1. Do you think Malaysia places enough emphasis on astronomy? How do you think we might do better?

Malaysia is doing a good job of encouraging and developing astronomy, albeit slowly. We have about 20 Phds in astronomy working in Malaysia currently. We also collaborate on several major international scientific research projects. In fact, most Malaysian astronomers perform expertly on the international stage. While only 15 Malaysians work overseas, many are well known internationally, including professors at the University of Tokyo and National Taiwan University. Moreover, three Malaysians were awarded the most prestigious postdoctoral honor in astronomy: The NASA Hubble Fellowship (even for top schools like the University of Oxford and Peking University, each of them only produced one and two Hubble Fellows, respectively, in the last 30 years). Recently, I talked to my colleague at NASA who oversees the program, and he commented that while astronomy has called many scientists, the few that Malaysia has chosen really make a difference.

Moving forward, I think there are three aspects that we should focus on: (1) raising awareness of astronomy for the general; (2) adding astronomy to the syllabus at an earlier stage, say in secondary and high school would likely propel more Malaysians into the field and (3) enhancing research opportunities in tertiary education, especially international collaborations.

I think Malaysia has planted a solid foundation in astronomy; what remains is how we can best organize and assemble the various strands into a single field. Together, several of us organized the first Malaysian astronomy convention, originally scheduled for March 2020. Attending were the leading astronomers from our neighboring countries, government education department officials, as well as amateur astronomer groups in Malaysia. Our goal is to work with them all to promote, encourage, and nurture the study of astronomy. The pandemic kind of fogged our telescopes, so to speak, but this could very well be a blessing in disguise. The postponement gives us even more time to promote our convention, and with the added publicity from our friends in the media, we believe more people can participate in what will prove to be a historic event.

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2. What makes astronomy important for a country's development?

There is a famous story about Henry Ford and the Ford Motor Company operations. In 1933, at the height of The Great Depression, Ford hired management experts to review his plant and its staff. Improvements to the assembly line were suggested, including the spinning-off of smaller

parts manufacturing (this was the birth of what we now call 'outsourcing'), and the experts also recommended firing the research and development scientists at Greenfield Village, a theme park, "who sit with their legs on their desks while drawing" and whom they felt were redundant because a team of research engineers was already on staff at the famous plant in Dearborn Michigan. Henry Ford refused to fire his research staff at the Village. When the lead expert confronted Ford and said, "at a time of severe economic depression, you cannot afford to have men sitting with their legs on their desks." Ford replied, "it seems to me their legs were in exactly the same position last year when they figured out how to make the V-8 out of a single block." Cars were already in mass production but it was this development that "gave everyman some real horsepower and changed our world."

Fundamental scientists — some of whose peculiar habits and fashion-sense are an acquired taste — may seem "useless" or even removed from technological advancement. In fact, "pure" or fundamental science is often the cornerstone of technological advancement. It may seem counter-intuitive, but fundamental science engenders practical wisdom. This is because to do sciences, such as astronomy, we need instruments or algorithms that often do not yet exist. And in fulfilling this need, we advance the very frontiers of technology. Many of these technologies end up benefiting society in unexpected ways. For example, as you might know, the World Wide Web was invented by particle physicists in order to better communicate among themselves efficiently. The GPS that we now all use and love stemmed from a calculation of Einstein's that he devised in order to resolve a deviation about the orbit of Mercury. The history of technology and science is filled with this kind of serendipity.

My own research is also an example. I study the movement of stars. But studying them is excruciatingly difficult because of their extreme distances from Earth. Therefore, even though stars move very quickly in space, their projected movement on the night sky on Earth is minuscule. Therefore, to measure the movement of stars, we had to construct large instruments of utmost precision. So precise, in fact, that the instrument that we use to measure the movement of the stars could observe the movement of a single hair on the head of a person in Penang by a viewer in Kuala Lumpur[1] (as a matter of fact, it is more precise than that, but I simply could not find a tinier example visible to the naked eye!). In fact, some of these amazing optical advances we design for astronomy are often "repurposed" into medical instruments.

Since ancient times, people have looked to the heavens and that has caused us to wonder. This is the reason why, more often than not, astronomy is the gateway to science. After all, what we study in astronomy is more apparent and easier to explain than other subjects in science, such

[1] Penang is a city-state in Malaysia, 220 miles or 350 kilometers from the Malaysia capital, Kuala Lumpur.

as chemistry or particle physics. Who does not love stars and black holes, right? In fact, many colleagues of mine, in other fields of science, tell me that they loved astronomy when they were young, and that led them into science. Maybe this is why, if you look at the top schools in developed countries, they are often the most advanced places in astronomy (for example, Harvard has some 400 scientists working on astronomy alone). Astronomy makes us more scientifically literate and fosters a deeper appreciation of Nature. Its influence often goes way beyond its intended purposes.

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3. Did you always want to study in the USA?

No, it was a case of *wanderlust*. When I was applying for my doctoral program, I only applied to Harvard University and Princeton University in the US because of their faculties. At that time, I was working with Prof. Ken Freeman, whom I admire deeply, at the Australian National University in Canberra, Australia, and I was admitted to their Ph.D. program quite early on. One important lesson I remember from my undergraduate years is to choose the professor, not the school, and so I felt very torn after I was admitted to Harvard University. But, in the end, I thought the opportunity to spend time in North America was not an experience that I should pass up (I had already studied in Asia, Europe, and Australia). Funny enough, of the two schools to which I applied in the US, I ended up doing my Ph.D. at one (Harvard University), and my post-doctoral studies at the other (Princeton University). Now I've gone full-circle and have accepted a faculty position at the Australian National University.

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4. What does it take to become an astrophysicist? Good scores in your studies?

Well, honestly, I don't think it is different from other careers. The most important thing is whether or not you have a passion for the topic. If you love astronomy, you could consider paying more attention to physics and mathematics in primary and middle school. And since astrophysics is a very 21st Century science, that is, an intersectional one, it's a good idea to familiarize yourself with topics such as statistics and computer science.

That said, research can be lonely at times, and you would need to mentally prepare yourself for working alone. Exploring the unknown means that there will not be many people to guide you. Perseverance is vital as most research can easily span a few years. In a way, it resembles getting lost during a hike and trying to find your way home. If you are meticulous and systematically

eliminate repeating taking the same paths, while expecting different results, you will find home more quickly than by randomly wandering. As a matter of fact, I often feel like doing science is like knitting, a hobby that many of my astronomer friends acquire (we are all very patient people). Science is like knitting, it might seem boring at first, but the fun that you can find from it is often inexpressible in words. You simply have to try it out yourself!

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5. Why did you choose to do a double degree?

It was serendipitous. While I was enrolled in the National University of Singapore, I was given the opportunity to be part of a concurrent program that allowed me to pursue my studies in both Singapore and France. I thought this would be a great opportunity to better myself, and even learn French. So when I was at this fork of the road, I took it.

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6. What makes you love to study so much?

I would not say I love to study. I just think I am curious. And curiosity drives one to study. More often than not, people might think that they lack the motivation to study. I can relate to that as we can often be burdened by more mundane things, and "forget" to be curious. Everyone has gone through these periods. In fact, I dropped out of high school for three months. I just was not very curious and lost the drive to study. But I bounced back once I found my inner-self again. For the Ancient Greeks, *thaumadzein*, to wonder at the spectacles of the world, was the beginning of all knowledge. As an educator today, I find that the best thing we can provide for our students is kindling their curiosity, and encourage them to stay true to what they passionately wish to know. One never really gets old if one is curious about the world. As one leaves curiosity behind, so does one's soul.

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7. So you were not into astronomy at first, but later found out that astronomy is intersectional, and this changed your mind?

I think it's more accurate to say that at first, I did not know much about astronomy. The choice of astronomy was most fortunate. I worked on various subjects during my college year. I found that I worked best when working on astronomy topics, so I thought I should try it out more.

Finding out astronomy is an intersectional science came later, but that further confirmed that astronomy is my calling. Quite serendipitously, the many subjects that I dabbled in my earlier years, such as rigorous mathematics training in France, became the defining characteristics with which I made my name in Astronomy.

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8. What was the biggest surprise to you when you got more involved in astronomy? How does it differ from what you had imagined?

I was concerned, at first, that astronomy is too specialized. I was worried that if I do not make it in academia, the other jobs that I could do would be limited. But to my pleasant surprise, astronomy provided me with the opportunity to learn a wide range of topics — physics, mathematics, computer science, artificial intelligence, statistics, chemistry, and others. As most of us in astronomy are experts in dealing with big data and making inferences, my colleagues and I are very highly sought after in the industrial world. In short, studying astronomy does not limit my job prospects, it broadens my career choices instead.

On top of that, even if one decides to stay in academia, astronomers tend to switch their research topics quite often. For example, while I focus on stars, I also study black holes, cosmology, and galaxies. I found this aspect of astronomy very inspiring for people like me who love to explore a wide range of topics.

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9. How did you get into Harvard University? Did you feel extra pressure while being there because you were surrounded by so many talented people? How do you stand out from your peers?

Being at Harvard was one of the best times of my life. It is true that there are many talented people there, many of whom are brilliant. Sometimes I felt I was at the X-men Institute, where the people around me all seemed to have superpowers. But I don't see that as competition. On the contrary, I found it inspiring and enjoy many great friendships with my peers. For one, our research topics were not all the same, and we complemented each other. Having had the pleasure of working with some of the most dedicated people in the world also pushed me to be a better version of myself; every day. In fact, most of my friends have now become my collaborators or simply people that I can ask questions when I have doubts. John Donne wrote that "No man is an island." I guess the best thing that Harvard taught me is to embrace people

who are talented, and never to ostracize them. More often than not, I want to find our people's strength and seek opportunities to collaborate.

How did I get into Harvard? Yes, having a solid foundation is important, but there are many people who have perfect scores. Top schools often aim to attract people who have a strong vision about their field and have demonstrated the ability to execute their vision. Knowing your field inside and out, and aspiring to break out from the current mold, is far more important than having top grades.

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10. Have you thought of coming back to Malaysia? Have you always wanted to stay in the United States?

Of course I think of coming home. My parents are in Malaysia, my childhood friends are all there, and I miss them, as well as my time in Malaysia, very much. In fact, part of the reason I chose Australia is that it balances, at least geographically, a place between my family and my career. You don't even have to be an expert in astrophysics to calculate that Australia is a lot closer to Malaysia than the United States.

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11. You must have done amazing jobs in your research. Is that the main reason for getting multiple fellowships?

With all due modesty, research is not enough. There is no shortage of talent in academia, but fellowships are harder to come by (each year, top fellowships in individual schools only admit one or two fellows from 200 or more applicants with a Ph.D.). Having a vision in your field does help, but getting the fellowship or not can still be challenging. It depends heavily on how people perceive the future of your subfield, and it also depends on the directions a school wants to take. While I have been working very hard, I would not attribute my success solely to my research. If there is one thing that I do well it is that I always make sure to have a good grasp or "touch" with the rest of astronomy and beyond. Staying current as well as having a great vision and the courage to execute your vision is mission-critical to being a good scientist.

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12. Since what you have chosen (astronomy) is rather esoteric, do you find it hard to explain to your friends and those close to you what you do?

I don't think so. Astronomy is fascinating at the bottom of it all. But most topics that astronomers study are rather straightforward. Many have even entered the lexicon of pop culture, such as stars, black holes, and the Big Bang. Most people do have a basic understanding of astronomy. Therefore, as long as my friends are willing to listen to me, it is not hard for them to follow. In fact, the last time I visited home, I went to the famous Wang Kee Yum Cha Restaurant with two of my high school friends. We ended up spending the whole afternoon eating bao and discussing astronomy!

I do believe that a good scientist should be able to explain science well to the public and not only stay in his or her ivory tower. After all, most of our research is funded by taxpayers. Being able to communicate with the public is as important as doing the science itself. I was once told "If you know your science well enough, you should be able to explain it to your grandma." I tell my students this all this time. My grandma passed away many years back, but if she were still here, I bet she would like what I do.

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13. Did your family support your choice to become an astronomer? After all, you wanted to be a doctor. Wouldn't that have been a more lucrative job with a better future?

My parents never interfered with my decisions. While my parents do care about my study, thank god they are not "tiger dad" or "tiger mum". Maybe this is because of me. I tend to be introverted and quiet. But this does not mean I lack imagination nor passionate thoughts. More poetically, I am more like the still water that runs deep. When I was young, I would stay in my room and study all the time. I never stopped reading even during dinner (even in a restaurant!). In fact, I think that bothered my parents. When I was young, they often "bribed" me to not study — "If you stop studying, I will bring you to the night market for Roti Canai[2]". They are quite funny actually. When I was at Harvard, I had the impression they thought I studied too much "Just go out to have fun. You never know, you might meet Obama's daughter. If you marry her, you might not even need a Ph.D." (Obama's daughter studied at Harvard too)

[2] A common snack in Malaysia that we all love.

As for being lucrative or not, I think being at the top in any field pays well. We often only see those who are at the top of the pyramid and shape our perceptions based on them. While I was studying in different places, I learned that different countries could have drastically different perceptions about jobs. For example, French revere mathematicians and think that being a mathematician is one of the most prestigious jobs (to be honest, I am not sure I get that either!), and being a doctor might not be such a good job. That aside, I should also say that being in academia is not so bad. Professors do enjoy a very high quality of life, and fewer disruptions, even during pandemics. In fact, being a tenured professor might be the most secure job that you can dream of.

Even so, it is not uncommon for the top Wall Street hedge funds to seek out astronomers to work with them on their fundamental research. What oil was to the 20th Century, data is to the 21st. Those like astronomers who understand how to interpret and, most importantly, explain data are increasingly in demand, both inside and outside the academy.

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14. It appears to me that research in astronomy is something that you will never finish. So what is your end goal? Or your future goal?

I think this is exactly why research is so fascinating. Whenever you reach new heights, another summit beckons. In a way, doing research resembles mountain climbing. It comes with new challenges every time. But it is the process, not the outcome, that gives me the most joy. Conquering a new height often opens my eyes, and brings new opportunities. And these new opportunities are often what I will attempt next.

In terms of my personal goals, I love taking part in the paradigm shift that is revolutionizing science today. My interest in the Milky Way, for example, is largely driven by the data. We can now, because of advances in telescopes, optics, and data science, have a dramatically larger information-data to describe the Milky Way. But to interpret this data, to see the patterns and "connect the dots", Artificial Intelligence (AI) is needed. This is why I thought astronomy is the right field at this time to fulfill my intellectual curiosity. But astronomy changes day-by-day (night by night?). Figuring out what will be the next Big Thing to study is quite a challenge. But that is part of the fun and reminds me that I have to stay current and keep a good grasp of the sciences going on all around me.

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15. What challenges do you usually meet in your research? How do you overcome them?

It is hard to tell what challenges one will encounter in research. As such there is no standard answer. But this is half of the fun. Encountering something news forces one to come out of their comfort zone, break out from your old mold, and make a better version of yourself and the society as a whole.

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16. Studying the history of the Milky Way sounds pretty complicated. Were there any interesting discoveries? Can you also share some of your recent research?

The study of the Milky Way has a long history. After all, before the night sky was hidden by "light pollution," the Milky Way was the most obvious object above us. In fact there is a rather funny story. In 1994, there was a major earthquake in southern California. The story goes as follows: The night was completely dark because there was no power being generated. This is the first time in living memory that the people of Los Angeles could truly enjoy the night sky. But they were perplexed. People started to call the nearby Griffith observatory. People asked if an ominous-looking silver line in the sky had to do with the power outage. An employee in the observatory replied: "No, Sir. It is the Milky Way. It has always been there."

The study of the Milky Way has always been one of the key topics in astronomy. On the one hand, we would love to know where do we (in the Solar System) stand in the Milky Way (remember, the Sun is only one of a trillion stars in the Milky Way). And we would love to know how this gargantuan structure was built. It cannot be mere coincidence that almost every element that we have on Earth (apart from hydrogen, helium, and a little bit of lithium) is also stardust in the Milky Way. Every atom in our body, at one point, originated and was burned into existence by stars (or the explosion of stars), and was subsequently recycled back into the Milky Way. Parts of these "stellar corpses" in the Milky Way first became the Earth and then, later, us. So the famous song by Crosby, Stills, Nash, and Young is correct: we are stardust; we are literally the children of stars. To understand the Milky Way is to partly understand the stars: where are they from? Where are they going? But it is also to understand ourselves: Where we are from? and where we are going?

As for the latest discoveries in the Milky Way, there are quite a number of them. We are blessed by the new data. This massive data amplifies signals that were not obvious in the past.

For example, it was not until two years ago that we learned the Milky Way had been "invaded" by another galaxy, about 10 billion years ago. The galaxy collided with the Milky Way "head-on", and this slowed star formations in the Milky Way for two billion years! But wait! You might have thought this was the end of this sad story. No! Also about five billion years ago, the Milky Way was again crashed into by another galaxy. The collision was relatively smaller, but it did create ripples in the movement of stars. And it is through these very ripples that we uncovered what transpired. These are the newer discoveries, but with the efforts from many astronomers over the years, we already knew a lot about the Milky Way. For example, we know that the Milky Way, on average, makes one star every year. The Sun is about 26 thousand light-years from the Galactic center, and the Galactic center harbors a black hole that is about four million times more massive than the Sun.

As for my research, last year, I looked into the thickening of the Milky Way disk, trying to understand why the Milky Way more resembles a "Roti Telur" (because it is puffy), than the thin "Roti Tissue". Previously, my student and I studied the movement of many stars around the Sun and concluded that, within the last 4.6 billion years that the Sun has lived, the Sun has not migrated much. The Sun is like an obedient child, always staying on the radius of around 26 thousand light-years from the Galactic center. Recently, I also worked with my students on finding the "lost siblings" of stars. We know that stars were born in "big families". Usually when stars form, a few thousand stars form simultaneously, but they also soon disperse in the Milky Way. Our work sheds new insight on how to use the current movement of stars, and the light spectrum of their chemical properties, to discover which stars are stellar siblings. We pledge to leave no child behind!

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17. Do you mostly stay in the lab, or do you have to do field trips? Do you visit other observatories?

Astronomy is unlike other experimental sciences: our laboratory is what we have in the sky, but we cannot do experiments with it (and it is not as though we can "pick" the stars). Most astronomy labs do not have much equipment except for laptops. In terms of observations, we are also getting very specialized. Quite often, the data nowadays is taken by professional operators. While we still go to collect data from the telescope ourselves sometimes, but more often than not, we are working in our office, dealing with data, performing theoretical calculations, and comparing them with the data. In a way, an astronomy department functions very much like a tech company. We have our own offices, but we also have a central open area for interaction.

It is true that we do go to other places to exchange ideas. To do good research, it is crucial to interact with others. In fact, I flew quite a bit last year (I may be at the extreme end); I flew 150,000 miles last year, which is equivalent to orbiting the Earth six times. My mum always complains that I fly too much and that she never knows where I am. I tried to explain to her: You can think of individual departments as having their own specialties. My department might be good at making soy sauce, and your department might make a good tofu. It is important to make sure that your soy sauce is flavorful, but it is always equally important to make sure that you can collaborate with others so that you both will make a great dish. (My mum agrees, but insists I wear a seatbelt at all times during a flight.)

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18. Can you tell us what your daily life is like? How do you do your research?

I have a very regular lifestyle (maybe a little too regular). Waking up in the morning, I first read through new articles published overnight. Not everyone is aware that there are quite a few astronomers working today. So, on any given day, there could be 50 new published articles. To do my job right, I have to understand what is being done all around me. The morning is also usually when visiting astronomers give seminars. I join the seminars as often as I can. Before noon, the department regularly hosts coffee meetings. In the meeting, we discuss the highlights of the previous night's publications. And between these, if I can find free time, I do some of my own research. And there is always coding...

As my seniority grows longer, it seems my afternoons become shorter. Most of the time, I spend talking to my students, discussing what they have done, giving them advice, and making sure that they are on the right track. The afternoon is also when group meetings happen. At 3 pm, the department often hosts tea time (and you wonder why waistlines correlate with age!), a platform where we interact with other colleagues. Because of the pandemic, we no longer have "physical" tea time, so we meet online. In a way, I am grateful that the pandemic has not had too great an impact on my work. Finally, there is a little pond near the Institute. I like to go there in the afternoons, especially whenever I feel stuck and need inspiration.

After dinner, I do my own research. This is the only time that I have time for my own projects. While my students are leading most of my research, I always try to keep a project or two for my own purview. I simply like to solve problems unaided, much as people like to do crossword puzzles alone, and I find that very rewarding, and it makes me happy.

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19. Is life being a researcher very busy? Do you often work until you forget to eat? What do you do for fun?

Since research is often alone, the good news is that we have a lot of freedom to decide how we want to spend our time. But the bad news is that much depends on your self-discipline. Most of my colleagues often spend insanely long hours in their research. As such, research often becomes an integral part of our lives. It is not uncommon that we are so into it that we, proverbially, miss our meals. That said, while the work is unavoidably a big part of academic life, to make it sustainable, there has to be a modicum of work-life balance. This is something that people in academia have been promoting for many years, something that I am still learning.

As for leisure, I think I am just an average Joe. I like to hang out with friends, have dinner with them and I love to watch movies. I am a foodie at heart, so l love making new dishes (my latest adventure includes kumquat bubble tea.). And I love the latest electronic toys (I am contemplating buying a drone). As you can imagine, most astronomers are pretty good at coding, data, and technology, so it is no secret that we are big nerds at heart, and have been known to get excited by product specifications! In fact, with the pandemic, a good number of my colleagues use their spare time to crunch pandemic data. Some of them have even written journal articles on the topic.

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20. Have you thought of coming back to Malaysia？

Of course I do. Being close to home is always a blessing. Also, as astronomers are good with data and making inferences, we can work on a wide range of topics and areas. For example, some colleagues of mine now work in big hedge fund groups on Wall Street. Another friend of mine works as a consultant for Hollywood. His group uses big data to decide which actors and actresses to cast in order to maximize the box office. Another old colleague of mine, whose fashion sense has always been terrible, became someone who predicts the next trendy outfit with data. As for me, I am just contemplating in what area I can make the most difference for the country. Before finding a place where I can make a bigger difference, I am currently content with making sure that I do well in what I do. Who knows what the future has in store for me?

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21. How do you think we can attract more young people to join astronomy?

I think the main thing that prevents young people from joining astronomy is concern about job prospects. Clearly, one should only do science if they are into it. But as we have discussed, the study of astronomy provides many choices of career. How to deal with data, making inferences, and statistics are at the core of astronomy. In this sense, the job prospects are actually quite good. In fact, when I finished my Ph.D., a major hedge fund group showed a strong interest in me. As I stated earlier, what oil was to the 20th Century, data is to the 21st.

Finally, currently, most people in Malaysia who want an education in astronomy still have to go overseas to receive it. This is not always feasible for young people, and it is certainly not ideal to force them to choose between their homes and their careers. Fortunately, Malaysia has taken various initiatives lately to build up astronomy. My hope is that Malaysia can continue to flourish in the development of fundamental science and provide more courses in astronomy. I am sure this will yield ever-greater options for dedicated young people to join and enjoy world-class careers in the exciting field of astronomy.