Transcript

SPEAKER: The Open University is really delighted to sponsor the Northern Ireland Science Festival and recognizing the brilliant work that the festival does. So we're here celebrating the wonders of science, of technology, of engineering, of maths. And we're also promoting gender equality across all STEM areas and disciplines so through teaching, research, and engagement.
The University seeks to acknowledge the contribution of female scientists, engineers, mathematicians, challenged gender stereotypes and equalities and encourage children and young people to pursue STEM disciplines. So I can see, can we get away from any young people that we have in? Any young people in? Kids? We've got quite a few. We've got loads, which is fantastic. The woman over there is waving, there's nothing young about her. But we've got lots of young people and kids which is fantastic.
So today's event features a world renowned astrophysicist and an advocate for encouraging more women into STEM and physics themed Jocelyn Bell Burnell. So she taught for over 29 years at the Open University. She was one of the first professors of physics, female professors of physics at the Open University.
She has a whole book, a whole string of prestigious honors to her name, including being elected fellow of the Royal Society in 2003, president of the Royal Astronomical Society from 2002 to 2004. She was the first female president of the Institute of Physics in 2008. This makes me feel incredibly inadequate. Awarded a CBE in 1999 and was appointed Dame in 2007.
So in 2016, Jocelyn became the president of the Royal Society of Edinburgh. She was the first in it's 230-year history. She helped set up the Athena SWAN program, and that is widely credited with improving the lives of women in academia. Basically, she's much smarter than I could ever hope to be, and I'm very, very excited to get the chance to hear her talk.
Jocelyn was awarded, you probably heard more recently on the news, the Breakthrough Prize in 2018 for her pulsar discovery. And she donated the 2.3 million prize fund. She chose to donate it to the Institute of Physics to establish research studentships for people from underrepresented groups, which is incredible. You're very good. A round of applause. Yes, please.
[APPLAUSE]

Which is an incredible, incredible thing to do. I would have kept every penny. And I know that we're kind of continuing that theme tonight of encouraging young people, encouraging women, encouraging everyone into STEM. So we're delighted that she's joined us here in Belfast to deliver a talk on the intersection of astronomy and poetry, two of her big life passions.
After this, I'm going to sit down and have a chat with Jocelyn. I'm going to ask her all the burning questions that I've been saving up and after that, we're going to take questions from the audience. So while Jocelyn is talking, if you do have questions, please, do keep them in your head, write them down, wherever, so you can ask at the end. So without further ado, please give a very big round of applause for Dame Jocelyn Bell Burnell.
[APPLAUSE]

JOCELYN BELL BURNELL: Thank you very much for that welcome. Can I ask folk in the AV box, can I have the house lights up please? And could you keep them up because people are going to be able to need to read, great. Read poetry. Can you read by that light level folks? Good. Thank you very much, indeed. That's great.
So astronomy and poetry. I'm going to give you a brief introduction to modern astronomy. I'm then going to say a bit about poets who are into astronomy. There's quite a few when you start digging around. What kind of astronomy have poets noticed? And then we've got poetry on comets on the night sky. I'll say a little bit about how we're made of star stuff and a bit about the vastness of the universe. And if I witter on too long, we're here for hours, so I will try not to.
So for people in the audience who've done some physics or astronomy, this will be familiar stuff. But I'm going to assume that you haven't. My apologies if you have. So this is what we call the electromagnetic spectrum. Here in the middle is light. Do you see the little rainbow? That's what your eye responds to. And it's only a tiny bit of the whole spectrum.

If we go out the blue end of the rainbow, we come to ultraviolet. That's what gives you sunburn. X-rays. How many people in the audience have had an X-ray? Yeah, it's a lot of us, isn't it? Beyond X-rays, there are gamma rays. Gamma rays got used for sterilizing equipment. Some kinds of radiation treatments as well involve gamma rays.
And if I go back here to the visible and come out the red end, we come to infrared. You've maybe heard of infrared lamps, infrared heaters. Beyond that, there's what we call millimeter wave. You get that in microwave ovens, for instance, and in radar. And going on to the left, we come to the television bands and shortwave radio and longwave radio.
And astronomers used to think the stars worked in this little bit only. But as we've got better equipment both ways, we now find that you can do astronomy right across the spectrum. You may see different objects in different ends of the spectrum, but there are things that give gamma rays and equally, there are things that give radio waves. And you can learn a lot about them by picking up those radiations.
Radio astronomy started around about-- well, it really got going about the 1950s. It arose out of World War II radar. At the end of the war, some scientists took the radar-receiving equipment. Took it, purloined it, borrowed it. Took it back to their universities, pointed it at the sky and to their surprise found that there were lots of things that give radio waves.
They discovered during the war that the sun gave radio waves. It was apparently the Japanese who noticed that there was a source of interference that was low in the East in the morning, high in the sky at noon, and low in the West in the evening. And it said they never worked out what it was.
So we've been around doing radio astronomy for quite a while. Optical astronomy using light, of course, for centuries. And we've moved into X-rays now that we have good rockets that can launch satellites up into space. Because the Earth's atmosphere cuts out the X-rays which keeps us safe. But if you want to study the stars, you have to get your kit up on a satellite.
So poets, poetry, and astronomy, which is the main theme of this particular talk. Two of the poets, I know for sure, were amateur astronomers themselves. Robert Frost and Thomas Hardy. They each had their own telescopes. This is Robert-- oh, sorry. Robert Frost as you can probably deduce. This is Hardy with his bicycle.
One of the prominent constellations in the night sky at this time of year is the constellation of Orion, and you'll probably see it this way up. There's three rows in the star that makes Orion's belt. This very bright star, Betelgeuse, is one of his shoulders. He's got a sword hanging down. Top of his legs are here.
If you track up his belt, you come to a group of stars called the Pleiades, the Seven Sisters. Mythology has Orion forever chasing the Seven Sisters. But he never catches up on them, at least not in the sky. And if you track down Orion's belt, you come to a bright star called Sirius, which is the eye of Orion's dog. His hunter's dog.
And we come to our first poem. Somebody has Robert Frost's Star Splitter or part of it. Yes, could we have a microphone to a lady with a pinkish red top? Come down. Yep, she's one seat in. Thank you very much. Thank you. Would you like to read it for us?
AUDIENCE: The Star Splitter, part of. "You know, Orion always comes up sideways, throwing a leg up over our fence of mountains. And rising on his hands, he looks in on me. Busy outdoors by lantern-light with something I should have done by daylight and indeed, after the ground is frozen, I should have done before it froze. And a gust flings a handful of waste leaves at my smoky lantern chimney. To make fun of my way of doing things or else fun of Orion's having caught me.
Has a man, I should like to ask, no rights these forces are obliged to pay respect to? So Brad McLaughlin mingled reckless talk of heavenly stars with hugger-mugger farming. Till having failed at hugger-mugger farming, he burnt his house down for the fire insurance and spent the proceeds on a telescope to satisfy a lifelong curiosity about our place among the infinities." By Robert Frost.
JOCELYN BELL BURNELL: Thank you very much.
[APPLAUSE]

Well, that's keen, isn't it? Burn your house down and use the fire insurance to buy a telescope. Now, there are some families where there are both poets and astronomers. Robinson Jeffers is a poet and his brother, Hamilton, was an astronomer. They're from the United States, both of them. His brother

was an astronomer at Lick Observatory, so he probably had quite a lot of inside information about astronomy.
And Hilda Doolittle who published just as H.D. was the daughter of the director of another observatory in the United States, the Flower Observatory in Pennsylvania. Nearer home, Cardiff, Wales. Gwyneth Lewis, these are her words on the building in I think it's Cardiff, maybe Swansea. She has a cousin in the United States who's a US astronaut.
And Robert Lowell who's a US poet you've maybe heard of had a cousin called Percival Lowell. Percival Lowell spent most of his life trying to find Pluto. They were distant cousins. I'm not sure how much they overlapped because they were fairly distant cousins. The generations had begun to get a bit out of kilter but there was a family relationship.
Some poets regularly write on astronomical topics. Diane Ackerman is one of them. She worked with Carl Sagan at Cornell University as well as doing that bit of science writes a lot of poetry herself. Robert Frost that you've just heard a poem of, he was a US poet who wrote quite a lot of astronomy. Carl Sandburg also in the US. And Frederick Seidel, if that's how you pronounce his name. And there are other poets who've written one or two astronomical poems, but those first four have written a lot of astronomical poems.
So what have the poets noticed? Well, they've noticed radio telescopes. Things like the big radio telescope at Jodrell Bank. It's fairly visible to be honest. But they don't notice X-ray satellites probably because they're hundreds, thousands of miles up in space, and they're not that big anyway. They write about the scale of the universe, which is quite awesome for us as humans and our paltry, 2 meters height if that.
They talk about the Big Bang because we understand that our universe started all in a very tiny, tiny ball. And there was a dramatic explosion nicknamed the Big Bang now officially called the Big Bang, and everything expanded out and is still expanding. The universe is moving away from us.
They write about black holes, they write about space exploration, they write about comets. Sometimes we get a comet that's really very handsome and bright that we can see well. And of course, they write about the moon, who doesn't? And planets.
So comets. Comets are part of the solar system. They are fairly small things. When they come close to the sun, the sun evaporates some of the material off the surface and gives this handsome sort of tail.
Our next poem is by Stanley Kunitz, it's called Halley's Comet. And somebody has Kunitz. Yes, thank you very much. He saw Halley's comet in 1910. Halley's comet was around. So bear that in mind as we hear this poem. Thank you very much.
AUDIENCE: "Miss Murphy in first grade wrote its name in chalk across the board and told us it was roaring down the storm tracks of the Milky Way at frightful speed. And if it wandered off its course and then smashed into Earth, there'd be no school tomorrow.
A red-bearded preacher from the hills with a wild look in his eyes stood in the public square at the playgrounds ends proclaiming he was sent by God to save every one of us, even the little children. "Repent, ye sinners!" He shouted waving his hand-lettered sign. At supper, I felt sad to think that it was probably the last meal I'd share with my mother and sisters, but I felt excited too and scarcely touched my plate. So mother scold me and sent me early to my room.
The whole family's asleep except for me. They never heard me steal in the stairwell hall and climbed the ladder to the fresh night air. Look for me, father, on the roof of the red brick building at the foot of Greene street-- that's where we live, you know, on top of the floor. I'm the boy with the white flannel gown scrawled in this coarse gravel bed searching the starry sky, waiting for the world to end."
JOCELYN BELL BURNELL: Thank you very much.
[APPLAUSE]

His father had committed suicide and had died a few years earlier. And I guess mother has had to move the family to a smaller house, and he's busy giving dad up there the current address. Yeah, we still get maybe not red-haired preachers. I've known nuns telling us the world was about to end when a comet arrived.
Actually, a comet is quite a small thing. It looks spectacular. But if one hit the Earth, there wouldn't be a catastrophe. OK, maybe one or two houses would get demolished but not much more than that. But comets remain fascinating.

This is a lovely photograph of a comet showing its two tails. And you can see some people in the foreground. It turns out that if you were to go out now and it was clear, you would have trouble seeing the night sky because your eyes are adapted to a light environment. If you want to have a good view of the night sky, you need to get somewhere dark. But if you need to look at something, write down something, how do you do it? You can use red light because red light doesn't destroy your night vision the way ordinary white light does.
And this photograph has been taken with a red light, which astronomers regularly use when they want to check their equipment or write something down. And so we can see some people in the foreground.
So somebody has Kenneth Rexroth's Halley's Comet to read for us. Yep, thank you very much. There's a microphone coming. Maybe parent could hold the microphone if you need two hands.
AUDIENCE: "When in your middle years, the great comet comes again. Remember me, a child, awake in the summer night, standing in my crib and watching that long-haired star so many years ago. Go out in the dark and see its fume over water, dribbling on the liquid night, and think that glory and life flickered on the rushing bloodstream for me once and for all who have gone before me. Vessels of the billion-year-long river that now flows in your veins."
JOCELYN BELL BURNELL: Thank you.
[APPLAUSE]

I love his description of seeing the reflection in water, it's just gorgeous.
We're back to the constellation of Orion, it's a good landmark in the winter sky. So we're seeing it rather better here. I said, you track up the belt, you come to the Pleiades, the Seven Sisters. Track down the belt, you come to Sirius, the eye of his hunting dog. So this is Orion and a lot else of our galaxy, the Milky Way.
There's a poet who just goes by the name of Antler. I don't know what his full name is but he just writes as Antler. And he's reflecting on the idea of the fact that on a typical clear night, you can only see about 6,000 stars. Somebody has Antler's poem. Yes, on this aisle. Thank you very much. Microphone's coming to you.
AUDIENCE: "If seeing only 6,000 stars with the naked eye, awestruck soars to topple in drunken ecstasy or piss looking up in devout praise of being. What would happen if we could truly perceive, comprehend, and experience the zillions of stars, galaxies, universes, past, present, future?
And if as scientists agree we only use 10% of our brain's potential, then the astonishment we sense is only 10% of the astonishment we could sense. And so it would seem that what seems like dots of light twinkling in pretty patterns moving across the black is really enough to shatter us like goblets when the soprano hits the highest note.
And if the 10% of the brain power we do use is ignorant of the 99.9% of the totality of the universe, perhaps a little vino in our goblet ain't a bad idea. Perhaps a flask of wine in deep wilderness night is more powerful than the largest telescope." By Antler.
JOCELYN BELL BURNELL: Thank you.
[APPLAUSE]

Well, I'm sorry I can't supply you all with some vino, but there we go. We suspect there's about 100,000 million stars in our galaxy, the Milky Way, and there's probably 100,000 million galaxies each with 100,000 million stars in the universe, give or take, a note or two. Huge, huge place. And we, we feel so important. We are on one planet round a boringly bog-standard star in a very typical galaxy in the universe. But maybe you don't want to dwell on that before you're trying to get to sleep.
Now, I don't know if you've thought about where the atoms in your body have come from. When you were born, you were kind of that size give or take, a bit. Very much fewer atoms in your bodies. And we're bigger now. And the extra atoms have come from our food and drink.
So let's think about the things we eat and drink. Where do those atoms come from? Probably simplest to think about plants. Animals eat plants. So if we can suss out the plants, we'll understand where the animals got their atoms from. Plants start with a tiny seed or a bulb and they grow. They end up with a lot more atoms in them, particularly if they're trees.

Where are those atoms come from? Well, some from the Earth, some from the air, some from rainfall. So where did the Earth's atoms and the air and the rainfalls atoms come from? Well, came with the Earth.
The sun formed from miscellaneous stray atoms, largely hydrogen, and some material was left over and became the planets. So basically, we're made of the same stuff as our planet, and it's made of the same stuff as was kicking around in the galaxy when the sun and the planets formed. So we are actually made of the same stuff as stars. We use the stuff in a different way because we don't shine in the same way and we've got more complex systems but basically, the atoms in our bodies came from the stars from the universe. We are made of star stuff. To such an extent you can say, you're a star without doubt.
So somebody has John Haines' Little Cosmic Dust poem. Thank you. Near the middle of the front block. Microphone's coming to you, sir.

AUDIENCE: I've gathered quite a few items myself. A Little Cosmic Dust poem by John Haines. "Out of the debris of dying stars, this rain of particles that waters the waste with brightness. The sea-wave of atoms hurrying home collapse of the giant unstable guest who cannot stay. The sun's heart reddens and expands, his mighty aspiration is lasting as the shell of his substance one day will be white with frost.
In the radiant field of Orion, great hordes of stars are forming just as we see every night, fiery and faithful to the end. Out of the cold and fleeing dust that is never and always the silence and waste to come, this arm, this hand, my voice, your face, this love."
JOCELYN BELL BURNELL: Wonderful.
[APPLAUSE]

Thank you very much. So the slides that I-- the pictures that I have up on the current slide, the left-hand picture shows some dust glowing in starlight. The dust is debris formed in one of the exploding stars. Exploding stars make some of the heavier elements that we know about, and some of it is gathered there. But it will only shine if there's nearby stars to make it shine.
This debris on the right-hand side is the remains of a star that exploded in 1054 AD. It was observed by the ancient Chinese and recorded in their annals, so we can date it very, very precisely. There's the core of the star, I think is that little notch. There's just a very compact remnant left. And all this material got kicked out as the star exploded and is kept shining by this little object, which is actually a pulsar here. And it makes sure that the debris remains shining even 1,000 years after the explosion.
And these explosions also create some of the dustier stuff in the universe. Most of the universe is hydrogen. But clearly, there's some oxygen because hydrogen and oxygen make water. There's a certain amount of carbon kicking around, there's some silicon, there's a number of chemical elements. And basically, it's explosions that create the elements other than hydrogen. And this is the kind of debris from that kind of explosion.
Now, stars group in galaxies. Our galaxy is called the Milky Way, and it's got something like 100,000 million stars in it, of which our sun is one. Our sun is a very average star, boringly average. There's nothing special about it except for us on this planet because of the light and so on that it gives us and the heat. But it's actually a very common kind of star. Which raises the question, how many other common kinds of stars have planets?
We are beginning to answer that question. We now have a lot of research going on in what we call exoplanets, planets around other stars. And they're being found right, left, and center. The number of exoplanets, I've given up trying to count. There's probably several thousand stars that we now know that have planets a bit like our solar system. Not necessarily the same as our solar system, but they seem to come in all kinds of shapes and sizes, these systems of planets.
And stars tend to be grouped into galaxies. Our galaxy is called the Milky Way. And a galaxy is spiral, circular if you see it face on. But edge on, it's very thin. And you can see our galaxy, the Milky Way, if you look at the night sky. But because we are inside something thin, we see a band across the sky. Actually, it slopes across our sky. So the Milky Way is a relatively thin band with zillions of stars in it slanting across our sky. That's our galaxy.
This is a rather attractive photo, I think, of a galaxy. Its hub there and what we call spiral arms. Our galaxy has spiral arms too. We live in one of the spiral arms of our galaxy. The spiral arms are made

of lots and lots of stars and probably a certain amount of dust as well. But in the center of the galaxy, the stars are relatively close-packed and you can't see them individually. And this is rather a nice one because it's got a little tadpole attached to it. A small galaxy.
They're big. To travel across our galaxy, the fastest you could go is the speed of light. And if you go the fastest you possibly can, it'll still take you something like 100,000 years to travel across the speed of-- to travel across the galaxy. Speed of light is a little bit short of 200,000 miles per second. So that's the world speed record. Nothing can go faster than the speed of light. So that's what you're aiming for, guys, on your bikes. 200,000 million miles per second.
But it does not go infinitely fast, and so to travel across the galaxy like this one-- I've lost my pointer. To travel across the galaxy like this one will take thousands, probably millions of years. And somebody has Elizabeth Jennings poem, Delay. Can the microphone see where they're going? Oh, good. Thank you. Thank you very much.
AUDIENCE: "The radiance of that star that leans on me was shining years ago. The light that now glitters up there, my eye may never see. And so the time lag teases me with how love that loves now may not reach me until it's first desire is spent. The stars impulse must wait for eyes to claim it beautiful. And love arrived may find us somewhere else."
JOCELYN BELL BURNELL: Thank you.
[APPLAUSE]

That was the poem that started me collecting poetry with an astronomical theme. Somebody-- I was doing a talk and somebody said, do you know Elizabeth Jennings poem? Poetry and I didn't get on at school where I had ignored it. In fact, there's a lot of poetry with an astronomical theme, and I now have several thick files of the stuff. But that's where my particular journey started.
So galaxies are big things, 100,000-- let me get the number right. 100,000. Yes, light years across. 100,000 million stars, but that still leaves a lot of space between the stars. The stars are quite far apart. And even our star with its planets takes up a bit more space, but there's a huge distance to the next star.
The analogy that I find most useful is to imagine a big cathedral and imagine a few grains of sand in that cathedral. That's the kind of spacing between the stars. The spacing between those sand grains in a cathedral is analogous to the spacing between the stars in a galaxy. So lots of space.
We have another Robert Frost poem. Somebody has Robert Frost's Desert Places. Again in the middle block, Thank you. Microphone's on its way.
AUDIENCE: "They cannot scare me with their empty spaces between stars on stars where no human races. I have it in me so much nearer home to scare myself with my own desert places."
JOCELYN BELL BURNELL: Thank you.
[APPLAUSE]

Thank you very much. How very true he is.
So galaxies are each great congregations of stars. The galaxies are very well-spaced. And because we live in an expanding universe, the galaxies are getting further and further apart. The galaxies themselves are probably not expanding but the space between them is expanding. It's a bit like baking a currant bun, as the cake rises, the currants move further apart.
So one of the things that astronomers have to deal with is the fact that we live in a one-way universe. It seems to us that the universe will expand and expand and expand. The galaxies will get further apart. The stars in each galaxy will gradually run through their life, run out of fuel and die. One day, our sun will die and life will probably not be sustainable on planet Earth when that happens. Now, it's zillions of years away, so don't panic. But it does seem to be we live in a one-way universe.
A slightly facetious poem, JDGM Lines Inspired by a Lecture on Extraterrestrial Life. Somebody has that? Down here, front row. Brilliant, right near the microphone.
AUDIENCE: Thank you. "Some time ago, my late papa acquired a spiral nebula. He bought it with a guarantee of content and stability. What was his undistinguished chagrin to find his purchase on the spin. Receding from his cell or back at several million miles per sec. And not, according to his friends, a likely source of dividends.

Justly incensed at such a tort, he hauled the vendor into court, taking his stand on section three of Bailey, seal of nebulae. Contra was cited volume four of egglestons galactic lore. That most instructive little Tom that lies uncut in every home.
"Cease!" Said the siege. Your quarrel bias. Lift up your eyes to outer space. See where the nebula like buns. Encurranted with infant suns. Shimmer in an incandescent spray, millions of miles and years away. Think that provided you will wait, your nebula is real estate, sure to provide you with wealth and bliss beyond the dreams of avarice.
Watch as the ruling eons pass, new worlds emerging from the gas. Watch as the brightness slowly clots to eligible building lots. What matters, a depleted purse to owners of a universe. My father lost the case and died. I watched my nebula with pride. But yearly with decreasing hope, I buy a larger telescope."
[APPLAUSE]

JOCELYN BELL BURNELL: JDGM. He was perhaps prudent not to give his full name to that. The M stands for Maori. He became vice chancellor of the University of Melbourne. I don't know if he ever penned similar things for folk at the University of Melbourne. I'm going to finish there. Thank you to the readers. Thank you for your attention. And I hope you found this interesting and entertaining. Thank you very much.
[APPLAUSE]

SPEAKER: OK, thank you so much. That was fantastic. I think I learned more in that lecture than I did in all my years doing science at school. Particularly those parts that-- that part about the cathedral and the grains of rice, that makes it very real, doesn't it? You nearly lost me at the currant bun because I'm a terrible baker. But whenever you explained it, I was thinking it's like, a cookie. It was very, very good for people like me who aren't particularly talented in physics.
And just before we start our conversation, I just wanted to say a really, really big thank you to our volunteers. And particularly, I'm delighted that we had so many young volunteers to read and particularly so many young girls. So could we get one more round of applause just for them. Thank you.
[APPLAUSE]

The poems were beautiful. They were really beautiful. Some of them pretty witty as well, which was fantastic. So just off the back of the discussion, obviously, there was so much poetry in it. Poetry and literature. Do you think for people who maybe don't feel that they're naturally inclined towards the sciences, do you think using poetry and literature could be a way to teach those people?
JOCELYN BELL BURNELL: I think it perhaps makes things feel a bit more accessible. It's not so much the hardcore physics, it's got slightly softer with the poetry. I think that's helpful myself.
SPEAKER: Yeah. Did people find it helpful? Yeah, yeah, really, really helpful. And kind of on the flip side of that, would there be anyone here that would find themselves to be more of a creative person than a scientific person? Yeah, quite a few people. Do you think that there is a place in science for creative people?
JOCELYN BELL BURNELL: I think there's a place for creativity in science. And some of us are more creative than others. It has to be said in science. But scientists are testing theories. They dream up these theories. Well, maybe what's going on is da, da, da, da, da, da, da, da, da. And that's a creative act, envisaging the da, da, da, da, da that's going on. And then you sit down as a scientist and try and check out whether that's true. But you need the creative bit to create the theories that you're going to test.
SPEAKER: Yeah, I know people usually think it's kind of you have a creative mind or you have an analytical mind, you have a musical mind, for example, or you have a logistical mind. But I do think that as well. Coming from the background of being a musician, and I think there's patterns in these things. And it can both be creative, it can both be beautiful, but the difference with the science is obviously testing out using the evidence. So it is very, very interesting.
And just in terms of-- I know obviously, we've talked about poetry this evening. But in terms of your career, I want to touch on that a little bit because I know people are very interested. So your discovery

of pulsars was very, very early in your career. And I always wondered, do you feel was that a help for you or was that a hindrance?
JOCELYN BELL BURNELL: It was a huge help for me in that fairly soon afterwards, I got married. I married a guy who worked in local government. And the way you advance in local government is moving to another locality and going up a level in the move. And so we were moving every five or six years.
And I was trying to find a job in astronomy near where my husband had his new level job. And because I had a bit of a track record, people were prepared to find a bit of money to employ me. I was also only wanting to work part-time because we had a child. But directors of laboratories, they had access to enough little pots of money that they could offer me a part-time job, which was great.
SPEAKER: And obviously, give you a level of gravitas very early on, which is great, whenever you were saying there about it was great because then, you got married. I was thinking, oh, my God, am I going to have to discover some pulsars to be eligible to get married? I don't know where that was going.
So obviously today, we're wanting to encourage and inspire women who are in STEM, women who want to pursue a career in STEM, all the girls that we have here today. And I know whenever you're a woman in a kind of male-dominated industry, everybody asks you about it. It can be a little bit tiresome because I get asked about it all the time and comedy and radio and things. But it is very essential in encouraging other women. And as I say, we have so many people here today.
So were there any kind of detrimental impacts you felt of being a woman in a male-dominated field whenever you kind of started out or even at the minute?
JOCELYN BELL BURNELL: I think it's a lot better now. But for example, I remember when our son was probably about five or six attending primary school, primary school had phone numbers for both my husband and me as they did for every child in that primary school. And one day, this six-year-old kid felt a bit ill. And they phoned my work number, and I was actually away from that site. I was at a meeting in London.
So they turned to the child and say, "You're not so sick that we have to phone daddy, are you?" And the child said, no, but had the wit to tell us that evening what had happened. So yeah, it wasn't an even world.
SPEAKER: Yeah, I'm sure particularly we talked about you discovering the pulsars, how early it was. And I had read previously that you were kind of at that time treated more as like a human interest side of the story whenever you discover the pulsars. I know it's a well-known story that your male thesis advisor was kind of asked the more scientific questions, which I would think would be very demeaning and things like that. And there was a very big part of it in that recent film with Jennifer Lawrence and Leonardo DiCaprio, the Don't Look Up, where he's she's kind of ignored really, in favor of him.
And how did you find that? What kind of things were you asked?
JOCELYN BELL BURNELL: This was the late 1960s, so it's a while back. Typically, what would happen is after the discovery of pulsars, there'd be my thesis advisor, Professor Tony Hewish and myself. And the journalists would ask Tony about the astrophysical significance of this discovery. And then they turned to me for the human interest.
How many boyfriends did I have? Was my hair color brunette or blonde? What were my vital statistics, please? And the photographers would say could I undo some more buttons, please. And that was the role of young women as perceived by the press. And quite a lot of the public as well.
SPEAKER: That's unbelievable. I mean, I know obviously, you're saying late '60s but even then, that's quite unbelievable. You know, that kind of--
JOCELYN BELL BURNELL: No, perfectly normal.
SPEAKER: Yeah, that's unbelievable. No one's ever asked me to undo more buttons, so it is unbelievable. But whenever I think of the sciences now, I feel like women are nowadays much more represented in the medical sciences, the psychological sciences, biological sciences. And I always feel that maybe physics and maths and maybe some types of engineering, there's not the same uptake. But that's maybe my ignorance because I don't work in the area. Is there still a very uneven keel in those topics?
JOCELYN BELL BURNELL: You're right, there's fewer women in the physical sciences and rather more women in the biological sciences. Yes, that's absolutely true. Still true. It's gradually changing. It's kind of evening up, but it is still the case, yeah.

SPEAKER: I mean, I don't know if you'll have a specific opinion on it, but why do you think that is? I can understand obviously the medical sciences and health care, that kind of more old-fashioned view of women going into nursing and women going into that kind of thing, but why in physics do you think there's less of an uptake?
JOCELYN BELL BURNELL: It's still the same old-fashioned view that hasn't gone.
SPEAKER: Yeah. I mean, it's interesting in itself, but I just think it's a very bizarre thing to think nowadays.
JOCELYN BELL BURNELL: There are getting to be pockets in the physical sciences where there are a lot of women. I alluded to the fact that we're finding planets around other stars, exoplanets. The exoplanet field contains a lot of women. It's a very new one. Maybe that's something to do with it.
SPEAKER: Yeah, it's new. There's maybe not those kind of views already in place. There's not that pre-kind of conceptions about what it should be in that field. So what about for you? What kind of first drew you to physics? Was it just a natural talent or were you--
JOCELYN BELL BURNELL: Yes, I actually had a battle to get to do science. And this is what? Mid-1950s. Boys did science, girls did cookery and needlework. That was the assumption in my grammar school. I protested, I wasn't heard. Told my parents that evening, they hit the roof, phoned the headteacher. The local doctor had a daughter in my class, he too phoned the headteacher. And so did the parents of another girl.
And when the science class had its second meeting, there were three girls and all the boys. And if you're the science teacher and that's their desk, the science teacher made us three sit there because clearly, we're dynamite.
[LAUGHTER]

SPEAKER: But you obviously must have just had a natural inclination for it, it's just a talent.
JOCELYN BELL BURNELL: I certainly liked physics right from the go, yes. Chemistry was OK. I got put off biology because in that same year, we did biology in the summer term. Here's a flower, draw the flower, label the parts, learn the names. You've done that, good. Here's another flower, draw the flower. That went on the whole flipping' term. I thought, that's not science.
SPEAKER: And how many times have you drawn those flowers and labeled those? One of the things that I really loved about your talk there was your way with words. And I know sometimes scientists aren't known for their way with words, so I love the kind of mix of the poetry and the astronomy. And of one of the bits that really stuck with me there was when you said-- when you talk about the sun. I don't know if people--
It was a very romantic thing to say, you are the sun popularized by a very dodgy episode of Gray's Anatomy. You are the sun. And I was just thinking, I much prefer your term. I would prefer to say to someone, you are a boringly, bog-standard star. I think that is just a great turn of phrase. And obviously, you do you have kind of the language for it and the scientific backing and things like that. We had everyone reading these beautiful poems. Have you ever kind of tried to write poetry yourself?
JOCELYN BELL BURNELL: If we were England and you started a piece the way you started, you'd say, it's because you're Irish, aren't you? Good caricature of the Irish out there. And never mind what kind of Irish, I know we're in Australia.
SPEAKER: It's a cross-community event.
[LAUGHTER]

JOCELYN BELL BURNELL: I have vivid memories of primary school when our homework was to write a poem about a daisy. And I struggled with this flipping homework. And I couldn't produce anything I was satisfied with. The teacher, however, very much liked what I'd written. And I recognized, despised her for it because it wasn't good. And that actually put me off poetry for a long time. I thought, that's not my area.
Until one day, I was lecturing to a group of friends and the friend pointed out that poem of Elizabeth Jennings about Delay. And I thought, well, that's good. Wonder if there's any more where that came from. And really started looking at that and for poetry and found these reams of poetry with an astronomical theme. Two thick files stuff.
SPEAKER: Collecting them?
JOCELYN BELL BURNELL: Yeah.

SPEAKER: I know when I was sitting there listening to them, I was just thinking, these are-- it would never occur to me to look up an astronomical poem. But I was just sitting there thinking, these are absolutely beautiful. They're really, really lovely. We're going to go for-- in a sec and we're going to ask if you all have any questions.
But I just kind of wanted to finish off by asking, if you were to go back again and kind of go through school and go through your subjects and things like that, would you choose physics? Would you do it all over again? Because I'm aware a lot of young people in them.
JOCELYN BELL BURNELL: Yeah. If physics was always my best science?
SPEAKER: Yeah.
JOCELYN BELL BURNELL: And my next best subject probably was maths. And then it was Latin. The Latin teacher wanted me to do A-level Latin, but I was doing maths. Higher maths and physics, and we were only allowed to do three.
SPEAKER: Maths, higher maths, and physics. My God, that sounds very, very difficult.
JOCELYN BELL BURNELL: If you want to be a professional physicist, that's the fairly typical route.
SPEAKER: Really? That must be why I didn't end up being a professional physicist because I didn't choose any of those subjects.
JOCELYN BELL BURNELL: You can leave now if you want.
SPEAKER: That was so interesting. It was fascinating. And as I say, I loved the poetry and I learned a lot from that. So just before we get you guys to ask your question, could we get round of applause for that?
[APPLAUSE]

Thank you, Jocelyn. So I'm really hoping our audience have some questions for us. We've got a--
JOCELYN BELL BURNELL: Oh, yes.
SPEAKER: Oh, oh, oh, excellent. That's my one job, choosing who gets to ask a question.
AUDIENCE: Dame Jocelyn--
SPEAKER: Go ahead.
AUDIENCE: OK as a Lurgan resident, may I say that we are tremendously proud of you, that you're from the return of Lurgan. And here's my question. A few years ago, NASA and ESA, I believe ESA, put a request that could anybody had any idea to replace the atomic clock? My request I sent to them was that the pulsar would have been an ideal idea to do that. And I also recommended that it would be called the Jocelyn Bell Burnett cosmic clock. What's your thoughts on that?
[LAUGHTER]
JOCELYN BELL BURNELL: Well, pulsars are things that spin pretty fast, and they are remarkably accurate. But if you measure the period to five or six decimal places, you'll find they're are not perfect. They are gradually slowing. And some of them occasionally hiccup, and that's the last thing you want in a time standard.
SPEAKER: Thank you so much. I thought you were maybe alluding to that you were saying about going part-time and things. That you were gradually slowing and hiccuping and things like that. And I thought no, we should still call--
JOCELYN BELL BURNELL: I probably am gradually slowing.
SPEAKER: We should still call it after you. That's lovely. And that's such a lovely thing to say that Lurgan are so proud. Thank you so much. Lurgan don't have too much, so that's great.
[LAUGHTER]

We've got a lovely person here going to ask a question.
AUDIENCE: Excuse me, I'm from Lurgan also.
[LAUGHTER]
SPEAKER: Oh, my God. She's organized a [INAUDIBLE]. This is the Lurgan fan club. Goofus.
AUDIENCE: Thank you very much for tonight's and your language for me is very accessible. And I was just-- have you ever written anything yourself, poetry?
JOCELYN BELL BURNELL: No. Partly, I think thanks to that school teacher and the poem about the daisy. No, I very much enjoy reading it, but I don't think I have this skill with words to manage the meaning and the rhythm. I can do one or the other, but I don't seem to be able to get the two together.
AUDIENCE: OK, thank you.

SPEAKER: You maybe give it a go and present your poetry at the next Science Festival.
JOCELYN BELL BURNELL: Well I doubt it, actually. But thank you.
SPEAKER: Maybe so. Yes, we've got another question here from one of our very, very first poem reader. Very brief.
JOCELYN BELL BURNELL: You've also got center back, I think.
AUDIENCE: What do you use the Open University? Because you're doing it for them, the talk.
JOCELYN BELL BURNELL: I've worked for the Open University for a good many years, starting off as a tutor. You know that students are studying at home, they get sent material or pick up material off the web. But if they've got questions, then they've been assigned a tutor and to be able to answer all their questions. And that tutor will also mark their work.
Now, I've never been a tutor in Ireland, but I was a tutor in various parts of Britain, and including the highlands and islands of Scotland. So for example, Ailsa Craig. You know what I mean by Ailsa Craig? Yeah, has a lighthouse. At the time, I was a tutor, the lighthouses were staffed. And one of the lighthouse keepers in Ailsa Craig was my student.
I had another student on Foula. If you go way up to the Shetlands and turn left for 30 miles, that's the island of Foula. I had a student there. The OU students that I tutored were fantastic people doing amazingly good work in amazingly adverse circumstances. It was really inspiring to be a tutor. Students were so remarkable.
SPEAKER: Thank you. Thank you, also that was a great question. Do we have a question at the front here? Yes, we have a question here, and then we'll go to you then.
AUDIENCE: [NON-ENGLISH SPEECH]
JOCELYN BELL BURNELL: I didn't catch that.
SPEAKER: Oh, go again.
AUDIENCE: [NON-ENGLISH SPEECH]

Of all of the two files of poems, do you have a favorite?
SPEAKER: Thank you very, very much. Do you have a favorite of all your collection?
JOCELYN BELL BURNELL: I think it's probably the one that introduced me to it, which was the Elizabeth Jennings poem, Delay. That's where my particular journey started. And obviously, that poem grabbed me sufficiently that I went on to look for other poems of an astronomical theme and discovered that there were thousands. Yeah.
SPEAKER: Thank you. That was a great question. And obviously, we heard that lovely poem this evening. We've got our second volunteer wants to come down with the mic. We've got, yeah-- and then we've got someone on here. Yeah, go for it.
AUDIENCE: This one's for Jocelyn again. And before coming to this evening, I was reading about your pulsar discovery, and it was, if I'm right in saying, your Professor Hewish who got the Nobel Prize based on your findings. Do you feel that the discourse for women in STEM has changed since your time as a young scientist? And do you think that-- if you were to have made that discovery now, do you think you would have had more likely a chance to get credit for your work as opposed to your male peer and tutor, I suppose?
JOCELYN BELL BURNELL: Yes. I think if it happened now, I'd be more likely to be included in the Nobel Prize. Incidentally, my graduate student colleagues were incensed on my behalf, and Nobel got renamed as no-bel.
[LAUGHTER]

SPEAKER: Very good for everybody. I wonder if we could do a petition or something to get them to name it back in your name.
JOCELYN BELL BURNELL: Actually, just to continue that story, a good friend of mine got the Nobel Prize a few years later. It was both he and his student also for pulsar work. And they invited me to Stockholm as their guest. And you should have seen the Nobel Prize secretariat, they were very twitchy. I don't recommend winning a Nobel Prize but going as a guest to the ceremonies in Stockholm is fantastic.
SPEAKER: And I'm sure she saw you come in, she was like, oh, dear God, this is-- Thank you so much for that question. I love that you started it with this is a question for Jocelyn. I thought, please,

don't ask me any questions. I don't know anything. We've got a little girl here who had read-- one of our poetry readers. Yeah. Who's been waiting to ask a question for ages, just in the middle. Go for it.
AUDIENCE: What made you want to be an astronomer?
SPEAKER: Thank you.
JOCELYN BELL BURNELL: Yeah. Well, I was good at science at school, particularly when we got into secondary school and science got divided into physics, chemistry, biology. I was good at physics. And as I went through school, I continued good at physics and I thought right, I'm probably going to go to university and do a physics degree, but what am I going to do after that?
There are actually lots of things you can do with a physics degree. And my first thought was I'll be a medical physicist. Hospitals have employed physicists for some jobs. But my father was very widely read. He had access to the Linen Hall Library here in Belfast. And he used to bring home some very good books from the Linen Hall Library.
And one day, he brought home an astronomy book by Fred Hoyle. And I thought, this looks interesting, and removed it to my bedroom to read and realized through reading that book that the physics I was learning in school could be used to help explain stars and galaxies. So right, I'll be an astronomer. I'll do a physics degree and be an astronomer. And that's actually what I did do.
SPEAKER: Thank you. That was a great question. Are you are you interested in science? Almost. Feeling very inspired after today. I think so. Thank you so much. There's a question right next to you as well.
AUDIENCE: Actually just following on from what you said about your father. Am I correct in thinking that he actually designed the Armagh Planetarium? And would that then inspired you as well to take up astronomy?
JOCELYN BELL BURNELL: Yeah, my father was the architect for the whole of Armagh Observatory. And most of that involved crawling through the roof space trying to find where the roof in the old building was leaking. But he did also design the planetarium.
But actually, I had found the first pulsar, maybe even the first two pulsars by the time the planetarium was beginning to be like a planetarium. I can remember visiting it one Christmas vacation. Patrick Moore was the first director, and the planetarium had reached the stage where he had installed the first projector of stars. And we were inside this-- the floor wasn't finished but the roof was up and the projector was in and Patrick Moore was wittering away about the number of stars and blah, blah, blah, blah, blah. And dad's busy looking for cracks, where the rain gets in.
And I found the first pulsar and I've been told to keep fairly quiet about it over the Christmas holiday. But I work out which bit of sky it's on. And it turns out it's in the Milky Way in an incredibly crowded part of the sky. Vulpecula for any amateur astronomers. I thought, crikey, there's an awful lot of stars in that bit of sky. There's no way we're going to be able to say which one it is. It's really, really crowded.
So Armagh Planetarium actually came along quite late on in terms of the discovery of pulsars. I was already set on my track by then. Yeah.
SPEAKER: I didn't know that. That's amazing. That's very almost kind of serendipitous. I was glad because I was thinking maybe your dad kind of designing that had inspired you. And I was thinking, is that how career has come by? My dad's funeral director, so I was getting a bit anxious. We've got a question over on this side. Yes, person in baseball jacket, go ahead.
AUDIENCE: Firstly, sorry, I just wanted to say I really look up to you and I think loads of girls here and this here particularly. In my physics class at school, there's only three of us in the whole class still. So we've progressed in all the ways but in lots of ways, we can't. But when our teacher put you on the screen, she said like, you're such a legend so--
[LAUGHTER]
[APPLAUSE]

But basically, I really love science, physics and all of it. But like you, I really love poetry and stuff, and I really can't decide on what is my actual passion and what to do as a career. I'm really stuck between both of them. And what would your advice on that be?
JOCELYN BELL BURNELL: You land money more easily as a physicist.
[LAUGHTER]
[APPLAUSE]

Just to be mercenary.
SPEAKER: That's a great question. Thank you so much. I mean, you can always be a poetry-writing physicist. It might be a bit harder to be a poet who occasionally dabbles in physics. So probably physics is the way to go there. Thank you for that great question. That was great.
We've probably got time for one or two more questions. So I'm going to let our-- we've got a question here at the back.
AUDIENCE: This is about the analogy that you used about the grains of sand in the Cathedral and just to try and get across that scale of space. And it blows my mind, and I just don't really comprehend it. But what is between the grains of sand?
JOCELYN BELL BURNELL: Pretty empty. I won't say totally empty. There might be some very, very, very thin gaps between the grains of sand. But actually, nothing noticeable. The grains of sand are the most substantial stuff that you see. And you can't normally spot what's between the stars because it often doesn't shine.
SPEAKER: Thank you so much. That was a great question. We've got one in the middle here. Someone's very keen.
AUDIENCE: I just like to share a poem, if that's OK.
SPEAKER: Yes, go ahead.
AUDIENCE: So actually, I was only about halfway through the session that I actually remembered that I wrote a physics poem. And so it was actually in an interview. I had to explain what forces act on a ball shortly after its hit by a tennis racket. And so this is the poem that I wrote to answer that.
"This question can be tricky, so be sure to take your time. Don't let it confuse you or you may begin to rhyme. A ball in mid-flight has both a horizontal and vertical component. The horizontal is quite simple, containing a negligible drag opponent. Then just as Newton discovered when the apple fell from the tree, the only vertical force acting is the one called gravity. With no external forces, the ball carries along its curve with acceleration due to gravity and constant velocity from the serve.
JOCELYN BELL BURNELL: Brilliant.
SPEAKER: Very good. Brilliant.
[APPLAUSE]

JOCELYN BELL BURNELL: Thank you for that. That's lovely.
SPEAKER: That was great. You might need to include that next time in your-- just kick out one of those poems. That was great. Thank you so much.
I think Calum, do we have time for one more question? Yeah? You have to say yes for all these people anyway. So I'm going to let our mic folk choose whoever they want.
JOCELYN BELL BURNELL: OK, this one.
SPEAKER: That was lazy but all right, go ahead.
AUDIENCE: First of all, thank you very much for the talk. And it's quite a straightforward question just, what scientist inspires you yourself? What scientist do you admire?
JOCELYN BELL BURNELL: I don't know. Can't actually think of people that do. There are places that I find quite meaningful. County Donegal is one of them. It's probably the one that's nearest to my heart. And in later life, I've become quite a keen gardener, so you can find some very beautiful flowers and beautiful landscaping of flower beds and trees and things. But I think that's probably the nearest I'm coming to what you're looking for.
SPEAKER: Thank you. I think it says a lot about how inspiring and kind of at the top of your game you are if you can't think of people who inspire you.
[LAUGHTER]

Thank you so much. I mean, I'm sitting right here, you could have said me but anyway-- I'm going to give our other volunteer one last question because I know we had a few people in the middle and on that side of the room who had their hands up. So who wants to be our last question to close our event for this evening?
JOCELYN BELL BURNELL: Time to go home.

SPEAKER: Oh, sorry, it was over this side. So if you could just run down those stairs and back up. Yeah, that's great. Thank you very, very much. I hope this has been no pressure because it's last question will hold on.
JOCELYN BELL BURNELL: No pressure.
AUDIENCE: Maybe it's a slightly follow on question from the previous one. And I did physics as a researcher and I knew the sheer amount of effort and skill it requires to be professional and a professor level. What do you think is your unique skill to allow you to achieve the level of success that you have? I'll say I'm not a professor, so I never got there. But I realized the amount of commitment that level takes. So what do you think is your unique skill?
JOCELYN BELL BURNELL: There's quite a stubborn streak in me, and I had quite a tough time as an undergraduate in Glasgow University, which kind of meant I invested a lot in studying physics. And having invested that, I kind of didn't want to back away from it. So I also enjoy the physics very much, I must say. And I particularly enjoy teaching physics, which is why being an Open University tutor and a member of the science faculty at Walton Hall was an important part of my life.
So I think that's probably the nearest I can come to answering your question. Thank you.
SPEAKER: Thank you so, so much. Yes, I think to kind of be at the top level, particularly obviously a professor level in universities and things, no matter what your subject is, it's kind of mixture of talent and hard work and single mindedness as well on the topic.
JOCELYN BELL BURNELL: And luck.
SPEAKER: Well, I don't all about that because I'd never been as lucky to be a professor. So I just think there's kind of a lot of natural ability and just hard work goes into it.
So I want to just say thank you so much. That is a first level that we have time for. So could we just give Jocelyn a very big round of applause, please?
JOCELYN BELL BURNELL: Thank you very much.
[APPLAUSE]

SPEAKER: Thank you. Thank you for being such a lovely audience. Thank you for getting involved for all the people who read. Reading the poems, asking questions, thank you so much. And a big, big thank you, of course, to Dame Jocelyn Bell Burnell for being so open and so fantastic.