

Mapping the Galaxy with Kevin Jardine



[Opening theme music with voiceover.]

Kevin Jardine

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[Theme music plays out.]

Joel McKinnon

Hi, gang, and welcome back to our final Seldon Crisis episode of 2022. I wasn't planning to release another one so soon, but I had an accidental encounter with something way too cool to pass up when I stumbled onto an account on Mastodon called Galaxy Map. Kevin Jardine, the author of this feed, is a cartographer from the Netherlands who builds beautiful maps of our home galaxy. Using data from the European Space Agency ESA Gaia spacecraft, he's figured out a way to visualize this data in some really interesting ways. I love maps of all kinds, but I'd never seen anything quite like these ones.

Joel

I decided I really wanted to share these with you folks who have been inhabiting Asimov's galactic empire with me for the past couple of years. So I got in touch with Kevin and asked him to join us. Welcome to Seldon Crisis, Kevin.

Kevin

Glad to join you, Joel. It's only recently that we've been able to construct detailed maps of our home galaxy thanks to the Gaia spacecraft, and I'm really looking forward to seeing them getting used.

Joel

Well, our listeners know a little about Asimov's version of the Milky Way galaxy as he described it in foundation and some of his other books. There are places like Trantor, the metal covered capital of the galaxy at its core, the outer fringe worlds of Terminus and its neighbors, Anacreon, and the other worlds of the four kingdoms. There is Korell, Hober Mallow's opponent in *The Merchant Princes*, the unfortunate Siwenna, which revolted from a tyrannical imperial viceroy and consequently got nuked for it. And of course, there is the vacation plan at Kalgan, where *The Mule* and later Lord Stettin set up shop.

Asimov just made up all these places, of course, because he didn't have any real maps to use back in the 1940s. What I find fascinating about your work is that there are many colorful regions we now know of that definitely do exist, and you are helping to make them understandable as real places that could possibly be visited by humanity or our distant descendants in the far future. Can you tell our listeners a little bit about how our understanding of the galaxy structure has changed in the past 80 years since *Foundation* was written?

Kevin

Well, when that Foundation series was written, astronomers already knew some basic stuff about the Milky Way. It's a flattened disk galaxy with a central bulge surrounded by a large halo filled with globular clusters, and part of that we can just see by looking at the sky. And part of it was some research that was done at Harvard University with globular clusters, in the 30s and 40s. Shortly after the Foundation series was written, radio astronomers started to observe structures in the velocity of hydrogen gas and they started giving names to these structures after constellations in those directions, such as Perseus or Sagittarius or Carina or Centaurus.

And astronomers have used those early hydrogen maps to speculate on spiral arms in the Milky Way and these have often appeared in artistic impressions. But in the absence of a major star survey actually astronomers don't agree on even basic questions like how many spiral arms our galaxy has or where they're located. About the only fairly firm addition astronomers have made since Asimov wrote the Foundation series is that the bulge contains a bar. But even then, astronomers debate about how the bar is shaped, how long is it, what its angle is relative to the sun, etc. And this is why the Gaia Star Survey is so revolutionary.

For the first time, we have distance estimates for about 1.5 billion stars and this has mapped out much of the galactic plane to about four kiloparsecs, or almost 15,000 light years. It goes much further above the dust in the galactic plane and we are even starting to get some results on the bar. And amazingly, Gaia can detect even faint star wobbles enough to catalog multiple star systems and ultimately even exoplanets. By the end of the mission, in about ten years or so, Gaia is estimated to have detected some 70,000 exoplanets. Yeah, 70,000.

Joel

That is exciting. Our listeners and those who have read ahead, especially into the sequels, will recognize Gaia if they don't know it from the popular zeitgeist. But it's a word that first entered our popular consciousness in 1970 when James Lovelock and Lynn Margulis wrote a book hypothesizing that the Earth was a self regulating living being. And the word comes from the Greek goddess of ultimate maternal power, the ultimate Earth mother. Asimov became aware of this a decade or so before he resumed writing Foundation in the early eighties and integrated it into the plot of the sequels we haven't covered yet.

And as I mentioned in the intro, it's also the name of a spacecraft built by the ESA and is the source of much of the data you used to create your amazing maps. Can you tell our listeners a little bit about this program, the Gaia program and how you access and use the data it has produced?

Kevin

Sure. Gaia was launched in the year 2013 and it took a few years for it to start delivering data. And the first major data release, which was DR2, was released in 2018. So it's a relatively new system. It's got two optical telescopes fixed to a platform that rotates at a very precise speed and several instruments that can collect light in various optical frequencies basically white, blue and red. It sends a massive stream of data every day back to the European Space Agency, and it compares star positions against a database of about half a million quasars.

So quasars are the very active hearts of galaxies which are located very far away. So essentially, they're fixed in the sky and they can form a celestial reference system. And Gaia can measure really small shifts in a star position as it orbits the sun. And so it has a system that's a little bit like a survey does on Earth, where a surveyor looks at an object from one angle and then moves the surveying instrument to a different angle and

looks at the object from a different angle and then uses trigonometry to figure out how far away that object is.

And Gaia does the same thing, except that its baseline is the orbit of the Earth around the sun, so it's pretty large. And the data that Gaia collects is made available to a large group of more than 400 scientists called DPAC, and that stands for the Gaia Data Processing and Analysis Consortium, which is chaired by Leiden University professor Anthony Brown here in the Netherlands. And I've been lucky enough to be made an honorary member of the DPAC Coordinating Unit number nine. I'm not a professional astronomer. My degree is in pure mathematics, actually. But the Coordinating Unit number nine is responsible for the data archive, visualization and public outreach.

And so, as a member of DPAC, Gaia astronomers can send me data, and sometimes it's before its public release, and I can use that for my maps and other visualizations that I do for them.

Joel

I'm just curious how you become an honorary member of this DPAC.

Kevin

Well, I've run a website, which, unfortunately, I haven't updated for a few years, called galaxymap.org, and so I became known by professional astronomers. I've been running this website for about 20 years now, I think, and I started out using data from our predecessor to Gaia called Hipparcos. And so when Gaia was launched, I approached some of the astronomers, and it turned out they already knew about my work and were quite happy to have me involved.

Joel

Cool, that's great. One of the neatest things about your maps is the way you've transformed these actual places in space and turned them into something resembling the kind of maps you see in fantasy novels and video games with kingdoms, forests, mountains, little castles and cities and stuff, and the seas around the land masses. It really kind of gives them the feeling of being like real places. And I always love that when I'm reading a novel, to see, to relate to a place. And my first thought was that this one looked like these look like something out of Tolkien.

And then I thought, no, these places are actually real places, so they might not look like the way you've represented them, but they are real places. So tell us a little about your process of how you do that, and if you can introduce to us some of the ones you really like, the ones that really pique your interest.

Kevin

Well, it's a challenge to create these maps because no one has ever mapped the Milky Way in this much detail before. Not in terms of like a top down map showing all these different star formation regions and star clusters and things like that. So I've been experimenting with different approaches. And one of the key decisions I made early on was to map the density of young hot stars of types O and B. So these are very rare stars. It's a tiny fraction of the overall data set, just a bit less than a million stars. So that sounds like a lot.

But the total data set is 1.5 billion, so it's a fairly small fraction of them. And I pick these stars partly because they are believed to mark the positions of spiral arms and also because they're young and haven't drifted very far away from the star formation regions where most of them are born. And older stars tend to drift randomly. And mapping those gives me a pretty fuzzy map compared to these OB stars. Also, these stars, these OB stars

are the stars that illuminate most of the famous nebula that Hubble has been taking pictures of for so many years.

And so, because I know where these stars are, I can also locate a few hundred nebula of the kind of beautiful images that Hubble has been taking, like the Orion or the Eagle Nebula. And I can put them on my maps as well. And also there's a group of Gaia astronomers that have been focused on star clusters and they've sent me positions for about 2000 star clusters. And another group has been focused on dust. And they can actually use the color data that Gaia has been collecting to map dust clouds. And so I can also put dust on my maps.

And if you've ever seen images of galaxies outside our own, you can tell that there's a lot of dust in those galaxies. And that's an important part of the image. So there's a lot of information that I can put in my maps. And I think sometimes that people are a little bit overwhelmed by it. So in the last month or so, I've been experimenting with a simplified design inspired by fantasy maps like the Middle Earth map in Lord of the Rings. And so I've been simplifying the map and actually using a lot of terrestrial cartographic metaphors. So, for example, I'm representing young hot star density as forests.

Dust is represented as mountain ranges and nebula and star clusters as towns and castles and other structures. And I wasn't really sure what it would turn out to be and whether people would like it. But personally, I really do like the result. And I think people find it easier to absorb the Gaia data when it is presented in a more familiar format. But I am finding it hard to single out a favorite region on my maps because there are so many fascinating places. Maybe I could just mention a few, like Cygnus X, for example, is quite a mysterious large star formation region in the local arm.

And it has an amazing star cluster which is called Cyg OB2 that has 70 ultra hot O-type stars. And that's a huge percentage of the known O-type stars in the Milky Way. So it's amazing that there are so many of them in one location. And there's also another large area which I've called on the Fantasy Map, the Isle of Cassiopeia. And it's a huge star island off the main coast, sort of like the Madagascar of the Milky Way. There's the territory of Pismis, and that has a huge nebula that I don't think Hubble has ever even imaged and doesn't even seem to have a name.

That's one of the good things about being able to use this new Gaia data is that you're actually sometimes mapping regions that no one knows anything about and no one has seen before. There's an area of young, hot stars that I've called Puppis City, and it's a sort of Lost City because it's a massive region of young, hot stars. But astronomers have debated for decades whether it even exists, and if it does, how far away it is. And Gaia has confirmed that it's real and come up with a specific distance. And then there's the Carina Empire, which, of course, has the famous Carina Nebula.

And it's got a huge concentration of nebula, not just the Carina Nebula, but many others, and star clusters in one general region. So it sort of acts like, I don't know, Minas Tirith of Lord of the Rings. It's this big kind of capital city that dominates this part of the galaxy. Those are just some of a lot of interesting places.

Joel

That picture that the Webb took is now my desktop, and I don't think I'm alone in having that as my desktop wallpaper. Yeah, it's just so gorgeous. I'm curious how Webb has affected any of your observations. Has it had any impact on what you're doing? On any of the pictures they've taken?

Kevin

Well, the Webb telescope is... the James Webb telescope is quite new, and so, of course, I follow a lot of astronomers who put up images. I'm very interested in the details of it. And what I find personally is that Gaia and Webb and Hubble and some of these other optical or infrared telescopes really make a good combination because Gaia can tell us where these things are and how they interact with other objects in the Milky Way. And so we can use these beautiful images and at the same time actually place them on a real map.

Joel

Cool. What you said earlier about finding these nebula that aren't even mapped or there aren't images of them, it reminds me of Star Trek just how they will stumble into some new nebula or something. And that always just really struck my imagination. There are things out there that we don't even know about that you could just fly to and see for the first time. Your project is almost like having a little enterprise to go out and find things in that respect. These things sound so cool, all these places you're describing. And I would love to be able to point my listeners to a way of looking at them for themselves.

And I do Show Notes that I think 90% of people, maybe 99% of people, never look at where I have links to various things. So I'm hoping that you can maybe help me populate those Show Notes with some places where they can see some of these things you're talking about.

Kevin

Oh, yeah, I'd be happy to do that for sure.

Joel

So Asimov didn't know about the enormous black hole at the center of our galaxy and the bar you're talking about. It seems like Gaia's findings might have complicated the picture he was painting quite a bit, such as having the capital of the galaxy at its center. And I'm wondering if you can tell us anything about what this region might really be like and how habitable it could possibly be.

Kevin

Well, the center of the Milky Way and the galactic bar in general are very different than the region around the sun. On average, the stars are much older, although there are some young clusters, too. And also the stars are typically packed much closer together. And the regions at the heart of young, dense clusters or near black holes would tend to have too much radiation for life to exist, for sure. But elsewhere in the bar and somewhere in the general galactic center, there might be actually a number of advantages for galactic civilizations. Older stars would have systems with more dust and minerals, making planets very likely and also giving life and civilizations more time to evolve and plenty of minerals to exploit.

Interstellar travel would be easier with the stars closer together. Although, of course, you'd also have to worry about getting too close to a supernova because the galactic center is pretty active.

Joel

Inconvenient.

Kevin

But overall, I don't think that the galactic bar or places near the galactic center would be that hostile to life.

Joel

I was just thinking about the history of humanity and learning things and how as recently as half a millennium ago, we thought we were the center of everything, that the Earth was the very center. And we are so special in that way. And then gradually we've learned more and more. That's kind of dashed that realization that we're not that important. We're now just one star that's kind of out in the boonies. It looks like it's not even that close to the center. And this even makes it more like that in thinking that maybe there are much more advanced and long lasting civilizations closer to the center that just couldn't even imagine caring about what's going on here out on the very fringes.

We're like, I don't know, somewhere in Idaho or something; or farther, the Yukon Territories, I don't know. But that's interesting. One of our past guests, an astrophysicist named Stephen Webb from England, described a very compelling reason why a Galactic empire wouldn't be workable even if humans could eventually spread out throughout most of it. And this is the incredible amount of time that would pass while attempting to communicate across any significant distance. By the time the Emperor finds out, there's trouble brewing in Terminus, the residents of that region are long dead and gone and vice versa. So a lot of Asimov's narrative structure kind of falls apart when you think about it in that way.

What other problems can you imagine that would crop up when trying to inhabit and run a Galactic empire?

Kevin

Well, the first point is a matter of timescale and it depends on how long lived the beings are. And if you're talking about someone with a human life scale, no doubt galactic distances are just enormous. But if there were beings that lived for millions of years, then galactic distances wouldn't be so extreme. And it's technically possible to imagine that, I guess. But the other issue is that most empires have some kind of economic basis and it's hard to see what materials might be light enough and valuable enough to transport for light years to make some kind of galactic economy work.

And that's why a lot of science fiction stories invent ultra rare materials like dilithium crystals or unobtainium. But actually, as far as we know, most materials useful for a galactic civilization or for a civilization of any kind, local or whatever, are pretty widely available in local systems. So the question is, what is the motivation for building larger structures? I mean, you could see something like peace treaties happening or something like that. But a civilization that is galactic in extent, I'm not sure.

Joel

Yeah. Our last guest, Dr. Robert Zubrin. Really interesting guy; heads the Mars Society; he described to me a method of transmission of life from star to star known as Panspermia. And he made a point. — Whoa, it sounds like fireworks are going off. This is the end of the year.

Kevin

Yes, I'm afraid so. It's a very big thing here in the Netherlands.

Joel

It's not too loud. Anyway, Zubrin made the point that the position of the stars in our galaxy are not fixed in place. They all orbit the center of the galaxy over an extremely long time span, but in much smaller time increments, they wander around to a smaller degree above and below the galactic plane and occasionally some come into close contact with each other. Close enough that they're Oort clouds. That's the region fairly distant from the central star, but still gravitationally bound to it. They intermix to some degree and out in these Oort clouds. There are a lot of frozen bodies that are just kind of hanging out in there.

And if two Oort clouds would intermix to some degree, it would destabilize those Oort clouds and those bodies, and some of them would fall in towards their center stars, or they could even fall into the other star. So they could pass information between star systems in this way. And he thinks that this could result in cometary bombardments of the inner planets, bringing new life in to make to any that just happen to have the conditions available for that new life to germinate on those planets. He thinks it's very likely that Earth life arose from one of these exchanges, perhaps more than once, and that we may have already seeded other star systems with life.

From your understanding, does this seem reasonable? And do you think we will ever have enough data to understand the past and future paths of stars that may be candidates for this kind of intermixing with our solar system?

Kevin

Well, I do find the whole Panspermia Hypothesis really quite interesting. And personally I'm open to it. But I'm not a biologist, certainly not an exobiologist, so I can't really speculate on that. But jumping onto planets orbiting passing star systems is a very real possibility. And in fact, several professional astronomers have already been using Gaia data and published articles looking at the next few stars that will pass near the sun. So there's already a list of these stars. And in our relatively sparse neighborhood around the sun, we can't expect a visitor more than once every one or 2 million years.

But in the galactic bar region, that might happen a lot more often. And yes, that could be dangerous and cause something like the dinosaur extinction event with comets or asteroids being disturbed and falling closer into the center of the solar system where the sun is or where the Earth is. But presumably, civilizations capable of jumping across star systems can also redirect a disturbed comet. So in theory, if humanity is still around in a million years or so, we could take advantage of a passing star to send probes there or even settle on a planet. And so that's kind of interesting.

And it is a different way of thinking about spreading around the galaxy because we may not have to go to other stars, they might come to us.

Joel

Yeah, that's kind of a new thing I didn't realize about, until — not just what Zubrin told me, but earlier I had seen — there's a great YouTube channel called Cool Worlds, and they did a study — he talks about a study on that that shows how often stars come very close to one another and how it's not necessary to travel tens of light years necessarily to — I'm hoping you can hear me.

Kevin

Yeah, I can hear you. I'm really sorry about the fireworks.

Joel

No problem, I don't think it's too loud in the recording but we'll find out. But one thing you said, just peaked to my interest, which is about the stars that may have passed near the sun or that will pass near the sun. And I'm wondering about the reverse. I'm wondering if we could figure out what stars have been near our sun and have gone away. And might those be candidates for Earth life that they picked up when they were close to the sun?

Kevin

Well, again, it's possible. I can't really speculate on that. But there is also a list of stars that passed by. And of course, there's also increasing interest in, I don't know what you call them, interstellar rocks. Interstellar ...

Joel

Oumuamua, whatever that was.

Kevin

Yeah, exactly. I didn't mention it because I can't pronounce it. But, yes, there's a whole class of objects that astronomers are looking at closely. And it could be actually that if we start actively looking for them, we'll find that there's quite a few and there may even be some already in our solar system.

Joel

Yeah, that would be really interesting to see if we could find evidence of life on those or artifacts of some kind. Anyway, can you talk a little bit about what the future holds for Gaia and other proposed projects for understanding the shape of the galaxy?

Kevin

Sure. Gaia itself still has a number of data releases and most of the measurements that it's going to take haven't happened yet, or at least haven't been recorded and released to the public, I should say. And it's probably going to continue on for another four or five years. There's going to be data release four in 2025 and then the final data release, I'm not sure exactly when, but somewhere around 2030. So there's a lot more data that's coming and more accurate maps. And, you know, as I mentioned earlier, there's also going to be an incredible catalog of exoplanets that could be up to about 70,000 exoplanets, around the Milky Way, that we'll know about, that we wouldn't have known about because of, without, Gaia.

But then the question is what happens next? And the problem that Gaia has is dust. And there's a lot of dust in the Milky Way, and after a while, Gaia can't see through it anymore. And so there are limits to the region that Gaia can map, especially in the galactic plain where most of the stars are. And we need to have some kind of surveying system that has a system like Gaia but does it in frequencies that can see through dust. And we don't know how to do that right now. There's a technique that works for microwaves given off by certain massive stars called Masers, but it's very time consuming and we only have about 200 locations mapped.

So that's a huge difference between Gaia's 1.5 billion stars and only about 200 Masers. But still, I think we should fund more of that Maser astronomy, especially in the fourth quadrant of the Milky way, which you can only see from the Southern hemisphere, and we hardly have any Maser

observations there yet. There's also a proposal for a Gaia follow up mission that uses infrared and that would get us a lot further, at least on this side of the galactic bar. But it requires new technology. And even if that is funded and developed soon, the reality of science projects is that the data won't start flowing for probably another 30 years, and so we probably won't actually get new data other than what Gaia is giving us, in a large scale anyways, for a generation.

But maybe we need that generation to teach kids about what we are learning now about the Milky Way.

Joel

Yeah, it's certainly different than when I was in school, in how much we know. I was very inspired by the limited maps we had then and the limited visualizations we had at that time. I can't imagine how intriguing it must be for kids now with this kind of stuff that you're developing to start. Another thing I was really thinking about is how in science fiction everything is always made up now because we just don't have the data, have the picture. So we create our own ideas of what planets are where and what star systems are where and all that.

But once we have a more complete picture, I can imagine drama being set in these places, future drama of actual places and you could have them mapped so you can get a better picture of where things are going. That's one of the things when I'm reading Asimov that I'm almost wishing there was a better map of like —here is Siwenna? How does it relate to Terminus? And, you know, where are all these planets and star systems and everything?

Kevin

Well, one of the frustrating things for me about the new Star Trek shows is that in theory, Star Trek is set in the Milky Way. It's sort of in a real galaxy, that's supposed to be our galaxy, and yet they're not taking advantage of the new data from Gaia at all. And there is the chance to redo the maps that science fiction is using to make them a lot more realistic. And actually there are a lot of interesting things in the real Milky Way that maybe science fiction writers wouldn't have thought of. And so there's a good advantage in using real stuff.

Joel

Right. So let's let our listeners know where they can find you online and how they can interact with you. Can you give us any information about that?

Kevin

Well, for years I was active on Twitter and my handle there is @galaxy_map. So don't forget the underscore — @galaxy_map. But because of various problems with Twitter, more and more I moved to Mastodon, and you can find me there at the same handle @galaxy_map@mastodon.social.

Joel

And I have to say I'm the same. I moved over from Twitter not too long ago for the same reasons you're talking about. And you are one of the first really cool discoveries I made on Mastodon, just exploring the feed. And so it was great to see that you don't have to be on Twitter to find cool stuff.

Kevin

Well, that's part of the reason why I've been posting so much on Mastodon actually, is I'm hoping to be part of the group of people that sparks that into a really exciting place to be.

Joel

Yeah, I think it's going to take some time. I'm doing the same. I'm doing most of my posting on Mastodon and cross posting it to Twitter automatically. The only problem there is that I have a longer character limit on Mastodon, so when they get tweeted over, they get truncated. But then there's a link to the Mastodon tweet, so hopefully it brings a few people over.

Kevin

Yeah, well, I love a lot of the new features with Mastodon: Longer posts and the ability to edit anything...

Joel

Oh, me too. Me too. It drives me crazy to tweet something. It doesn't matter how many times I look at it before I press the button to tweet it, then I will see the embarrassing typo every time and it's so great to be able to fix that. Well, you mentioned something as we were preparing for this, about wanting to create a VR starship project, or maybe I picked that up from your Mastodon profile. Can you talk about what you had in mind for that?

Kevin

Sure. Most of the maps that I've done up to this point are traditional top down 2D maps. And I'm really quite interested in trying to find ways of producing 3D maps and being able to travel through them. And so what I'm doing right now is building a WebXR application. So it's a web application that works using VR headsets and it will enable you to travel to about 35 different locations around the Milky Way and then get a semi-realistic view of what it would actually look like at that location. And then you can actually bring up a map and bring up details and you can search for objects and do all the sorts of things that you would expect to be able to do on a starship.

So I'm hoping to be able to deliver that next year and that will be a completely different, and I hope, very exciting way of absorbing the Gaia data.

Joel

That sounds so cool and I will definitely be following up to find that because I've been wanting that my whole life. So that's great that somebody's thinking about building it. And thanks to Gaia for giving us the data to populate the worlds that we can explore. But it makes me think in Foundation, there are several places where Asimov talks about similar kind of 3D projections. There's one called The Lens, when The Mule and Han Pritcher are going out looking for The Second Foundation and it's supposed to be like this 3D projection that you can go into and zoom in on anywhere and see it from any orientation and just find all kinds of new stuff.

He's basically describing something like a VR spaceship.

Kevin

Well, I'm finding it an interesting coincidence that VR headset technology, the ability to actually immerse yourself in a 3D environment is developing at the same time as the Gaia data set, which really requires that in order to understand it. It's really a perfect combination.

Joel

Yeah, and the big difference there is that here on Earth as normal human beings, we don't really need 3D headsets because we see the world in 3D all around us without wearing anything. You really need to have something to explore that requires that kind of visualization capability. And this sounds like an ideal use case for that.

So anyway, this has been a spectacular journey through the stars and I can't thank you enough for taking the time to be with us on such short notice and over the holidays at that, as we hear. I wish you the best on your continuing mapping projects and hope you have a wonderful New Year.

Kevin

And you too, Joel.

Joel

Thanks a lot, bye.

Kevin

Bye.

Joel

Well, that was another superb guest and I want to expand a little on how I found Kevin's work online. I have an unfortunate tendency to wake up in the middle of the night and often have trouble getting back to sleep. Often I'll open up my laptop and look at the news or whatever chaos is happening on Twitter these days. And that's not always the best medicine for getting back to sleep. Lately I've been substituting Mastodon, which I found to be a more peaceful experience, and I'm slowly connecting with more and more content authors I appreciate there.

What's great about Mastodon is that there is no algorithm feeding you stuff that it wants you to get excited about. You have to do that for yourself. In this case, I found a post by Galaxy Map, the handle @galaxy_map@mastodon.social you need two @ signs in every Mastodon address. First for the username, and the second one is for where they are on Mastodon, which server they're on. So that's @galaxy_map@mastodon.social. I found his feed had these intriguing fantasy maps showing things like the Carina Empire, the Forrest of Centaurus, the Kingdom of Vela, all laid out like the geography of Middle Earth, and got instantly drawn in.

After scanning a few more of these posts, I managed to fall asleep and when I awoke, I realized that Kevin had fed me some outstanding dream material. I can't remember them in particular, but I know I was cruising all over the galaxy and exploring some amazing places. I also started thinking what a great guest he could be for Seldon Crisis if he was willing and impulsive chap that I am, I reached out and offered him a spot as soon as he had the time, and he jumped on it. The whole time, from discovery to recording was less than a week.

Every episode has Show Notes, and I often mention I'll be putting links there. But this time you really, really want to take advantage of them and

click on a few of those links. Kevin has provided me with a list of some great visual resources he's created, including both science and fantasy oriented maps like we've been discussing. Definitely take the time to visit the episode page at seldoncrisis.net to see these wonderful maps. There will also be a transcript of our conversation available there, and a link to the active transcript for reading and listening will be available quite soon. If I could ask a small favor, it would be great if you would click the "Reviews" tab while you're on the website and add a few words.

It's always hugely appreciated. Lastly, before I sign off in the waning hours of 2022, I want to thank all of my many listeners and collaborators for making this an amazing year for the podcast. We covered the last volume of The Foundation Trilogy and introduced a wonderful new cast of voice actors, including Megan Skye Hale as Arkady Darrell, Jon Blumenfeld as Hoir Munn, Zac Kreidler as an imperious First Citizen of the Galaxy and of course, his wonderful wife, Amanda Kreidler returning to play several characters, including Lady Callia, the spirited maid Poly, and of course, the charming Mama. They all deserve some kind of award, maybe a "Pody" or something.

I think we can do better, so suggestions are welcome for what to call their prizes. I'd also like to thank all of the year's guests, including indie Sci-Fi writers Tobias Cabral and Erasma Acosta, Sarita1046 for her fanfic, Priya for her Foundation TV analysis, Paul Levinson and Danielle Pajak for their wonderful conversations on Star Trek, The Orville, Art, and other Sci-Fi topics. Our first returning guest, Nathaniel Goldberg, for his philosophical analyses, and our most recent guest before this episode, Mars Society President Robert Zubrin. What a year. I look forward to another great year on the podcast coming up when we'll plunge into those sequels and welcome a few more guests and maybe some returning ones as well.

Last but not least, I want to send a special thanks to my son Jeremy McKinnon for his excellent sound design work, Tom Barnes for his work on the ever

evolving theme music, and Mike Topping for the immortal logo. Also, I want to thank one of my Patreon supporters named Basil for helping to develop the active transcript feature, which, if you haven't checked it out, please do so. It's still being developed, but it's a wonderful way to look through the podcast as you're listening to it, or to just read it and you can search it and find whatever you're looking for that you heard, maybe. Great resource to check out. It's always going to be at the top of the Show Notes — a link to the active transcript. So may you all have the happiest of New Year's, and I look forward to seeing you all soon again here on Seldon Crisis.

[Closing theme music.]