PROFESSOR: Have you ever wondered how all the chemical elements are made? Then join me as we are lifting all this data secrets to understand the cosmic origin of the chemical elements.

Let's summarize what we've learned so far about the older stuff and how they can be used in our concept of stellar archeology to understand what happened soon after the big bang in terms of the chemical enrichment and chemical evolution.

Still we have old stars, and we call them metal-poor. And they are our tool. They are our tool to study the early universe.

These stars are long-lived, so they have a low mass, something like 0.6 to 0.8 solar masses. And that means they have lifetimes of 15 to 20 billion years. And that means that they are still observable. And that is very lucky for us.

And they are not just observable. They are actually fairly easily observable, because they're now located in the Milky Way. Let's look at this again. So this is very quick drawing of our Milky Way. This is the bulge, the inner part of our galaxy with a supermassive black hole in the center.

And this here-- actually two disks. So this is the disk. And we're about here, 2/3 on the way out.

And the bulge contains a lot of young stars. There's a lot of gas, which means you have formed a lot of stars, which means you make a lot of elements and you form more stars. So the bulge is very metal-rich. And the disk here is not quite as metal-rich but still pretty enriched.

Now, this is not the only part of our galaxy. This is just the most visible part, namely the Milky Way band on the night sky. That's when you look into the spiral arms that make up the disk.

But we look in a different place for the older stars, because they are kind of located up here and below the disk in something that's called the halo. It's actually much larger than what I'm drawing right now. And so that's called the halo of the disk. It's a spherical envelope of the disk here.

And all the old stuff is parked there. It's a bit of a junkyard. Because when a galaxy forms, you have small systems that actually come together and form a bigger system.

And then here you have a bigger system too. And then they come together and make an even bigger one. So that's called the hierarchical structure formation paradigm. And so this is the Milky Way.

And which means that these little guys here kind of end up in the outskirts, or at least a good amount of these little guys end up in the outskirts. But they are completely shredded apart. And what is left are all the stars that are being spilled into the Milky Way. And so this is how old stars actually get into the outer halo of the Milky Way.

I should mention here that little dwarf galaxies are also actually in the halo of the galaxy. So they are also pretty old. So these are entire little systems here that are not completely shredded yet. So they are just in the gravitational field here of the Milky Way. And they're orbiting around the disk.

And we also have globular clusters. These are clusters of stars with up to a million stars. They are also located here and down here. And they are also really old. We don't really know where they come from.

So the halo contains mostly three things-- globular clusters, dwarf galaxy, and lots of old stars. And so with our telescope we can peek from here kind of here up into the halo and down here and observe all the old stars that are in this range. So all in all, our metal-poor stars are the local equivalent to what we call the high redshift universe.

In a very complementary way, both metal-poor stars and the furthest most distant galaxies are used to study the early universe. These faraway galaxies, when their light comes to us, we receive it from this early time. And this way, we can figure out what this galaxy can tell us about the early universe, because it formed at that early time.

Our metal-poor stars, their light hasn't traveled for a long time. It has traveled maybe just from here to us. That's a negligible amount of time. Because these stars are today located in our Milky Way. But they are really old. We see them as when they are old, not as when they were young, as in the case of these distant galaxies.

But the fact that we see them all doesn't matter to us. Because these stars don't get wrinkly or anything. They just sit there. And they are just waiting for us to observe them.

And as we will see in the following, these stars are really undisturbed. And today, they look like just what they did 13 billion years ago. So that's a huge advantage for us. And of course, we're going to make use of it.