Astronomy Cast Episode 248 for Monday, January 16, 2012:

The Carina Constellation

Fraser: Welcome to AstronomyCast, our weekly facts-based journey through the Cosmos where we help you understand not only what we know, but how we know what we know. My name is Fraser Cain; I'm the publisher of *Universe Today*, and with me is Dr. Pamela Gay, a professor at Southern Illinois University – Edwardsville. Hi Pamela. How are you doing?

Pamela: I'm doing well. How are you doing Fraser?

Fraser: Again, we're running this episode of AstronomyCast as a live Google plus hang-out, so if you want to watch us, you can watch us live as we record the episode and make all our mistakes, and that's…you can circle both, you know, me or Pamela on Google plus, and then you'll get a notification in your stream when we start the recording, but the plan right now is for us to record them every Monday at…the time zones again. OK, so at noon Pacific, 2:00 Central, 3:00 Eastern and 8:00 pm in London, so that's every Monday, that's when we're going to try and record, but we'll tell you if we record at a different time because of Pamela's travel schedule.

Pamela: And usually we'll just shift to Wednesday -- same time, same bat channel -- just on Wednesday.

Fraser: Right. Right, and then it might just be that she's in…I don't know -- China, and we'll be recording at 4:00 a.m. her time, but she's a professional and a trouper, so don't worry about it.

Pamela: Yeah, except the social medias just don't stream there so nicely.

Fraser: That's true.

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Fraser: OK let's roll. So time for another detailed look at a constellation, one of the most fascinating in the sky but hidden to most of the northern hemisphere: Carina. Home to one of the most likely supernovae candidates we know of: Eta Carinae. Let's talk about this constellation, how to find it, and what you can discover in and around it. Now, we were like planning this show and sort of talking about constellations and you…this was like in your mind like the third good constellation to talk about. Why did you pick Carina?

Pamela: It's one of those constellations that just full of the good stuff. We already did the Orion constellation, and in my mind these two constellations sort of go together. They don't thematically go together -- you have Orion the Hunter you have Carina is the keel of the ship Argo Navis, which was the ship that the Argonauts took while they went to get the golden fleece – not so united there, but these two areas of the sky are two of the richest star-forming regions we have, and the thing is, here in the north, we are always "Orion, Orion, Orion – look at the Orion nebula! Isn't that awesome?" But if you actually go to the southern hemisphere, the Carina Nebula puts the Orion nebula to shame. It's bigger, it's brighter, and it has one of the brightest stars in the sky -- and it's one of the few stars in the sky that attempted to go supernova and failed and that alone makes it kind of awesome.

Fraser: So if you had to choose between the Northern Hemisphere and the Southern Hemisphere, which one would you pick?

Pamela: Oh, man…

Fraser: If you only look at one hemisphere's constellations and objects, which one would you choose?

Pamela: Am I allowed to say I want to live on the Equator?

Fraser: Sure. Fine. [missing audio]

Pamela: So I have to say that folks living in the Mediterranean area have some of the best views in the sky because they're far enough south that they get to see a fairly good view of Sagittarius, they get to see the beautiful tail of scorpion high in the sky as opposed to those of us who are further north, they get to pick up on the Carina Nebula, but at the same time, they get to pick and choose the best of both hemispheres. As you go further north, sure you get the Big Dipper high in the sky -- that's pretty awesome. As you go further south, sure you get the Southern Triangle high in the sky – pretty awesome, but the cool stuff likely tends to be on the Equator.

Fraser: Alright, alright, good answer.

Pamela: A weasel answer.

Fraser: Good weasel answer. No. OK, so let's talk about the Carina. So you sort of gave us a bit of what its name means, but what does Carina mean?

Pamela: It literally means keel of a ship; it's Latin. This constellation used to actually be part of a much, much larger constellation called Argo Navis, that, if it still existed, would be by far the largest constellation in the sky, and would dwarf absolutely everything else, but because it's so large, it's a little bit unwieldy to use for astronomical purposes, so it got broken up into three

different constellations. It got broken up into Carina, Puppis, and into Vela, and each of these different parts represents a different part of the ship, where Carina is the keel, and Puppis is the poop deck, and Vela is the sails, so between all three of these you have the ship from Jason and the Argonauts.

Fraser: If you looked at the constellation, what does it look like? Does it look like the keel of a ship?

Pamela: No. It just kinda looks like this random shape of stars on the sky. It's not one of those constellations like, well, this is where Orion does when Orion…you can actually see – it's a dude in the sky with a sword. Carina, no, it's just miscellaneous shape of stars.

Fraser: Yeah, and Sagittarius absolutely looks like a teapot.

Pamela: Yes. Yes.

Fraser: No question.

Pamela: Yeah, but it doesn't exactly look like the Greek figurine it was supposed to look like.

Fraser: Yeah, alright, so then…and so then if we were going to try and find it, where would we find it? If we were in the Southern Hemisphere, the lucky Southern Hemisphere…

Pamela: Actually anyone who's south of about 30 degrees north of the Equator, so anyone…tropics -- you're doing fine, folks down Florida, south of Florida -- you're doing fine. It's at 50 degrees south declination, so it's going to be low on the horizon if you're in the Northern Hemisphere, and progressively get higher up. It's a winter object for the folks in the Southern hemisphere, so you want to go and look for it June, July, August… I've actually been

able to see it in March while down in South Africa. And basically, look away from the Milky Way for a big, bright, fuzzy bit and there you're starting to find Carina.

Fraser: OK, well that "fuzzy bit"…so would that fuzzy bit be obvious? I'll bet you people in the Southern Hemisphere see that big fuzzy bit and go, "I wonder what that is?" and, I guess, never look any further or think about it.

Pamela: No, I'm sure some of them go further than that. So the Southern Hemisphere is kind of chock full of fuzzy bits. You have the Large and Small Magellanic Clouds, you have the Carina Nebula... So the Carina Nebula, as far as fuzzy bits go, it's fairly similar to the Orion sword belt Nebula (Orion Nebula M42) region. It's bigger and it's a little bit brighter, but the thing that makes it stand out is the second brightest star in the sky for a while: Eta Carinae. It's still one of the brightest stars in the skies right in the middle of all of this glowing bit, and if you pull out a fairly good telescope (or even with binoculars), you can start to tell that this really bright star is extended, and this is because Eta Carinae is embedded in this amazing hourglass-shaped nebula of expanding gas and dust.

Fraser: And so is Eta Carinae the brightest star in that constellation?

Pamela: Currently, and this is where things get confusing. If you've been listening to any of our prior shows on constellations, you know that normally, not always, but normally the brightest star in the constellation is Alpha+ the constellation name, so you'd expect "Alpha Carina" to be the brightest star in the constellation and if its not, it's going to be hard to tell it apart from the star that actually is the brightest star in the constellation by eye, but with Eta Carinae, when they were counting through the stars in that particular constellation, it was much fainter than it is today, but

back in the 1800s, it underwent this amazing brightening until in 1841, it actually was the brightest thing out there for the Southern Hemisphere viewers, and at this point it was undergoing this amazing nova activity. Supernova's not the right word, cataclysmic variable isn't the right word; it was this weird thing where the star almost exploded but didn't, and in the process gave off this amazing amount of light. It's since faded periodically, brightened periodically, and it's currently back in one of its brighter phases.

Fraser: And so it's definitely now the brightest star in the constellation?

Pamela: In the constellation, yes.

Fraser: And one of the brighter stars in the sky?

Pamela: Yes, which at a distance of 7,500 light years is kind of amazing.

Fraser: Yeah! Yeah, well that star alone, I mean, that star alone is worthy of its own show, but so then why don't you talk …where do you want to start? Do you want to start with the other stars and sort of get back to the Carina Nebula? We usually start with the stars themselves, so I mean Carina, which we've talked about…Eta Carinae is going to be probably the bulk of this episode. Let's talk about some of the other stars in the constellation as well.

Pamela: Well, most of the stars in this system aren't entirely worth noting; they're just everyday stars. The other star in this system that's actually worth paying attention to has the rather boring name of HD93129A. This is another O-type hypergiant, and it's out there basically saying, "Hey! You know, when other stars in the system explode, I might be following on the their footsteps." This is a system that has very young stars, and this is another one of

them. Now, while it has that long, boring name, it has another name you might be more familiar with and this is Canopus. It has a magnitude of –0.72, which makes it another one of the brightest stars in the sky.

Fraser: I think it's the second brightest after Sirius.

Pamela: Yeah, so this is the quintessential "Alpha Carinae." When it was named, it was the brightest star in the constellation. It's just Eta likes to be all competitive and threaten to explode at a younger age.

Fraser: Alright, so really the two main stars that we should think about are Canopus and Eta Carinae, so then let's talk about some of the other things to view in that constellation. I guess there's no avoiding it, the most interesting thing in there is the Carina Nebula.

Pamela: Right, so beyond that, this system, when we say Carina Nebula, we mean the great star-forming region that has the Eta Carinae Nebula (The Homonculus is what it's often referred to "The Man") embedded within it, but the great star-forming region (it's what's called an H2 region) -- this is ionized hydrogen. It's giving off beautiful red light, and embedded within this entire star-forming complex are eight different open clusters. These are areas where fragments of the cluster have condensed down, or fragments of the nebula, rather, have condensed down to form clusters of stars. These are sort of what the Pleaides looks like, except they're much, much younger. Some of these systems are just 3-4 million years in age. We've identified eight different open clusters within this system, and what's amazing is when you look at the great Carina Nebula and it's embedded open clusters in x-ray light, you can see all of these little pin-pricks of light that are representing the places where supernovae have gone off in the not too distant past. This is a system that's basically popping like popcorn, but with supernovae, and that's kind of cool.

Fraser: Yeah, yeah, and so then how big in the sky is it? If you could, you know, how many degrees of sky does the whole Carina Nebula take up?

Pamela: It's basically: go out and multiply the Moon by seven, and you're starting to get a sense of just how big on the sky this entire region is. Physically, it's about ten parsecs across, so this is a large system in terms of its physical extent, sort of. I mean, I don't know if you consider that many light years particularly big – that's about 30 light years, but in terms of angular size in the sky, it's pretty big too.

Fraser: And so how far away is it?

Pamela: Ranging on where you're looking at it in the system, it's 6,500-10,000 light years away.

Fraser: So then, how would you compare the state of this nebula to the Orion nebula that we mentioned before? How do they compare in terms of, sort of, size and age and power?

Pamela: So Carina's actually a bigger system. They're very similar in age actually. They both have ongoing star-formation going on. The difference is when you look through Orion, you don't see as many rich, open clusters as you see with Carina. What's interesting is how many parallel studies are done between these two systems where they can use them to confirm one another. So back in the early 2000s, there was this fabulous Hubble study that looked at knots in both of these nebulae to identify stars in the process of forming. So these are star-forming proplets, and so you can see these little caterpillar-like structures where stars are forming (or comet-like structures is how some people have also described them) embedded in the gas, and these are places where stars are just now starting to form, and will soon begin burning off

that thick gas around them to reveal themselves as the young stars that they are.

Fraser: And those open clusters that we can see, those are ones that have already a little older have cleared out some of the gas, dust and are starting to separate out.

Pamela: Yes, and just imagining what it would be like in these systems – you're getting in some cases hundreds of stars within the same region that we, and our nearest ten neighbors, occupy. So these are much, much denser regions of space.

Fraser: Sounds really amazing! And then the far future, if we could look out into space and find a region that Carina will look like in the far future, what might we see?

Pamela: So there we start to imagine things like the Hyades cluster here in the Northern Hemisphere. This is an open cluster that has had time to spread itself out as it orbits around and around the Milky Way, except this is that system times eight because there are so many open clusters embedded within the Carina Nebula. Now, what's going to be amazing, though, is the process to get there. We know of…at least Eta Carinae is probably not just going to go supernova, but it's going to go hypernova when it explodes, letting off this amazing gamma-ray burst in the process. We don't know when that is going to happen. Various people have said it's probably going to happen in the next few years. That's actually probably not true, so if you've heard the rumor: "Eta Carinae's going to go any day now," that rumor is based off of the fact that we've observed other stars that undergo these false supernova events, where it looks like they're going supernova and then the star stays together. Well, in the other cases where we've seen that, in one instance, there was the false supernova, and then two years later, the full-blown supernova, but that star where that was seen was much more advanced than Eta Carinae, so there's the

likelihood that Eta Carinae's going to trick us a few more times and then finally go and clear out the space around it, completely destroying the Homonculus, rearranging the inside of the great Carina Nebula. Each of these supernovae has the potential to clear out a region, creating an empty bubble in this giant complex.

Fraser: And I know with some of the more detailed images, astronomers have actually seen a lot of these bubbles all throughout some of these nebulae.

Pamela: Yeah, and so if you want to take a look at these bubbles, you want to take a look at Spitzer's infrared images, and there's just absolutely amazing images across the entire electromagnetic spectrum, across all the different colors of light of this system. There's also interesting time variation. I'm going to keep harking back to Eta Carinae because really it is the coolest thing in this system. And it's actually a binary system with a 5.2-year period, and so as you watch it in the x-ray over time, you can see its variations. As you watch it in light, visible light, over time, you see these variations. So as you step through the different colors, the electromagnetic spectrum, you see in visible light, the keyhole nebula, which is a dark, particularly opaque pocket of gas that makes it look like someone's taken a chunk out of the luminous material. It's just blocked it out with dust, but as you start looking in the infrared light that's able to penetrate this dust, you start to see it open up and see a lot more stars, as you move into the millimeter, you're able to see more and more star-formation occurring. If you go the other direction, looking at high-energy light, as you look at it in the x-ray, you see all these supernovae that have gone off. All of these different colors put together are what allow us to get the complete understanding of this amazing system.

Fraser: Now, you said that Eta Carinae is not going to blow right away, but I think in earlier podcasts, we've sort of alluded that it's

pretty much ready to go off, so has there been new science that's come out at this point?

Pamela: We're just starting to understand more and more about, well, these false supernovae. We're starting to understand what differentiates them from one another. We've now observed a handful of them, and we're starting to get a better sense of what stage in their evolution these different stars are in, and it looks like (and we could be proven wrong at any instant -- the Universe is the final determiner)…it looks like Eta Carinae is a young enough Wolf-Rayet star that it's probably good for a few more false alarms in its future.

Fraser: Like, well, what does that mean? How many years? Give me a date.

Pamela: I can't do it. Sorry.

Fraser: Ten years? A hundred years? A thousand years?

Pamela: Well, probably thousands of years. The papers that I've been looking at say…

Fraser: How many thousands? A hundred-thousand?

Pamela: We don't know. We don't know.

Fraser: OK, I like that answer. I want to know.

Pamela: And it could always just decide to prove us all wrong and explode tomorrow, but the papers I've been looking at say it's now imminent. It's probably on the thousands-of-years timescale.

OK. Alright, I'll let that slide. Now, you mentioned a few things already. You mentioned we can look at Eta Carinae, we can look

at the Keyhole nebula. If you get in really deep into it, what are some of the prominent features of the Carina Nebula itself?

Pamela: It's really…the Keyhole nebula is the big one to look at, Eta Carinae is the big one to look at, but beyond that if you really just want a stunning pretty picture, use a telescope that has a low focal ratio, so that you have a nice big field of view, and take a look at the full complex. It's as beautiful…to me it looks kind of like an orchid. It's this beautiful structure where on one side it has kind of a triangle of brightly glowing material that fades away from the center, and then on the bottom you can almost see – well, depending on how you flip the photo – you can almost see like the petal of an orchid coming out of the center, where it's kind of dark in the middle of the petal with bright edges. It's just this absolutely stunning, reddish region where all of this hydrogen gas is being excited, and we get to benefit from the excited gas.

Fraser: Now, are there any other deep sky objects around the constellation that might be interesting?

Pamela: Well, as I said, there's the eight open clusters, which are all worth looking at. They're all slightly different ages, ranging from 3 million years out to about 10 million years. They're all rich and very bright blue stars, and just jumping back and forth between them and seeing how one class of objects can have so many slightly different appearances is one of the fun things with this nebula.

Fraser: And one of my favorite things to look at with a telescope is double stars. Are there any double stars?

Pamela: So there's actually two different double star systems in this. There's the Epsilon and Upsilon (just to make them rhyme)… Epsilon and Upsilon Carinae double stars, which are always good to look at with a powerful enough telescope. Beyond that there's

also one globular cluster, which you're peering through all the gas and dust, so it still looks good, but I'm much more into the open clusters in front of it.

Fraser: And one thing that we all can see is there's a meteor shower that comes out of the Carina constellation. That's the Eta Carinids?

Pamela: Eta Carinids -- and this occurs every January, so January's just a month of meteors. So go up and look out, and all because the meteors appear to be radiating away from the Carina Nebula doesn't mean that you can't see them all over the planet when it's dark outside.

Fraser: That's right. Yeah, and so you might not see the constellation where they appear to be coming from, but they're kind of roughly pointing in that direction. So I guess if you want to find Carina, wait 'til January, wait until the meteor shower's happening, and then follow the source of the meteors until you get back to the source.

Pamela: Yeah, but that seems to be the strangest way possible to find a constellation. I much more recommend getting yourself a copy of *Stellarium,* or *Planisphere*, or something like that.

Fraser: Searching for a pot at the end of the rainbow...

Pamela: Exactly.

Fraser: So when was Carina going to blow again? Eta Carinae? I forget, what did you say?

Pamela: We don't know. We don't know.

Fraser: Alright. So thanks for all that information, Pamela and we'll talk to you again next week.

Pamela: Ok. Sounds great, Fraser.