Randall Rosenfeld—Archivist at Royal Astronomical Society of Canada

Head archivist at the Royal Astronomical Society of Canada (RASC), Randall Rosenfeld explains the different types of eclipses, and how they have appeared throughout history. This discussion of important figures in astronomy adds to the conversation and changing understandings of eclipses. Rosenfeld rounds out this interview by talking about personal experiences on what it is like to view an eclipse in-person.

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Interviewee: Randal Rosenfeld (RR)

Interviewers: Samantha Davis (SD), Ernest Okine (EO), Joe DeSario (JS)

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Transcribed by Whisperboard, edited by Amílcar Challú and Hope London

[START OF INTERVIEW]

SD: [00:00:00] So to begin, could you just tell us a little bit about who you are and what you do?

RR: [00:00:06] My name is Randall Rosenfeld. I'm an old white guy, and I do the history of astronomy. I'm the archivist for the Royal Astronomical Society of Canada and for the casket, which is a professional association of astronomers in Canada. And I'm fascinated by the history of astronomy. And I should also point out that I wasn't trained in that at all. But that's a whole other story.

SD: [00:00:38] Well, thank you. I think we'll start with the first question. If you could speak to what is an eclipse?

RR: [00:00:45] Sure. Um, I like simple rather than complex. So I guess the simplest way to put it is when one celestial body or the shadow one celestial body passes in front of another one. Another way to, or if you want to make it even simpler, is when a celestial body obscures another one. And it's that simple.

SD: [00:01:13] Okay. Awesome. Could you speak to maybe the different kinds of eclipses and how they're different from each other?

RR: [00:01:20] Sure So also aural effects. Things get really dark. So that's the, that's the dramatic one. There's another one called an annular eclipse. And that's from the Latin word for ring anus. And that's when the moon is farthest. It's far enough away from the Earth that it doesn't cover the entire sun. And so when it's at its maximum or its maximum for that eclipse, you get a ring of sunlight around it, which is sort of cool in its own way. And then the and then the others are partial eclipses. So that's when the viewer is not in the central path of the eclipse, but on either side of it. So the body which is which is darkened or occulted, it's only partially occulted. But those can still be fun to watch, and you can still see part of the effects of the environment around.

SD: [00:02:38] Awesome. Thank you so much. Our next question is, have eclipses mattered in the history of astronomy? And then maybe you could speak to in Canada specifically as well.

RR: [00:02:51] They've mattered very much. And of course, the way they they've mattered varies over time. You know, as you'd expect. Give you a few examples. I'm not going to start with Canada. And one reason for not starting with Canada is if you're looking at a particular discipline. We're looking at astronomy. It inherits the cultural stuff that went before it. And that could happen anywhere, which is sort of cool. And astronomers, often they look to where the earliest records and theories survive. And for the Western tradition, they often look to places like Babylonia or Greece. So give one example. An eclipse was great because you've got this rigid, dramatic observation. And you've got to explain it. So if you have a theory and it doesn't agree with the observation, that's a sign that you've got to improve your theory. And that's how eclipses were sometimes used. In one example, the second century BC Hipparchus, very important astronomer, he spent a lot of effort to improve his models of eclipses and compare them to observations. And he came up with some really cool advances in mathematical techniques, mostly with trigonometry. And some scholars think that he developed those in order to respond to the eclipse observations he had, and improve and improve his predictions of when these would happen. People could put a lot of effort, a lot of intellectual effort, a lot of time with the parchment or wax tablets and writing tools and compiling tables of eclipse predictions.

RR: [00:04:41] One example that comes to mind there is this guy. He didn't live very long, but he was sort of a mid to late mid to later 15th century. His name was Regiomontanus. And one of his most famous books was a collection of planetary tables, including eclipses, and he is reported that he spent a lot of time trying to get that right. And those were quite popular. Um, there's a story that Columbus. It was no longer such a cultural hero, and that's probably a good thing. But the Columbus was armed with those when he came to the New World. Uh, as for North America, eclipses were important in various ways. A lot of the astronomy that was that was practiced here.

So in places that became Mexico, the United States and Canada, a lot of that astronomy was very practical. It was oriented to really quite utilitarian ends. I'm often allied to cartography. So you would determine your place on the Earth through astronomical observations. So latitude and longitude latitude was a lot easier to determine. You just basically find out where the pole star is from your location.

RR: [00:06:01] And you guys could go out and do this, you know, tonight if it was clear. It's really quite easy with the protractor if you wanted. Longitude was a lot more difficult. But if you had an accurate table of eclipse predictions you had and you had a decent telescope and a better clock. In. You are perfectly set up to observing eclipses to find your longitude. And this was seen as important at the time as as European settlers carved up the the lands they met. And we know about some of the consequences of that now. They usually use lunar eclipses, but they could use solar eclipses. The reason why they mostly use lunar eclipses is just that they were more frequent. As I mentioned earlier. So astronomy changes. So the way it's used and in the various countries we're in also changes. So one of the interesting uses of solar eclipses happened with the rise of astrophysics in the 19th century. And you had observers then paying a lot more attention to the possible physical constitution of the sun. How it was, how energy was generated, what it was made of, things like that. Well, there were really dramatic phenomena that you could only see because there were only visible during an during an eclipse.

[TECHNICAL DIFFICULTIES, HAD TO SWITCH TO PHONE INTERVIEW]

RR: [00:07:29]...Just about to get to the the phenomena. You could do with 19th century astrophysics. The side look of the sun. There were dramatic phenomena they could only see during an eclipse. So when we look at the sun now, it's outside an eclipse. We're looking at the photosphere. But there are other layers of the sun, which, when that's blotted out by the moon being there, you can see these other layers which normally are too, too faint to be seen because they're drowned out by the other light. So one is the chromosphere, and you get these prominences, and these are best way to think of them. Um, they're gas, which is just sort of shot out from the surface of the sun, appears very red to us. And they can see those prominences off the limb of the sun. And that's really cool. The other thing they can see is the corona, and that's the outer layer of the sun. And you've got these coronal streamers there, these ethereal glowing, um, rays of, of gas. Again, they're incredibly hot, though they didn't know that at the time. They've got this. You've got these incredible phenomena. You can see them during an eclipse, but that means that a total eclipse is only going to last between 10s. And maybe 7.5 minutes. You know, the people doing the observing, they got to work fast. But at the end of that, when the eclipse is over, those phenomena disappear. Well, they don't actually disappear, but they

disappear from sight because the normal sunlight surface of the sun that we can normally see overwhelms those other layers.

RR: [00:09:26] So eclipses became really important for that. And a lot of places sent out scientific. A lot of places in Europe, for instance, sent out scientific expeditions to North America to take advantage of a solar eclipse. So in that way they were important for the rise of astrophysics. In regard to Canada. Um, yes. There's three things that jump to mind. One is. What I describe as a as an instance of pure luck for the observer. So this is just after the Second World War. There's a chap named Arthur Covington who's one of the pioneers in radio astronomy, particularly radio astronomy, directed towards observing the sun. He built his telescopes. So these are radio antennas. He built these from surplus war parts. And this would be in 1949, 1945, 1946. And his dish was only about four feet across. And you think of the size of radio telescopes now that's you know, that's nothing. That's almost something you put in your in your knapsack. Nearly. Um, he'd originally wanted to observe cosmic noise. So radio waves from the Milky Way. He tried that. His dish wasn't sensitive enough. It wasn't big enough. He got nothing. But it was big enough. Get the signals from the sun. But his problem was he didn't have good resolution. But he could tell. What he could tell, he could detect signals, but he couldn't tell where on the surface of the sun these things were coming from. But the solar eclipse, the luck of a solar eclipse, enabled him to get really good resolution.

RR: [00:11:17] And the way this worked is, as the moon advanced over the sun, it was. It was chopping out bits of the sun, right? It was it was covering it over. And if you could coordinate the advance of the moon on the sun. So it was blocking out the surface with your recording of the radio frequencies, of the strength of radio frequency received, it would tell you what was transmitting strongly and what was transmitting weakly. And he used, he used this to tell that the corona was incredibly hot. He had evidence for this, and that a lot of activity that the really powerful waves he was getting from the surface of the sun were from sunspots. And if it wasn't for him, if it wasn't for the fact that where he observed in Ottawa there was an eclipse, then a solar eclipse, he wouldn't have been able to make that observation. That's sort of cool. The two of the things are a little more trivial. And one involves a lost document that was found again by the the Royal Astronomical Society of Canada. It's founded in 1868 by a handful of people and one of the big projects in the 1869 was to organize a serious eclipse observation program. They did this. And in some minor journals they publish the results well. 30 or 40 years later, a member of the Royal Astronomical Society of Canada, the RASC, he sees an advertisement for a telescope, and he thinks, well, I'm interested in this. He's in Toronto.

RR: [00:13:02] This advertisement was placed by someone who was a little bit outside the city. So this guy, he goes to look at the telescope, see whether he wants to buy it. He goes there, he opens up the telescope case. He's interested in the telescope pinned to the top of the telescope case. On the inside of the lid was an old blue Victorian document, a document from the 1860s. Written in ink, written quite beautifully in ink. But I mean, the thing sort of, you know, rat eaten. It's got bits missing. What this was, was the first draft of the regulations of the bylaws. First bylaws for the Royal Astronomical Society of Canada. And there it was, just by chance. And this telescope case on the back of it in pencil, where a rough observations of that solar eclipse just sort of at the heart of the beginning of the RASC and that's sort of cool. So this thing again was found by chance. The other thing I would mention is—So in the 19th century, I, I did talk earlier about European powers sending out eclipse expeditions and these, you know, these went around the world usually following paths that were open through colonial administrations. Where it's where European powers navies were. It's where their colonial agents were. So it provided a way for astronomers to get to those places. Well in Newfoundland, on the extreme east coast of Canada. There was an eclipse, I think it was 1905, and Canada decided that it would show. They said it's a new country. Well, relatively new country as a as a united national entity, not subject to Britain anymore or less and less subject to Britain.

RR: [00:14:55] It would show its seriousness as a country by mounting a serious astronomical expedition, and it would invite observers from Europe. The Canadian astronomers built all of this expensive, complicated equipment. They practiced their observations before the eclipse because if you've only got a maximum of seven minutes to do your observations, you've got to make sure that what you're doing works really smoothly. The practices. The Canadian government contributed funds. They carted their instruments, you know, out to the observation site in Labrador. They had good documentation happening all the time. So they had they had people photographing the equipment and the progress exposition as they went there. They got clouded out. And this happens, of course. So all that effort for nothing in a way. But what does survive are these fantastic albums, the Eclipse Expedition, showing them, gathering their instruments, showing them on the various modes of transport, you know, ship and other ways until they got to their location? There are—there's almost an ethnographic document. It's an ethnographic document of the European tradition. The European trained scientists and the Canadians fall into this, as well as the people who are not scientists. So the various First Nations groups, they meet their. And it is valuable that way. So here's an eclipse providing an in a way. So the eclipse itself, that 1905 eclipse observation that expedition was a failure. But it produces document which is not a failure. It's a treasure trove of, of of evidence from the period.

SD: [00:16:46] Well that is thank you for that narrative description... I know you already spoke to this a little bit, but I was wondering if you could speak more specifically to how scientific observation of eclipses has changed over time.

RR: [00:17:16] Well, I guess at the earliest period, because people were limited to just naked eye observations. They were really concerned, it seems they were concerned, at least those with an interest in what we would now call a science. They were concerned with the timings of eclipses when they started, when they ended various phases, they might describe the environmental changes. So you get this gradual darkening. Wood gets, all of a sudden it would become very quiet because a lot of animals, as it's gotten dark, they they behave the way they do. They would at dusk. Get ready to go to sleep. This sort of unnatural quiet there would be. Various optical effects caused by the eclipse. So all kinds of cool things, and they may or may not record that. But the big thing so in in the ancient period was timings in the first place, whether the eclipse actually happened when it was supposed to happen and how accurate those timings were attached to this were also. And you've got these celestial, celestial phenomena happening. They were tied to other things that they wouldn't be tied to now. Things like astrology or or or predictions. You have an eclipse. You're paid by your king. You've got to interpret this. Is this is this eclipse going to be bad news for your king? Does this mean you know the king is going to be deposed by an enemy? Does this mean the crops are going to fail or is it a good thing? So there is that added sort of interpretive stuff they had to worry about, which is not part of modern science now. As time went on, and measuring an astronomical equipment for doing measurements improved.

RR: [00:19:19] It also meant that those timings for eclipses. Moved and as time measurements. Got better. So you could almost say that as. As improvements in instrumentation happens, the observations would have improved. People started to look at different things. But with the rise of the telescope in the early 17th century, with the rise of telescope applied to astronomy, people could start to observe what happened to the surface of the sun. And that leads into. And that leads into the astrophysics which I mentioned earlier. I guess another way to look at that, scientific or not scientific, is the changing cultural preoccupations. If you were going to go on an eclipse expedition, you're going to spend all this effort, all this time with the possibility that you could be rained out or clouded out. Well, you didn't want to waste all your effort. So one way of making the most of it on one of these expeditions was not to not to just do astronomy, but also do botany or geology and what we would call anthropology now. We'll talk to the people you met, make records of, of of their lifestyles, of their economy, how they sustain themselves. And that means that if you had that, if you gathered that information, it was like a knowledge colony, I

suppose. But if you gather that information and you weren't able to do your astronomical observations, the whole thing was not a write off. And that sort of approach really marks, I guess, the expeditions in the 18th century, the 19th century and early 20th century, that sort of a. Approach involving other other human sciences and and culture.

SD: [00:21:39] I was wondering maybe if we could shift gears a little bit. How would you characterize the relationship between the science of astronomy and indigenous traditions?

RR: [00:21:52] Oh, that's a great question. Um. Certainly not a constant. If you look at some of the earliest records of interactions between settlers, between Europeans, when they come to the shores here and, and the First Nations. Well, it's interesting. It's not what one would expect. Sure, there were idiots. There's always going to be idiots on the boat with you. But. I'm struck by. Recently, the Europeans would treat the First Nations people. They met with respect and they would note, well, these people do X better than we do, or they have a technological way of doing something which is really good. And so you get these things like the Jesuit relations. So the these are parts the Jesuits compiled and sent back to Europe. Just about how their missions were going. And there's a lot of really interesting scientific. The scientific information in there. There's social information in there. And they would report they would report the views of the First Nations about various celestial phenomena that they that the Europeans experienced and, and the First Nations people. And it's interesting, you know, there there's very little there's the ones I was looking at and they were later 17th century, the ones I could remember best. There's none of this. Well, here's what these First Nations people believe. Here's what these Indians believe. And ha ha, what a joke.

RR: [00:23:34] They're not scientific. That doesn't happen at this period. They report what the First Nations say, their explanations, their cosmology, and they say, that's interesting. It's not what we believe. But this is worth reporting. He gets to the 18th century things. I mean, there's still that attitude, but things start to change. But it's really in the 19th century that you get this sort of, oh, I don't know the right term for it. I'll call it European cultural or. Yeah, I mean European, European or Western cultural attitude of superiority compared to people who are not part of that group. Well, we have modern science. We have modern technology. These people don't. Here's what they think. Aren't they ignorant? Find that in the 19th century and into the 20th century. While things seem to be coming around again. Present period, perhaps spurred by things such as, well, many things, but people realizing that, you know, the communities that we have to come to terms colonial past if we want to, if we want to make a success of the way we're living now, we have to come to terms with that, and we have to take the bad things we did in the past seriously, and work with the communities who were here long before we were.

RR: [00:25:01] That means taking their cosmology seriously. So now the other thing I should say is when I speak about this stuff, I am not a First Nations person. I'm an. An old white guy. So anything I say is is worth less than you know about this stuff is worth less than someone who is a First Nations person. I mean, that's a given. That's obvious. So some of the people in the First Nations communities have come up with an idea of a two-eyed seeing. And. There'll be variations of that. But what it is is to inform yourself. So you learn what Western science has to say about whatever so about astronomy, and you learn its techniques as much as, as much as you can. And then you also don't throw out your own traditions, but you try to see the world, both those lenses at the same time. The idea is your the insight you will gain is greater than if you were just looking through either a western lens or a native lens, but they're both worthwhile. Providing both of these ways of seeing things are worthwhile, provided you approach both with mutual respect and understanding. And that seems to be catching on in a lot of the astronomical, the scientific astronomical community. I mean, there are other questions you can raise.

RR: [00:26:23] How? How, um, are these ways of seeing the world, um, commensurate? Can they really be brought together? And that's something that people have to work on. And why should it be easy? But I can think of an analogy that gives some hope of this being useful. There was an important European astrophysicist, Arthur Stanley Eddington. It was based at University of Cambridge and he is one of the people. Well, speaking of eclipses, he played a major role in the eclipse. I think it was the 1919 eclipse. The that eclipse provided the opportunity for him and his colleagues to the first real test of whether Einstein's theory of relativity actually confirmed observation, and it was an eclipse that provided that. Anyways. A scholar, a scholar working on Eddington at present has talked about Eddington's Quaker beliefs and how those beliefs a different way of seeing things enabled him to astrophysics in a slightly different way from his contemporaries, and that was actually an advantage. So by the same, by the same analogy, looking at it is possible that looking at a First Nations cosmology may provide an insight that can be used in modern astrophysics. It's not impossible. So things have changed in a way for the better. There's still a long way to go though.

SD: [00:28:10] Yeah, that's. We've been speaking a little bit about the boundaries between science, religion and magic, especially in relation to First Nations. So that's definitely a really interesting scientific analysis of that. Thank you.... Um, I think we have one final question. Just to wrap it up briefly. How would you describe the experience of seeing an eclipse in person?

RR: [00:29:02] Um. I have a mission to make it first. I have not seen a total solar eclipse. I haven't experienced that yet, so I'm hoping the 1 in 2024, which is partly the excuse for what you guys are doing, and I'm glad you're doing it. I'm hoping that one I will not get clouded out of

that, but we've got accounts of these things and. There's some really interesting aspects of this. You'd almost want to talk about an emotional history of an eclipse. You read these accounts and you've got these scientists in the 19th century or 18th century or 20th century. They're trained. Their image of themselves is a people who are wholly rational. They're in control of themselves, are in control of their equipment. They're in control of the experiment and the observation. They're not going to get emotionally involved. That doesn't happen. It's such a powerful experience that in a way, it overwhelms the senses and you. And there are some accounts of some very famous scientists. Rittenhouse of the, uh, um, he was an important natural philosopher. I think it was Philadelphia based, supposed to be the 18th century, and a very good maker of instruments during a type of eclipse, a transit of Venus. He was overcome by his reaction to it that he couldn't make he couldn't perform the observations. So overcome by it, even though he trained. As a scientist he'd prepared as a scientist. And reading accounts. Read other accounts where people.

RR: [00:30:50] Um. In a way have to fight if they're doing the science. You have to fight the way their body wants to react. So this natural show, I mean, you think about the sun, the brightest thing. You the brightest thing in the environment every day. Is suddenly affected, it starts to dim. There was a total eclipse. It's going to go out already. That's uncanny. The animals around you start to react. People around you start. Start to react. If you're near a tree, you can have an effect where the tree, the leaves and the tree or a picket fence actually acts as a sort of as a filter of sorts. And there's one stage in the eclipse where you get all these tiny images. The sun being eclipsed. That's caused by the optical effect. The of the of the image of the eclipse. Of the light being intercepted. By you know, you know, by the cheese. You've got all these little filters. They're shadow bands. Let's go across the landscape. And also you can be aware that the eclipse is moving very, very fast. I think it's the equivalent of what, thousands of miles an hour or hundreds of miles an hour over the landscape. So just the feeling that this is a very big thing and you're not all that big, but you're experiencing it. There is an esthetic theory, a theory of the sublime. And I think the way it went, this is an 18th century thing, but it did affect 19th century esthetics and I mean into modern times.

RR: [00:32:44] And the idea was you'd go and experience something. Out of the ordinary in its dimensions. So it could be something involving lights which are unusual or sound, which was unusual. That's, you know, very loud or perhaps very quiet, but it was usually a landscape. Or something in nature. A spectacular waterfalls, a mountain range and the the way it was explained is that this was so. It was so unusual that I think it was Edmund Burke who came up with the idea that you first experience fear because this thing was so large and out of normal experience,

but that that was immediately followed by relief because you were experiencing it, but you were safe and that this gave rise to enjoyment. Well, as an explanation that strikes me as ridiculous, um, however, I think human experience of a of a solar eclipse does have some. It does have something of a sublime about it. A lot of people are very moved by this experience, and some people become Typekit sound ridiculous. Some people become addicted to eclipses. You have to see the next one and they'll spend a lot of money going on an expedition to see the next eclipse, wherever it is on the earth. I guess because they like the adrenaline rush and the whole experience. We'll say that. I would say that, um, it'll be memorable. You have to see it.

SD: [00:34:29] Yeah. I think we're all very sorry to cut you off there. Oh, no. Sorry. That was my fault. I think we're all very excited for the upcoming eclipse. It'll be very, very interesting. So thank you so much for joining us today. You gave us so much great material. We really appreciate it.

RR: [00:34:55] Oh my pleasure.

[Note: Some tangential discussion from the audio file has been omitted]

[END OF INTERVIEW]