREBEL:** Have you ever wondered how all the chemical elements are made? Then join me as we are lifting all the stardust secrets to understand the cosmic origin of the chemical elements. We want to talk about the cosmic origin of the chemical elements today.

In order to understand where the elements come from, we need to consider two different components-- one is nuclear physics and one is astrophysics. When the nicely combine, when we want to understand where the chemical elements come from, and so let's look at that in more detail. We have the nuclear physics part. And we have astrophysics.

And on the nuclear physics side, we have two things that we want to consider or learn about, namely how the light elements are formed, light elements up to iron. And they are formed in fusion processes in stars. Fusion processes. And so this is one.

And then we have also lots and lots of elements on the periodic table that are heavier than iron. So how are the heavy elements formed? That would be heavier than iron. And so they are made in what's called a neutron-capture processes. And that's a really neat way of making big heavy nuclei.

And so these two parts here together really explain how most of the elements in the periodic table are made. And there are a few extra processes that we will not consider. But this gets us almost there.

Then we have the astrophysics, because this is basically a lot of theory. And we need to put this to the test. And one test that the universe offers us is investigating chemical evolution. Chemical evolution is that the successive build up of heavy elements in the universe with time, with cosmic time, over the last 13.8 billion years. And we can observe stars at different times and thus trace the signatures of these nuclear sort of processes here and reconstruct how the nuclear physics operated.

That works particularly well at early times when the universe was a much less messy place than it is now. And so the second portion here is going to be the oldest stars because they are the tool for us to really figure out how the elements were made first in the universe. That allows us to again obtain clean signatures of these processes there. And that's a very exciting and timely avenue for us to study.

And together with the older stars, comes the concept of stellar archeology. And that sort of encompasses how we use stars that are still available and shining today to study the early universe when everything got started. And in order to study chemical evolution with old stars, we actually need to use a scientific method called spectroscopy. So we're also going to look at spectroscopy and how that works, observing all the little stellar little rainbows.

And because we do that with big telescopes, we're also going to look at what it's like to use big telescopes and observing. Because all of this work is based on astronomical observations with the largest telescopes, mostly in Chile. And I will explain all these different parts one by one. And then in the end, we're going to put it all together to understand the origin of the elements.

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