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NICHOLAS DIBELLA: So welcome to the big questions. My name is Nicholas. You can call me Nicholas if he want, or you can call me Nick, or sir, or whatever you feel like. I am I'm a physics major here. I'll be a senior next year. I like physics, philosophy, math, pizza. Pizza, did I mention pizza? I guess I'm addicted to pizza. And that's all you need to know about me.

OK so this class, *The Big Questions,* we'll be looking at questions that are big, questions like what's the beginning of time. Will there be an end? Do aliens exist is time travel possible? Is the universe a computer simulation? Is he really heading outside the door to someplace far more interesting than here? Because that seems quite unimaginable and inconceivable to me. Questions like that, there's a whole bunch of them on the syllabus. Yeah so these are big questions.

Due to the bigness of them, they're kind of hard questions. And people have been asking them for thousands of years, 2000 maybe 5,000, some number of thousands of years. And they haven't really made a whole lot of progress, historically, even though they were very, very smart.

And I aim in this class to make a lot of prog-- I aim to show you how we've made a lot of progress on these questions. I'm not going to claim that we're smarter than the people that already thought about them, but we're finally able to make a lot more progress on these questions because we know a lot more. We just know a whole lot more than people knew 1,000 years ago, or 100 years ago.

In fact, probably the last 100 years have seen the greatest accumulation of new transformative human knowledge out of any 100 year period. So in the early 1900s-- like about 100 years ago, Einstein proposed his theory of relativity, special and general, which showed us that mass and energy curves space and time. I'll just let you be-- I'll just like you wonder about that mystery for now.

And quantum mechanics showed us that there's an intrinsic randomness in nature, very, very non-obvious very, very profound and paradigm shifting. Don't worry about relativity and quantum mechanics for now. I'll get to those eventually. I just want to emphasize that really over the past 100 years, we've gained so much new more knowledge, more new knowledge,

and we're finally able to make headway in these questions that people just had a hard time catching a grip of.

We know a lot more, mostly because of physics, and also because of some new ideas and philosophy as well. So the types of questions in this class will be kind of physics-y. I mean I'll be talking about the universe. I mean you don't usually hear a chemist talking about the universe, or an economist talking about universe. I suppose they could, I mean I don't say that they can't, I mean they just don't. So the question sound physics-y. and maybe me a little metaphysics-y.

So even though the course is called *The Big Question,* that won't really be looking at not physics-y big questions, like they're big questions and ethics, for example, or religion, or so forth. Like what should a person do. I won't really be looking at questions like that. I be looking at more physicsy type questions.

Now the physicsy questions I want to analyze completely conceptually. So my plan for the class is to have a minimum of equations uttered, written, thought about, et cetera. So if you see me, you see I'm on the board going crazy writing down equations, please stop me. I mean I might just forget what I'm doing, and accidentally just become a mathematical menace or something. So stop me if that happens.

You should also feel free to ask questions at any time, or stop me if I'm mumbling, or if I'm being unclear, if I fall asleep, or something like that. You should feel free to stop me and ask questions. Oh yeah. So all of these questions are also kind of philosophical sounding. I mean where is the nature of reality, kind of philosophical sounding.

You have a question? Oh, you're just doing the old lean on the hand when it looks like you're asking a question trick. No, he doesn't have a question.

So a lot of the question a philosophical sounding but there are a lot of questions historically that have started out as philosophical sounding questions and have eventually become physics questions. Questions like what's the beginning of time. And if you ask this question 100 years ago or 110 years ago or something, no one would have-- people have ridiculed you if you said it was a science question.

But when the Big Bang Theory was eventually, it was eventually thought of, it became a very legitimate question. And particular according to the Big Bang Theory, yes there was the

beginning of time and we call that beginning of time the big bang. And it has a very physical basis to it.

But there are still some questions, I mean there are so many questions that are big and are philosophical sounding. And they're still philosophy right now, but maybe eventually there'll be physicsy. We'll see.

OK, so my plan for the class is to talk, to analyze these questions from a physics point of view, or from a philosophical point of view. In particular, I don't want to invoke religion at all, so there should be a minimum of-- I mean there should be no religious talk. I mean you feel free to talk, ask me questions after class, or send me an email or something. But the goal for the course is to look at these questions from a science or philosophical point of view.

OK, so the way the class will work will all convene here in this cozy room. Sundays 1:35 to 2:55 PM, except for today, which is 2:05 to 2:55 PM, actually 2:10. I guess we started-- And so I'll just I'll just talk. I'll just talk to you guys. There won't be any homework. There won't be any tests. You'd be crazy to want that over the summer, my opinion.

But I will post notes on the website, if I can figure how to use the website. And I will post some things for you to think about if you want. But I mean you can just treat this whole class as a series of entertainment like yours if you want. I just want to entertain you. I just want to show you that these questions are really interesting and they make you feel good to think about them. That's all I want to do.

I mean you can take the whole course much further if you want, but I mean you don't have to I mean I'm not going give any grades. Is that it? OK, I think that's it in terms of course organization and all that. Does anybody have a question? Cool. I'm going to just close this door. Almost close the door.

OK, so where do we start? Big questions. I have a lot of big questions on that sheet. So do we start the biggest question? Maybe we start with a big question, but not the biggest, and then progressively move farther to bigger and bigger questions. I don't know the best way to start is. So I figure let's just start at the beginning, and by beginning, I mean beginning of time, if there was a beginning of time. OK, sound good?

So we'll start at the beginning. So the modern approach to understanding the beginning of time, if there was the beginning of time, to understanding the origin of the universe from a

science point of view, really started in the 20th century. And our first experimental or observational evidence that allowed us to say things about the early universe, about the history of the universe, came in the 1930s with Edwin Hubble.

So write down Hubble. And he looked at the sky when it was dark. And he was able to conclude that, in fact, if you look at the galaxies, most of them are moving away from us. That that's why he was able to conclude. I won't tell you exactly how he did that. He used something called redshift. But you do just trust me for now that he observed the night sky and he was able to conclude that most of the galaxies are moving away. So I'll just write that down. So most--

So if you're Hubble, you see this. Most of the galaxies are moving away. If you have the slightest bit of curiosity. You might wonder why. Why are the galaxies moving away? Why isn't it that half and moving away, half way towards us, or why we are moving toward, why are they all moving towards us. I mean after all attracts. Why isn't that the case?

So he concluded that most of the galaxies are moving away from us. And so you'd wonder why is that true. Does anybody have an answer what they might think it's due to? Sure.

AUDIENCE: [INAUDIBLE] scared of us?

NICHOLAS DIBELLA: So it's possible the galaxies-- is it possible that galaxies are in fact scared of us? I guess that's, maybe back then that might have been a legitimate scientific hypothesis. But we don't really know a whole lot-- we didn't know a whole lot about the nature of consciousness. Well, even-- I mean we don't know a whole lot about the nature of consciousness, if galaxies have a conscious.

And most people who think about this sort of thing would think that that's a funny answer, but probably not the right one. Yes?

AUDIENCE: Maybe like why do galaxy in this place, they don't have like enough gravity?

NICHOLAS DIBELLA: Maybe. Maybe the galaxies don't have enough gravity so they're moving away from us. We don't have enough gravity to pull them all towards us. Maybe? Yeah, that's possible. In fact, you're on the right direction. But you might still wonder why don't they have enough gravity. Why don't they have enough gravity? We still need an answer to that question. Another guess?

AUDIENCE: There's something else that started [INAUDIBLE]

NICHOLAS DIBELLA: What's that?

AUDIENCE: Something else that's driving [INAUDIBLE]

NICHOLAS DIBELLA: Something else, sorry, that started--

AUDIENCE: That has started gravity.

NICHOLAS DIBELLA: Something else that has started gravity. Like so maybe there's something far away from us that in fact, pulling-- I mean where we're sitting-- we're living right here. And we see that this is us. And we see all-- you see a whole bunch of galaxies. They're all moving away. And you're suggesting maybe something out there that's pulling them towards it, like some really big thing. Who knows what it is? Right. Is that your suggestion?

I suppose it's possible. Well-- so the fact-- So Hubble actually observed everything, regardless of the direction, every galaxy, well almost every galaxy, regardless of the direction you looked is moving away from us. So if this is us, and these guys are moving in that direction, then it's a legitimate hypothesis to think that maybe they're being attracted to this huge mass.

But what about what about these guys? I guess it's possible that maybe all the galaxies the Hubble observed, all the galaxies that Hubble observed, he's sitting, Hubble is sitting. He's sitting in his room, or whatever, and there's some kind of a big shell, a really massive shell, surrounding all the galaxies that he observed. And maybe we're the center of it. We're just somewhere inside the shell. And this shell is really massive and it's pulling everything towards it. Is that your suggestion basically?

AUDIENCE: Yeah.

NICHOLAS DIBELLA: OK. That's another-- that's a valid hypothesis. Yes?

AUDIENCE: The universe Is expanding.

NICHOLAS DIBELLA: The universe is expanding. Why would that imply that the galaxies are-- which galaxies are moving away from us?

AUDIENCE: The space between them is running out.

NICHOLAS DIBELLA: The space between them is running out. That's actually the right answer. That's actually the right answer. And I'll talk a little more about it in just a couple minutes. I'm just curious, I'm just curious of other, I'm just curious of other guesses that you guys might have. I mean, I already said that's the right answer, but what might be another conceivable answer? Any other conceivable answers? Yes?

AUDIENCE: Maybe because it's just moving away.

NICHOLAS DIBELLA: Maybe because it's just moving away. Well me I'm asking why is it moving away. Or do you accept that as a fundamental postulate of reality? Galaxies have the property that they move away from us, people that live on Earth. Is that what you're suggesting?

AUDIENCE: No.

NICHOLAS DIBELLA: Oh.

AUDIENCE: [INAUDIBLE]

NICHOLAS DIBELLA: So maybe they're just all for some reason they're just all moving and that-- they're just moving. Well, I mean they're not all moving in the same direction.

AUDIENCE: They're just moving in whatever direction [INAUDIBLE]

NICHOLAS DIBELLA: Oh and so, I mean they're like basically moving in random directions, but it just turns out that most of them moving away from us. Well I mean I can ask why and most of them moving away from us. I'll take one more guess. It's fun. I mean I said that's the right answer, but it's fun to think about what alternative hypotheses might be because people back then, they got the data, and they had to try to understand it somehow.

They actually had a little help because earlier people made suggestions about whether the universe would be expanding or not. And so they had a little help. But for someone who's just starting, he's just observing them. It's really-- I think it's important, as a scientist, to wonder what does the data tell us. Yes?

AUDIENCE: Well, it's sort of far fetched, but have you heard about diffusion where in the liquid

[INAUDIBLE] would spread throughout it evenly?

NICHOLAS DIBELLA: Sure, yes. OK, so the fusion is just when the molecules pass through small-- Do you know what diffusion is? I mean things diffuse. I don't want to waste too much time on it. OK so, what about diffusion?

AUDIENCE: Maybe this is gonna sound far fetched, but maybe that's why.

NICHOLAS DIBELLA: Maybe the galaxies are diffusing. Is there some kind of fluid presence? Maybe space is a fluid? Actually that's not as far out as it sounds, because it actually turns out to be useful to think of space as a fluid in some context. I read about it once. I'll stop with that.

I mean you said the right answer. I just want to give one more-- I want to give one more possible-- I want to have one more possible explanation. So I'll give-- so there'll be two hypotheses. So we've got we've got the observation. Most galaxies move away. And I'm asking why. One explanation is that, well it's not really an explanation.

So if most of them as most of them are moving away now, then that means that in the past they were closer to us, right. They're closer to us yesterday than they were today. And they were closer to us two days ago than they were yesterday. And so on and so forth. And so if you extrapolate very far back. If you very far back, rewind time to very far back in time, then everything will be very, very close to each other. And in fact, maybe everything is concentrated at a point.

So this is the situation now. There's us, there's us here and there are galaxies moving away. That's now. What about-- a long time ago. So a long time ago, everything would be very concentrated. Everything is at a single point.

And if you look at things from this perspective, say a long time ago. If you look at things from this perspective, it would seem that perhaps some kind of explosion occurred that's centered at us. And this explosion just caused everything, all the galaxies to explode away symmetrically in all directions.

And we won't ask what the explosion actually was, but it's conceivable that there was some kind of a bang, one might call it a big bang that was centered right at us. And so the Big Bang happened. So here space and everything. There's nothing there. Everything is there. Near where we are right now. And some kind of explosion occurred, everything went out. That's another legitimate hypothesis.

It would explain why are these moving away. But you might have a problem with it in the sense that it's kind of arrogant in the sense that why should we be special. Why is everything moving away from us? Why not the Andromeda Galaxy or something? Why should we be special? But nonetheless, it's a legitimate hypothesis and it would explain why everything's moving away.