Into the Headlines_ Episode 6: Watch this Space

Intro: (00.01) <ROCKET SOUNDS> Six, five, four, three, two, one – ignition. We have a lift off, we have lift off.

Speaker 1: (00.20) Space. Almost sixty years on from both JFK and Star Trek iconically referring to it as such, it is still the final frontier. But it's also changing. With the first orbital satellite launch from Scottish soil due later this year and Elon Musk's Starship rocket aiming to have people on the Moon by around 2025 and then onward to Mars in the 2030's; space exploration is no longer the domain of governments or national and international agencies. And that just makes it even more exciting. From the University of Aberdeen I'm Laura Grant. Strap on your jet pack, cause we're going Into the Headlines.

Intro music: (00.59)

Speaker 1: (01.12) Episode 6 – Watch this Space. I'm joined today by Professor Javier Martin-Torres, theoretical physicist and personal chair at the School of Geosciences; and Dr Maria Manoli, lecturer in space law at the University's School of Law. Welcome both.

Speaker 2: (01.28) Thank you very much.

Speaker 3: (01.29) Thank you very much.

Speaker 1: (01.30) Javier, Scotland and the University of Aberdeen aren't necessarily the first places that people think of when it comes to space exploration but we've got quite a bit going on here, haven't we?

Speaker 2: (01.40) Yeah, actually Scotland is a beautiful place to be in the first instance and the UK in general has been always a very nice place for space exploration. And Aberdeen is a very interesting place in particular because, I don't know if everybody knows this but there is a site in Aberdeen where there is a mineral and this place where this mineral called Macaulayite is found is the only place on earth where this mineral is. The only other place where this mineral is, is on Mars, of course this is not the point that attracted me to Aberdeen. I have always loved the environment of the city and the University itself and we started this group of planetary scientists from scratch so this is a new group that in more than 500 years of the University, it is the first time there is a department of planetary sciences but there has been a few researchers that have been contributing to research in planetary sciences, like John Parnell, who is still active at the University, and some other people that have been contributing in the past to a very nice history of planetary science and some papers about planetary science, space and about noctilucent clouds. I mean noctilucent clouds is a very nice phenomena that you can see in the summertime in Aberdeen, it's one of the best places in the world to see them, and those are clouds that are formed at more than 80km in the atmosphere and they are bright at night-time. Aberdeen is a unique place to observe them and we had an astronomer actually in the 70's or 80's that was working at the Cromwell Observatory at the University, he had an observatory of noctilucent clouds and those clouds are very important from an atmospheric point of view so there is a kind of tradition in studying space weather and studying planetary atmosphere but this is the first time we've had a department of planetary sciences in Aberdeen.

Speaker 1: (03.48) I love that we have the mineral that's found at the base of Bennachie, I think they should put that on the welcome signs to Aberdeenshire – 'twinned with Mars'. That would be amazing.

Speaker 2 (03.58) <laughs>

Speaker 1: (03.58) You've described the time that we are living in as being the golden age of space exploration – what do you mean by that?

Speaker 2: (04.05) Yes, actually we are in a time where we see that there is a huge increase economically in investment all around the world about space exploration. There are many companies in the world now, some of them are very famous like SpaceX, but there are hundreds of companies that start every year all over the world and we have, very recently I heard a prediction from one of these broker companies in the United States where they said that in 10 years the investment of space exploration in general will be around three trillion dollars, which is a massive amount of money and very importantly most of this economy will be moved by companies not, as traditionally it has been, by space agencies. Actually right now we have it that space agencies like NASA rely on rockets launched or built by SpaceX, for example, a company. So we have this transition that goes from the traditional space that was governed by governments and space agencies, to a new era of space that will be governed by space companies. Also you just have to look at the last five or 10 years, the space exploration, the space launches that we had, hundreds of them, satellites – I mean we have a constant constellation of satellites around the world that is used for telecommunication; so we are living in an era where there is a lot of launches, a lot of space developments that there has never been before. It is very popular and famous, that period of the Cold War where the United States and Russia were fighting to be the kings of space and to be the first to go to the moon and the first to launch an instrument to space, and that period of time was kind of bimodal, there were only two participants in that career but now we see that it is all over the world that we have countries able to launch instruments into space. For example we have not only the United States and Russia, we have Japan, we have Sweden, we have Israel, we have India, we have China – we have all of these countries they have the capability to launch instruments into space, so I see that now we are really living in the golden age of space exploration.

Speaker 1: (06.39) Space is cool. There's no two ways about it. It easily captures the imagination but how easy is it to transfer into a career? The rise in private companies involved in space exploration must be making that easier, is it?

Speaker 2: (06.52) Oh yeah it is, absolutely. Actually we have currently a Masters in Planetary Sciences at the University of Aberdeen and the way that we advertise it is that we try to communicate to students or to people in general that there is space for everybody in space. Because in the future if we have colonies on the moon or Mars when we have a space gateway around the moon, we will need people working in many different fields. We need medical doctors, we need nurses, we will need lawyers, we will need biologists, chemists, physicists, engineers of course, so we need people from all branches of science who will have a contribution in space. So we cannot say that in the past we were always thinking about space as something just for physicists, engineers, mathematicians and things like that, now we are going to have the opportunity very soon to have more astronauts only going to the International Space Station but also landing on the moon, trying to go to Mars and land on Mars, so we are going to have a lot of opportunities for people from all the different fields to participate in space, not only to working for space agencies, as I said before, but also for companies which are going to be, I think, the biggest stars in the future.

Speaker 1: (08.14) We've spoken about Mars, you and your team are involved in the Mars Exploration Research Programme, what can you tell me about that?

Speaker 2: (08.20) Well this is an ambitious programme I have to say, and I say ambitious only because its relying on international collaboration, which is always difficult,. For example we have developed an instrument that is in the ExoMars platform that is not going to be launched soon as, due to the war between Russia and Ukraine, the mission has been stopped for the moment. So its ambitious because we have to rely on international collaborations, its' also a very expensive mission where there are missions that have to be planned many years ahead so from the time that you have an idea of a space instrument to the time when it is really operating it could be 10, 15 years. So every instrument in every mission has these long-term thoughts, this long-term process, this long-term funding too. We need to keep people working for many years in one project. Some of the people, they leave, because they find another opportunity, they change cities, they change country, so it is very hard to keep running one project for 15 years in general, and so space is challenging in that sense. And this Mars programme is now divided into three different stages. The first stage is to have instruments in what is called low earth orbit, so we already have that, a lot of satellites are spinning around the Earth, observing the Earth, so that one is already accomplished. The second stage is to have what is called a Gateway, it's another International Space Station but this one is not going to be around the Earth, it's going to be around the moon. So there will be international space station, in this case called Gateway. It will have contributions from the many different countries and space agencies and it will put the basis for transportation of material from the Earth to the moon; and at the end we are going to have a base of astronauts on the moon, either temporarily or permanent, this is to be decided yet, but its likely to be a base likely in the south pole of the moon. And then the third step is going from there to Mars. So it's a very long term and ambitious project involving many different stages. And that exploration of Mars, it has within itself different stages too. One of them, and this is within what we call the Mars Sample Return Programme, this programme has the idea of bringing samples from Mars to Earth and the first stage of that programme has already started, it is the Perseverance Rover which is now on the surface of Mars, this is a NASA Rover which is now making holes on the surface of Mars and taking samples, so it is storing the samples and leaving some of them on the surface. Then there will be another spacecraft in the near future that will go to Mars and will grab all the samples. And then after that, there will be a rocket from Mars that will send the samples to space and another aircraft that will be orbiting Mars will take them back to Earth. So it looks like a science fiction movie and its something that will happen in the next 10-12 years, and this is the first step to put a man or a woman on Mars. It will be the first step because we want to know if, for example, there is life on Mars. We want to know if those samples are able to hold life on Mars. That will be a very important discovery; and also one of the reasons that we want to take samples from Mars and we are not launching astronauts to Mars yet is because we want to know very well the environment of Mars. If you want to send your kids to a place, you want to know how the environment is, you want to know if there is danger there, you want to know everything very well. So we want to send astronauts to Mars and we want to know that they are not going to suffer anything there as something that we are not predicting. We want to know exactly what the conditions are, we want to know how are the radiation levels, what kind of dangers they can find on the surface. We know that the surface of Mars for example is full of perchlorates, those perchlorates, when they become humid are a bleach, so the astronaut will be stepping on bleach, so they will be exposed to a high levels of radiation, to extreme temperatures – so we need to characterise that very well before we send astronauts to Mars.

Speaker 1: (12.58) And is there always going to be a need to send people? Is there not a point where technology overtakes man's ability to do something or is there always going to be a role for humans?

Speaker 2: (13.09) Yeah, I think that as humans we want to explore, we want always to reach limits that we haven't seen before. I mean we've been to Antarctica which is probably not the most nice place in the world and we've seen people like Scott suffering to reach those places and dying in the process, and still we try. Even, you've seen this Mars One Mission, that they were asking for people to go to Mars in a one-way trip and still they had a lot of people that wanted to do it, I mean, so I think its human nature to want to explore. I think the future of Mars exploration and in general solar system exploration, because its not only Mars, after Mars we have, for example, very nice moons in Jupiter and Saturn that they have surfaces like Mars, Titan for example has lakes; there are other places to explore and I think the long term future of planetary exploration will be developed by artificial intelligence. I think that artificial intelligence is growing exponentially with time. We see that more and more algorithms and very intelligent algorithms have been developed in the last years and I think that at some point we will have robots that will be able to use artificial intelligence and take their own travel decisions on Mars without the need to expose live astronauts. Also it will be much less expensive to go to another planet if we don't have to feed astronauts, if we don't have to have water for them, if we don't have to have food. We don't even have to have this robot back to Earth, we can educe a lot of expenses for missions.

Speaker 1: (15.02) I'm really interested to know a little bit more specifically about the instruments that you are involved in developing for the Mars mission. Can you give me the elevator pitch on what they are?

Speaker 2: (15.13) Yes, we developed in the past an instrument called REMS that is now in the Curiosity Rover, it's been operating on Mars for more than 10-12 years now, and that instrument was a meteorological station, so every time you see the weather on Mars, it is from our instrument actually. So we have developed a more advanced form of that instrument, this time again it is a meteorological station but at the same time it is an in-situ research observatory instrument. The instrument is called HABIT, that stands for HabitAbility, Brine Irradiation and Temperature, and this instrument will produce liquid water on Mars. So it is a prototype of how to produce liquid water on Mars, and that is an interest that will kind of pave the way for future human exploration of Mars because with this small instrument that is now a prototype you can develop a larger scale of that one and, for example, produce water than can be used for a greenhouse or to feed astronauts.

Speaker 1: (16.15) Now Maria, I feel like we've spoken about a couple of areas where the law might come into play and I'm sure you have some thoughts on that to share but, for context, the University was one of the first in the world to incorporate space law into its research curricula back in the 1980s - you joined the fold last year. Why was the University of Aberdeen the place to come for you?

Speaker 3: (16.33) Yes, absolutely, Aberdeen has a history in space law with Professor Lyall, one of the most well-known professors in the field having taught space law in the Law School for many years so that's what drew me to the University of Aberdeen. It's tradition and history in the field, it's course in the field and also the fact that I was not going to be the first one introducing space law in the curriculum in the Law School but I was going to be the one reviving it. The University of Aberdeen is very, very well known to everybody that conducts research in space law, together with other universities with tradition in the field such as McGill and University of Cologne, so it's one of the very, very few universities worldwide that were able to offer me an environment with tradition in my area of expertise and coming to the University of Aberdeen I've met colleagues like Javier with vison and involvement in so critical projects for the future of humanity and that's something that really confirmed my decision to come, I've really found what I was looking for.

Speaker 1: (17.37) It's really great to hear that. Now, I have to ask, if this is the golden age for space exploration, is it also the golden age for space law? Or has the law not kept pace with how technology and the industry itself has evolved?

Speaker 3: (17.49) International space law was produced in the 50's and the 60's so it's not a new field of law like a lot of people think, it's quite an old one. It was produced during the tensions of the Cold War and the two main countries that actively participated in the negotiations for the five UN space treaties were the two superpowers of that era, the United States and the former Soviet Union. So international space law emerged through the Cold War period and the purpose of international space law was to secure peaceful uses of outer space. Now, of course, it emerged out of necessity to provide a field for cooperation in space exploration and that was its main purpose, it did not foresee modern space activity such as space tourism, for example, or space mining or mega-constellations and things like that. Now modern space law and the production of modern space law is called upon to fill these gaps but at the same time, because of the very general nature of international space law as it was produced in the 50's and 60's it is able to cover a broad area of activities because space law itself is very broad, it's mostly a field of principals rather than detailed truths and it has the capacity to govern and cover and address modern challenges as well, but the truth is that the last internationally binding instrument that was produced was the Moon Agreement which was signed in 1979 and entered into force in 1984. Since then there is no internationally binding instrument produced to regulate the uses of outer space. It's many decades since then and many more activities have been introduced so it is true that it's a golden age for space exploration and perhaps it is a golden age for further regulation of space activities but that being said the existing international legal framework is sufficient to regulate the broad scope of even modern space activities. Just a tiny, tiny comment on the Mars Sample Return Mission, it's something actually that space law addresses clearly and there is an exception to the Non-Appropriation Principle when it comes to return missions. So governments, when it comes to scientific missions, they can extract and own space resources for further exploration and we see here how space law really tries to enable scientific exploration of outer space and how collaboration between law and science has always been at the forefront of international space law.

Speaker 1: (20.36) What are some of the big-ticket items? Responsibility, I imagine, for things, is a bit of a hot topic. Environmental concerns - debris, territory, patents – can you tell us what the big questions are and how it works in terms of the legal landscape?

Speaker 3: (20.51) Absolutely, there are several issues that have been coming up all these years. The issue of responsibility is quite a complex and interesting one. In the field of space law governments are responsible for the activities of their private entities, their non-governmental entities. So when a private company launches a satellite or engages in any other space activity their government is in fact responsible for this activity, simply because they have the obligation to authorise and continuously supervise their activity. The private company will not be responsible internationally for their own activities but their government that had to authorise and supervise this activity will always remain internationally responsible for them, and part of this process is the licensing, so when a government licenses a space activity they have to make sure that this activity will be in accordance with international law and will respect international legal rule. So that's one issue that comes into question nowadays, simply because involvement of private actors and the influence of new space actors is exponentially growing. Other areas that need further regulation or simply further thinking, like you mentioned is the environmental protection of outer space, the production of space debris which is now becoming an issue more than ever before, the regulation of space debris does not exist, it consists simply of soft-law instruments, meaning non-binding

instruments, guidelines, manuals that are not binding among states so it is up to the goodwill of states to follow them or not, and to the internal policies of states and private companies. And of course one of the major issues is space mining, one of the most exciting but at the same time challenging issues. Space mining involves, of course, the extraction of minerals from outer space, from the celestial bodies of outer space, and that inherently involves the question of whether this is legal or not, simply because space law prohibits the appropriation of parts of outer space, so how could we mine something, how could we extract something and perhaps even sell it at a second stage, for the private companies perhaps might want to sell it at a second stage – how can we do that if we can have no property rights over parts of outer space? And so here we see the shift from the global to the local, and from the international to the national, simply because several states such as the US and Luxembourg that are very active in space regulation and the regulation of space activities, they are willing to provide a facilitative environment for private companies and an environment that will attract them and could make them feel secure that profit can be a result of such activities. So they produce domestic laws that allow for the appropriation of parts of outer space and they have been very successful. The US was the first one in 2016 to introduce such a law, and Luxembourg followed; and Luxembourg introduced their law in 2017 and within approximately a year they really attracted an amazing number of private companies into their jurisdiction but at the same time international law remains binding, so there is a conflict there between the national and the international and we see that whenever the international doesn't cover modern activities we see a shift and a tendency to regulate from within domestic forum.

Speaker 2: (24.23) I have a question for Maria. I am going in two weeks to Luxembourg because there is a space week there organised by the European Space Agency and they have this Master in Space Law and have passed this law. Is it a real thing or is it something more like an invention or a way to attract companies to Luxembourg to invest money there?

Speaker 3: (24.47) I'll just say that Luxembourg has been very successful in achieving what they wanted to, to attract many, many private space companies. So I see Luxembourg as the hub of space exploration, European space exploration, or potential hub, but I also see Scotland being able to take such a role in the future. I've been reading about the strategic geographical position of Scotland and how easy it is to perform launches from Scotland and how cost efficient it might be so I'd say, yes, Luxembourg has taken the lead but maybe Scotland should follow.

Speaker 2: (25.22) Yeah, we should try it. <LAUGHS>

Speaker 1: (25.24) We could get some University funding I'm sure, for something.

Speaker 2: (25.26) Yes

Speaker 3: (25.26) <LAUGHS>

Speaker 1: (25.28) Javier, how often do you bump into the law in terms of the activities you are doing? Is that something you think about or just something you have to deal with?

Speaker 2: (25.35) Yes, it is actually something that is very important. As I said before, international collaboration is very important, so international law applies. So I have a clear example today, our HABIT instrument that was going to be part of the ExoMars Mission is in the ExoMars platform right now in Italy, in Torino and because the platform is from Russia, it was developed in Russia, because this project ExoMars was an international collaboration with the European Space Agency and Russia, now we have that we cannot access the platform, we cannot touch the platform because its Russian, but the platform is located in a

European place, in Italy. So the problem now is that Russian personnel from IKI, the Russian Space Agency, cannot access Thales Alenia because they don't have permission due to the war and we are just waiting to see when they get permission to access and they can send our instrument back because something important that I haven't mentioned is that we have received a grant from the UK Space Agency, something called bilateral grants, to collaborate with another space agency and in this case the idea is that we are going to have HABIT being part of the first Japanese mission to Mars. So international law is important and in general all these big projects they are a joint effort between many countries so it is very important of course, you know.

Speaker 1: (27.19) It sounds like you can also spend years planning and testing and spending an awful lot of money and then something unexpected happens and pffft! It's over, or you have to wait for years for another window to come round. Is that frustrating to be part of or does the scale of what you are doing outweigh the downside?

Speaker 2: (27.42) Yes, it's part of the business I would say, I think it's accepted. Of course it's very tragic when it happens. I mean when I was working at the Jet Propulsion Laboratory in California I was part of a mission to analyse the data from CO2 in the atmosphere. It was a project they had been running for 15 years and I was at the launch site and the instrument fell down into the Pacific Ocean in three minutes, after launch.

Speaker 1: (28.12) Oh god.

Speaker 2: (28.12) So all that work from a lot of people working for 15 years was lost in one second. So yeah, it was tragic but I think it's part of the business, I mean we see other examples. Actually, in the history of Mars exploration, I think that around 50% of the missions have failed.

Speaker 1: (28.34) Really!

Speaker 2: (28.34) So it's a lot, yeah. It was mainly at the beginning, in the 60's, 70's and 80's. Now in the last years we've been more successful but still there is a risk that the mission is not successful, there is always that risk. By the way, before I forget, I've been looking at the numbers, you asked me about the golden age of exploration and there has been 250 robotic space crafts launched, and humans on the moon we have 24. And in the last 20 years we've had more than 600 people that have been in space as astronauts and the number of launches every year of satellites is about four hundred, and this is increasing with time, so we are really living in an age where space is becoming more and more important and our lives rely on space. One of the courses that we teach in the Master is about space weather and we were discussing today how catastrophic it would be for all of us if one day the Sun sent a lot of energy to the Earth and killed, for example, all the satellites of communication. We would be lost.

Speaker 1: (29.58) That would be it, wouldn't it. No telly, no phones.

Speaker 2: (29.59) No, even no ATMs and no phones, no internet. We'd be lost. It would be quite cathartic but we rely on all these space crafts that are in orbit around the Earth.

Speaker 1: (30.15) One last question from me. Would you like to go to space?

Speaker 2: (30.18) Are you asking me?

Speaker 1: (30.19) Yes, both of you.

Speaker 2: (30.21) No.<LAUGHS>

Speaker 1: (30.23) No?

Speaker 2: (30.25) No. You did say at the beginning, I'm a theoretical physicist. <LAUGHS>

Speaker 1: (30.28) Feet firmly planted on the ground.

Speaker 2: (30.30) Yeah, yeah, yeah. And definitely I would not go to Mars. The more I study Mars the more I see how dangerous it is. <LAUGHS>

Speaker 1: (30.39) Apart from the no oxygen thing it's a fairly hostile environment all round.

Speaker 2: (30.42) Exactly, exactly, But I appreciate that others do it. That's great. <LAUGHS>

Speaker 1: (30.38) what about you Maria? Any interest?

Speaker 3: (30.51) Well in space law, the biggest part of space law scholarship characterises outer space as an ultra-hazardous environment, so I'd say no.

Speaker 2: (31.01) <LAUGHS>

Speaker 1: (31.02) I think we're all in firmly in agreement on that one.

Speaker 2 & 3: (31.04) <LAUGH>

Speaker 1: (31.05) And on that happy note we're going to have to bring this conversation to a close. Thank you so much guys for taking part, it's been brilliant. I say this every time I do one of these podcasts but this has been so interesting so thank you so much for giving me the time.

Speaker 2 and 3: (31.18) Thank you very much.

Speaker 1: (31.20) And thanks to you for listening. I'll be back soon with another dip into the headlines from the University of Aberdeen but if you just can't wait, you know what to do. Visit abdn.ac.uk/news to catch up on all the latest announcements.

Outro music