DJORGOVSKI: So a lot of this observed variety was explained through so-called unification models, which are kind of a cartoon version that is given here, or in more details shown here. So the idea is that there is a black hole, an accretion disc in the middle, lot of ionizing radiation. Clouds of gas are highly ionized by that radiation because they're so close to the black hole they move with high speeds. So that explains presence of strong broad emission lines.

Little further out, gas is still illuminated by the solar radiation, so you see strong narrow emission. But they're moving at normal speed for stars and galaxies, like hundreds of kilometers per second. So if you're looking from an oblique angle, you'll see the whole thing. You see the continuum from the accretion disc you see broad emission lines from clouds near the black hole, you see narrow emission line clouds from clouds a little further out.

But if you're looking from the side, the continuum source and the broad emission line region are obscured. You only see the narrow emission line side. And those are a type 2 AGN. And if you're lucky and look right down the jet, then you have all these extra phenomena due to the Doppler boosting and those are the real axis. So this picture can pretty much explain all of the observed phenomenology with one distinction, which doesn't necessarily tell you why some are radio loud and some are radio quiet. So unification of active galactic nuclei basically says well, it's all one kind of thing.

The different accretion rate, which maps into luminosity, because just like with the creating binary stars, but they can moderate those obscure or unobscured version or blazars of extreme version of unobscured version, and that pretty much can explain everything that we've seen about. But for the difference of radio loud versus radio quiet, so the possible, not entirely proven, but very likely explanation is that they're due to the difference in the spin of the black hole.

Black hole can be stationary-- Schwarzschild black hole-- or could be spinning--

Kerr black hole. Black hole can only have three quantities about it. Mass, always, angular momentum, and electric charge. And because their charge is so well mixed, they never have electric charge to speak of. And so the difference here is that in the spinning black holes, if you have magnetic field present, and then bound together, that can produce jets to accelerate things. And so that energy then gets extracted from black hole, from the kinetic energy of the black hole just like with pulsar's energy was extracted from kinetic energy of rotation.

In the radio quiet case, black holes have low or no spin and most of the emission is really produced just by accretion. So how that can be, right? So just like it's hard to spin up neutron stars, in order to produce a millisecond pulse, and really it's even harder to spin a black hole [? then ?] and the best ways to do mergers. So you'd expect then, that however you make initial super massive black holes they'll probably be radio quiet.

Then as merging of galaxies proceeds, locationally you have major merger too. That would create a product black hole with a very high spin. Those events we should be able to see in gravitational waves someday. But there is a hint that indeed, the onset of radio loud quasars lags behind the offset of radio quiet quasars in the universe. So that fits nicely in this picture. So therefore, a lot of the observed classification is really apparent. It's just due to the angle from which you're looking at.

And a priori, you don't know that. So simple example, if you're an extraterrestrial coming to planet earth, flying in your UFO over Los Angeles, you'll conclude that cars are the inhabitants of planet earth and you classify them by color. Right? Silver ones, and white ones, and red ones. Red ones a little faster than anybody else. But they all have same engine inside, which you don't see directly.

So a more physical classification would then be something like this. There are two relevant properties of the black hole itself, mass and the angular momentum. And what produces energy is accretion, so there has to be mass accretion rate. So these are three minimum quantities needed in order to account for these things.

And in fact, from what we can tell, there is more or less a relationship that follows exactly like this. And then on top of that, you have obscuration, which is superficial, but just then emphasizes or de-emphasizes some of the observed quantities.