Student Presenter – Tajwar

****How do black holes cause problems for the world of physics, and how can we unify our understanding of them to get a better understanding of the universe?****

The Research Project, it’s the one subject where you call the shots. It’s a clean slate where you design your own course.

Compared to the rest of the year 12 subjects, it’s a breath of fresh air.

When it comes to choosing your topic, the universe is the limit. But make sure that you choose something that you’re interested in. Something that you’re passionate about. Something that you love to do.

Some people actually don’t like the Research Project and I tell them, ‘if you don’t like the Research Project, then you don’t like learning the thing that you’re most interested in’, which doesn’t make any sense.

So what do I love? What am I interested in?

Breaking Bad… but that’s not my topic.

It’s black holes, the real monsters in the universe. Which is like Walter White…

Now why did I choose black holes out of everything else in the universe? Well I’m a physics guy, I love physics, and black holes are at the centre of physics. They also encompass all the other topics that I would have done into one nice package.

Black hole research is also a continuation of the work of the people I admire, like Isaac Newton, Einstein, Feymann and so on. We all love mysteries don’t we? Of course we do. And black holes are the greatest mystery in the universe. Speaking of the universe, our job is to understand how the universe works and black holes may lead us to it. And it may also lead me to understanding my goal of inventing something myself.

Black holes may also lead us to get the theory of everything.

What? The theory of everything? What is that? Well I’ll talk about that a bit later.

Now let’s talk about my research topic. Here’s the long version.

How are the laws of nature at risk due to the presence of black holes and how can we unify our model of nature to grasp these irrational objects, will give us a better understanding of the universe?

That’s nice, but what does this actually mean?

Well our current understanding of the universe is based on the standard model of particle physics, but you see black holes, they’re rogues, they don’t work with this model. But why? What’s the problem here? that’s part of the question.

And to understand it, we need to expand our thinking.

To expand our thinking, we need to fuse theories together to form super theories.

But how do we do that? What are the steps we take? That’s a part of the question.

And this new theory, it will give us a better understanding of the universe. How? What will it do? That’s part of the question as well.

Now to answer this question, we have six sub-questions. A bit excessive I know. But the first sub-question is you introduce black holes, what are they?

Where do they come from?

Then we go on to ‘what problems do they cause?’

How do they cause these problems?

Then who actually cares about this?

What’s the point of all this? Then we move on to the fourth where we talk about what things we need to join to understand black holes.

Moving onto this, how we do this and finally how this improves our understanding of the universe, the theory of everything.

And now to answer these sub-questions, I had to go through so many research processes.

I had to read article after article, theses, books from universities.

I had to interview nuclear physicists and quantum physicists, do an experiment on logarithmic cleansing.

I also had to go to university lectures - no I didn’t sneak in.

And all of this combined helped me answer these questions.

The most useful was the interview.

Now, conducting the Research Project opened new doorways for me.

Like I would have never gone to the Barr Smith library – maybe next year at university – but never accessed the national library of Australia, if I hadn’t done the Research Project.

Now I have access to so much knowledge that I can put into my other work. It’s amazing. But now let’s go on to my actual findings.

So what are black holes?

This is the deep end.

So black holes form through collapsing stars.

Stars like our sun release light, and this light comes from nuclear fusion. This outward light bounces the inward gravitational pull but when the sun or any star runs out of fuel, there’s no more outward release of light and the gravity just sucks it in.

It collapses the star and if the star is big enough, it collapses it down to a single point. Known as a singularly.

Something infinitesimally small but really really heavy.

The escape velocity of anything from this singularity in more than the speed of light so nothing can escape it.

And the boundary after which I think an escape is known as an event horizon. The region inside the event horizon is a black hole.

Now what’s up with these black holes? What are the problems?

Well yes they can suck you in and kill you, but that’s not the problems we’re talking about, we’re talking about the problems in physics.

So Einstein described gravity as the curvature of space, so if you imagine space time – an abstract concept – as a trampoline.

And yet, and you imagine a bowling ball as the sun.

You put the bowling ball on the trampoline, the trampoline will curve down.

That is what gravity is in Einstein’s mind. Now if you have, say, a singularity which is really really small but really really heavy and you put it on the trampoline, it will tear through the trampoline.

Basically tear through space time. But where does it go? Space time is supposed to be smooth not broken. What happens? There’s a problem here.

Now one of the most fundamental laws is information conservation. It states no matter how scrambled you scramble things, as long as you know the final product you can trace back to the initial event.

Now black holes they can evaporate, yes they can. They can evaporate into nothingness as discovered by Stephen Hawking.

When they evaporate, they take away all the information with it. What? Information isn’t conserved?

That’s a big problem in physics. People try to explain this and they go into other problems like the equivalence principle and then monogamy of entanglement and such that and at the centre of a black hole, time stops, what does that mean? We don’t know.

And our equations for black holes, they break down at the centre. They give us infinities, which don’t make any sense.

And the entropy, the disorder of a black hole is proportional to the surface area not the volume and if you were a thermodynamicist you’d be really surprised, you’d be like ‘What? No way!’

Now what’s the deal with this? Why do we care?

Well think about this, the basis behind everything is logic and reasoning and the building blocks of logic and reasoning are axioms. Things that we all accept but cannot prove, like a portion is always less than a whole. And we use this to prove the consecutive findings and we keep going, keep going until we come to our model of the world now.

If black holes don’t agree with the current model, it means they don’t agree with the model used beforehand to prove this.

You keep going back and back and back and you get, oh nothing’s right. We’re stuck, everything we’ve done is wrong.

Now physicists don’t like that. How are we going to advance if everything we’ve done is wrong?

And what’s stopping the things, our scientific world from breaking down at this point if everything we’ve done is wrong?

Nothing. So we need to fix this problem.

So that’s why we have to unify things. Now a singularity is really really heavy and has strong gravity. So it’s a territory of general relativity – the theory of gravity. But it’s also really really small so it’s also the territory of quantum mechanics. General relativity is the theory of stars, planets, galaxies, all the big things.

Quantum mechanics – the really small stuff. The particles, the weirdness that happens in the small level. But when you put these two theories together, they don’t mix.

These kids just won’t play together.

Their mathematics just don’t work, you just get anomaly after anomaly.

But how do we join them together?

To join them together we use string theory.

Now instead if thinking of particles as points or balls, we think of them as strings which wriggle around and their frequency is what determines what particle they are, and this gives us a deep brain separation explanation of the information.

It also tells us you know how it punctures through space time, maybe it leads to a different dimension. It’s all mathematically consistent, I assure you. But the problem is, we can’t test string theory, we can’t experimentally test it, so like religion, it’s all taken in faith. Some people don’t think it’s a real thing.

So if string theory, the theory used to explain black holes is correct, we get to, we can get to the theory of everything. Now as we can, if you can actually see it, this flow chart diagram. From the start, we unify theory we combine dynamics and statics to create classical mechanics.

Classical mechanics with atomic theory to create quantum mechanics.

Quantum mechanics and you keep going on further and further and further.

And you go to the end where you have the theory of everything.

Now to get to this, we need it to unify quantum mechanics and general relativity but now that we have string theory we can. Now you’re probably thinking ‘what is the theory of everything?’

Well as I found out from Research Project, everything in this universe can be explained with four forces – electromagnetism, gravity, the strong force and the weak force. You might be thinking ‘no no it’s not’, well think about this.

Why does life exist? Because cells form.

Why did cells form? Because cell membranes form.

Why did cell membranes form? Because of electrostatic attractions.

Why is the universe, why is the universe structured? Because of gravity.

Why do atoms exist? Because of a strong nuclear force which hold the protons together in the atoms.

If you have this theory of all forces, we have a theory of everything.

Have I answered my Research Project question? Of course not, because there’s way more stuff left.

The objective of the Research Project is to give you the skills necessary to do well in university.

Some of these skills some people do not have. I’ve developed skills like, you know, properly in-text referencing, evaluating sources, evaluating myself.

Proper time management.

You have, you know, critically analysing the sources, the word limit helps with that. Then we have improving my academic tone, you know, making the writing as academic as possible. And improving in skills such as communication, you have more understanding of mathematics, visually thinking about things.

Creative thinking.

Literacy skills and so on.

These skills will help me in the future. And speaking of the future I do plan on continuing mathematics and physics at university and I’ll probably do a PhD and I wish to go to NASA or CERN to continue my research in black holes. So this Research Project has started my journey to answering my question with my own hands. One day maybe in 10 years, I’ll answer my Research Project completely with my own hands and this is what started it all. Thank you.

[applause]