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 have come to the end of our little journey where we wanted to explore the origin of the chemical elements.

[MUSIC PLAYING]

I hope you enjoyed it, and I hope I could help you to understand that this is actually not just one origin. It's a whole process. And it's a process that's still going on. So let's summarize what we covered.

Well, we talked a lot about fusion and neutron capture processes that create all the elements in the first place. We talked a little bit about where that happens, I mean the cores of stars, as well as in supernova and neutron star mergers. And once these elements are created, they can then be observed, and they contribute to the chemical evolution of the universe.

If they are produced in the early universe, then we can see them in the older stars. So if produced in the early universe, then we have this chance of observing clean signatures. Today, that is not possible anymore, because chemical evolution has moved on too far. It's too messy today.

And so, we use the most metal poor stars in order to detect these clean signatures, and to work with nuclear physicists to understand how these processes exactly work, and in what astrophysical sites that might occur. So here we have the oldest stars. And one reason why we can infer that these stars must be very old, because if there weren't we wouldn't get these very clean signatures that were only present at the earliest times.

Now the very fortunate coincidence for us, is that these older stars actually found in the Milky Way today, so they are fairly local objects. And that is a great advantage over very distant galaxies that are also often used to study the early universe. We find them in the Milky Way, but we need the kind of data, of course, to do a chemical analysis.

And we do that with spectroscopic observations. And we use the world's largest telescopes for that, because only they can give us the kind of data quality that we need in order to measure these tiny little absorption lines that tell us about the composition of all the different elements

across the periodic table. And then finally, if we put this all together, we can determine the chemical composition of our old stars, and actually we can do so not just of old stars, but of stars at a variety of ages, a variety of metal contents. And that helps us to piece together how the amount of each metal actually changed with time.

And that's a very exciting prospect. So that's chemical evolution. And as I mentioned before, this is an ongoing process. Much of all the elements are still being produced. right now.

There's probably a supernova going off right now as we speak somewhere in the universe where more elements have been created. And so, the chemical makeup of the universe is changed again. So it's continuously changing process.

And that brings us to the end. So this is really all the star stuff that we are made of. And while the origin is not entirely stars, but also stellar remnants, as I mentioned, supernova and neutron star mergers should be included in that.

But, yeah, that is really our cosmic origin. And as humans, it lays in the cosmos, in the cosmic objects, in a variety of them. And it takes a whole bunch of processes in order to unravel that all those stardust secrets.

And one last thing I wanted to mention, doing this kind of work with all the different elements has shown pretty clearly that carbon is not only the most important elements for us humans, because all lifeforms are carbon based. It actually turns out, it's also the most important element in the universe, because at that early time it needed the carbon to help for the gas to come together to form small stars in small structures. And so, I think carbon really plays the most fundamental role in the universe that we can think of, because it helps star formation and galaxy formation, and ultimately planet formation, and formation of life.

[MUSIC PLAYING]