Demetri Kofinas: What's up, everybody? Welcome to this week's episode of Hidden Forces with me, Demetri Kofinas. Today, I speak with astrophysicist and experimental cosmologist, Brian Keating. Brian has devoted his career to developing and using scientific instrumentation to study the early universe. He is the author of over 100 [00:00:30] scientific publications and holds two US Patents. He received an NSF Career Award in 2006 and at 2007 Presidential Early Career Award for Scientists and Engineers at the White House from President Bush for a telescope he invented and deployed at the US South Pole Research Station called BICEP.

Professor Keating became a fellow of the American Physical Society in 2016 and co-leads the Simons Observatory [00:01:00] Cosmic Microwave Background Experiments in the Atacama Desert of Chile. He is the author of the recently published Losing the Nobel Prize: A Story of Cosmology, Ambition and the Perils of Science's Highest Honor. Selected as one of Amazon's Ten Best Nonfiction Books of the Month and one of Nature Magazine's Six Best Books of the Season. Brian, welcome to Hidden Forces.

Brian Keating: It's great to be with you, Demetri.

Demetri Kofinas: It's great having you on the program. I was just telling you that I [00:01:30] really, really found your book a surprising delight. It's a wonderful book and I highly recommend it to anyone who's listening because it's not just a foray into the world of experimental physics or experimental cosmology, but it's also really a very personal journey. I think it's interesting because you have this personal journey that's happening to you with your father, with yourself, with your relationship to God, to religion and at the same time you are exploring the foundations [00:02:00] and origins of the universe and you're at the center of this unfolding drama around that and with the Nobel Prize.

This book is actually about a great number of things, but you start the book talking about your early life, your early days and how you encountered the universe as a boy. I can't remember any particular moment when I became fascinated by the stars, but it's clearly something that was very meaningful in your life and obviously had an impact on you as you developed. Can you talk to us a little bit [00:02:30] about your foray into the universe as a young boy?

Brian Keating: Yeah. Well, like many people I was always fascinated driving home late at night, you're in the backseat of the car. Parents are upfront talking and you're falling asleep. You see the moon and the moon is sort of following you and following alongside of you. It seems like no matter where you go there the moon is. When I was a little boy, like 5 or 6, I was always fascinated and looking up and seeing what was up there in the sky, but it really kind of lay dormant for several years. [00:03:00] I didn't really pay much attention to a burgeoning interest that I had until one night I woke up, I was about 12 or 13 years old, and I thought I had left the light on in my room but really, I look outside, it was the moon.

The moon was full and so bright and close to the horizon, and when that happens, you have this optical illusion that kind of makes the moon appear much bigger than it actually is. Next to the moon, the moon wasn't alone. There was really bright star and I had never seen anything like it, a star that can rival the moon's brilliance and so I [00:03:30] really kind of watch it for several days and this is 1986 or so or 1985 and it was decades plus before Google and Wikipedia. You couldn't look anything up online. There was no internet and so I had to wait until the Sunday New York Times came out.

We were subscribers and I got the Sunday Times and this had a section on the back called Cosmos and you could look up the positions of the constellations and positions of stars and moon and I found it was actually not only the moon that had I seen but also the planet Jupiter and that just blew [00:04:00] my mind that I had a seen a foreign planet, another planet. I doubled the number of planets that I have ever seen. Each twelve or so is pretty mind blowing and I just realized that actually in retrospect that was my first piece of astronomical research, kind of consulting source materials and testing a hypothesis, etcetera. At that moment, I resolved to get a telescope and see what that would reveal through the eyepiece of a lens connecting my brain to the heavens, [00:04:30] and shortly thereafter, I got one and I've been a professional astronomer ever since basically. I mean I've never had a real job.

Demetri Kofinas: So that was your first planet that you saw? Was it Jupiter?

Brian Keating: Yeah, with the naked eye and then I saw it through the telescope and the telescope for your listeners even if they're in the middle of New York City or Shanghai or wherever they are you can still see the same fantastic visions that Galileo saw through his telescope barely a couple of inches across and you can get it online at your favorite online retailer if [00:05:00] you don't have a camera store nearby for $50 or something, less than some apps cost on my iPhone.

Demetri Kofinas: Well, you called it your time machine and I think that's appropriate, obviously one in the sense that light takes time to travel across the universe and when we see something depending on how far away it was that determines when we're seeing what we're seeing in a sense, but it was also I think at least as I read your book it was a way for you to travel back in time to be with your mentor, Galileo, who you called your first hero and to have [00:05:30] this burgeon experiences that he had in the same way that he did to look up and to see Jupiter's moons.

Brian Keating: Yeah.

Demetri Kofinas: To see the craters in the moon and it made me stop and take a moment to appreciate the wonder that we experienced as children when we look for the first time through telescope or we hear someone on a telephone. I think there's something that we've really taken for granted, understandably, but we have nonetheless taken for granted in the way in which we incorporate all these instruments [00:06:00] and devices, these technologies that we've created with our intellects and our brains and our capacities, to collect information and to measure things and to communicate across vast distances, something that would otherwise be confused with magic.

Brian Keating: Yeah.

Demetri Kofinas: And it's part of our daily lives and I think when you're a child, you encounter that for what it really is, the magic that it is and it's a wonder that I think it's worth sort of appreciating and I think it's interesting and I want to ask you about this, when you were a kid [00:06:30] and you were looking at the stars and then later reflecting on that and thinking about Galileo and these astronomers who came before you with much less advanced technology, what you think that was like for these scientists who were literally at the beginning of the scientific revolution, 400 to 500 years ago and looking out into the heavens and seeing all of a sudden these things for which they had no reference, these discoveries, these observations, very different from the mathematics [00:07:00] and the theory and the modeling that happened earlier on? Tell me about that a little bit.

Brian Keating: I think what surprises most people and this is an emotion that can still connect us to Galileo even a practicing scientist today to the Maestro as he was known 450 years ago and that is that this time machine, this telescope, it's sometimes a discovery like the ones that Galileo made in 1610 or so, those discoveries really, sometimes they come with a little bit [00:07:30] of fear, when you see something and you're the first person to see it. I always tell my graduate students that when you get your PhD, the requirement to get your PhD is you need to contribute to the corpus of human knowledge in some way that no human being has ever done before and therefore you need to do something that you don't even know if there's an answer.

When you're an undergraduate, you might not be able to solve a hallmark problem or two, but there's someone in the class that she can solve it even if you can't, but when you get to graduate school and you're a research scientist, professional for the first time, [00:08:00] you're working to try to ask questions that have never been asked before and try to answer questions that may not even have an answer. Sometimes, some of the emotion you get is fear because you're seeing something and you're conjecturing something and you're going out in a limb and you're literally in Galileo's case, he's sticking his neck out for science and so many of the great scientists did that in centuries past.

We benefit from their knowledge. Galileo wasn't the first scientist of course. I mean he was standing on the shoulders of giants just as Newton said later [00:08:30] referring to predecessors as well. Science is about this continuing refinement. The story is never done with science. It reminded me I heard a lecture about that famous cathedral that Gaudi designed I think in Barcelona and this cathedral has like never been finished and I think people have this notion with science that you discover something, you mark at checkout box maybe win a Nobel Prize or not and then science is done, but it's never done.

Demetri Kofinas: Well, you talk about that in the context of the Great Debate. I mean there is of course the classic Great Debate Shapley and Curtis, [00:09:00] but you delineate the book in the timeline and the evolution of experimental cosmology and observations in physics along this line of multiple great debates and this first one, you kind of place there at the beginning with Galileo. Of course, if you go back to Aristotle, there was a geocentric view of the universe and I think there is this interesting interplay that happened in my mind while reading the book because of the amount of work we've done on this show with modeling and modeling theory [00:09:30] and looking at Ptolemy's model of the universe that was based on geocentric view of the world in an attempt to explain the movement of the planets adhering to a geocentric view, he created this absurd model that we would view as absurd today.

When you look at it, it's very inelegant and that's also something that sort of came to mind as I was reading your book, this relationship between beauty and what we want or expect to be true, and in some cases, it guides us in the correct direction. Certainly, I think there [00:10:00] was an aspect of that in Copernicus and the concentric circles and the orbits though at the same time, they were not elliptical and I think that's a double-edged sword which of course feeds into confirmation bias to something that's so often talked about in your book, but I'd love if you could give us a history.

Of course, Aristotle isn't probably a good place to start. We could go earlier, but history of the progression of this field as far back as the Ancient Greeks and coming into the present day where you and your team have played such an instrumental role [00:10:30] with BICEP.

Brian Keating: Yeah, so it's true, and in fact, if you look back in cosmology history, people have always kind of thirsted to understand the origin story of both themselves, their tribe, their community, whatever but also of the whole shebang literally and so it's not coincidental that cosmology is sort of the oldest science in the sense and that even all the great origin stories of humanity's past including the Bible begin with it, so the Old Testament begins with the genesis [00:11:00] of the universe, in the beginning, and the question of how we found ourselves.

It's kind of like we've awoken from amnesia and we want to understand who were we in a cosmic version of the movie Memento and you look back and throughout scientific history since the advent of science and mathematics and the Ancient Greeks as you said, even to Plato and so forth and certainly to Aristotle, a great influence on Ptolemaic Model and that really held sway for a thousands of years because it was [00:11:30] elegant, because it avoided the notion that there had to be this inelegant origin time to the universe whose exact unfolding still is elusive to scientist wielding modern-day versions of Galileo's telescope.

The question of whether how the observation of science and how empirical data is so inextricably intertwined with advances in science and we normally hear about them sort of on the periphery. Like here's someone, a Stephen Hawking or a Brian [00:12:00] Greene or a Lisa Randall and they'll suggest these fantastical sounding theories of extra-dimensions and superluminal travel and wormholes, but in reality, a lot of what's actually observable is left out because some of their theories, you can propose many, many theories, but unless they're confrontable by evidence, it's impossible to say if they're right or wrong.

Demetri Kofinas: That's one of the things I really love about Ptolemy's Model. When you look at it, I mean he was able predictions, accurate predictions about the movement of the planets within the confines of certain assumption [00:12:30] because he had not introduced falsifiability.

Brian Keating: Right, that's right.

Demetri Kofinas: He wasn't able actually and I think that's so valuable again to really point out in these discussions, one of the reasons that I wanted to have you on the program besides the story of the Nobel Prize and the book and your experience to your father is very much this encounter with science. I think there is a misconception in the popular mind around what science is. I think in some sense, science is synonymous with authority and it's synonymous with atheism [00:13:00] and it's synonymous with truth, somehow that's it's a definitive answer, when in fact science is very much about the opposite of that. It's about falsifying theories.

It's about looking to disprove something and I think the advancements that happened after Ptolemy for example and Aristotle and all through this evolution in the last 500 years really speaks to that.

Brian Keating: Yeah, when you have the introduction of scientific method a thousand years ago in Middle East, this notion that you could confront [00:13:30] ideas against data or observations which is really basically unrivaled the alternative that was unrivaled where there was conjecture or something like a heavier object falls faster than a light object. When you could do that, my 5-year-old can do that experiment, prove that, falsify that and all the other notions that we know not to be wrong about that.

Now on the other hand, there were great mathematicians and physicist who did use a scientific method who would still fall victim to this beauty, the beautiful hypothesis that you mentioned early. [00:14:00] I'm thinking of people like Johannes Kepler who tried to construct the model of the Solar System based on the relative size of platonic solids nested within each other, cube in an icosahedron, etcetera. These objects, they appeal to his sense of both Pythagorean ratios and music and harmony of the spheres, etcetera and we know it to be utterly false.

On the other hand, he acquired magnificent data that even Galileo's thesis had to be dependent upon [00:14:30] and so Galileo would kind of make fun of him because he really dabbled in astrology and all these other things, but it just shows you that we're always born with this incomplete notion even as just individual human beings but then as the collective of science. The question of whether or not the accumulation of facts is what makes science or the confrontation with hypothesis of those facts and what remains after being rejecting the ones that don't work and refining them to make better ideas, I think that's really where science has gotten us [00:15:00] today.

A lot of my colleagues unfortunately what seems like, as you mentioned there, there's a synonym between scientism and atheism and I wonder how scientific that really is as core that a lot of these notions of alternative models to the Big Bang came about because of scientists' desire to not want to have a description of the origin of the universe that was reconcilable with the Genesis 1:1 narrative and that extrinsically nonscientific. I mean they could be right, we really [00:15:30] are in this quasi static universe, but we don't have evidence for it yet, but nevertheless a lot of it was driven by actual animosity towards the Biblical creation narrative which I don't think is very scientific even if they're right.

Demetri Kofinas: Well, interesting about that, you're talking about the steady-state model, right? What I think what's interesting about that also is the opposite as well which was that the Church played a very strong biased role in preventing the progress of science in the earlier period in the case of Galileo for example.

Brian Keating: Correct.

Demetri Kofinas: Heliocentric views, models of the world were not welcome [00:16:00] until there was a way in which that could be break with the Copernican Principle. In other words, what's interesting about the progressing of scientific thought and I'd love for you to speak about this as we try to follow this thread is that even though the original models, the Aristotelian view of the universe put the Earth at the center of the universe, the center of our Solar System, it was in the Solar System, the center of our system. Later adaptations of that put the Earth or at least our Solar System back in the center of whatever it was we were discussing [00:16:30] later on for example in case of the Milky Way.

There was this biased by the scientists, by the scientific community, by the public at large and institutions, etcetera to somehow give us a privilege position in the universe.

Brian Keating: That's right.

Demetri Kofinas: I think that's such an interesting point. Again, it feeds back to bias. I think it also deals again with religion, with questions of origin, place, purpose, being special somehow. I mentioned the heliocentric models, that's another great example I think where it took an enormous [00:17:00] leap of creativity and faith in a sense, maybe faith is a wrong word, a capacity to think outside the box, to think completely differently because, like I mentioned, Ptolemy's Model, Ptolemy was working essentially with the same data that Copernicus is working with and was there any significant difference. Couldn't Ptolemy have come up with a heliocentric model of the Solar System if he had sort of had the creative potential?

Brian Keating: Yeah, absolutely. I think that there was less trust in the observational scientific method at [00:17:30] that early point. As I said, there were demonstrably falsifiable hypothesis of heavier objects falling faster than lighter objects which as I said you could prove wrong quite easily. I think you're absolutely right. There are on your terminology these hidden forces that act psychologically on scientists and scientists are very low to admit that they are subject too, because we like to think we're these passionate followers of truth and evidence no matter where it may lead us.

I think that's kind of hubristic nonsense actually. I mean scientists are just like " [00:18:00] normal people." I mean we have the same foible, peccadillos, flaws as you may and I think one of those is prejudices and another one is biases and just like anybody else, we're subject to this force of confirmation bias where we have a preconceived notion, whether it's the universe was always there or whether it wasn't. I mean Galileo made a huge number of blunders as well despite his greatness and I think that demonstrates his humanity because he was biased to try to prove the Copernican Hypothesis and he did so at all [00:18:30] cost, meaning that even when he conjectured things that were absolutely almost as demonstrably falsifiable as heavy objects falling faster than lighter ones he still was steadfast in it, and of course, ultimately, he was right.

I mean we do live in a Copernican universe, not in Ptolemy Geocentric universe. I think sometimes even bad conjectures can lead you to the right path and the converse is true as well, but never forget that within every scientist is a human being and all human beings have their blind [00:19:00] spots and Galileo was no different.

Demetri Kofinas: I wonder if you would agree with this that that initial period with Galileo was an important moment in the progress of science, a really defining moment because of the falsifiability.

Brian Keating: Right.

Demetri Kofinas: The fact that he was able to say this definitively disproves this theory and it disproves it because of observational data and here is the data and here is how you can replicate the findings.

Brian Keating: Yeah, exactly. Also the beneficiary of technology. Back in Ptolemaic history, you couldn't rattle [00:19:30] off 800 copies of your theory about the Centrality of the universe. You just had to rely on the cult of personality carrying the day and being written down on piece of fiber somewhere and having that preserved until the library of Alexandria burned down. In the case of Galileo, he knew he couldn't build telescope fast enough, disseminate his knowledge and he actually didn't want to because he knew that is his one kind of-

Demetri Kofinas: Scientists, he wanted the credit.

Brian Keating: He was a businessman. He was businessman too. I mean he had a monopoly [00:20:00] on these telescope stores.

Demetri Kofinas: He had the patron Medici’s.

Brian Keating: Exactly, so he didn't want to give that up. I mean I wouldn't want to give that up either, but he couldn't make the telescopes fast enough even if he wanted to, but on the terminology of Silicon Valley, he could scale the idea by printing it on a printed material called the Starry Messenger and that spread like a wildfire throughout all of Europe and had made him one of the famous people of his day, didn't still make him super wealthy and of course eventually had brought him all these negative attention from the Catholic Church.

Demetri Kofinas: [00:20:30] There's so many people that we could obviously cover here and I don't want to get stuck in the weeds, but one of the things that I wanted to point out in this sort of progression to today, you mentioned technology absolutely. I mean that is sort of the defining characteristic of the modern age. The Greeks, they were rich in culture, rich in philosophy, rich in mathematics, but they were poor in their technology by any modern standards, even by Roman standards. The Romans were tremendous engineers and poor philosophers by contrast to the Greeks if we were to [00:21:00] compare that as a ratio.

One of the things that I love about science is our capacity to find creative ways to extract information or to use phenomena as measuring sticks or as sort of oracles for the world. This is obviously the case of radioisotopes, carbon dating. It's the case also with Cepheid. That's something I'd like to discuss. That's what's known as a Standard Candle and that's something that has been instrumental in [00:21:30] helping us come to very firm conclusions about or at least to disprove theories about the universe.

Can you talk to us a little bit about the progression and some of the most sort of important examples of these, I don't even know what you would call them and how essential they were in the progression of science and observational experimental cosmology over the last few hundred years?

Brian Keating: Yeah, since the Ancient Greeks, since the Aristarchus and other Ancient Greeks, he could actually measure the distance to [00:22:00] objects that are fairly nearby based on just simple trigonometry or geometry. You can actually do this if you hold your thumb out in arm's length and your right hand and close one of your eyes and then alternate your eyes back and forth and see which position against the distal wall your thumb appears to be at. If you know the distance between your two eyes which is easy to measure you can essentially measure the distance by measuring the angle that is subtended by the different shift in position of a distant doorknob or something that you're covering up.

That's called parallax [00:22:30] and parallax works really well, but if you try to do it out here in California from where you are, the angle is so infinitesimally small that you actually couldn't measure without significant uncertainty, so this measurement of geometric distance which you can trace directly to say the separation of the human eye or if you like you can trace it between two different periods in the Earth's orbit saying the spring and in the fall, when the Earth is six months moved and the stars will shift slightly against the background of more distant stars.

Astronomers knew about this technique [00:23:00] for literally thousands of years and so they can measure things very accurately in terms of the size of the Solar System, but once you get a few hundred times the distance of the Solar System, or the Earth's orbit rather, actually you're unable to do this measurement and so scientist came upon serendipitously this type of star called the Cepheid Variable Star, named after the constellation Cepheus or Cephei in the Northern Hemisphere and this type of star has a wonderful property that it's intrinsic brightness varies overtime [00:23:30] and the timescale over which it varies is just a few days.

What's interesting is that all stars have some variation. I mean you may have heard of solar flares and space weather and things like that. Our sun is a variable star too, but it doesn't vary as dramatically as this particular type of star does nor does it vary on this predictable time periods as this star does with this intensity changes. These stars can kind of get half as bright and then they can double in brightness over the period of a couple of days. I just want you to think we now use these stars to measure [00:24:00] literally across the universe, thousands and thousands of kiloparsecs, megaparsecs, going deep into the past of the cosmic history, but if they varied on say 100-year timescales we would never know about it because we wouldn't be alive long enough to count the cycle.

It's kind of fortuitous that this female astronomer by the name of Henrietta Swan Leavitt, she discovered this remarkable periodicity and she turned these pulsations of a distant star into sort of a ticks on a ruler [00:24:30] and allowed her to measure to the distance to a satellite galaxy not far enough away from the Milky Way to really get us into too much trouble using parallax so she can compare measurement using trusty geometry to one using say something that ultimately depends on nuclear fusion which is the star's pulsation. She did that and she established this relationship between the number of pulsations and the type of pulsations with the distance to these objects.

They can be seen as I said across the entire universe. She [00:25:00] built a universal yardstick that stretches from galaxy to galaxy, and without it, we wouldn't really have been able to figure out what we did, where we are and where we sit in the universe.

Demetri Kofinas: This is really amazing to me. I mean this particular like Leavitt's Law specifically but more generally our capacity to reason in such a way that we're able to discern standard measurement, tools. I mean the technology gives us the ability to see things, to collect information, but to make sense of that information [00:25:30] is a remarkable thing and this is in a sense a piece of technology in a sense, this law and then all of a sudden completely changed the game. Was it Hubble who was the first person to use that, to prove through his observational data that in fact, the Milky was not the universe and that the universe is much larger than that consisting of so many other galaxies?

Brian Keating: He was one of the first. You mentioned Curtis and Shapley and they really had this first one. Some astronomers called the only Great Debate. I claim [00:26:00] there has been five of them and there's probably going to be 500 more stretching into the future, but in 1920s they had this debate on whether or not the Milky Way is the entire universe or not and the Milky Way is our galaxy and we now know the Milky Way to be only, with quotes around it, a collection of about 100 billion stars and we now know that there's about 100 billion other galaxies in the observable universe. Therefore, there's a hundred billion squared stars in the observable universe, just incomprehensible numbers, one with 18 [00:26:30] decimal places or 22, whatever.

You think about that and you wonder what is the significance of the Milky Way at all and this was kind of very important stretching back to the same kind of debate as Galileo, Copernicus waged against the Ptolemaic geocentric which is how important, how central are we in the arrangement of the universe and the way that it's known in each particular scientific generation. Back in Galileo's day, the universe was the Solar System. First, we [00:27:00] were center of it and then he moved us off axis, off center, and then became this, are we the center of the Milky Way and then Herschel and others made some mistakes about that.

That wasn't really solved until Shapley came up with this theory of how the galaxy was not centered on us but was centered quite a distance away from us but even he was wrong because he thought that the Milky Way was so big even though we're not at the center of it, it was still the entire universe. That debate went down kind of half and half in his favor and then in Curtis's favor. [00:27:30] I wonder if I'm an astronomer living back then would I be as confused as we are now about these other strange forces that are hidden to our observational senses and detectors, like dark energy, dark matter and this kind of very interesting physics at the microscopic level and they would be thrilled and they would fit right in after a brief tutorial on what's happened.

What's interesting to me is that the cosmology story, it doesn't repeat but as Mark Twain said, history doesn't repeat, but it rhymes. In our case, it's rhyming again where [00:28:00] we're in the midst of another debate which is are we the center of the multiverse.

Demetri Kofinas: This is also rich time in physics particularly theoretical physics in the early 1900s. Einstein was front and center during this period, but this was went the steady-state model was coming under attack and I guess early notions of the Big Bang began to emerge. I got to say, this subject, physics and astronomy, of all the subjects that I have covered on the show [00:28:30] is the one which I have the most trouble wrapping-my-arms-around and we've covered some really complicated subjects, but for whatever reason, there doesn't seem to be a good resource where you can get a complete comprehensive and a history of this field in the developments in it and because it feels as though there are so many different aspects and they emerge in so many different places and no one really knows where they fit exactly.

I guess that comes back to this point of wanting to create a grand unified theory. [00:29:00] How can we understand? We hear these terms like dark energy, dark matter, Big Bang, inflation, how do these all fit together and when did inklings of these begin to emerge during this period in the early 1900s?

Brian Keating: What happens in this field and it's not too dissimilar to say how our understanding of quantum mechanics say is evolving over time and then particle physics, nuclear physics. We're always born kind of in the middle of the story [00:29:30] and cosmology, it's not any different. You take the kind of good with the bad. We're given certain leg up on our ancestors as they had a leg up on their ancestors, but then we're also have the capacity for innovation and creativity. I think the developments, if you trace developments of technology, that's one way to appreciate the modernization or the modern story of cosmology.

I mean there was very little that happened between say the time period of 0 BCE to 1400, [00:30:00] 1500 and Copernicus and Capillary Star, their activities, that millennium and a half if you think about it, almost nothing happened. Today, there is more papers published per day on what's called the Scientific Preprint Server than were published any point in time before 1950. It's just unfathomable how this progression of science is taking place and I think a lot of it had its inflection point as you say, kind of in the '40s and '50s after the telescope. For many people [00:30:30] didn't think of astronomy as a hard science.

They didn't really think of cosmology certainly as a hard science because we were making all these embarrassing statements like there were objects in the universe that we were claiming, we meaning the astronomers in the early 1900s, that there are objects, stars in our galaxy that are older than the known age of the universe at that time. It's kind of like as a I joke, if you found out that you're older than your parents, it would be kind of embarrassing to go around telling people that, and those controversies were only resolved [00:31:00] decades later. I think now we're kind of getting into the era where cosmology has become as precise as many disciplines were when they became respectable disciplines.

Demetri Kofinas: Can you explain to me how this Theory of Inflation works? First of all, as I understand I think it was Lemaitre that first posited somehow or some sort of nascent version of it.

Brian Keating: Relative of it. Yeah, relative of it. He sort of had the first version of almost what you'd call a Quantum Theory of the Origin [00:31:30] of Cosmology -

Demetri Kofinas: I want to ask you though because this is also I think it works along the lines that we were describing here which is that you've observed data, you see something, and all of the sudden, that contradicts the models that you have that worked. Now you have to go by figuring out, "All right, well first of all after verified, did I see what I saw and if I did then how do I reconcile this with these models and do I need to update my models? Do I need to create new models in order to account for what I've seen here? How did that happen?" How did that process happen for example that gave birth to the Theory of Cosmic Inflation [00:32:00] because that's so central to your work?

That's what BICEP was about. It was about looking to find the earliest sort of signs of ripples of the Early universe and I'd love for you to explain that to me, but give us an understanding of this is and how does inflation tie in with the Big Bang and I want to ask one more point which is we're talking here about centers and being at the center of everything, but does this framework, does this model of the universe make a center? Is there a center in a universe [00:32:30] that is expanding every day?

Brian Keating: Right. So I'll answer your last question first and your first question-

Demetri Kofinas: I think there was a third one in there somewhere.

Brian Keating: There's like five questions packed into that one. You're last question is absolutely correct. There is no center of the universe and that is sort of the one of the great debates as well that I cover, but the illusion of centrality is given by the observation of galaxies that we see in all case except for literally a handful of galaxies. [00:33:00] They're all moving away from us. I heard an ambulance coming by your studio a little while ago, but imagine like every ambulance in the city was coming towards you.

You think it must have been causing some great accident right where I am or ambulance leaving the scene of where you are and you could tell that from a Doppler shift that increase or decrease in the pitch of the ambulance's siren. You would think you're pretty special but because on average you should expect that all the ambulances are kind of moving randomly around you in the city right now unless you're as I said -

Demetri Kofinas: You're talking about [00:33:30] the Doppler effect which is that when an object that's emitting a noise is moving towards me those sound waves are compressing because it's moving towards me as it's emitting those sounds whereas when it's leaving me those sound waves are longer which is why we hear the difference when a speeding car moves towards us and then moves away.

Brian Keating: Exactly and so for astronomical objects like galaxies, they don't only emit sound, but they do emit light and the analogy for increasing the sound wave proximity crests of the waves, decreasing the wavelength as they are pitched or the frequency [00:34:00] goes up as the sources move towards us, but there's very few galaxies that are blue shifted and most of them are red shifted, meaning their light goes from bluer to redder because of this increasing wavelength or decreasing frequency. Almost every single galaxy, remember there is a hundred billion galaxies in the observable universe we believe and all by five or 10 are actually rushing away from us at fantastic speeds, large fractions of the speed of light in some cases.

That was a big puzzle that astronomers didn't really understand and was part of the [00:34:30] really the impetuous for the Inflationary Model for the universe. The Big Bang really takes over after a couple of minutes after the origin of the universe, but no one really understood what put that expansion into motion, what was kind of the rocket fuel the expansive push that is blowing apart or moving apart space time itself and what kind of energy source could do such a thing. It almost appear as if the universe is possessing some form of a squishy repulsive antigravity that it's not like an ordinary [00:35:00] explosive or rocket fuel or something like that.

It does act in that way and it caused the universe to accelerate to such large distances in such a short time that the Big Bang could not really explain it. It was impossible for the early model of the Big Bang as proposed by people like George Gamow and others to really understand to really understand how can all the matter in the observable universe be compressed into one point. If you run the movie backwards with these all ambulances rushing away from you, you run that movie backward, [00:35:30] they're all touching each other at one point. They're picking up the stretchers outside -

Demetri Kofinas: They wouldn't-

Brian Keating: I mean-

Demetri Kofinas: Right.

Brian Keating: If you really took it seriously. So if you really took it seriously as Lemaitre did then that expansion coming back to the ultimate what he called the Cosmic Egg or the Primeval Atom, was an atom, a single atom with the equivalent atomic weight of the entire universe as he observed it or knew it back in 1920s and so this idea was really considered too crazy to take seriously and actually Einstein [00:36:00] ridiculed him for many years about it and Lemaitre was a Belgian priest in the Roman Catholic Church and he actually didn't want the Church to use this as evidence for the Big Bang or claim for the Big Bang.

They didn't take his advice, and even by that time in the 1920s, they still hadn't pardoned Galileo for the crime of heliocentrism 400 years nearly before. It's kind of ironic that they had latched on to a certain data, but not other data. Anyway getting back to the Big Bang and Inflation, it was noticed that let's just say the galaxies were so far [00:36:30] apart that they really could have gotten the properties that they observed unless at one point in time there were actually literally all touching, but if you run the expansion backwards, there is no way to get that to happen.

They just were not going to be moving with enough velocity to get them at the literal astronomical distances that we observed them at unless something almost magical happen and that magic phenomenon is called Inflation and it really posited that the universe that we observed today emerged from some very mysterious entity called [00:37:00] a quantum field, a field called the inflation which expanded faster than the speed of light and it allowed us to break this extrapolated barrier that seemed to indicate that the universe was too big to have gotten as large as it was which is the simple ingredients of the expansion known back in the '20s and '30s.

Demetri Kofinas: Just to clarify something when you're saying the expansion known back in the '20s and '30s, you're talking about that sort of Primeval Atom which is still a derivative of a four-dimensional [00:37:30] space time.

Brian Keating: Well, it was an actual and his conception was an atom with atomic mass of the entire universe.

Demetri Kofinas: It was basically as small as you could get whilst still obeying the laws of physics?

Brian Keating: In some conceptions, yes. In others, let's put this way, in most cosmologists' minds even until the 1980s it was basically a singularity. It was basically infinitesimally small and all the matter and energy in the universe was compressed into that infinitesimally patch of space and then that patch of space caused [00:38:00] the evolution of the properties of this quantum field as time progress, then it allowed this field to produce the accelerated expansion that we observe today.

What evidence could you have for Inflation? If you imagine taking all the matter and energy in your room that you're in now, compressing it into an infinitesimal point, it would basically make a black hole and if you sort of run it in reverse, I'm not saying I know how to do this, but if you put all the matter and energy in one point [00:38:30] and then cause it to decay in such a way that the room, all the matter in the universe is sort of expanding, then you can turn it from a black hole into a white hole.

Demetri Kofinas: Can I ask you something? Theoretically, a black hole as I understand it is mass that falls in on itself. It is of sufficient density that it collapses in on itself. Do we have any notion? I mean we know that theoretic, we think of that theoretically but do we have any evidence for that and do we know at which at sort what the threshold would be where let's we know [00:39:00] that in the case of stars for example some we say will turn to blue dwarves, others we say will turn to black hole? How do we know that?

Brian Keating: We actually have observed black holes in some cases via their indirect emission of either light from surrounding material that's flowing into it or at the center of our own galaxy we believe there's a black hole and we observe the dynamics of stars orbiting around us, invincible dot basically at the center of the galaxy that you can't see but from the properties or the orbit of the star surrounding the center [00:39:30] of the galaxy, we infer that it has a mass of million times the mass of the sun. So you have a million times the mass of the sun compressed into a volume, maybe smaller than the size of our Solar System, the extended Solar System, that object is an enormous black hole, but we won't be able to see the black hole.

We can't see this black spot up against some backdrop so we infer it indirectly, but in physics, that's actually enough circumstantial evidence for the existence of black holes actually, essentially amounts to verification or proof and then [00:40:00] in recent years since 2015 we've known about the properties of multiple black holes as they come crashing together. They emit a wave of energy called the gravitational wave and we've directly detected gravitational waves for the first time at the LGIO Experiment in 2015. As I said so, this notion of the existence and reality of black holes is extremely well cemented albeit circumstantial but certainly verifiable confirmed by multiple routes of evidence.

Demetri Kofinas: [00:40:30] Okay, I took you off there a little bit, but we were on Inflation and I want to get to the work that you guys did at the South Pole in order to use gravitational waves or try to capture data from gravitational waves to get at a much earlier point at the origin of the creation of the universe right after the Big Bang as I understand it. Please continue it and then walk us through sort of that journey and that would lead us to your story about the Nobel Prize.

Brian Keating: Yeah, it was conjectured in 1980s that if Inflation really ignited the [00:41:00] Big Bang, if it sparked the expansion that Hubble and others saw in the rush away of galaxies at great distances and great velocities, if this process called Inflation was the root cause of it, then there would be disturbances produced in the very fabric of space time and these disturbances are ripples that really change and squish and squash the positions of all material, of all light, of all matter in the universe as they travel. If a gravitational wave is passing through the room that you're in, you would alternatively [00:41:30] feel lighter and heavier if you're on a scale and you do so at a rate determined by the wavelength of that gravitational wave and the fact that they travel at the speed of light.

The more matter in motion that you have, so if you have two enormous black holes as LIGO detected in 2015, 30 times the mass of the Sun more or less, and they're orbiting around each other until they coalesce to make a single giant black hole with a mass of almost 60 solar masses, then that will emit a certain amount of waves of energy, I [00:42:00] can't admit in the form of light, because black holes are completely dark and absorptive and suck in the light that would be produced, but instead they can release pure gravitational energy. If you were there near this coalescence of two black holes, you'd be ripped apart by these forces that would stretch and squish your body alternatively traveling at the speed of light.

Demetri Kofinas: How do we think about it? Can you explain it? The way I think most people think of black hole is that they have one direction that's in the hole. Can you explain [00:42:30] what you're describing?

Brian Keating: Yeah, what Einstein conjectured is that space time is not this infinite latticework of distances that remain fixed for all time. Instead each moment in time is like a slice through or is like a trampoline surface. Imagine you take a trampoline and you put a bowling ball on it. The trampoline will bend by the mass of the bowling ball in a gravitational field, but just assume that this bowling ball is in a gravitational field, now you could roll a tiny marble around that bowling ball and that's Einstein's model [00:43:00] how gravity distorts space time and the curvature of space time is what we perceive of as gravity.

Now if you imagine increasing the mass of that bowling ball until it's the mass of a car and then you keep going, it's a mass of a building, then it's the mass of the entire planet and then it's the mass of the entire universe-

Demetri Kofinas: It collapses space time.

Brian Keating: Enormous, it's a complete singularity in space time. Right. As you do that, as you add more and more mass to that object, it's going to produce tiny ripples in the fabric [00:43:30] of that trampoline, so the trampoline if you were to add more mass on top it, for a little as you add mass onto it, it will produce a little tremble of that trampoline. The trembling of the fabric is what I'm calling a gravitational wave.

Demetri Kofinas: As the objects move into the black hole, they create ripples, is that what you're saying?

Brian Keating: Exactly, 100% right. Yup. And conversely if you're going to play the movie backwards where the black hole is kind of shedding matter out of it outwardly, that's kind of like a white hole and that is the origin story of Inflation, that it began [00:44:00] with this rapid expansion acceleration of all the matter in the universe, not just the bowling ball here and there but all the matter in the entire universe faster than the speed of light. You've got all those ingredients of mass and motion, acceleration at the speed of light and beyond and that violent process would produce ripples in space time. That would then spread out through the universe and eventually they'd interact with the matter in the universe and they produce this particular pattern on the oldest light in the universe which is called the Cosmic Microwave Background.

I [00:44:30] break all these down very distinctly I think in the book because I think you can't really understand it all at ones even from a thorough discussion, but you need to kind of understand how do I take people through the history of it and what people think of as a gravitational waves, how those were slow to be adopted and how the Theory of Inflation came to be accepted without any proof for it. What I decided to do in the year 2001 is design an experiment which would essentially only be susceptible to see these signals from these gravitational [00:45:00] waves and the thought process was if I could see these gravitational waves with the telescope then that would more and less confirm that Inflation was correct and that Inflation was the spark that ignited the Big Bang.

Then if that was true that the universe began with this inflationary expansion then it also would mean that something called the Multiverse is true and that would mean that's the ultimate Copernican Principle because it means that we're really nothing, we're really just one universe out of an infinity of other possible universes, [00:45:30] so the stakes are really high for me when I created this experiment and we built this with my colleagues and we had to take it to the bottom of the world, Antarctica, where the atmosphere is particularly well suited to do the types of Microwave Astronomy that this telescope called BICEP would later do.

It was really built to confirm the Inflationary Hypothesis and therein lie some of the problem with what eventually ended up panning out for this experiment.

Demetri Kofinas: Just listening to you talk just reminds me of why this [00:46:00] is sort of difficult subject. I mean you just throw Multiverse out casually but like that literally just creates a crash in my brain. I want to ask you one thing, I don't what to beat it to death because I don't understand it well enough and I don't want to get caught in the weeds, but you're talking about these white holes. First of all, to be clear, there are no white holes in the universe, right? The only version of that would be the exploding singularity of a Big Bang.

Brian Keating: Yeah, we think so. Right. That would be I believe kind of an example of one.

Demetri Kofinas: But as I understand it and the vision that I'm getting, the visual that I'm getting when you describe [00:46:30] that is this idea of a black hole in reverse, this bowling ball that has sunk down into this sort of infinite bottom of the trampoline, all of sudden all of that matter coming right back up but when I think about the way that the universe expands according to the Model of Inflation, it feels more like a rubber band or something where the entire universe is expanding everywhere, like you describe everything is moving away.

I guess my first question is how do you square those two visuals and then the [00:47:00] other one is if that's the case, does that also mean that our planets are also expanding from each other just in a small way that we're not able to sort of measure in our -

Brian Keating: That's right. There is another force also, a hidden force called dark energy and dark energy is related to the observation that nowadays we see galaxies and we see them moving away from us and they're also accelerating. They're not accelerating nearly as fast as the early material in the universe was expanding during the Inflationary epoch if that's true, but they [00:47:30] both have this antigravitational kind of expansive properties that's exactly sort of the opposite if you will of rubber band. Rubber band is like pulling stuff in, but this would be like a rubber band that pushes out as you try to compress.

Even if without compressing a block of rubber say, it would expand if you can imagine such a thing and it would expand faster than the speed of light at early times and then it would slow down for some reason that we don't understand for billions of years and then later on it would start accelerating again. It [00:48:00] may be that those two forces are unified in some way. In other words, whatever is causing galaxies to rush apart, it's just a latter day version of this Inflationary Early Expansion of the universe, but we don't know. We don't really understand either one well enough.

My idea is kind of like that old joke about the drunk who's looking for his keys underneath the streetlight and the cop asked him why you're looking here and he says, "Well, did you lose them by the street light?" He said, "No, but that's where the light is," and so we don't want to look where the dark it is. We want to look and understand the things that we [00:48:30] can understand even if they are just a tip of the iceberg or just what's illuminated by the street light and that for me was to really understand how Inflation itself unfolded.

To answer your second question, no. It doesn't mean currently that our Solar System is expanding because the gravitational field that's caused by matter is weak but it's much, much stronger than the antigravitational force that's causing the universe to expand, but in a trillion years or so, that may not be the case. In other words, if the amount of acceleration [00:49:00] would continue then eventually all the atoms in our Solar System would move apart and even the atoms themselves might theoretically break apart and we'd be left with a real white hole.

Demetri Kofinas: And we don't know whether the universe will continue to expand indefinitely or if it will collapse back onto itself, correct?

Brian Keating: That's right, although there's a lot of evidence right now that the latter is less likely however. What's healthy about science is that science is always about [00:49:30] proving what's right and removing what's wrong, and to do that, what's very dangerous in science when there's a monopoly, when there's one way of thinking about the universe and that prevails. You saw that with Galileo where it was the Church's ideology was prevailing and you then later see that in the 20th Century with the steady-state versus the Big Bang when it looked for a long time that the steady-state would be correct until one day it was basically completely and utterly destroyed by falsifiability.

Nowadays there's a new [00:50:00] debate and that new debate it was really an echo of this Copernican debate which is that the universe instead of just our position being central in space, are we central in time. If Einstein is right, then space and time are actually one in the same thing. You can't specify something in the universe without saying when it happened or which events are simultaneous with other event that's dependent upon the observer who witnesses them, but suffice it to say that there's a notion now [00:50:30] that our position in time is also special.

In other words, it's not just where we are in the galaxy or where we in the Solar System or where we are in the universe, but whether or not there is something greater than our universe called the Multiverse, a collection of impossible infinite number of other allied universes, some very different than our universe, some very similar to our universe where I'm interviewing you on my show Forces Hidden and you're the guest as an astrophysicist. The capacity of the Multiverse to boggle the mind is basically -

Demetri Kofinas: Is the Multiverse [00:51:00] Theory a derivative of what we know about quantum mechanics?

Brian Keating: Yeah, it's very good. Yeah, that's a very good point that very few people have touched upon. Multiverse Theory has elements of quantum mechanics. It has elements of cosmology. It has elements of what's called quantum gravity and these notions of how you describe matter and energy at very, very high gravitational fields at very short timescales, at very high energies with high velocities, those are all inter alia and they blend together into what's called quantum gravity [00:51:30] and there are some that suggest that there are findings in the Multiverse which are related to entities in a completely disparate field called String Theory and those String Theoretical Models have predictions also for an infinite number of universes and infinite number of properties of that universe where the speed of light is 1 mile per hour instead of 186,000 miles per second in some universes.

Those would have drastic consequences for the existence of intelligent [00:52:00] life like us. There's a violent roiling debate in cosmology now and it's actually taken an ugly turn where cosmologists are not stooping to the level of calling each other names, it's not getting into the level of politics yet, but there's been some pretty nasty back and forth between the adherence who believe that we live in an infinite number of universes as even Stephen Hawking, the late great cosmologist, conjectured and then alternatively there are other scientists, very brilliant eminent scientists that are friends and colleagues that are working on a model [00:52:30] that resuscitate the Steady-State universe and certain guys where the universe is basically a cyclic universe that comes collapsing after trillions of years potentially and then there's just a violent debate as to who is right.

Demetri Kofinas: Well, the stakes are high. They're really high about individuals and careers and egos. I mean ultimately the outcome of the questions I think is irrelevant. Does it really matter what the answer is so long as we further on our understanding of whatever the sort of [00:53:00] objective reality is if we could sort of pin that down to begin with? But these are really careers at stakes. These are names at stake. These are Nobel Prizes at stake.

Brian Keating: Yes, absolutely.

Demetri Kofinas: And to sort of bring it back to that aspect of the story, you're down in the South Pole. You're part of a team that's put together this instrument, BICEP. I think it was BICEP one at the time or was it BICEP2? But there had been iterations of it and there's also the Planck satellite at the same time and they're trying to discover the similar sort of evidence of the early universe and you guys are [00:53:30] in the race with them and whoever else is out there trying to sort of attain this data and there is an impetuous to come to conclusions, to be beat out the next person.

I think that and the number of other factors create that bias, create that metaphorical dust which you talked about in very literal terms throughout the book, which has been present throughout the history of science and has gotten the way, the smudge on the land has gotten the way of so much of what scientists look for when they look out into the universe. Tell us [00:54:00] what happened with your team and the fallout from the early results that turned out to be incorrect and what you learned from that experience.

Brian Keating: We were told from an early time that if we were successful with BICEP that we would win Nobel Prizes, and presumably as the originator, I'm one of the two people that originated the experiment, I would share one of the three possible slots that each Nobel Prize can be awarded to, and honestly, I'm ashamed to admit it now but you grow and you learn but that was a big impetuous for me as a young kid, my mid- [00:54:30] 20s, fresh out of grad school looking to make a name for himself, to get a faculty job, to be able to support a family, etcetera, as you said, it was a career-building way to go about it and certainly there's no better thing to do for your career than win a Nobel Prize and certainly that was foremost in my mind.

I know it was prominent in the minds of other cosmologists because that's all they've ever told me. They said, "If you're successful, you're going to win a Nobel Prize." That sort of the sine qua non of a lot of these discoveries is [00:55:00] that scientists as I said, they're human beings, we're human beings and we're driven by sometimes nonscientific rationales. In the case of BICEP, we went looking for the signal from Inflation. It was clear as day that's what we're looking for.

That's all we could see as a matter of fact, would be the imprint of Inflation on the Big Bang's heat called the Cosmic Microwave Background Radiation, and lo and behold, as they say in the book, sometimes when you look for something, there you are, there you find it and we ended up making announcement in 2014 on St. Patrick's Day at [00:55:30] Cambridge, Massachusetts Harvard University except I wasn't there to lead the team. When end up happening was I had been kind of edged out of the top three leadership positions on the project and part of the reason may have come down to I don't know, I'll never know for sure, but there's only three people that can win a Nobel Prize and I was kind of at least the fourth wheel if not even more.

By the time the announcement had been made, I had already accepted a new job here in California at UC San Diego and I had been kind of edged out of the leadership [00:56:00] day-to-day role, but I was impossible to kind of fake the origin of the experiment. It's not being my idea, so they had kind of pay lip service to me.

Demetri Kofinas: That must have been a pretty difficult experience. I'm sure many people listening to this will say, "Well, you know, that's tough luck, whatever," but actually I think it would be really pretty devastating to experience that. I mean your whole career is built on that and anyone that's working in the physical science and getting the Nobel Prize is everything. I mean having that attached to your name is like immortality.

Brian Keating: [00:56:30] It is. It's as close as immortality as you can get. I think in any field it's the highest honor that humanity, the whole planet has to offer.

Demetri Kofinas: Except in the Peace Prize ever since Aung San Suu Kyi got it for Cambodia.

Brian Keating: Yeah, that's right. Yeah, that's right and there's been many other blunders and of course, this year, they canceled the Nobel Prize in Literature because of a sex abuse scandal perpetuated by a man obviously, as most sex scandals are, and then his wife took the fall for his misdeed, so the [00:57:00] King of Sweden intervened because they don't want to tarnish the reputation of the sister lusted after a prize and I think it's causing a lot of harm not just in literature but in scientific fields as well and part of that was to corrupt the scientific process to us in a competition between this rival satellite project called Planck as I mentioned in the book which was threatening to scope us out of Nobel Gold.

It happened in my field many times before where somebody had stumbled upon something [00:57:30] before someone else and they won the Nobel Prize and even their original people had the idea in the first place lost out on that. We didn't want to fall victim to them. We did some, I think not unethical but certainly questionably scientific integrity practices where we took embargo data from another experiment or experimental data that wasn't permitted for our use in a way to justify to ourselves that we saw was the Big Bang's Inflationary Period. In fact, what we ended up seeing was that it wasn't anything of the sort. It was actually [00:58:00] the smutch in the cosmos called dust which as any of us who have kids know is ubiquitous. There's dust everywhere and the cosmos is not -

Demetri Kofinas: This was a huge deal. I mean I don't know if people remember at the time, New York Times article about it, I forget the title. It's huge and there was a video of one of the researchers who went to [Lang's 00:58:14] House.

Brian Keating: Yeah, it was on the front page. He went to [Lindsay's 00:58:18] House in Stanford University, two Stanford professors.

Demetri Kofinas: Champagne Toss. We've confirmed your theory and everything else. I mean the desire for them to be right [00:58:30] was so clouded and -

Brian Keating: And the pressure from their university, from Stanford University and Harvard University and Caltech to be at the forefront and to the exclusion of perhaps other people who played a role, but the stakes could not be higher. What I would say when people say, "Well, you just have sour grapes or you're just a sore losers," and I say, "Well, not everybody wants to win a Nobel Prize," and I say, "That's true. Not everyone was as avaricious as I was wanting to win a Nobel Prize," but on the other hand look at like Hollywood movies. Every [00:59:00] year, you find out like not only who wins an Academy Award but you find out like well so and so is nominated 30 times for Palme d'Or at the Cannes Film Festival or the Sundance.

You find out all the minutiae of nominations let alone who won and so that goes to show that the agencies behind those movies namely the movie production house you better believe that they want all their big name films to win Oscars and their actors and actresses to win Oscars. It's their currency. It's the coin of the realm. For us, [00:59:30] the analog of these movie studios are the universities and the funding agencies that support our work. We're just a subject to those same forces and scientists are maybe not honest enough to admit that sometimes they are really driven by this desire to win a humanity's ultimate brass ring which is the Nobel Prize.

Demetri Kofinas: It pervades not just fields that are affected by the Nobel Prize but more generally speaking I mean the confirmation bias, the desire to be right for reasons that have nothing to do with the merits of the experiment or [01:00:00] the validity of the theory, but in fact have to do with one's own place and totally understandable.

Brian Keating: I think for us when we set out to make this measurement, there are many, many emotions and I think only part of it was the Nobel Prize desire, but not all of it and in the end, we ended up seeing what we wanted to see and what the whole world wanted us to see as well as this was mentioned. It was front page news in like not just the New York Times, but some weird magazine in the middle of Uzbekistan. It was fascinating to me to see how it was received and I knew [01:00:30] at that point that I had lost a Nobel Prize.

In other words, I knew at that point, I had some doubts about the validity of our results, but I knew I wasn't there. I knew I wasn't going to get the credit even though some people had done their homework and suggested that I should be nominated for the Nobel Prize for originating the idea, the experiment. I knew that was a long shot, but in the writing of the book, soon after we actually had to re-track our claim that we had discovered Inflation to much embarrassment and much humiliation. I was actually asked to nominate the winners of the subsequent years Nobel [01:01:00] Prize. You can imagine, like imagine some big name guest doesn't want to come on your show but then asked you, "What other shows can you get me on?" I mean it's kind of humiliating.

Demetri Kofinas: I never had happened, that would have been pretty bad.

Brian Keating: I know, I know.

Demetri Kofinas: That's pretty good analogy.

Brian Keating: That's right. You have good guests. You have fine guests, but what end up happening was the Nobel Academies of Science in Sweden asked me to nominate the winners of the 2016 Nobel Prize and it was kind of shocking to me the way that they asked me to do so [01:01:30] was basically in contrast to all the requirements and desires that Alfred Nobel nobly wanted to be included for consideration for the Nobel Prize and it shocked me that this organization who really was the caretaker of his estate. So Alfred Nobel never married, had no spouse, had no children and he basically gave all of his money to endow the Nobel Prizes to benefit all of mankind and he said it had to be done in such a way very explicitly and I go over this.

There's three [01:02:00] chapters in the book about what's wrong with the Nobel Prize, so out of 12 chapters it's a small portion of the book and I color code the chapters to make them accessible. If you want to choose that adventure in the book, you can choose your own adventure and read it or not, but the ultimate finding that I had was kind of what Alfred Nobel wanted was he wanted to use his legacy to control the future and as most people do with the will. They want to have some say whatever happens to their wealth and their legacy and it was partially unethical will or what we call an unethical will which is [01:02:30] that he explained what his highest desires were for his vast resources, the fortune he had earned from inventing dynamite in the late 1800s and so this will which I think most people treat would treat a sacrosanct that's in solemn duty to uphold somebody's will and I found that the Swedish Academies of Science and Literature and Peace, etcetera, a Norwegian account, that they were really undermining what these lofty visions that Alfred had and it actually made me kind of angry.

I took upon myself a one-man campaign to kind of [01:03:00] improve the Nobel Prize through concrete suggestions as to improve it before it's too late. I had no idea that this sex scandal would be breaking as it came to the publication of my book just to -

Demetri Kofinas: I'm not even aware of this sex scandal. I'd like to think that I'm up to date on all sex scandals. I must have missed this one.

Brian Keating: Well, yeah, this is not one of the -

Demetri Kofinas: [crosstalk 01:03:23] afterwards.

Brian Keating: The Nobel Prize, it was in the front page of the New York Times a couple of weeks ago. Somebody sent it to me jokingly saying, " [01:03:30] Well, you're book won't win the Nobel Prize in Literature this year," and I said, "I don't think it'll ever win it," but nevertheless if you do a search afterwards, you'll find that the Nobel Prize in Literature was canceled by order of the King of Sweden because the Literature Prize Committee has been really exposed for both sexual abuse, sexual harassment and this is all done under the auspices of a female lead of the Nobel Prize Committee in Literature. The Nobel Prize were canceled this year for the first time I think [01:04:00] in history for that particular field.

There's also been a lot of controversy over the prospect of Donald Trump winning a Nobel Peace Prize. There have been financial investigations by a crime's units into the Nobel Prize's finances and I started to think well there is no law of physics that will say that the Nobel Prize will always be the most prestigious prize there is. In the early part of the 1900s when there was a Pulitzer Prize and there was a Nobel Prize at the same time, the Pulitzer Prize was a lot more popular. If you do a Google Trend [01:04:30] search you'll find that out and there's no law of nature that says it can't happen again that the Nobel Prize can fall in prestige as the Pulitzer Prize has diminished in precision and attention.

I think if the Nobel Committees are smart, they'll listen to my suggestions. Some of their committee members have read my arguments and they say they agree with it, but today I've seen no actions towards that goal. Right now, it's a little bit of a lonely voice in the wilderness, but I couldn't really leave it idle after being a part of a Nobel-worthy experiment that dissipated [01:05:00] and then to be a part of the process to feed the machine that nominates and awards a Nobel Prize each year. I felt that it was my duty. That was the least that I could, "Oh, this poor deceased man named Alfred Nobel."

Demetri Kofinas: I could speak with you for another hour for sure because there's so much in your book and we're not doing it justice. We're not doing this aspect justice. I think we did some justice to the history of experimental cosmology. We're definitely not going to do justice to something else, but I want to just touch on it before we [01:05:30] end which is the arc of this story of your book which begins with you as a child looking out into the stars and it ends with you as a man doing the same thing and you speak about your faith in the book to which I think is refreshing to hear.

If for nothing else, because there is this conflation between science and atheism and even theism and atheism and notions of the mystery I think for me at least by definition these are beyond langue. [01:06:00] There is no way to talk about this and I think science and the empirical science and religion they both attempt to answer these same questions, but they come at I think through different perspective and necessarily so because the answers to where did I come from you from the physical science are going to be different answers. Where did I come from? Where, time, place, whatever.

We're talking about Multiverse, etcetera but the question of why. When a human being ask [01:06:30] that question, it means something very different and you, you were on a personal journey during this time with your father becoming ill, a person who you had been estranged from for most of your life and you talked about all of that and I feel that like that journey that are and the dust being there I think throughout the book everywhere, there is a sort of harmony to that and I think it's something that people can really relate to and I think what comes across for me in the book is that losing the Nobel Prize for you or losing [01:07:00] sort of that opportunity, maybe sort of the debacle if that's not too strong a word of the way in which that you experience the fall out of that, there's a sense in which that also caused death, so there was the death of your father, but there's sense as a reader that I got which was the death blow against your career in some sense, certainly against the near opportunity to get the Nobel Prize, but through that, there's sort of this rebirth again.

I really appreciated that and in closing I'd love if you could sort of just give us some remarks that [01:07:30] was my experience of it but what was that experience riding it and what did you mean by all of that.

Brian Keating: What sort of a cathartic experience, when I started off writing the book, I knew I wasn't going to win the Nobel Prize either because we would ultimately be proven wrong in which none of us will win the Nobel Prize or we'd be confirmed and I wasn't a member of the three people still left standing at the end of it all so I wouldn't have won the Nobel Prize and then of course, in writing the book, I got asked to nominate the winners of the next year's Nobel Prize after our debacle as you rightfully [01:08:00] call it and then I felt well the Nobel prize itself needs to be gotten rid of, maybe it should be lost or at least radically reformed.

The notion of searching for some sense of I witnessed of this historic events and I was a key participant in them and from what wisdom can come about and as I said before, science means knowledge with all of its foibles and missed turns and wrong directions, etcetera, but it doesn't mean wisdom and I want to extract something of wisdom for this. [01:08:30] For a long time in my life, I mentioned my father, I had wanted to kind of exceed. He was a scientist. I always kind of earn his ultimate respect. We have a very difficult relationship as I described in book, but I knew that the ultimate way to earn his respect would be to win the Nobel Prize.

There had been no way for other way for an atheist scientist like him to really appreciate the accomplishments and to be forced, if nothing else to take pride on his son's accomplishments and part of it was that and I just wanted just make him proud [01:09:00] and he was the smartest man I have ever known, and unfortunately, he was no longer with us but as I dealt with kind of realization that we weren't going to win the Nobel Prize, I realized that that shouldn't be the ultimate journey and it really isn't and the fact that I may never win a Nobel Prize again, one of the reviewers on Amazon I don't know who he is, he said something like, "You shouldn't be so negative because in a book I take a picture of a Nobel Prize that a winner brought to US SD to display for everyone around and let's take a picture," and I say, "It's [01:09:30] the last Nobel Prize I'll ever touch. He said, "Well, don't be so sure. You're young and you're able to do."

Actually it's been revealed to me for what it is which is that I pursued this magical kind of mystical Lord of the Rings-type ring, this precious and this almost deity-like idol for me and for many scientist and killing that sacred cow for me was part of this book's purpose and I think afterwards I'd become liberated and I become more conventionally tuned in to spiritually but less so [01:10:00] in the “Church of Nobelism” or Alfred Nobel's church which I think is a deep liberation for me to come out of the closet and say I no longer care about winning the Nobel Prize.

Demetri Kofinas: What a relief. What a relief. I hate that stuff. I stay away accolades.

Brian Keating: Yeah, absolutely.

Demetri Kofinas: Well, to close it off, I'll say one of the things that maybe of our listeners who many of whom work in venture capital or they're engineers or founders of startups, etcetera is that [01:10:30] there is a tension also in the enterprise, corporate world between the corporate sort of the going following the path, climbing the ladder, getting the approval of the authority figures or striking out on your own following your heart and wherever it may lead. I think the irony in science and academia is that this where it should happen most. This is where you should follow your heart most.

Brian Keating: That's right.

Demetri Kofinas: But unfortunately, there are many reasons why that isn't the case. Some of them certainly [01:11:00] understandable and funding is at the height of that. Brian, this is the longest we've done in a long, long time. I'm not surprised.

Brian Keating: Is that a good thing?

Demetri Kofinas: Well, I mean it's necessary and it was necessary. Like I said, this is the most complicated field that I've ever tried to touch in my life. I don't even know where to grab it from but I appreciate you coming on the program. You gave us a really great perspective on part of physics and science that we don't get to really cover on the program so I really appreciate that.

Brian Keating: I'm so glad to be with you Demetri. It has [01:11:30] been a real honor for me as well.

Demetri Kofinas: Thank you so much. Have a great day Brian.

Brian Keating: You too.

Demetri Kofinas: And that was my episode with Brian Keating. I want to thank Dr. Keating for being on my program. Today's episode was produced by me and edited by Stylianos Nicolaou. For more episodes, you can check out our websites at hiddenforces.io. Follow us on Facebook, Twitter and Instagram @hiddenforcespod or send me an email. [01:12:00]. Thanks for listening. We'll see you next week.