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Dear Megan,

I am an astrophysicist. Nobody ever told me what an astrophysicist is, but I think I have figured it out. An astrophysicist is someone who is trying to understand how the things in the night sky work. Imagine all the things you can see in the sky at night: I don't mean aeroplanes, or bats, or owls, or clouds, although it's true that sometimes you can see all those things at night. I mean the things that are so high up that you can't tell that they are moving: things in outer space, like the Moon, and the planets, and the stars, and our galaxy (the Milky Way), and all the other galaxies in the Universe. These are the things that astrophysicists are trying to find out about.

Did you know that stars live in galaxies? Astronomers discovered this, about a hundred years ago, by looking at the night sky with telescopes. Astronomers observe objects in the sky, and make measurements of them – like where they are, how bright they are, how far away they are (although that's quite hard), how fast they are moving (so's that), and so on. Astrophysicists then listen to what the astronomers tell them, and then try and figure out how those objects work. Actually, most of us spend some of our time doing astronomy, and some of our time doing astrophysics, and it's not easy to tell where one of them stops and the other one begins.

Let me give you an example of what astrophysicists do, so that you can see that it is not very difficult to be an astrophysicist. The first thing astrophysicists do is *ask themselves a question* about how something in the night sky works. This is the easy part, because there are lots of things we don't know much about! (In fact, we love it when we find something we don't understand – it's a bit like getting a new jigsaw puzzle.) Since you are new to astrophysics, I'll give you a good question to get you started.

What makes the Moon shine?

Do you know? If you don't know, good! It means you have a new puzzle to solve.

Astrophysicists never just say “I don’t know,” though. They try and figure out the answers to their questions. So, the second thing they do is *imagine some possibilities*. Can you think of some things that you already know about, that the Moon might be like as well? What else do you know that shines? What else do you know that is shiny? (Can you see the difference?) You don’t just have to imagine – I bet you could make some models of the Moon yourself, that shine in different ways.

Then, the third thing to do is think about these imaginings and ask yourself some more questions, *questions that start with “What if…”* What if the Moon was like a lightbulb? Would it always look the same? What if the Moon was like a mirror? Where could the light come from that the Moon reflects?

The last, and most important, thing you have to do is *go and see what the Moon does*, and find out the answers to your “What if?” questions, and decide which of your imaginings is actually most like the Moon. Look at the Moon before you go to bed tonight! (I hope it’s not cloudy…) And then look at it a week later (because the Moon is not always there - and if it was, it might not look the same the next time…) Then look for it in the daytime to see if it looks any different then! Which one of your models shines like the Moon does? Can you figure out what makes the Moon shine?

Now, you could have just asked your Mum and Dad, “What makes the Moon shine?” and they could have told you, and that could have been that. But it’s much more fun to figure things out for yourself! And anyway, it’s good practice - one day you might be a grown-up astrophysicist, trying to find out how things work that *nobody else understands*. A hundred years ago, nobody knew what makes the stars shine – but now we think we do, and we didn’t get the answer from our Mums and Dads.

Here’s another example for you - a question that I am helping to answer. We know that stars are born in groups, together, with a range of different weights. Some are very heavy, but many others are lighter. But in some galaxies there seem to be a lot more very light stars – and no-one knows why that is. So, some astrophysicists are imagining possibilities for how this could have happened, and others (including me) are weighing galaxies to find out how many light stars they have. And together we all hope to figure out a bit more about how stars are born.

You said you wanted to know where you could get an astrophysicist’s toy. Most of the toys that astrophysicists play with are *models that we make ourselves, on computers* – models of planets and stars and galaxies that show us how they would work if what

we are imagining about them was true. It's a bit like how computer games let you play at driving a car, or have other adventures, without you actually having to go outside. So here is a toy that you can play with that is a lot like the ones that we make: it's a model of how the Moon might be moving around the Earth. It has lots of possibilities that you can test by looking at the Moon for a month!

<http://isthis4real.com/orbit.xml>

Astronomers also play with telescopes when observing objects in the night sky (although there are strict rules to follow so that we don't break them!), but you might like to start with a pair of binoculars. The Moon looks pretty interesting with binoculars! There are also some fun toys at the Science Museum shop, at <http://www.sciencemuseumshop.co.uk>. You might find even a model of the Moon there.

I seem to have written quite a lot more than I meant to. Never mind! I hope this letter has answered two of your questions, Megan. I also hope you have a lot of fun asking a lot more questions!

Yours sincerely,

Dr. Phil Marshall