



**IOP** Institute of Physics

# **Shaping UK space science strategy**

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# Introduction

On Wednesday 31 July 2024, the Institute of Physics (IOP) hosted a dinner and roundtable discussion with 20 individuals from the UK space science and related sectors. The purpose of the event was to begin a process of articulating the importance of a strategic plan for UK space science and to consider some of the parameters that could shape it.

Attendees were high-level stakeholders from government, academia and industry, including:

- UK Space Agency
- Department for Science, Innovation and Technology
- Universities
- Royal Society
- Royal Astronomical Society
- UK Space Partnership
- Science and Technology Facilities Council
- RAL Space
- Large and small businesses
- Institute of Physics (IOP)

The aim of the dinner was to gather a range of views and insights on space science in the UK. By bringing together key thought-leaders and decision-makers, IOP seeks to facilitate a robust discussion around space science's strengths and weaknesses, and explore national and wider environmental opportunities and threats.

Following opening remarks from some key stakeholders, discussions, facilitated by Professor Tara Shears, IOP Vice-President for Science and Innovation, focused on three areas which each guest was asked to consider:

- Why is UK space science important and what are UK space science's strengths and weaknesses?
- What opportunities and threats might impact UK space science?
- Ideas related to shaping the strategy.

These discussions were held under the Chatham House rule. This readout paraphrases and summarises what was said. Some comments are reported verbatim but none are attributed. All comments reflect individuals' personal views and do not necessarily represent the views of any organisations or government policy.

## Findings in brief

The conversations detailed in this document covered a number of important issues about the UK space science sector, the need for a strategy to help it advance, and some of the wider challenges it faces. This section gives an overview of these points.

### Importance of the UK space science sector, its strengths and weaknesses

Space science presents a huge opportunity for the UK across research and innovation. Space science uncovers fundamental truths about our place in the universe, drives innovation, skills and new technologies, and inspires participation in science, attracting students from around the world to UK universities and enabling UK companies to recruit the best graduates. Space applications can support strategically important activities including defence and security, and climate science.

The UK sector is relatively small compared to some other countries, but has a wide range of strengths, including an innovation and research base spanning multiple disciplines across 50+ UK Universities around the country, and the ability to attract significant human capital. It is however perceived by some as over-dependent on ESA, and struggles with long-term strategic planning. The size of the sector could also be an advantage as it should provide more opportunity for coordination and effective collaboration. While human capital was flagged as a strength, particular weakness was identified in the UK's ability to develop skills, with a bottleneck around physics teachers in schools.

### Opportunities and threats

Opportunities for the sector were identified in relation to political changes in the UK which are resulting in fresh thinking and new perspectives. Changes in the global space sector, with the entrance of new players, and significant challenge to incumbents, are also creating opportunities. These changes are leading to opportunities for the UK space sector to work in new ways, which could help to address issues such as skills shortages.

Conversely, participants identified risks associated with failures to act on these opportunities, or failures to implement them properly. For example, while longer term investment could be transformational, an inflexible long-term commitment could prove burdensome over time and fail to capitalise on changing circumstances. Other threats included systemic issues such as the health of the university sector and wider physics ecosystem, geopolitics, and physical barriers to the sustainable use of space. Finally, there

was the issue of the culture around science in the UK, and the need for system players such as funders and the government to recognise the value in failure more effectively.

### **Recommendations for action and key issues**

The final part of the discussion sought recommendations from participants for actions the government could take in support of space science over the coming decade.

- The need for a well-supported long-term space science strategy was universally recognised. The new UK government has indicated an intention to invest for the long term in science. Currently the structure of ministerial responsibilities, and ownership of aspects of space strategy is widely distributed. At the same time, the community has great strengths and is small enough that it has the potential to come together to be more than the sum of parts. It is important that the government works strategically to support long term planning for space science, which will give confidence to international partners, our universities and the private sector.
- The value of a strategy process, including all the relevant stakeholders, with clear roles and responsibilities, and accountability, that takes some difficult decisions for the benefit of the community over the long term, came through in various remarks.
- A strategy could enable UK companies and research institutions to benefit more from the commercial opportunities, and to further build its reputation to work with a broader range of international partners on science missions, including developing opportunities to partner with NASA, while maintaining and building important role with the European Space Agency (ESA).
- It could address structural skills issues which threaten to hold the sector back, such as the financial health of the university system, and how they work with each other, and industry. Equally, broadening participation in physics is key to the future health of technology sectors but is undermined by a failure to recruit specialist physics teachers in schools.
- Important additional arguments were made about the need for a national strategy to include academia and industry: recognising the important role of primes in large scale science endeavours as well anchoring an ecosystem where UK SMEs benefit as part of the supply chain.
- Finally, the space science community must also consider its role in support of government – and articulate how space science can support solving challenges in our everyday lives.



# Summary of opening remarks

## **Tom Grinyer, CEO, Institute of Physics**

Tom Grinyer began proceedings by welcoming attendees. He introduced the evening as the start of a conversation. With stakeholders like the group assembled, we can help articulate the importance of a strategic plan for UK space science and articulate some of the parameters that could shape it.

Tom went on to outline the new IOP strategy and its three key areas of skills, science and society. To deliver the strategy, IOP has embarked on impact projects to strengthen physics in science, innovation and technology. Previous impact projects have focused on quantum and semiconductors, helping shape national strategies and influencing long-term funding commitments of £3.5 billion. Current focuses are the green economy, venture capital and space.

Within the space project, IOP will be looking at skills for space, science for space and society, with plans to look at the hidden impact of space in our everyday lives and across traditional economic sectors like transport, agriculture and finance.

## **Michele Dougherty, President-elect, Institute of Physics**

Michele talked about her career and life-long passion for space. She led teams developing instruments for the NASA-ESA Cassini-Huygens spacecraft which flew to Saturn, and the recently launched ESA JUICE spacecraft which flies to Jupiter's icy moons.

The UK punches well above its weight and has leading roles in various vital international missions as well as in bilateral missions. The UK's space sector added £7 billion in value to the UK economy.

Michele invited guests to consider how to build on the strengths of the UK's rich space science base. how to harness space science to boost the space sector, and how to harness space science and tech capability in traditional sectors to kick start economic growth.

## **Paul Bate, CEO, UK Space Agency**

Paul began by thanking the IOP for organising the meeting. He spoke about the rapid progress made in space science over recent decades, pointing out that 30 years ago no exoplanets had been discovered.

He noted that Patrick Vallance is highlighting the value of discovery science. One third of all UKSA spending is on discovery. Missions taking place today are built on science undertaken by previous generations, which means we have a big responsibility today.

Paul closed by outlining the major funding challenge amid recent announcements from the new chancellor that some government programmes are being cut. Without funding we cannot do what we want in space science. Therefore the 'case for space' is very important.

**Miriam Grigg, Deputy Director, Department for Science, Innovation and Technology**

in her comments, Miriam explained the responsibilities of the new ministerial team at the Department for Science Innovation and Technology. Peter Kyle is the Secretary of State and Sir Chris Bryant's Ministerial role covers overall space policy. International science and research, including space science, falls within the portfolio of Lord (Patrick) Vallance, Minister of State for Science, Research and Innovation.

Miriam stressed that it is still too early in the government's tenure to make firm policy commitments. But the Secretary of State has indicated that none of the government's five missions for national renewal will succeed without innovation. Space science is a vital part of this. The Secretary of State has set out his intentions for ten-year R&D plans for the UK, providing long-term certainty for the scientific base.

# Readout of conversation

The next section covers the following areas of discussion:

- Why is UK space science important and what are UK space science's strengths and weaknesses?
- What opportunities and threats might impact UK space science?
- Ideas related to shaping the strategy.



# Why is UK space science important and what are UK space science's strengths and weaknesses?

## Why is UK space science important?

Most responses to this part of the question related to the instrumental value of space science research, as a catalyst for innovation and technology, and as a means to attract people and develop strategic skills.

However it was also said that “We should not be afraid to say that the reason we do it is to understand humanity’s place in the universe.” Many people noted the excitement that space science generates, particularly in young people.

## Research and innovation

There was acknowledgement that space science research is challenging and highly valuable for discovery phase research. “All the weird stuff in science has come from space” quipped one participant, citing research on neutrinos from the sun.

Others made a link between this early-stage research and technological innovation. For one person the nature of space science was a driver of this process, making it unique as a discipline:

“{Space science poses] questions that we don’t know how to answer. It forces us to invent technologies to enable answers, which produces spin-offs that we have no idea about when we start work.”

Another noted that “things we do in space inspire things that we do here”. Space science leads to innovation because of the constraints it places. For example, the challenge of getting things into space led to the development of micro-scale technologies, which seeded a huge global industry. Funding constraints have also driven people to be creative.

Space science is important because there is some unique science that can only be done through space. It delivers unique technologies.

Space science was also identified as important because of its links with other physics disciplines and industries, such as climate science, defence and security. This means there is a strong economic case.

### **Capacity to inspire**

The most commonly expressed view was that space science is important because it is inspiring and helps to attract people into science and engineering. As one participant asked: “Why do governments fund space science? Because it gives back a workforce with strategic skills.”

Several others noted that space “drives the imagination” of young people. One person said that they see space mentioned often in applications for university physics courses.

The IOP’s recently launched exhibition on ‘Mimi’s Space Adventure’ was cited as evidence that space excites children. One person described space as “very tangible” in this regard. The importance of attracting young people from an early stage was a theme that recurred throughout all parts of the conversation.

### **Strengths**

Guests described a range of strengths for the UK space science sector. One speaker said that the UK space sector as a whole is growing faster than the sector globally (which is itself growing fast). While data shows that there are good numbers of people engaged in space science in the UK, and a strong innovation base at universities, different opinions were expressed about which parts of the UK sector were strongest.

### **Innovation and research base**

While it was noted by multiple speakers that part of the UK’s strength in space science is its disciplinary diversity, individuals pointed to different parts of the ecosystem as examples of particular strength.

A clear line of argument was that UK strengths are ‘upstream’ – i.e. that a lot of the social, economic and environmental value in the UK sector is derived from innovations and techniques that enable space science – demonstrated by expertise and capability in ground stations and building a domestic launch capability. But the UK also has clear ‘downstream’ strengths in the design and operation of services that generate specific value from space data.

It was also argued that the UK is “punching above its weight” in data and research, and another speaker said they thought ground-based astronomy programmes were complementing a lot of work in space.

Others pointed out that the UK has expertise in a wide range of disciplines in adjacent areas, including AI, quantum, photonics, materials, optics, communications and robotics, and it would be useful for other government strategies where relevant to make the link to the space sector as a driver and user of these disciplines.

Several speakers concluded that the breadth of strengths in the UK indicates that UK strategy may have challenges in deciding where to focus.

### **Human capital**

Another key area of strength for the UK space science sector is its people. It was often observed that people working on space in the UK are “creative” and “innovative”, that there is “lots of talent” and a “spread of skills”. The UK is able to attract people to come and work here.

Some speakers argued that the UK boasts some world-leading space scientists (including around the table at this event). An example was given of a NASA scientist who flew to Scotland to visit an academic there. A point was also raised about the strength of public advocacy for space in the UK.

### **Weaknesses**

Participants identified a range of weaknesses in UK space science. Some of these related to the scale of the sector compared with other countries, and the UK’s relative influence in multinational activities. Others were to do with how the sector is organised, particularly in relation to long-term planning and skills.

More generally, but linked with the health of the space science sector, one speaker observed that the UK’s geopolitical context has changed significantly in the last few years. The UK risks decline and it is important that the industrial base is supported.

## Relative scale and funding

The UK space science sector is quite small compared with other nations. Figures cited at the event said the UK's sector is about "a quarter the size of France's; half of Germany's, and smaller than Italy's". It was reckoned to be about level with Spain and Norway.

(In the later discussion on opportunities and threats, this point was reiterated as a threat, when a speaker noted that the UK has great scientists but not enough science programmes compared with competitor countries like Germany and France.)

It was also noted that a weakness is funding levels, but one person expressed a view that the UK is never going to compete with the major players in terms of funding. (Later in the discussion, a speaker said that the US space budget is 0.2% of GDP – which in the UK context would translate to around £4bn). Therefore it is important to be strategic and enable strategic funding by choosing particular parts of the sector to support.

## Relationship with ESA

ESA was seen by several attendees as both a strength and a weakness. While they recognised ESA has an important role to play for the UK, providing opportunities and enabling UK scientists to work on large flagship projects, some frustrations were also in evidence among guests about the nature of the relationship.

People expressed frustration at the UK's dependency on ESA settlements. In the absence of a more independent space programme, "we risk becoming a component provider for ESA, not a systems provider".

This dependence on ESA makes UK companies and research teams vulnerable as there are long gaps between projects, and the timetable is set by others. The UK's international standing was seen as a weakness as the UK does not have the negotiating power of other nations.

Several people argued that an important focus should be on developing more bilateral relationships with other countries as a counterweight to this weakness. Bilateral links would provide greater agency for the UK.

## Long-term planning

Most participants identified a weakness in long-term planning for the UK space science sector. This is partly linked with the challenges of working as a junior partner in multinational projects. Because these projects take a long time, they require a long-term approach to management.

The weakness in long-term planning also relates to a failure to take an “end to end” or “systems approach” that looks across the whole space science sector. One person spoke of a tendency to “spread bet” rather than think strategically in the long term about where investment is needed. Another argued that this failure to plan for the long term has meant that “we build very good technologies but we don’t always hang on to them” as they are lost to other countries.

## Skills

The planning issue was most strongly linked with skills requirements. As one participant said: “If we want to make space pay off in terms of skills of the economy, a long-term approach is needed”. It was further argued that we should think of space skills in terms of their benefit for the whole economy.

There were many different articulations of the skills issue. Some speakers noted that the skillsets required for a healthy sector extend beyond space scientists and should include non-scientists.

Others described a pipeline issue with skills, pointing to a long-term decline in physics uptake at school when compared with other sciences. Linked with this is a shortage of qualified teachers, and challenges of perception. One speaker argued: “We need to fix skills problems upstream instead of fighting amongst ourselves to attract people downstream.”

Fuelling the skills shortage, one person argued, is a sense that science still isn’t ‘cool’. They made a comparison with the respect that Olympians receive.

This comment was later developed by someone else who argued that space *is* cool but that there is generally an association with America rather than UK– as exemplified by the popularity of NASA T shirts. The weakness therefore may be that the ‘coolness’ of space science is not associated with the UK sector.

# What opportunities and threats might impact UK space science?

## Opportunities

The group identified a large number of opportunities for the UK space science sector. For many people around the table, these related to the context of a new government and ministerial team, and the fresh start that a new government represents. Several people spoke about the opportunities that a UK space science strategy could deliver.

## A moment of change

There was praise for the new government's science minister's approach so far, with reference to comments he had made framing the UK as a trustworthy partner. By creating consistency and clear long-term goals, the strategy can help to build investor confidence.

This is in contrast to earlier episodes where the UK wasn't seen as a reliable partner. One attendee told the story of the Cassini project, which the UK almost pulled out of, which would have greatly upset relations with other space agencies and damaged the UK's reputation.

Related to the change of government, one participant flagged that, prior to the election a parliamentary sub-committee was set up to look at astronomy, including space science. There will be an opportunity for engagement if this work continues into the new parliament.

## Changing context within the global space industry

Other opportunities are presented by wider changes in the global space industry. With more players, including commercial companies, the cost of getting material into space is coming down. This increased accessibility changes the environment.

Several new international players are starting to be active in space science, particularly from the global south, such as India and South Africa. This represents a big opportunity to harness this dynamism through bilateral relationships.



Within the UK, the context is changing too. The development of UK launch capability could be a major strategic asset if used correctly. It was argued that launch capability, along with strong and diverse bilateral relationships and technology development, provides an opportunity to tie these developments together and have a programme that runs through the whole ecosystem.

### **Ecosystem opportunities**

Different voices around the table highlighted opportunities in different parts of the space science ecosystem.

There is a strong innovation base in the UK in disruptive areas such as small satellites and applications of space data – as well as high-risk/high-reward concepts such as innovative rocket engines and space solar. If UK strategic goals can tie in with major societal and economic challenges such as climate and energy it could present an opportunity to build a very compelling case for their development.

One speaker felt that a space science strategy would be an opportunity to seek ways to highlight important early-stage innovation work with low TRLs.

At the same time, the commercial market is very strong with lots of start-ups and SMEs. One participant argued there are many business opportunities for UK firms to be a service partner supporting bigger players.

### **Opportunities for new ways of working**

The 'reset moment' described above was seen as an opportunity to start to work differently. There was a strong sense of a shared desire for change, and for more strategic thinking. The prospect of ten-year funding was viewed by several attendees as potentially transformational.

One participant stated that the UK can't compete in the next ten years in 'old space', as other countries spend so much more money (0.2% of US GDP). But we do have an opportunity to exploit 'new space' with small satellites. Some countries are showing leadership in this emerging sector. The UK could also seek to exploit that gap.

One attendee said there could be an opportunity to do nationally led small satellite science missions. It would be important for the UK to choose the science carefully but it would be possible to do a science

mission if we can target the science we want to do. This could not happen through ESA but there are lots of potential partners from industry and NASA labs interested in being involved with the UK leading a national mission. Such projects would provide experience and help develop partnerships.

Another participant believed there is an opportunity to play a major role in the next big flagship programme, but that the UK needs to be seen as a reliable partner in order to do this. This will require regular opportunities to work consistently on projects between flagship programmes.

Several participants advocated for this “portfolio approach” – mixing big flagship projects (‘old space’) with emerging areas of application such as small satellites (‘new space’).

### **Skills and career development**

The idea of a mixed approach, combining large and small projects with different international partners, also extends to opportunities to promote and recruit to space science. People spoke of opportunities to leverage existing relationships and partnerships to promote space, as well as embracing new international players – particularly in the global south – as an opportunity in the skills space. It was also suggested that the growing importance of space to everyday life could be used to make a case to inspire people.

Linked to this were comments about opportunities to help people working in space science to develop their careers. “People want money and purpose” said one person. There was recognition that training and education opportunities should not only be for scientists, and that other skillsets also need to be motivated to join the industry.

Others spoke about the need to increase mobility for space scientists – including enabling talent to come into UK.

### **Threats**

Some threats identified were flip sides to the opportunities outlined above. For instance, while the UK’s reputation as a reliable partner was celebrated, an equivalent threat was the potential to fail to maintain this status.

Similarly, the opportunity inherent in the changing context is at risk from ‘mission washing’ – the relabelling of existing programmes to tie in with government missions, without putting strategies in place to succeed.

And one attendee described the present moment as the UK sector’s ‘scale up’ stage – noting that while change is in the air this represents an inflection point, presenting risk as well as opportunity.

### **Long-term planning and budgets**

While the promise of longer term planning was hailed as an opportunity, some people pointed to the related threats of creating an inflexible system. They argued that it is vital not just to commit to longer term planning, but to get it right.

One person described their experiences of working with flat-lining budgets as “grim” and pointed out that for a budget fixed over ten years, inflation would eat away at funding in real terms. It is necessary to build into ten-year plans an aspiration to ensure a sustainable level of support.

A related point was that “tying ourselves too hard” into a long-term plan without flexibility could stifle the ability to exploit emerging opportunities.

### **Threat of failing to invest in the right areas**

Some people said they thought that no space science strategy would be likely to result in huge budgets, given the country’s financial situation and the UK sector’s history of comparatively low funding. However, several participants voiced concerns about the danger of failing to invest in the right areas.

One person noted that it has always been the case that budgets do not match ambitions, but that we must be realistic and make sure we identify what we can do and do it well.

Three speakers indicated concern about failing to invest in early-stage conceptual work. Funding at present, they argued, is more often linked to higher TRLs, with a view to return on investment. This comes at the cost of work in discovery. As one participant said: “A hidden threat is the focus on innovation and TRLs rather than invention and creativity”. Another person spoke of the need to make the case for discovery, arguing that it needs to be shown to be relevant, with a business case.

### **Shift of focus away from 'old space'**

Interest in so-called 'new space' – industry based around smaller satellites, with lower costs to entry, was raised as an opportunity. But, there was some concern about whether, when this happens, it will still be possible for the UK to participate in large flagship missions. The threat is that if a strategy moves too far in the direction of 'new space' we may find the UK locked out of larger missions and the scientific opportunities they present. Several attendees spoke of the need for a 'mixed portfolio' of projects, spanning both old and new space, with a regular pipeline of projects and smaller scale activities filling the long gaps between work towards the large multinational projects led by ESA.

### **Wider systemic issues**

Participants also warned of threats to the UK space science sector from vulnerabilities in the wider science and research ecosystem, and geopolitics. One person said they thought the biggest threat is the potential for conflict, and that security and resilience must be core considerations.

A vital part of the wider ecosystem is universities and people voiced strong concerns about the challenges facing the university system. "This is at the heart of everything – we ignore it at our peril", said one.

Linked with the sustainability of university physics departments is the pipeline of talent required for a healthy ecosystem. Equity of opportunity within physics and science is important and there is a risk that the sector fails to attract enough people. It is important to get the message out that there are good careers available in the space science sector.

### **Physical threats**

There are also some physical threats to UK space science. For example, the growing number of satellites are impacting ground-based astronomy. Starlink satellites transmit on the same frequency as some receivers on earth and can cause problems.

There is also a need to consider threats to the sustainable use of space, such as space junk and militarisation.

## Ideas related to shaping the strategy

Participants agreed on the need for a space science strategy that would enable longer term planning for the sector and harness the opportunities outlined above. A range of ideas were put forward about the shape and scope of the strategy.

### Purpose of a space science strategy

There were several strong voices speaking in favour of a UK space science strategy. The UK sector is small and fragmented – strikingly so compared to other countries’ space sectors, according to one speaker – so strategic action is needed.

The value of a strategy was clearly articulated. If the strategy works, one person commented, “everyone [industry and academia] starts singing from the same hymn sheet”, whereas at the moment everyone has slightly different priorities, and everyone wants as many things as possible. A process is required for deciding on these questions and enabling people to understand the timescales and get behind the strategy.

Others argued that the benefit of a strategy was to enable people to take risks and be ambitious. The strategy should capitalise on UK’s strengths in other areas. The strategy would be useful because it would inject urgency.

Finally, it was argued that the strategy should provide a vision. “All this needs a strategy – we have to know where we want to get to in ten years’ time.” “Funding is one thing, but we need roadmaps to give vision and direction and ensure underpinning funding to make sure we can deliver on behalf of the whole community.”

### International relationships

‘Bilaterals’ featured a lot in people’s comments throughout the event, particularly as a way for the UK space science sector to move beyond its perceived dependency on ESA.

Commenting on the UK’s relationship with ESA, one person said: “We haven’t yet mastered the art of getting what we want from ESA.”

Another said that a condition of ongoing participation in ESA should be an ESA mandatory uplift.

Bilateral relationships, both with big players and with emerging players from the global south, represent significant opportunities which are not being fully exploited. Forging these new links at low TRL levels would be a good place to start, said one person.

### **Mixed portfolio**

Several people proposed action to develop the UK's position in relation to other space programmes. This was often linked with the notion of a mixed portfolio of projects, combining contributions to large-scale projects with more frequent, smaller scale projects.

This would enable a steady stream of projects for the UK sector. One person commented that the R&D community are seeking reliable regular opportunities that they can plan around, working with international partners.

Another commented on the need for a “coordinated, coherent strategy for a mixed portfolio in space.”

### **Commitment to being a reliable partner**

Another important goal for UK space science, underpinning new international partnerships and the mixed portfolio of projects, is the importance of being seen as a reliable partner. Several individuals stressed the importance of the UK making a long-term commitment to ensuring it finishes any projects it starts. Speakers expressed a concern to avoid any further episodes like the Cassini project, where scientists felt compelled to sign letters to the Times to exert pressure on the government to ensure they could complete their work.

### **Funding**

There were various perspectives on where funding should go. Support for early-stage research was sought by a few people. “I would like to see funding at *invention* level as well as *innovation* level”, said one. This relates to a willingness to allow for failure. A focus purely on TRL raising largely precludes failure.

Others commented on the need to spend on fundamental science, which “is an investment even if we don't know where it is going to lead,” and excites people.



More broadly, there were also calls for investment in physical sciences and engineering to increase.

Funding, it was argued, has to be long-term and stable to enable expertise to be retained in the country.

### **Ownership and accountability**

Several points were raised about the need for a space strategy with clear accountability. It was argued that a strategy is needed to bring together the breadth of the sector and to work within funding constraints. It needs to be clear who owns the government strategy – whether STFC, UKRI, UKSA, or another government body. One person commented, “We need to give agency to our space agency to give leadership.”

One person asked the question, “Who is the space minister?” Another asked: “Who is on the hook for the space sector?” At present, parts of space science fall under different governmental briefs. The problem of silos in government was described as “disastrous” because, for instance, it means that important perspectives such as defence are not linked up with policy making for space science.

There needs to be coherence in government over who owns and is accountable for the space brief. Within government it needs to be recognised that space science crosses departmental boundaries and must not fall between the cracks. A similar point was raised about space science funding being from different research councils. The interdisciplinary nature of space science means it must not get lost between institutional boundaries.

It was also suggested that the NAO needs to understand that things can “fail well”, especially in physics. We need understanding that a failure can be a learning process and things should be allowed to fail without creating panic.

### **Universities, education and skills**

Many people spoke about the need to attract young people to the discipline and address skills issues to ensure a strong pipeline of talent coming into the space science sector. Reflecting some of the strengths identified earlier, one speaker suggested using the inspirational power of a space strategy to engage young people with science.

A suggestion was made to build diversity into programmes and mission opportunities, so that they are more open to people who are currently facing barriers.

Several speakers indicated they would like to see action to support universities, which play a vital role in space science. People variously identified admissions and the university funding model to be significant concerns, resulting in questions over the sustainability of some university physics departments. Also of concern is the sustainability of UK national laboratories.

One speaker pointed to a need to address cultural issues within academia, citing research that found a culture with high levels of bullying and harassment.

Further upstream, serious concerns were also voiced about the shortage of physics teachers, which is a significant driver of low uptake among young people. The government's mandate from the recent election is to recruit 6500 teachers. This must include 2500 physics teachers – a target missed by 83% in the past year.

### **Collaboration**

Fostering better collaboration was also highlighted as an area to prioritise. Collaboration between universities was said to be difficult at times, as some universities are 'space established' while some are not, and it is hard for those that are not to break into the field.

Another speaker said that connecting the academic base with research organisations and industry is important. From the private sector, organisations and companies are keen to pitch in, but they are spending money competing rather than collaborating. A strategy might look at ways to address that challenge.

### **Private sector involvement**

Alongside discussion of where government investment should go is the question of how to effectively leverage and attract private sector investment. The narrative around a space science strategy needs to work for industry as well. The strategy needs to provide "a clear plan with a clear vision that people can get behind". One person suggested a success measure for the UK strategy should be that every pound spent by government is matched by a pound from industry.

One representative from business shared their experience of seeking to sell internationally. They reported that they tend to find the US and China have more sales power. When the UAE created their space programme, for example, most of the technology and expertise they bought was from these countries and not the UK. This person's suggestion was that the UK could develop an international centre (distributed across sites around the UK) for space collaboration – which would bring potential partners and clients to the UK and support businesses.

### **Government engagement**

These final points relate not to government action but to ideas for what the space science community should do in support of government.

The government cannot do everything – there are limitations and trade-offs – so it is necessary to decide which parts of the sector the government should throw its weight behind. Someone else put it differently, arguing that the community has to explain where the market failure is that the government should step in to resolve.

While many arguments were raised during the meeting, it was pointed out that it is important to make sure important messages do not get lost in the noise. The sector should agree on two or three key arguments that it makes consistently, to help get its message across. One participant described the need for “clear, coordinated asks [which are] ruthlessly prioritised” as a means to support the government to develop strategy.

Finally, there was acknowledgement of the value of meetings like this, where the IOP has brought people together to think about these questions and make sure people have a voice. To speak with a clear voice to government, it is essential to come together and develop a coherent view and narrative.