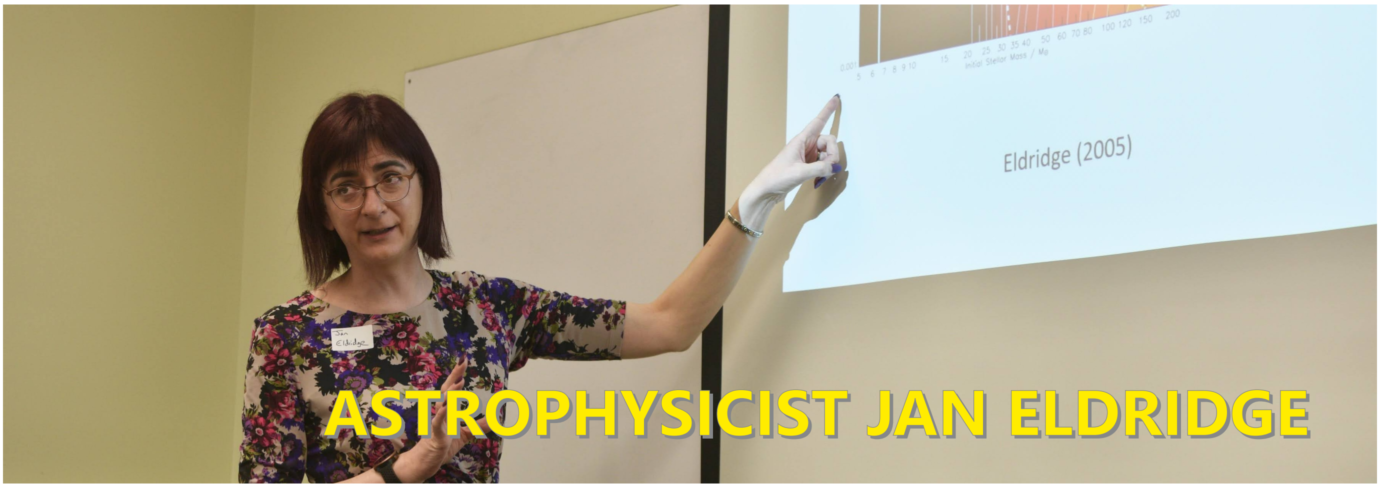


ASTROPHYSICIST JAN ELDRIDGE

Photo Courtesy: Jan Eldridge

Jan Eldridge is a pākehā astrophysicist and the Head of Physics Department at the University of Auckland. Jan's research focuses on the lives and deaths of stars, particularly binary stars. Unlike the stereotypical caricature of an astrophysicist, Jan's work does not involve long hours of peering into the telescope. Instead, her work as a theorist primarily involves coding programmes on computers to model the journey and evolution of stars in our universe. As we celebrate Pride and Matariki this month, Jan, who identifies as transgender, shares insights from her work and life on stars and genders with NZASE science communicator, Sneha Pillai.

BORN

Jan was born in1977 in Kent, United Kingdom. "I find it interesting that 1977 was also when Star Wars came out and when space probes Voyager 1 and 2 were launched by NASA to go on the grand tour of the solar system," says Jan.

SCHOOLS AND SUBJECTS

At Hillsgrove Primary School in Kent until the age of 11 and then Bexley and Erith Technical High School for Boys, Jan says, "I did Science, technology, maths, physics, chemistry, and further maths."

Jan notes that astrophysics has undergone a transformational change in recent years and that computer science, apart from maths and physics, would be the most important subjects to study today to become an astrophysicist.

"But, also, don't forget to learn how to write. Because you actually have to write up all your stuff! Even though we can ask AI to write things today, you need to make sure that you can take that and make it better."

HOW SHE GOT INTO SCIENCE

"I was lucky to have parents who encouraged reading, and I had always enjoyed reading science fiction. I read Isaac Asimov, Arthur C. Clarke, A. E. van Vogt, and series including The Hitch-hikers Guide to the Galaxy and Space Odyssey. I also watched Star Trek, Star Wars, and Doctor Who. In fact, the reason I went to Cambridge over Oxford or any other University was because of this book titled The Voyage of the Space Beagle by A. E. van Vogt. The book's hero had a good understanding of all sciences, and used his knowledge - what we identify as transdisciplinary knowledge today - to solve problems. So, I wanted to study maths, physics, chemistry, and geology. I very nearly became a geologist, too, because, to be honest, running around a mountainside with a rock hammer and smashing a rock to look inside seemed good fun!"

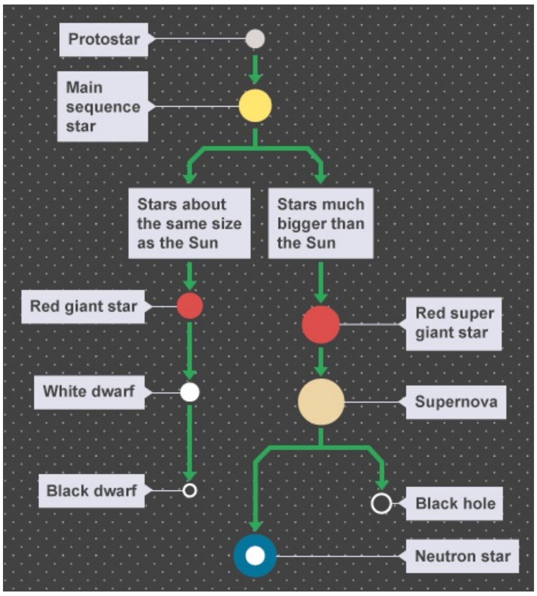
TRAINING AND JOBS

For her tertiary education, Jan went to Fitzwilliam

College at the University of Cambridge, where she studied Natural Sciences. After completing her Bachelor's and Master's, Jan stayed on at the Cambridge University to complete her PhD in Astrophysics.

She followed this with a year of post-doctoral studies at the Institut d'Astrophysics de Paris, followed by Queen's University Belfast and University of Cambridge before moving to the University of Auckland in 2007 to work as a lecturer.

Apart from her work in academia, she also worked on the tech teams of companies like CompuServe, IBM and the Defence Science and Technology Laboratory in UK.



The life cycle for a particular star depends on its size. This diagram from the BBC shows the life cycle of stars that are both smaller and larger than the sun.

FIELDS OF SCIENCE

Astrophysics. Her research is focused on the lives and deaths of stars, especially binary stars. Most of her work involves the suite of computer codes she has created, called the Binary Population and Spectral Synthesis code (BPASS). Using BPASS, she studies stars, supernovae and gravitational wave sources in our own Galaxy out to the edge of the observable Universe.

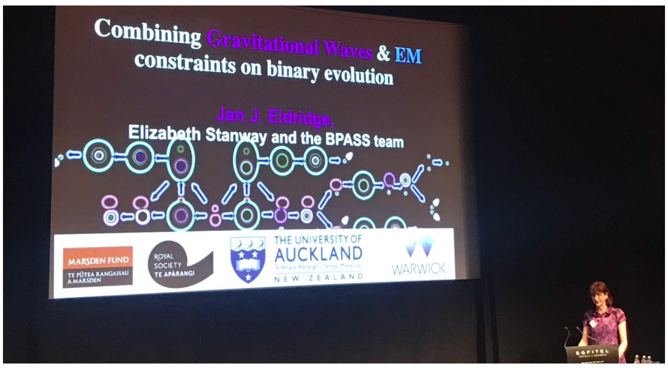
RESEARCH EXAMPLES

"In astrophysics, you have the theorists and observers. An observer analyses what they see through their telescopes. But as a theorist, I make computer models of how stars evolve from their birth to their death, especially binary stars. I model for what could happen if a star explodes, or if two stars collide, and so on."

A computer programme like BPASS allows her to model for different events. "By coding large computer programmes, you can take account of the complexity that goes on. The thing I like about modelling stars is you have to take account of all aspects of physics and there is almost nothing in our realm of physics that gets missed out when modelling. You have to use thermodynamics, quantum mechanics, nuclear structure, the way atoms and light work together... and it's really good fun because you have to know everything, which also makes it difficult!"

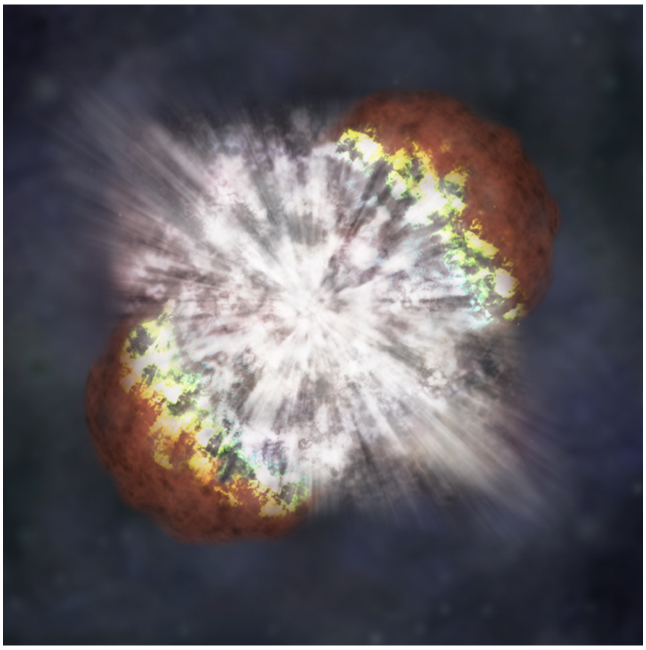
Jan's BPASS software is a suite of codes which interact to model either individual stars or whole galaxies. Her primary interest lies with binary stars. "Stars like our sun are actually rare because it is a single star. But most stars in the universe are binary i.e. in pairs. What's interesting about binary stars is that they get bigger in radius as they get older, so they can interact and get in each other's way. What this means is that you get different evolutions, different outcomes and different explosions because of these outcomes."

"At its core, my research is trying to model those interactions model when the stars bump into each other in some ways. It helps us understand the universe better. Jan explains that if we model for what galaxies look like using a single-star system like our sun, which is what we are familiar with, we risk getting the wrong output because over 50% of all stars in the galaxy are made by or are in a binary. Only 25% are single and the rest are triples or quadruplets. "And so that's what I've really been doing, trying to make sure that the astrophysics



Jan Eldridge presenting at an academic conference.

community has a tool to understand the universe, modelling stars as they really are.”



An illustration of one of the brightest and most energetic supernova explosions ever recorded. Image credit: NASA/CXC/ M.Weiss

"If you don't take account of them, you get the wrong answer or you don't get the full understanding of what's really going on."

HOW SHE FINDS THINGS OUT

There’s three main methods that she uses in her study. First, is just by like looking at models and seeing if anything interesting happens. “You discover something new within the models because you've put in new physics or a new method and you suddenly realize, that this explains a particular phenomenon. It also enables us to predict what could happen if a star or stars were to behave in a distinct way.”

The second method is by reading academic papers. Observers in astrophysics may see something interesting and write about it, but may not fully know what they’ve seen or why it is so. Theorists, through modelling, can help understand these observations.

The third method is through collaboration with other astrophysicists. “A couple of years ago, one of my colleagues had found what he thought was a weird star. It was a binary star with a completely circular orbit, which is not unusual. But it was unusual for this system because one of them was a neutron star, which means a supernova, a huge explosion should have happened. But the evidence of the binary was that in fact the explosion was quite "wimpy" which makes it a very rare neutron star. We had to then try and model that to understand it.”

MOST VALUABLE RESULTS

“I mean, there's two ways to ask that. Is there a contribution I've made? I think hopefully. A wider group of astronomers know that binary stars are really important. Because if you don't take account of them, you get the wrong answer or you don't get the full understanding of what's really going on. The reason I know this is because other people are reproducing the work we’ve done, which is good because we get other people to review and confirm our work.

The other unique single individual thing I've done is actually on these supernova progenitors - trying to understand those stars that explode. One of the most exciting papers I've ever written was on the progenitor of a supernova because I had written a paper saying that we've never seen the progenitor star for this type of explosion. After writing the paper, a supernova of that type did explode and other observers found the progenitor star in a pre-explosion image. So, I then had to go and write another paper because I had all the models ready and I could say look this star you've seen matches everything we had prepared. It was quite exciting to realize that it matches all the models!”

WHAT SHE LIKES ABOUT SCIENCE

“I think it's just like solving problems. I get to make cool models, and the universe is wonderful to try and understand! In some ways, there is no application to my knowledge. It's just a pure knowledge. We're just trying to understand where we come from, and I just want to know the answer and understand our world better.”

OTHER INTERESTS AND LEARNINGS

“While my interest lies in binary stars, as a transgender scientist, I am also interested in exploding the myth around binary genders. Growing up, I knew I was the wrong gender. But I wasn’t angry at myself, I was more confused about who am I and why do I feel this way. One of the things that's always kept me distracted from actually knowing that I was the wrong gender is physics.

When I was growing up all the examples of who is a physicist were a man. And I went to an all-boys school. But when I got to university, I met many women pursuing physics who became my friends and still are today. But it wasn't till I came to Auckland and they started setting up a Rainbow Student Network, that I found my voice. Because as an academic I've got to do 40% research, 40% teaching and 20% service and leadership. Some of the students set up a group called Trans on Campus and I got involved because about 10 years ago now, it was not as good for trans students on campus. As a lecturer, I had the privilege to help these students get where they want to. Of course, by going along to all the talks and meetings, I also learned a lot about gender. And that was also a part of me then, trying to understand myself because suddenly you have a deeper insight into a subject that's quite broad and that I had ignored.

When I came out in about 2015, people around me could see I was a lot happier and a lot more productive. The thing is, every journey is different and there's not one way of doing it. And there are many ways of being yourself. The important thing is to find the thing that makes you feel like yourself and go down that path.”

MATARIKI

Some of the stars in Matariki are interesting and unusual! So, it's at an age where we should expect some red supergiants. Some of those stars should actually be red, but they're all blue supergiants. Which kind of suggests that they could be the result of binary evolution. And it's the only star cluster you can see with the naked eye.

Also, normally when you look at constellations, those stars are hundreds of light years away from each other. But for Matariki, they're all really close to each other. Most other stars just vanish, and they sort of disperse from their birth clusters. From a Western science perspective, that's what I like about Matariki.

> **Ngā Kupu**
> Whetū: Star
> Uruwhetū, ikarangi: Galaxy
> Whetūao: planet
> Ika-whenua-o-te-rangi: Milky Way
> Karu whātat: Telescope
> Tātai arorangi: Astronomy
> *Source: Te Aka Māori Dictionary*

RELEVANT LINKS

Article: *The things binaries do ...* (2020)
Jan's article for the UK magazine Royal Astronomical Society

Video: *Exploding binaries: stars and gender* (2023)
Jan's inaugural professorial lecture at the University of Auckland

Science papers: *The death of massive stars – II. Observational constraints on the progenitors of Type Ibc supernovae* (2013)
Possible binary progenitors for the Type Ib supernova iPTF13bvn (2014)
The disappearance of the helium-giant progenitor of the Type Ib supernova iPTF13bvn and constraints on its companion (2016)

Web articles: NASA - Multiple Star Systems
NASA's Imagine the Universe