PROFESSOR DJORGOVSKI: Finally, let's just talk briefly about the remediate extragalactic neighborhood. That's the local group of galaxies. This pretty picture is our big neighboring spiral, Andromeda, also known as Messier 31. It's got two bright satellites and a lot of really dim ones. The M32, which is a small elliptical galaxy, NGC 205, which is supposedly a dwarf elliptical galaxy, but a special kind.

So if you were to count them all up, there is several tens of galaxies. Most of them are dwarfs. There are two big galaxies, us and Andromeda. There is one kind of smaller spiral that's a triangular galaxy, M33. And there is a whole lot of dwarfs. Some of them are star-forming dwarfs. Some of them are inert, just having old stars and then dark matter. But here it is.

So the content is, essentially, two big galaxies, a couple middling ones, and a whole lot of small ones. The small ones range from dwarf-irregulars, but Magellanic Clouds, which are satellites of the Milky Way, or the most prominent of those. And then there is a whole bunch of smaller ones. I'll talk about them next time.

It's about a megaparsec or two, all right? Andromeda is 700 kiloparsecs away. And it's coming towards us. So chances are pretty good, in a few billion years, we're going to collide with Andromeda. And maybe the Milky Way and Andromeda will merge and make a big elliptical galaxy. Not to worry, you won't feel a thing.

It is not a gravitationally bound structure. Some parts are, like Milky Way has a satellite galaxies that are bound to it. Andromeda has satellite galaxies bound to it. But the group, as a whole, is not bound. It's close, but not quite. And it's somewhere in the outskirts of a much bigger structure called a Local Supercluster, about which we'll talk more later.

And one thing to remember is that this is pretty typical. This is kind of continuing Copernican Principle. Most galaxies in the universe are family groups. Here are just pictures of some of the more famous members. The largest Magellanic Clouds are actually two nearest galaxies to us. Aside from maybe some pathetic little dwarfs,

they are about 50 kiloparsecs away. And they've been seen by Faraday and Magellan. That's why they have the name. And so you can see them with the naked eye.

M33 is kind of almost flocculent, not very big spiral galaxy. And then Leo I is one of the dwarf spheroidals. They are not spherical. Astronomy is full of these misnomers. Like, planetary nebula have nothing to do with planets, right? And dwarf ellipticals are not really dwarf elliptical, and dwarf sphericals are not spherical. They're dwarfs, right? But basically, they consist of mostly dark matter with some peppering of whole stars in them. This is a really high contrast picture. Usually, they're extremely hard to see.

And one final item, which is, what happens with these dwarf galaxies flying around the Milky Way and Andromeda? Well, what happens to them is what happens to star clusters. They gradually get torn by the tidal forces. The kinetic energy from passages has been dumped to internal degrees of freedom. Stars evaporate. But remember, stars are mass points. They remember the dynamics of their birth, so they tend to kind of continue with the same orbits. So these things are shredded out along their own orbits. And they make these tails of stars, which have been detected now in galactic halo.

And there is currently one dwarf galaxy in subject areas that is being shredded up right now, as we speak. It's called Sagittarius dwarf. It was not seen for a long time, because it's very, very thin by now. So people had to do very detailed star counts to notice this is the density contour super imposed on the galactic bulge.

And these are essentially, this is fossil evidence of how you assemble galaxies. Merging is probably the single most dominant process in which way the galaxies are made. And it goes on today. Now there are pictures of spectacular mergers of big galaxies, but even pretty dull vanilla galaxies like Milky Way keep gobbling up their smaller neighbors. And they build up the stellar halo.

They build up stellar halo, not the disk, because they come from large distances and from random angles, basically. They contribute to the random kinetic energy,

which is random motion, not rotation. In fact, if they were to merge with a bigger galaxy, that can disrupt nice, cold, rotating disk.