DAVID KOPLOW: It's always a great pleasure to be with you as part of this terrific institute. I do have to say that I feel it's something of a disadvantage compared to your other speakers in this program because my topic, outer space, is, after all, the biggest-- at least geographically-- the biggest topic on the program. And nonetheless, they've given me only the standard hour and a half. So in terms of cubic kilometers per minute, I have to talk real fast.

But instead of doing that, what I thought I'd do is try to make this program even more interactive than usual in the form of a quiz. As many of you know from personal experience, US educational system has just finished the exam period. And as somebody who very probably turned in all my grades on time and hit the curve exactly where I was supposed to, I'm going to go there again.

And so what I've got here is a little quiz about outer space, and especially the law of outer space, and we'll spend most of our time working through this. And I'm using it as the vehicle for doing a close legal analysis. Before we get to it, I'll give you some general orientation, some background about outer space and about the current national security situation with respect to outer space. And then we'll do a legal analysis, a lawyer's look at the Outer Space Treaty and at the other important international law instruments that affect security in outer space.

The starting point for all this I think at a philosophical level is that many people have customarily thought of outer space as being different. The outer space they think should be something of a sanctuary, at least partially free from some of the most rapacious forms of human exploitation, and competition, and military activity. Maybe this is just because space is a little closer to heaven, that it should bring out the best parts of human interaction.

And in fact, outer space has been the scene of some really marvelously inspiring international cooperation, including collaborative activity among countries that, on Earth, couldn't find a way to work and play nicely with each other. And nonetheless, they were able to engage in collaborative activities in outer space that have been truly inspirational and path-breaking.

On the other hand, many people consider that notion that space should be a sanctuary, consider that just a romantic model and insist that outer space is just a place. It's a place like any other place that has known human activity, has known arms races, and may someday know armed conflict in outer space. And that to try to deny that inherent nature of this medium, just like any other medium, is to fail to irresponsibilities to think seriously about the national security aspects of outer space. And so that clash, that underlying philosophical difference in how to think about this resource, this place, I think, underpins a lot of the uncertainties about

the national security aspects of outer space today.

So as background, what I thought I'd do is give you three points, three snapshots, of what the situation is with respect to outer space. And then we'll do this little quiz about the law of outer space. The first point may be the most familiar, and that is to emphasize the enormous and nonetheless still growing use of outer space for the full array of civilian and military purposes in the United States and elsewhere. And I said this is familiar, but in fact, that's why it needs to be emphasized. The use of outer space has become so ubiquitous that we often fail to notice and fail to appreciate how much of modern life, in this country and elsewhere, depends upon satellite services.

On the civilian side, we all use space, not just daily, but all the time every day for communications, telephone, television, internet, email, for commercial activity, credit card purchases, banking, scanner services, for transportation, the GPS in your car for weather forecasting, for Earth resources, monitoring disaster relief. Not all of those are done through satellites all the time exclusively, but many of those services do depend upon space. And if there were a serious degradation in the availability, speed, reliability, authenticity of satellite services, we would all suffer-- suffer immediately and suffer in serious ways.

On the military side, the use of outer space is, if anything, even more profound, that modern militaries rely upon satellite services for the full array of activities. At the moment, we do not have in outer space weapons in the sense of the pointed or explosive end of the spear. But we've got satellite support services throughout space. And a modern military uses those satellites for command, and control, and communications between headquarters and deployed forces; for position, navigation, and timing so every vehicle can know where it is and where it's going, including not only ships, and aircraft, and land vehicles, but some modern smart bombs use satellite services; for early warning of missile attack; for verification of compliance with arms control treaties.

Again, if satellite services were to be seriously degraded, the United States would not be disarmed-- still have a very powerful fighting force. But we fight the way we train, and we train with satellites. And if satellites were suddenly denied, the capability of waging war in the modern way would be seriously impacted. And that's true not just for this country, but for others around the world. Most other countries are a step or two behind the United States in the progression toward the integration of satellites and the exploitation of space services, but they're going on the same trajectory. And these days, more and more countries have an

independent capability for launching satellites. More countries own and operate satellites. And every country uses and enjoys the benefits of satellites in a variety of ways.

And in fact, this story is only going to get more intense as the internet of things proliferates and as we've got, now, the beginnings of what's called the democratization of space, featuring much more low-cost access to outer space. [? VOD ?] services are becoming cheaper. Satellites are becoming cheaper. We're going to see the number of operational satellites doubling, or tripling, or more, within the next few years and a change in the operation of who operates those satellites because the private sector is becoming engaged with outer space in a much more expansive, much more vigorous way than ever before. So that's the first picture, is that the use of outer space, the importance of outer space, the centrality of satellite services to your daily life, to your military life is enormous and growing.

The dark side of that is that the exploitation of space has become a reliance upon space, a dependence upon space. And that dependence has become a vulnerability, a vulnerability that potential adversaries have not failed to notice. Outer space has always had a substantial quantity of military activity. Indeed, the first beginnings of an anti-satellite weapons program in the United States are just about as old as the beginnings of the first satellite programs in the United States.

And during the Cold War, the 1980s, the United States and the Soviet Union engaged in a persistent arms race in outer space, with each country testing, developing, and operationally deploying anti-satellite weapons capabilities-- a variety of sorts. But for a period of time, that activity abated. And for much of that period of time-- and it seemed as if the arms momentum in space was considerably muted, compared to the development of arms races in other sectors between the United States and the Soviet Union.

That quiescence in outer space was abruptly ended about 10 or 15 years ago. Many of you would date the wake up call for the modern concerns about security in outer space to 2007, when China tested an anti-satellite weapon, launching the interceptor that collided with one of their defunct satellites, smashed the two spacecraft, and created a swarm of debris that will persist in outer space and continue to be a hazard to safe space operations for decades to come.

In fact, if we had more time-- if we had more time-- we could spend-- it's [? useless to ?] spend time on the problem of debris in outer space. That is now widely recognized as, perhaps, the

most persistent serious threat to the future exploitation of outer space. There's so much junk up there traveling at such high speeds and remaining in space for, depending on its altitude, for years or decades as a hazard to space operations.

The Chinese test was probably the world's worst debris-creating event in outer space, but by no means the only one. China tested its anti-satellite weapon vividly in 2007. 2008, the United States responded with its own demonstration of another anti-satellite weapon, shooting down a failing US satellite. Just a couple of months ago, India became the fourth country to test an anti-satellite weapon-- same sort of mechanism, shooting down one of its own satellites by an interceptor that collided with it in outer space. They did that one at a lower altitude, and therefore, the debris from that event should precipitate out of space relatively soon, and not persist the way the Chinese 2007 test did.

But it does demonstrate the vigor with which countries are pursuing anti-satellite weapons of a variety of techniques. This interception method is only one technique. It could be directed energy using laser beams or cyber mechanisms-- lots of techniques for shooting down satellites because they are, after all, vulnerable birds. They are expensive, and therefore you don't put up very many of them. They're hard to shield because weight is so expensive to put up into space. They follow known trajectories, and most of them have very little capability of maneuvering.

So they are, to a large extent, sitting ducks in outer space that, as I said earlier, countries have come to depend upon. It makes them very juicy targets for militaries around the world. Nobody's yet shot at anybody else's satellites, but the change in the perception of the security of outer space is dramatic over the last 10 or 15 years.

And it's a metric that the United States views with growing concern and alarm the increasing anti-satellite space control behavior-- experiments and activities by Russia and China. They view US activities in precisely mirror image sort of way. In fact, they probably feel that they are merely trying to catch up to the US lead in anti-satellite space control activities. And all three of them, as well as others, are proceeding down this increasingly hazardous and dangerous path.

So that's the second step-- the second point of introduction I want to make. First is that we're using satellites enormously and in a growing way. Second, that there is a growing perception of a threat to the security of those satellite operations. The third point is that the usual

mechanisms that the world has generated for responding to that kind of crisis have failed. That is the mechanisms of international diplomacy and international law have been inadequate to deal with this perception of a rising threat to the important security assets in outer space.

There is an important quantity of international law in outer space. In fact, when I teach the introductory international law course at Georgetown, I often use outer space as a brilliant example of how, at least sometimes, when the international community confronts a new challenge, or threat, or resource, or opportunity, sometimes you can generate law pretty quickly and pretty effectively.

The Space Age began in 1957 with the Soviet launching of Sputnik. By 1967, 10 years later, the world had negotiated and concluded the Outer Space Treaty-- foundational document that sets the basic constitutional principles for the use of outer space. They're still enforced, joined by just about all the space faring countries around the world. And it sets up the critically important starting points for the legal regime of outer space that outer space should be used for peaceful purposes, that international law, including the charter of the United Nations, applies in outer space, that countries cannot claim sovereignty in outer space. And it establishes some of the military limitations that we'll go over in just a moment.

Done within 10 years of the beginning the Space Age-- and within another 10 years after that, there were three more important treaties that fleshed out even more of the legal infrastructure for the safe and secure operation in outer space. The Liability Convention, Registration Convention, and so forth, that have been joined by, again, most of the countries active in outer space and have begun to support the safe and secure operations in outer space. So within only two decades, the world had generated binding law about outer space, which, to me, is a breathtaking success, when you compare that to how long it's taken the world to come up with the law of the sea convention after centuries of operations on sea, the law of airspace taking a century, law of land still underdeveloped. To do all that within 20 years is a remarkable success.

However, the process has broken down since then. And since the 1970s, we have not seen new treaties, new norms of international law, new customary international law generated to fill in the gaps that those beginnings of treaties did not articulate. And in fact, we haven't even seen much effort or serious proposals in that area, in that direction, in recent decades. I want to tell you about a couple of these, just to illustrate the difficulty that the lawmaking community has had in confronting outer space in recent years.

One is a proposal by the European Union that's been peddled for, I guess, a decade in various drafts. This would be a code of conduct, non-legally binding code of conduct that would attempt to articulate additional rules of the road for safe and cooperative operations in outer space. My view-- it's a pretty modest document. It would not do much to improve safe operations in outer space. And even it proved to be a bridge too far for the world, too controversial. For a variety of reasons, that document has never gotten much traction around the world. May not be totally dead as a diplomatic initiative, but it's awful close to that.

Second instrument, the second attempt has been a proposal by Russia and China that they've, again, peddled for a decade or more-- a treaty that would limit the placement of weapons in outer space. It's called the PPWT, a Prohibition on the Placement of Weapons in outer space. And I think it's a terrible document. It's a very poorly conceived draft. The United States and others have rejected it-- and wisely so, in my regard. But it's another illustration of how diplomatic initiatives have gone nowhere.

And the United States is at fault for this as well. The United States has not proposed, not suggested, not taken the leadership role in trying to develop new norms of international law. And this is not just a feeling of the Trump administration. The Obama administration didn't try. Prior administrations didn't try. But almost no movement on a diplomatic level to try to generate additional norms of arms control or any other kinds of infrastructure for outer space. So that's the situation we're in, where we've got an enormously important resource, enormously vulnerable, and the law has not done much about it. And that's the security structure situation in outer space.

So with that background, what I wanted to do-- oh, I should also add one other point. One of the remarkable things about this constellation of treaties and other norms about outer space, one of the remarkable failings is that space has never been defined. The Outer Space Treaty, none of the other instruments, none define what geographic area they apply to.

And that's crucially important because the law of space is different from the law of air in very important ways. As you probably know, every country has sovereignty over the air above its land territory. Your country has a complete right to control your airspace, to exclude others from entering your airspace. Nobody has a right to enter your airspace, to land in your airspace without your permission. Your country controls the airspace.

Outer space has exactly the opposite rule. With outer space, you can overfly other countries

without their permission, without paying them any rent, or tolls, or anything of that sort. Nobody can control outer space above their territory. But the dividing line between the regime of air space and the regime of outer space has never been defined. As an operational matter, it's probably something like 100 kilometers or so or maybe 100 miles, but none of the treaties approaches that definition. And so therefore, we're left with that other important ambiguity at the heart of the regime of outer space.

So maybe with that, we can-- or I was going to turn to this quiz, but let me begin by asking if you have any questions about those three points that I started with. I know that this group represents substantial diversity in terms of your backgrounds and your expertise, the political orientations. And so I really want to encourage you to make this as participatory as possible. Do you have any questions before I start asking you questions?

OK. Well, then, let's turn to this quiz. So this is structured as a series of questions about the law of outer space. And I put on the reverse of the handout the text of the crucial part of the Outer Space Treaty. Maybe we should start with that briefly. The Outer Space Treaty, reflecting the treaty drafting style of its time, it's a pretty brief document. And Article IV contains almost all the provisions that are relevant to the military operations in outer space. And it's got two paragraphs that briefly say that each party undertakes not to place an orbiter around Earth, and-- the obvious-- carry nuclear weapons or other kinds of weapons of mass destruction, install such weapons on celestial bodies or station weapons in outer space in any other matter.

And the second paragraph deals with the moon and other celestial bodies. So there's an important contrast there-- the difference between the rules that apply to the void of outer space and the rules that apply to celestial bodies-- the moon, asteroids, and so forth, other planets. The moon and other celestial bodies used exclusively for peaceful purposes, and you can't establish military bases, or installations, or fortifications, or test weapons there.

So with that, let's do a lawyer's analysis of the text of the treaty and see what principles we can come up with, OK? So question number one-- and I'll ask this in multiple ways-- first, what does the treaty currently require or prohibit? And what should the treaty or the treaties require or prohibit? And then finally, as a policy matter, what should countries do?

So question number one, is it legal to place an orbiter around Earth, a nuclear weapon, a dirty bomb, or a chemical weapon designed for attacking targets on Earth? What? What have you

got?

STUDENT: So the first paragraph says [INAUDIBLE] to place in orbit around the Earth and the objects carrying nuclear weapons or other kinds of weapons of mass destruction. So for nuclear weapons or chemical weapons, dirty bombs, those would all be weapons of mass destruction.

DAVID KOPLOW: Good. So this was the warm up. This was the easy one.

STUDENT: I took the easy one.

DAVID KOPLOW: Thank you for doing that, breaking the ice, getting it right. It's always a big risk if you ask an easy question, and somebody gets it wrong. Then you gotta back up a little bit. But that's right. So people often mistakenly think that the Outer Space Treaty is a broad prohibition against all nuclear weapons in space. And it's more narrow than that. That first sentence has three particular verbs that describe the things you cannot do. You can't place in orbit, install such weapons on celestial bodies, or station weapons in outer space in any other manner. And we'll see that those three verbs cover a lot of activities, but not everything.

One thing they do cover is placing those weapons in orbit around the Earth. And so another question is, what counts as a nuclear weapon or other weapon of mass destruction? And I think you're probably right. That's another term that international law-- in particular, this treaty-- does not define what is a nuclear weapon or other weapon of mass destruction. That's contested somewhat in international law.

There's an important resolution from the UN General Assembly that articulates what is a weapon of mass destruction. But as you know, the General Assembly does not have the authority to make binding law the way the Security Council does. And therefore, that's an important authoritative statement, but not legally binding. But probably, the world would define a WMD as including a chemical weapon or a radiological dispersal device, a dirty bomb as being a WMD.

So we got the first one right, unless anybody has any rebuttals or other elaborations on that. OK, let's move on to number two. Is it legal to deploy in space a non-nuclear ASAT, Anti-Satellite weapon, a space mine designed to orbit silently, passively, until somebody-- its owner-- gives it instructions to maneuver up against a target satellite during a future war? Is that legal?

STUDENT: [INAUDIBLE]

DAVID KOPLOW: Tell us why.

STUDENT: [INAUDIBLE] about nuclear or WMD is the only thing that you can't station out there. This would not fall into any of those categories of being a WMD or nuclear.

DAVID KOPLOW: I think that's right. And therefore, countries have experimented with-- have plausibly developed co-orbital, conventionally armed anti-satellite weapons. Couldn't put a nuclear weapon up there, at least not in orbit, but a conventionally armed ASAT device could be put into outer space and could passively orbit until instructed-- until guided to either collide with or maneuver next to and explode in proximity of a targeted satellite. The Outer Space Treaty does not prohibit that, as long as it is conventionally armed, rather than nuclear armed.

The second paragraph says you couldn't put such a device on the moon, at least if it's a-- you can't put a base installation or fortification, or test weapons, or conduct military maneuvers on the moon. But you could in the void of outer space. Somebody had a question about that. Yeah.

STUDENT: Doesn't it change or alter the definition of a weapon of mass destruction [INAUDIBLE]?

DAVID KOPLOW: Tell us more about that.

STUDENT: Well, maybe a single [INAUDIBLE] not a weapon of mass destruction, if you had 1,000 of them, [INAUDIBLE] couldn't that be a weapon of mass destruction?

DAVID KOPLOW: So the starting point for my answer is, this treaty does not define WMD. So we've got no real guidance on this, other than that General Assembly resolution and what people have said about it. Do you think 1,000 conventionally armed ASATs is a WMD?

STUDENT: It could be, but.

DAVID KOPLOW: What do the rest of you think?

STUDENT: If it's only attacking the satellites, is that a WMD? And by the way, in terms of this, if you [? have ?] specifically this [INAUDIBLE] so that would not distribute legal. 1,000, I guess, if, perhaps, a WMD [INAUDIBLE] destroy every satellite up there and totally destroys every communications and all the other activities on Earth, [INAUDIBLE].

STUDENT: I'll play the role in supporting this. Because space is so different because satellites are so

fragile, it is conceivable that you could design a conventional weapon that might have a massive effect in space. So thinking back to the China debris problem, if you created a weapon that was specifically designed to create debris and wipe out as many satellites as possible, some might see that as verging on weapon of mass destruction.

DAVID KOPLOW: Who can give us the argument going the other way?

STUDENT: Mass destruction, usually refers to casualties. You cannot define mass destruction by goods being destructed. It depends on what's in the satellies or the satellite up there.

DAVID KOPLOW: Again, you are now teetering on the cutting edge of what the definition of WMD is. There's no law on this point. Mostly, WMD has been defined to include nuclear chemical, biological, and radiological. But even there, you got sort of a puzzle about this. Does a chemical weapon cause mass destruction? It could kill a lot of people, but it doesn't blow up buildings in the way a nuclear or conventional explosives do. In outer space, there wouldn't be any human casualties, unless it affects the International Space Station or something. There wouldn't be any human casualties. Would that be a WMD?

STUDENT: I'm not super familiar with this, but I imagine that the intention [INAUDIBLE] was concern about placing nukes or WMD--

DAVID KOPLOW: That's right.

STUDENT: --in orbit because the speed with which they could come down would not allow the other side to retaliate [INAUDIBLE]. So it ended sort of this mutually assured destruction situation. So the concern that happens is that the weapon's coming down, rather than causing destruction in space.

DAVID KOPLOW: That's absolutely what people had in mind, was the apprehension that this would be a mechanism for attacking your enemy on Earth. And after all, the orbiting WMD could strike a target and an enemy very quickly. It would be orbiting above the enemy only a couple hundred miles, a few hundred miles. ICBM is having to go from the territory of one superpower to the other. That's thousands of miles. The space route could be a much more sudden armed attack.

But the definition of WMD-- is a hand grenade a weapon of mass destruction? No. What if you had 1,000 hand grenades? Is that a weapon of mass destruction? What if you had a million hand grenades? Is that a weapon of mass destruction?

STUDENT: Maybe if you tied them all together.

DAVID KOPLOW: The point is that the world has lots of ways to inflict pain on each other that don't fit into the traditional notion of what's a WMD. Traditionally, WMD has been confined to those small categories of unconventional weapons-- nuclear, chemical, biological. Well, let's press this forward with the next one. Number three, how about to send a nuclear weapon on a land based or sea based launcher, an ICBM or SLBM, through outer space on its way to a target in a foreign country? Would the Outer Space Treaty allow that?

STUDENT: If it doesn't go into orbit, maybe.

DAVID KOPLOW: Tell us more.

STUDENT: The first one that says could place into orbit an object of nuclear weapons, it doesn't really talk more about [INAUDIBLE] specifically flying through space.

DAVID KOPLOW: I think that's right, that this treaty, like every treaty, like every law designed to prohibit certain things and tolerate others. And as I said earlier, people sometimes think that the treaty is more broadly a prohibition on all nuclear weapons in space. It's not that grand. It's a prohibition on putting in orbit, installing on celestial bodies, or stationing in space. It probably does not prohibit transiting outer space on an ICBM, even if the ICBM, as traditionally it would, goes into outer space en route to a target. If it does not orbit the Earth, as ICBMs do not, that's probably prohibited.

And in my more cynical moments, I'd use this as an illustration of where countries negotiate arms control provisions and treaties to prohibit them from doing things that they didn't want to do anyway, or they didn't have any capability of doing anyway. But they draft it in a way that allows them to continue to do the things that they really are interested in doing. And in the 1960s, the United States and the Soviet Union anticipated that they would want to continue to legally use ICBMs. And so they drafted a treaty that prohibits putting weapons in outer space, which they didn't really want to do anyway, but allows them to have nuclear weapons that transit outer space on ICBMs or SLBMs.

One variant of this-- I don't know if you've heard about the fractional orbital system. The acronym is FOBS. FOBS was a system-- actually more of a speculation about a possible system than anything that was ever really deployed. But ordinarily, the flight plan for an ICBM

going from the heartland of the United States to the heartland of the Soviet Union or the other direction would go over the North Pole. And that's the shortest, most direct route. And that's where countries have oriented their radars to detect, and to the extent that they can, their interceptor missiles, their anti-missile systems for dealing with ICBMs or SLBMs that would go over the North Pole.

What if you turned things around and sent the missiles over the South Pole? They go most of the way around the Earth, attack the target from the south, rather than from the north, and evade detection by the radars and anti-missile systems that the other country had in place. What would the Outer Space Treaty say about that?

STUDENT: [INAUDIBLE]

DAVID KOPLOW: Hm?

STUDENT: [INAUDIBLE]

STUDENT: You can't do it.

DAVID KOPLOW: Why?

STUDENT: Because you're putting it into space because you're going to have to be in orbit at that point to re-enter after it coming down from the South Pole.

DAVID KOPLOW: And what you say to that?

STUDENT: The orbit [INAUDIBLE] circuit of the Earth. If it only goes 3/4 around the Earth, it's not in orbit.

DAVID KOPLOW: What do you think?

STUDENT: You're entering orbit. You don't have to go all the way around the Earth to orbit.

STUDENT: And they orbit and flying over the North Pole to the degree may only be for a very short--

STUDENT: OK, I'm going to change my definition now. I multiplied it whereby, based off of non-mechanical means, the projectile missile is traveling through space. So ICBM, they're positioned in such a way that they're using fuel, and that is going to get them to the target. Here, if we go ahead and put it the long way around, they're not. They're using gravity. They're using physics, physical forces, to get to the target.

DAVID KOPLOW: So that would have been a much more restrictive version of Article IV of the Outer Space Treaty. That would have said you can't put missiles in space. You can't put nuclear weapons in space on a missile. Whether you're going the long way or the short way, you can't do that. Or you could have said prohibition on going the short way, but it's prohibited to go the long way, but permitted to go the short way. Again, international law does not have an authoritative answer to this question. What you've got is all the text that exists on this.

Some other treaties did prohibit this FOBS system, the fractional orbital system. Both treaties have expired and are no longer in force. And I think that you've probably got it right, that the definition of place in orbit probably requires that the prohibition applies only if the satellite does at least one complete circuit of the Earth. If it only goes 3/4 of the way around, it's not in orbit. But that's contestable.

STUDENT: What is it then--

DAVID KOPLOW: What?

STUDENT: --if it's not in orbit?

DAVID KOPLOW: It's a fractional orbit. Do you buy that?

STUDENT: No.

STUDENT: So I do have a technical question. So is it still ballistic, or is it reaching orbital velocity and then decelerating? I mean, that's a technical question, but that doesn't matter, right?

DAVID KOPLOW: I'm not sure the term ballistic-- do we have any engineers here? No? So what's the definition of a ballistic trajectory?

STUDENT: I think [INAUDIBLE].

DAVID KOPLOW: So ballistic doesn't do very much work for you here. The term ballistic just means something that gets an initial thrust and then essentially coasts toward its target without any additional power en route. And once the initial thrust is finished, its trajectory is influenced just by gravity, or air pressure, or something of that sort. And in contrast, a cruise missile is one that is powered continuously throughout its flight, more like an airplane. A cruise missile, in effect, can be thought of as an unpiloted or no pilot on board the continuously powered missile.

A bullet fired from a gun follows a ballistic trajectory. It gets an initial thrust, and thereafter, it is

unpowered-- an arrow shot from a bow. When you throw a baseball that follows a ballistic trajectory, where it's just gravity or air, wind, friction, resistance that it operates on. It's not additionally powered. The fractional orbital system gets an initial thrust, and then the engines cut off and fall off. And the missile, the warhead continues on its trajectory around Earth.

OK, let's take the next one. Number four, to deploy in space a nuclear explosive device to be used-- I should have started by saying, in the last couple of years, I've been doing some work with NASA on the problem that NASA and other companion space agencies around the world identify as planetary defense. Planetary defense asks the question, what would you do-- what should be done-- what could be done if we discover some day that there's a large asteroid on a collision course with Earth? And someday, when we don't have to cram all of outer space into 90 minutes, we have a separate program just on planetary defense- tremendously important and difficult problem.

And one of the shocking aspects of this is that the world-- NASA, the Department of Defense, other countries-- don't have a good answer to that question. First of all, there are a lot of things, a lot of potentially very hazardous objects in outer space we can't even detect. We don't even see them coming. But even if you did see one coming, nobody has any capability at the moment for doing anything about it. They travel so fast. They come in at such an odd angle. You would not be able to shoot the thing down.

But people have speculated maybe one possibility could be that you might use a nuclear explosive device against this incoming asteroid. And you may have seen those movies of *Deep Impact,* and *Armageddon,* and all that. Yeah, don't pay any attention to movies. Here's a rule of thumb for you. You didn't pay your tuition for this. But if it's got Bruce Willis in it, it's not a documentary. And so the technology that was on display in those movies is not what would be used.

But one concept is that you might, if you saw an asteroid coming-- there's a variety of techniques, at least imaginable techniques-- but one could be to use a nuclear explosive device not to blow it apart, but to divert it, to use the heat and the energy from the nuclear explosive to cause molecules on the surface of the asteroid to evaporate. And as they evaporate, they impart an equal and opposite force in the opposite direction. And that might divert the asteroid just a little bit.

So the question is would that be legal to use a nuclear explosive device in space to divert an

asteroid? And that's question number four-- to deploy in space a nuclear explosive device to divert or destroy an oncoming asteroid that would otherwise crash into Earth.

STUDENT: [INAUDIBLE]

DAVID KOPLOW: Keep going.

STUDENT: [INAUDIBLE]

DAVID KOPLOW: Good. So I do want, for this purpose, to differentiate between the deployment-- that is, the placing of the explosive device in space-- and then the next question we'll get to the question of exploding it in outer space. So those two different verbs that, turns out, have different legal answers. So the first question is, could you just put it up there? Could you send the nuclear explosive device into space to rendezvous with this incoming asteroid in preparation for using it, for exploding it to try to divert the asteroid? Can you place it in space in that way? Yep.

STUDENT: I think you could argue that it's a peaceful purpose.

DAVID KOPLOW: Keep going.

STUDENT: Preventing the asteroid from hitting the Earth would maybe be a peaceful purpose.

DAVID KOPLOW: So let's start with that. The first sentence of Article IV says you undertake not to place in orbit around the Earth any objects or nuclear weapons, install them on celestial bodies, or station weapons in outer space and any other matter. That first sentence does not include the peaceful purposes part. That's in the second paragraph. The second paragraph says that you'll use the moon and celestial bodies for peaceful purposes, and you won't put military bases and things there. The first sentence doesn't have any escape clause, any permission for peaceful purposes.

STUDENT: The last sentence also says it shall not be prohibited. So it doesn't really have a safe clause either.

DAVID KOPLOW: Where are you looking here?

STUDENT: The very last sentence of the second paragraph, it's an equipment that would-- or I guess, not that sentence, but the one before it. The use of-- OK, never mind.

DAVID KOPLOW: No, so this is important part. And again, it's absolutely fair game for us to criticize the drafters

of this treaty. And there are lots of peculiar aspects of the drafting of this. If we were collectively to undertake to revise Article IV of the Outer Space Treaty, we could do a better job than our illustrious predecessors did. I think the general concept here is that the second paragraph is devoted exclusively to activities on the moon and other celestial bodies.

So then the question is, is this asteroid a celestial body? It probably is, and that would mean that there are certain things that you could not do under the first paragraph, but maybe there's an exemption for some parts of them under the second paragraph. Yeah.

STUDENT: [INAUDIBLE] not put it in orbit around the Earth.

DAVID KOPLOW: Keep going.

STUDENT: If I'm just hanging out there, it's not in orbit. Like oh, it's in orbit around the moon.

DAVID KOPLOW: Good, so one important question here is what would be the concept of operations for this planetary defense mission? And one of the first rules would be that if you could, you'd like to intercept this incoming asteroid a long distance away from Earth. Because a nuclear explosion in outer space would damage or destroy all the satellites that are around it anyway. If you're doing this to save the Earth, you may be willing to pay that price. But ideally, you intercept it far away from the Earth, not in Earth orbit.

STUDENT: [INAUDIBLE] exception, but placing something permanently out there, you could place a nuclear weapon permanently out there as long as it's not in orbit around the Earth.

DAVID KOPLOW: Well, what's the rest of that sentence say?

STUDENT: Or station such weapons in outer space or any other moon.

DAVID KOPLOW: If it's hanging out in outer space-- now first of all, since none of us really has enough scientific background on this, we'll stipulate that hanging around in outer space is a scientific term. It's difficult to do that. One of the important principles-- and so this says you can't station weapons in outer space.

I've tried to play with that sentence, that phrase a lot. Nothing in space is stationed. Everything in space is moving at very high speeds, including the Earth, including the solar system. Nothing is stationary, except the relationship to something else. So you might say that something is stationed with respect to the Earth, or with respect to the moon, or the sun, or

something. But that phrase, you can't go very far in interpreting this treaty before you wind up puzzling over that. Yeah.

STUDENT: Well, if the [INAUDIBLE] parties to the wouldn't it?

DAVID KOPLOW: Good.

STUDENT: But if it occurred in some sort of planetary defense agency, then you could do it.

DAVID KOPLOW: Good. Or you could call that the United Nations.

STUDENT: Yeah. I'll just do it.

DAVID KOPLOW: So this goes a little bit beyond what I'd intended to cover today. But it's an important point, and it's one that is sort of an anomaly in international law. Those of you who have studied international law know that the concept of state responsibility is that ordinarily, a country is accountable internationally for its bad acts, with things that the state does. But ordinarily, a state does not have responsibility for actions done by its private persons. If you are--

STUDENT: That's what Tesla could do.

DAVID KOPLOW: Well, so in general, if you are harmed by a private person in France-- is anybody here from France? OK, let's pick on France. If you are harmed by a French private person, you can pursue remedies against that person, but France is not responsible. You can't sue France if a private French person or corporation steals your wallet or defrauds you in a contract or something else. The government is not responsible for the bad acts of its private person. That's the general proposition, state responsibility in international law. And the United States is not responsible for things Tesla does. And the corporation is, but not the government.

However, space law is different in that regard, under a different-- Article VI of the Outer Space Treaty, which I did not give you, because I didn't anticipate you'd be taking this conversation in that direction. Under Article VI, every country is responsible internationally for the acts of its private persons in space. And that means that when-- and therefore the government has as an associated responsibility to authorize and supervise the activities of its private persons in space-- private persons or corporations.

And therefore if Tesla does something in outer space that violates the Outer Space Treaty, the US government is responsible. That's an extraordinary rule for international law. Ordinarily, an

international state responsibility does not extend that far. The Outer Space Treaty and the associated other instruments create state responsibility for the acts of private persons. Did you have a question?

STUDENT: Did this just come up. Didn't the US have a satellite that destroyed something in Australia? And it took the US government like 25 years to finally pay the private people in Australia for whatever was destroyed.

DAVID KOPLOW: So I think that one was not actually this. Because if I'm thinking about the same incident you're thinking about, that one was a government satellite. But there is another aspect to this that, again, I had not intended to go into today. But outer space also has a special rule about liability, which means that if you do something in outer space that causes harm to another country, to another country's satellites, or you launch a satellite that crashes to Earth and damages somebody on the ground, you are liable.

And in fact, there's a very sophisticated two part liability regime for outer space that varies depending upon the location of the harm. If your space activity-- you launch a satellite that crashes into somebody else's satellite, you are liable if you are at fault. The treaties don't define what at fault means. There's been very little, if any, state practice in implementing that provision. What the commentators say is that it's something like negligence. If you negligently undertake a space activity and your satellite crashes into somebody else's, you're liable if you're at fault.

But if your satellite causes damage on Earth, you have absolute liability, strict liability, regardless of fault. And therefore even if you've done everything completely reasonably and behaved according to the highest industry standards, if your satellite crashes to Earth and damages somebody on Earth, you have absolute liability. Again, an extraordinary exception from the usual international rules about liability.

Let's get back to what was advertised as the program for today. Number five-- oh, I'm sorry-- let's go back to one other aspect of number four. This is deploying a nuclear device in outer space for the possible use as an anti-asteroid system. And we've gone through how the question is, would that deployment-- would that be in orbit around the Earth? Would it be stationed in outer space? Would it be installed on a celestial body?

But there's another aspect to this that I want to pursue. If you've got this system, and it's designed for diverting an asteroid, is that, under the terms of Article IV, is that a nuclear

weapon?

STUDENT: It's not a weapon.

DAVID KOPLOW: What?

STUDENT: I was thinking about [INAUDIBLE] like you were saying, the weapons of mass destruction, same kind of thing if you're actually seeking to say [INAUDIBLE].

DAVID KOPLOW: Right.

STUDENT: It's different.

DAVID KOPLOW: So that suggests that a nuclear explosive device is not necessarily a nuclear weapon.

STUDENT: Yeah.

STUDENT: [INAUDIBLE] could be used for-- not as a weapon, but as a target for them. It could be used for other things in the weapon. And I don't think that that would allow us to say that this was not a weapon. That that nuclear device in its form is going to be used to destroy an asteroid--

STUDENT: Well, not until you put it into customary international law.

STUDENT: Exactly the same as a nuclear weapon.

STUDENT: Practice it.

STUDENT: Now if it could not be used as a nuclear weapon on Earth, then I think it would meet your definition. If it could still be used as a nuclear weapon on Earth, then I think it would still be a nuclear weapon.

DAVID KOPLOW: This is exactly debate. It's not a weapon because of its intended purpose. It is a weapon because of its inherent nature. What do the rest of you think? Yeah.

STUDENT: [? Maybe ?] a weapon's a weapon. [INAUDIBLE], that's a weapon. If I've got a steak knife, it's a steak knife. Could it be used as a weapon? Sure. So can a shovel.

STUDENT: So can this.

STUDENT: I mean, I think you're using this nuclear weapon has the capacity of a hammer to move this thing off course. It's not a weapon. Can I kill somebody with it? Absolutely.

DAVID KOPLOW: So your focus is on the use. The intended application is not for warlike or hostile purposes, and therefore, even though it's something that could be used for warlike or hostile purposes, because in this instance, we'd be not using it for that purpose, it is not a weapon. And therefore it's not prohibited by the treaty.

STUDENT: I was thinking that it would be very hard to define that because you mean that's why there for a long time you don't know what the future purpose is. I mean, you don't know about that. And to someday, you find I want to make another weapon. So that could be very, very ambiguous situation. [INAUDIBLE].

DAVID KOPLOW: So you want to say that it is that a nuclear explosive device is always a weapon--

STUDENT: If it could be used as a weapon, [INAUDIBLE] that as a weapon. Because when they declare that one, you don't know the exact purpose to the use that. You can't get the classified document to say, I want to use that as a weapon. It's very hard to prove that, right? If I want to get some certainty, in international law, [? I would say ?] [INAUDIBLE].

DAVID KOPLOW: Let me ask for show of hands. Because there are two views here. One is that it's not a nuclear-- that the nuclear [INAUDIBLE] device is not a weapon because it will not be used for hostile purposes. The other is that it is inherently and always a weapon because of its capabilities. How many of you would be inclined toward the first view, that it's not a weapon because of its intended purpose? Raise your hands.

STUDENT: Is nuclear weapon defined somewhere?

DAVID KOPLOW: Not defined. You're hoping there's an easy answer here. If there was an easy answer, I wouldn't have asked you. And how many think it's-- how many say it's prohibited because of its inherent nature? So it looks as if there's more on the first view, slightly-- close, but more-- so tell me more.

STUDENT: I can see the argument for the first view, but I would take the second view because it was custom in international law that might allow people just [INAUDIBLE] would allow nation-states to station nuclear weapons in orbit to say, well, we're just having them out there just in case more asteroids come. And, at that point, it would be difficult to distinguish that from the case [INAUDIBLE].

DAVID KOPLOW: Well, and, as a practical matter, if this came up today, the only nuclear explosive devices that

exist in the world are devices that were designed and deployed to be used as weapons. If you were going to use one against an asteroid, you would pull it out of a weapons stockpile or off of an existing ICBM or SLBM or some other-- and you would take that device and put it up against the asteroid.

We don't have any nuclear explosive devices that were developed for anit-asteroid use or for other peaceful purposes. Now, in the fullness of time, we probably could. Would that make a difference? If you started engineering something for the explicit purpose of using it as an anti-asteroid system, would that make a difference to you?

Or, since that device, too, could be a weapon and you wouldn't want countries to be able to evade Article IV of the Outer Space Treaty by saying, oh, no, no. We're putting lots of these things up in space and orbiting them over your country, but you don't need to worry about that because we're only putting them up there because someday there might be an asteroid, so it should be permitted by the treaty.

STUDENT: I think it's an easier question when you're talking about detonating it and deploying it just in case.

DAVID KOPLOW: OK. Well, let's take that one.

STUDENT: You wouldn't have a [INAUDIBLE] where it's hanging out.

DAVID KOPLOW: So just as we leave this deployment thing, I told you I've been doing some work with NASA. One of the activities on planetary defense has been that NASA and its counterpart space agencies from lots of other countries have started to study this. And they've started to explore planetary defense capabilities, one of which is a nuclear device.

They commissioned a group of lawyers from the different countries to write a report. And our report is now in the process of being finalized. And we adopt the position that it's the inherent nature, is what you control here-- that the device will always be a weapon, even though its articulated purpose would be for a non-weapons purpose. But, I've got to say, it's a contestable issue.

Actually, before we leave this, the usual mechanism for interpreting a treaty, under the Vienna Convention the law of treaties, is to construe terms in their ordinary sense and to pay attention to the object and purpose of the treaty. What's the object and purpose of Article IV in this passage?

STUDENT: [INAUDIBLE]

DAVID KOPLOW: What?

STUDENT: [INAUDIBLE] having nukes in space orbiting or on celestial bodies for military purposes.

DAVID KOPLOW: And so that leads you to the view?

STUDENT: That would lead to the view that it's inherently--

DAVID KOPLOW: It should be prohibited. Is there another way to construe the object and purpose of the Outer Space Treaty?

STUDENT: It's to use nuclear weapons to attack other countries-- to position them in order to blow up the asteroids, then that's [INAUDIBLE]. And that's not what this [INAUDIBLE].

DAVID KOPLOW: So, again, it leads you to this unresolved conflict about how to construe this sort of instrument. And that-- again, that's the state of the law on this point. You've now heard and said everything that can be said on this point. In 1967, the drafters of this treaty weren't giving all thought at all to oncoming asteroids.

Their only concept was that putting nuclear explosive devices-- nuclear weapons-- in outer space is a security threat. They use them against other countries, we want to prohibit that. Who knows what they would've said if somebody had said, well what about this possible peaceful use? In the 1960s and thereafter, there were concepts for peaceful uses of nuclear explosives.

In fact, there was a program in the United States, Program Plow Share, that undertook-- and comparable programs in Russia, and China, and elsewhere-- to use nuclear explosives for civil engineering purposes, the same way you would use conventional high explosives-- to reroute a river, to deepen a canal, to create an underground cavern for storage of natural gas or something. Mining operations use nuclear explosives for peaceful purposes.

And that was the thing, that people spent a lot of time and money investigating the possibilities of using PNEs. Ultimately, that proved to be a dead end politically, economically, environmentally. But even then, nobody was thinking about anti-asteroid PNEs. Nobody had that concept.

STUDENT: And there's some pretty serious research and experimentation going on and has been noted with respect to knocking asteroids off their path. What technology are they coming up with? Obviously, they're not using nuclear weapons, so what technology--

DAVID KOPLOW: So this is the very beginnings of this. People have-- sometime, you'll have to put on a separate event here for planetary defense. If I had known that John was going to be sick this morning, I could have come down early and I could have-- anyway.

STUDENT: Before he answers that, this testiness about time--

[LAUGHTER]

[INAUDIBLE] because when I [INAUDIBLE] every year [INAUDIBLE] entire body of the law of our [INAUDIBLE] in an hour and 25 minutes.

DAVID KOPLOW: It's true. It's true. And he complains about it. And so we have only the very beginnings of concepts for how to divert an asteroid. And one important aspect to this that I hadn't understood-- and we all went to law school so we wouldn't have to learn physics. And I still don't understand this.

But if you're trying to deflect an asteroid, the way to do it is not to nudge it to the side. The way to do it is to hit it straight on, which will slow it down a little bit, or to hit from behind to speed up a little bit so that when it intersects the Earth's orbit, the Earth isn't there. And for whatever reason-- you'll just have to take my word for it, because that's what I do to the physicists-- that's more efficient than nudging it to the side to change its trajectory.

So people have tried to figure out, how could you slow it down or speed it up? And the most obvious way is to ram a spacecraft into it, either head on or from behind-- to slow it down or speed it up. And the heavier your spacecraft compared to the weight of the asteroid, the more I could speed it up or slow it down.

And you wouldn't have to speed it up-- depending on the size of the asteroid and the trajectory and all, you might not have to speed up a whole lot. So the concept with this kinetic interceptor is that you would see this as-- step one, detect the asteroid a long ways away. So you've got years to be able to work on it and send up, maybe, multiple interceptors to crash into it to slow it down. Nobody's ever tried that.

For the first time, NASA is about to do that with a spacecraft that will launch in-- I guess next

year. They're aiming at a small-- many asteroids are complex structures. The one that they're aiming for is an asteroid called Didymos that actually consists of two bodies, a main asteroid and then a smaller asteroid that orbits around the main one. And they're going to ram into that small, orbiting asteroid head on and see if that slows down the "Didymoon" by a measurable amount.

And that might tell them how big a spacecraft you need in order to slow down an appreciable-sized asteroid by one form or another-- by one amount or another. So one concept, probably the most obvious, is to crash into it from ahead or behind. Another option that, again, is just on the drawing board-- none of this has ever been tried. But even without knowing the physics, it just seems to me sort of interesting.

And that is to use a spacecraft-- again, the heavier the better-- that would rendezvous with the incoming asteroid, but instead of crashing into it, would fly alongside it and would use the microgravity attraction between the asteroid and the spacecraft to sort of draw the asteroid toward the spacecraft. And the spacecraft would have thrusters that would incrementally move it a little bit away, and the asteroid would, a little bit, by microgravity, follow the spacecraft as it moves either faster or slower.

And, again, that seems kind of cool. I don't know whether it would work. There aren't even any experiments in that have been planned for experimenting with that kind of microgravity. Those kinds of options-- the microgravity, the kinetic interceptor-- do require that you have years or decades of advance warning.

If you don't have that, then using a nuclear explosive device to energize the volatile molecules on the surface of the asteroid and have them evaporate, or sublimate, and have that as part of force the act on the asteroid going the opposite direction-- that seems to most people to be the most plausible last chance aspect.

You probably would not want to, as Bruce Willis did, blow the thing apart. Because if you blow it apart, it's still following the same trajectory. It's still going to hit the Earth, but it's going to hit the Earth-- instead of in one big place, it's going to hit the Earth that many smaller places. And the physics of it suggest that that probably would mean that would cause even more damage on Earth than if it had one big impact. Or, at least, it could have an even bigger impact.

You may know that, with nuclear weapons, for example, one nuclear weapon on a target would have a certain radius, that would generate destructive blast and heat. But if you wanted

to do even more destruction, you would have three somewhat separated nuclear explosions-- even if the three of them were smaller. Even if the three of them combined have less explosive power than the one big one, the fact that they're spread out means that you do more damage.

And that's why many countries have pursued multiple MRV systems, or M-R-V systems. It expands the devastating power. If it blew apart an asteroid, it might have a similar effect of generating even greater damage through spreading out the impact area. Totally lost track of where we are now. You've collectively pulled me off the agenda. Let's try--

STUDENT: It just prevent your from proposing the difficult questions.

DAVID KOPLOW: Yeah, that's right. Let's try-- well, let's turn to-- I guess we're up to number five. So this is about detonating the device. We've tried to separate deploying it from detonating it. And then the question is, would it be legal to detonate in outer space? And here, I have to-- and to detonate for these purposes-- testing how well nuclear weapons work in space, or fighting a war, or destroying an asteroid.

And here-- I have to tell you, this a little bit of a trick question. I don't do this in my international law class, but with you I felt I could do that. It's a bit of a trick question because, although the focus here has been on the Outer Space Treaty, which is the single most important treaty, it's not the only treaty in outer space-- only treaty relevant to outer space.

And another treaty is relevant here, and that is the Limited Test Ban Treaty. Limited Test Ban Treaty from 1963 was principally designed to stop nuclear explosive testing in the atmosphere. During the 1950s, the easiest, cheapest way to test nuclear weapons, to develop better nuclear weapons, was to detonate them in the atmosphere. And that had the effect of spreading hazardous radioactivity around the world.

And therefore, there was a groundswell of support for stopping atmospheric testing and requiring, since 1963, that if you're going to test nuclear weapons, you've got to do it underground, in underground chambers where the radioactive effects would be confined rather than being spread through the atmosphere.

That Limited Test Ban Treaty does more than prohibit tests in the atmosphere. It prohibits tests in the atmosphere, in outer space, and underwater. And that treaty very expansively prohibits nuclear weapons test explosion or any other nuclear explosion. That is, even if it's not a test of a weapon, any nuclear explosion for any purpose, any description, is prohibited in

space by the Limited Test Ban Treaty.

It is, therefore, much more comprehensive than the Outer Space Treaty, which prohibits deployment of weapons in certain categories and leaves open the possibility that we've played with, that you could define a device as not being a weapon. The Limited Test Ban Treaty slams that door by prohibiting nuclear test explosion or any other nuclear explosion. You with me on that?

So then the question is, could you find-- is there any wiggle room around that for any of these purposes? Testing how well nuclear weapons work in space, fighting a war against enemy satellites, or destroying an incoming asteroid. I think the Limited Test Ban Treaty pretty well closes that down.

The important escape hatch that I was trying to get out there, with this question, was whether a treaty like the Limited Test Ban Treaty would apply during wartime. Is this the sort of treaty that would be considered to be suspended or operational during an international armed conflict? Again, blessedly, the world does not have any experience on this. I've never had the occasion to evaluate that.

STUDENT: [INAUDIBLE] galactic [INAUDIBLE].

DAVID KOPLOW: Right. So, fortunately, we haven't had-- the previous experiences with that has been limited, as well. But some people would say that the Limited Test Ban Treaty would not apply during an armed conflict, that if you're fighting a war against country X, including the possibly of a nuclear war against country X, this treaty would be suspended and not be operational during that armed conflict.

STUDENT: In outer space.

STUDENT: Is this [INAUDIBLE] because if it's not [INAUDIBLE].

DAVID KOPLOW: So you keep asking whether this treaty includes these terms and has these definitions, and the answer is no. This treaty-- again, reflecting the style of its times-- is a very bare bones treaty. It doesn't cover very-- it was designed to be the first piece of lawmaking for outer space, not the comprehensive, all-encompassing treaty for outer space.

So it doesn't address that and the Limited Test Ban Treaty doesn't address that. And in fact, most treaties do not explicitly address the question of whether they would be suspended

during an armed conflict. A well-drafted treaty, a thoughtful treaty that tried to address every contingency, might address that, but in general, treaties do not specify whether they are continued or suspended during a state of armed conflict.

And there is a small and obscure and not very precise body of law that tries to address the question of whether a particular treaty is the sort that countries participating in the negotiation and the drafting would have anticipated this applied during an armed conflict or not. And we got what we got on that. Other questions on that part? Yeah.

STUDENT: This is a kind of changing the subject just a little bit.

DAVID KOPLOW: Oh, sure. Why not?

STUDENT: Sure. Sorry. Just out of curiosity, where does the treaty define as the beginning of space? Does it apply to high-atmosphere balloons, for example?

DAVID KOPLOW: So, as I-- I think I mentioned earlier that space is not defined in this treaty or in any other treaty. And in part, that's because the United States and others have said, we don't know what's in our national advantage to define it as a high point or low point. We do know that the legal regime for outer space is different from the legal regime of airspace, but we don't know.

And it might, in fact, vary from application to application. There might be some circumstances where it's advantageous to have the line at as low as 100 kilometers and others where it would be advantageous to have the line as high as 100 miles. And so there's not a defined demarcation point, for this treaty or for any others.

The one place where this has come up a little bit is, who gets the special designation of being an astronaut? If you're on a balloon that goes up a long way, or if you're on an aircraft, a jet that goes up to a high level, at what point are you entitled to astronaut wings?

And that's a debated point, as well. And some people who have gone-- including tourists now, who can go as high as 100 kilometers on a suborbital flight-- if you've got $20 million, you can sign up for that. Are you an astronaut if you go up to 100 kilometers? And there's some debate about that. Other off-point questions that we should--

STUDENT: I think that the cases the [INAUDIBLE] are typical of [INAUDIBLE] of Article 62 of the Law of Treaties. And they call it a change of circumstances. Any [INAUDIBLE] of claim that [INAUDIBLE]. It's not clear. It's not clear. It's a potential argument to make.

If a situation of war, it's now a change of circumstance. [INAUDIBLE] in times of peace, what is a change of circumstances? If the potential destruction of the whole planet by an asteroid coming is not a change of the circumstances, what could be?

DAVID KOPLOW: Right. So you're probably generally familiar that, under the Vienna Convention, the law of treaties, which is the general-- the most authoritative source on how to interpret a treaty-- there is a section of that establishes the excuses for non-performance of a treaty obligation. And there are a variety of them that are, in some ways, comparable to the excuses that exist under domestic law for non-performance of a contract.

And they're quite similar. That, if there's been fraud in the creation of the treaty, or if there's been a material breach by the other side. The things you would excuse your failure to perform a contract, they have counterparts for failure to perform a treaty. And one of them is rebus sic stantibus, the changed circumstances.

And one could analyze an oncoming asteroid under that rubric. You could analyze the existence of a state of armed conflict as a changed circumstance. Under Article 62 of the Vienna Convention, on the Law of Treaties, however, changed circumstances is defined surprisingly narrowly. And international law is, in general, quite resistant to allowing countries to wiggle out of their treaty obligations by saying, oh, things have changed and therefore I shouldn't be held to that commitment.

There's been very little authoritative international case law on this point. But what there is erects a pretty high barrier against invocation of the changed circumstances-- including, for example, that the change has to be unforeseen.

If you could foresee it and you did not negotiate a provision in the treaty that would protect you if that eventuality occurred, then you can't invoke changed circumstances as an excuse for non-performance of your obligations. Maybe an oncoming asteroid was unforeseen in 1967-- maybe. But the possible existence of a state of armed conflict?

STUDENT: That was foreseen.

DAVID KOPLOW: That's completely foreseen. That's the one thing the world has plenty of experience with. And we know that happens, and therefore if you do not take care to negotiate an escape hatch in the treaty that protects you if there is a state of armed conflict, then you can't invoke changed circumstances.

STUDENT: Is it a UN treaty?

DAVID KOPLOW: Which?

STUDENT: The Outer Space Treaty.

DAVID KOPLOW: Well, so, what do you mean by a UN treaty?

STUDENT: Something that you would have the authority to go to the Security Council and ask them for an emergency resolution.

DAVID KOPLOW: So the Security Council can take up anything. And in fact, I mentioned that this group of international lawyers was trying to deal with the planetary defense scenarios.

Our bottom-line recommendation is that the use of a nuclear explosive device for a planetary defense mission would, in many circumstances, be incompatible with the Outer Space Treaty, with the Limited Test Ban Treaty-- for that matter, with the Liability Convention. We can go into that a little bit if you'd like.

And that, therefore, you've got to find some way around the law, some way to get out of the constraints of the Outer Space Treaty and the Limited Test Ban Treaty. Many people have the instinct of saying, well, if it turned out that the only way to save the planet from an oncoming asteroid was to throw away the treaties, to disregard the treaties, to ignore the treaties, that's what we should do. And that's a plausible instinct.

But our view is that, as lawyers, we should do better than that. We should find a way that preserves the rule of law, that formally sets aside the treaty obligations rather than just tearing them up or ignoring them. And so we went through the exercise of trying to determine, what about amending the treaty?

What about having the countries who are going to undertake the activity withdraw from the treaty? And these treaties all have amendment provisions and have withdrawal clauses. What about having the activities undertaken by countries that happen not to be parties to these treaties? And, for example, the Limited Test Ban Treaty never been joined by France and by China. So maybe there is an avenue there.

But our preferred method, the recommendation that we made, was along the lines you're talking about-- was to have the Security Council address the issue. And you probably know

that under Article 103 of the UN charter, the Security Council has special powers, under Chapter 7, to create new law. And those new rules created by the Security Council supersede prior treaty obligations.

So if the Security Council, acting under its Chapter 7 powers, decrees that the oncoming asteroid is a threat to peace and security and decides that particular countries shall undertake a mission notwithstanding the constraints of the Outer Space Treaty, or the Limited Test Ban Treaty, or any other international law, and authorizes and instructs them to do so, that Security Council resolution creates a new rule.

Doesn't amend the treaty. Doesn't dispose of the treaty. It supersedes the treaty as a rule of decision for those countries. And that's the avenue that we have in mind. Someone [? said ?] where you were going with that. And the Security Council could do that.

Of course, there are five countries that could prohibit the Security Council-- the five permanent members have the veto power. Therefore, this avenue would require the five of them to agree that this asteroid deflection mechanism is the appropriate response.

You have other questions on this, or should we-- We've got five minutes left. And I know we can't get through the rest of these questions. Do you have other questions about security in outer space that we should address, or where would you like to go for the last five minutes? Yeah.

STUDENT: I was just wondering about resources that might be found in space. [INAUDIBLE] talks about that or [INAUDIBLE].

DAVID KOPLOW: Tell us more what you have in mind.

STUDENT: Well, I've just heard that there is some minerals on the moon, for instance. I heard this anecdotally, and I really don't know if this is true.

DAVID KOPLOW: It's OK. There's only three minutes left, so make stuff up.

STUDENT: This could be rubbish, but so I've heard that there's helium 3 on the moon ant that the Chinese space program is [INAUDIBLE].

DAVID KOPLOW: Right.

STUDENT: When that happens [INAUDIBLE].

DAVID KOPLOW: So there are lots of resources in outer space that might be valuable in a variety of ways. One scenario is that one might find particular-- asteroids vary a lot. There are all different sorts of asteroids, and they're in different sorts of locations, and they're different sizes and configurations. They vary enormously.

But it's known that some of them are rich in materials that are scarce on Earth-- not just helium, but gold, platinum, resources that would be commercially valuable to mine an asteroid, recover that stuff, and bring it back down to Earth. But that might-- not today, but at some point, might be an economically viable mechanism for private enterprise.

STUDENT: [INAUDIBLE]

DAVID KOPLOW: And countries have-- the United States, and Luxembourg has done some-- have passed new legislation that would empower private corporations to do that kind of mining. That's subject to challenge, because the Outer Space Treaty-- the part that I did not give you-- says that you can't claim sovereignty in outer space.

And what would be the international mechanism for establishing your claim to the materials that you extract from the asteroid? And there's a substantial controversy in international law about that. In some ways, even more valuable than bringing platinum back to Earth is discovering water on other celestial bodies that you could turn into a power source-- not only to support human habitation, but as a power source that would fuel exploration into further in outer space.

As I said, the hardest part of outer space is escaping the earth's gravity. Lifting off the earth is still the limiting factor in exploration and exploitation of outer space. If you could find resources in outer space that you could use there to build your stations in outer space, to supply rocket fuel for outer space. If you could find stuff in outer space that you could use, that would be even more valuable. And people have begun to think about how you might do that.

The legal regime is quite incomplete on that. Sometimes people analogize to the law of the sea. And I don't know how much you've encountered that, where the resources of the deep ocean floor have been declared to be the common heritage of mankind and set up a regime for sharing the control over that, and sharing the benefits of the resources.

Outer space has not been declared to be the common heritage of mankind. There is a treaty

that's called the Moon Treaty that deals exclusively with the moon and does declare that the resources of the moon are the common heritage of mankind. And because of that, most spacefaring countries have not joined the Moon Treaty. And therefore, we are left with that sort of uncertainty as to what the legal regime for exploiting the resources of outer space would be.