Astronomy Cast Episode 33:
Choosing and Using Astronomy Equipment

Fraser Cain: This week we're going to talk about amateur astronomy again, but this time we're going to talk about the gear: how to choose it, fix it, upgrade it, buy it, where to buy it, how much to spend… all of that. Hopefully if you're wondering what's the best way to get rolling with buying your own telescope we'll hash that out this week.

Before we talk about telescopes, let's talk about some other stuff that you might want to get first.

Dr. Pamela Gay: Well I think everyone should start by going out and getting a planisphere or a star wheel. This simple little $5-$10 set of pieces of paper will allow you to find your way around the sky. It's the stepping off point, the math that you can use to find "oh, that's where Hercules is, that's where Cassiopeia is" to find the constellations to then be able to say "oh, I know that Saturn is currently on the nose of Leo the Lion, I can find Saturn now." They're just wonderful, practical little devices that are adjustable so you can set them to the time of year that it is where you're located and take off and explore.

Fraser: Everything with amateur astronomy is based on constellations. Everything that you're going to want to see: nebulae, clusters, planets, binary stars, everything is like, "start in this constellation, look in this star of the constellation it should just be a finger width above it or three degrees below it." So definitely learning the constellations is the first step and its amazing because once you start to know them, you walk outside, look up, and you're like, "oh, there's this and that" and it suddenly makes the sky very familiar. It's not a haze of stars, it's you know the constellations, you can orient yourself whenever you look up.

Pamela: I personally know the fall stars the best because that's when I generally, for whatever reason, have gone camping. I've taken my planisphere and just learned what the sky looks like in September and October really well. But this time of year, I'm moderately hopeless. A planisphere is a small thing that I can just leave tucked in with my maps in my car and anytime I'm out doing a star party or I'm at a friend's for a barbeque and they're like, "hey, what's that object?" I can pull out the planisphere and it's right there. Plastered between a map of Chicago and a map of Boston I have a map of the Universe.

Fraser: (laughing) I like that.

So, to go along with a planisphere then, my recommendation is a good book that maybe has something you can fold out and has some sky charts in it that are maybe larger. The problem with the planisphere, I find, is they're very small and its hard to put things into context while a book can be a little bit larger, you can lay it out flat, and you can have a bit better a view. My favourite book is *NightWatch*, by Terrence Dickenson, it's spiral bound, you can open it up, it's got one page per section of the sky and you can take your time to learn that.

I think the other thing you need is a red flashlight. They're easy to find, cheap, and something that doesn't ruin your night vision while you're able to look at the sky map. Many of the sky maps are actually designed to be viewable with a red flashlight.

Pamela: And you want to use the red flashlight because it will help protect not only your night vision but the night vision of everyone around you. Our eyes are least sensitive to red light. So if I decide I'm going to flash Fraser in the face with a flashlight, and it's a red light, his eyes will easily be able to go from staring at me being stupid to making out fairly faint objects in the sky.

If instead I beamed him with a blue flashlight, all the little chemical receptors in his eye that trigger on light are going to fire madly, and all those chemicals waiting to trigger are going to get used up and it's going to take a while for those chemicals to build back up and for him to be sensitive to faint objects again.

So red lights protect your vision and the vision of those around you, and if you're feeling really cheap, find someone's red nail polish and just paint the front of a $2 dime-store flashlight.

Fraser: That works? Wow, okay. All right, so let's talk about some *actual* gear. You know, you spend a couple nights looking at the stars, learning your constellations, time to use a piece of equipment. Let's start with binoculars.

Pamela: Binoculars come in a bunch of different sizes. When you're looking at the boxes they're going to say things like 7x50, 8x25, 15x35. These numbers indicate the magnification of the binoculars as well as the size of the big objective lenses out at the front end of the binoculars.

Fraser: So is it size in millimetres?

Pamela: Yes, it's size in millimetres. So if you look at a pair of 7x35 binoculars, it's going to be a magnification of 7 with 35mm or 3.5cm objective lenses.

Fraser: I can understand what the magnification is for: if it's 8, it's 8 times, if it's 10, it's 10 times, so if something looks like it's a metre tall in the telescope it's going to look bigger, right?

Pamela: Right

Fraser: By a factor of 10, right? But what does the measurement, the millimetres have to do with it?

Pamela: The size of the objective lens is going to tell you how much light is able to get into the binoculars and make it to your eye. The more light can get into the binoculars, the easier you're going to be able to see really faint objects.

So these binoculars are taking and grabbing a section of the sky, a section of the light coming from distant stars and nebulas that is much greater than what you're little tiny eyes on their own are capable of receiving. They're then funnelling all of this light out through an exit pupil, out through the eyepiece that your eye can then receive. The more light the binoculars gather, the more light they can funnel into your eyes allowing you to see progressively fainter and fainter objects.

Fraser: So, I guess buying binoculars is a mix between those two numbers, right? What if you get something that's really high power, like 20 power, but it's maybe 35mm.

Pamela: The manufacturers of binoculars are actually pretty good with not wasting people's time by combining huge magnification with little tiny objective lenses. So some common astronomy, giant objective lens binoculars are going to be a magnification of 11 with 80mm objectives, or a magnification of 20 with 80mm objectives.

The problem with these really big objective lenses is they start to get really heavy. So if you're going to be out there holding them by hand and you're just sort of interested in touring around the sky, I'd actually start off with something that has a 50mm objective lens and either a 7x or a 10x magnification.

Fraser: So you're looking for a 10x50 or a 7x50?

Pamela: Yeah. We usually say 7 'by' 50 or 10 'by' 50.

Fraser: Right.

Pamela: These aren't that heavy, you can hold them without big difficulties for 10-20 minutes, no big deal, and they're going to allow you to see the nebulosity of the Orion nebula, to make out all the little stars in the Pleiades, to start to get at faint fuzzy objects like the globular cluster in the constellation Hercules.

Fraser: Right, or you could see Andromeda, the galaxy.

Pamela: You can see Andromeda – it actually goes straight across the field of view in many of these different pairs of binoculars.

Fraser: So chances are most people have 7x35's kicking around; that's kind of your common binocular. It's the 7x50 or 10x50 that really kicks it up a notch.

Pamela: If you're looking for binoculars for astronomy, you actually want to hold them out at an angle and see if they reflect up a purple-y colour at you. Really good astronomy binoculars are going to have a special coating on all of the surfaces that prevent light from getting reflected out of the binoculars.

Glass surfaces have this nasty tendency to not just transmit light, but to also reflect light. We've all seen this at night when we're looking out of a bright room at a dark city.

We can see ourselves reflected in the glass. That light isn't making it through the window to the city (which may be a good thing). But if instead, you turn this picture around and you're looking through a pair of binoculars at a bright star, you want all of the light from the star to get funnelled to your eyeballs and none of it to get reflected back out to your friend looking at you looking at something through binoculars.

This special, purpley-tinged over-coating can help make sure that more of the light gets to you than gets to people looking at the back end of your binoculars.

Fraser: So how much would you spend on a pair of binoculars?

Pamela: About 80 bucks.

Fraser: Right. SO is there a tremendous difference? I'm sure if I look through some astronomy magazine, there'll be binoculars there for $500. Is there a big difference between a pair of $80 binoculars and $20 binoculars?

Pamela: There can be fairly significant differences in how much they weigh, in the type of coatings that are used on the optics, but for someone just starting out, other than the difference in weight, you're not going to notice any of these differences.

So if I'm buying binoculars to use with my students, I know those binoculars are going to have a shortened lifetime. Or if I'm just buying binoculars to keep poking around in my car where they're only going to get pulled out now and then, I'm going to spend $80.

It's only after I've completely fallen in love with using binoculars and I'm looking for something that I'm going to use night after night after night, that I'm going to invest larger dollars and get the several hundred dollar pair of binoculars.

Fraser: But definitely avoid those little tiny binoculars, the ones with the really small – like 7x20. It's just not enough light.

Pamela: Right. 7x50, 10x50 – that's what I'd start with.

Fraser: Let's move on. So you've got binoculars – and that's definitely what we both recommend, get a pair of binoculars first. One of the really nice things about them is you get that binocular vision – you can see with both eyes. There's a certain richness to the three dimensions that you get when both eyes are working that you actually don't get with a telescope.

Let's talk about telescopes. Say a person wants to make the leap and buy a telescope. What's involved in a telescope?

Pamela: For someone just starting off, you're still finding your way around the sky, you perhaps don't want to jump into a computerized this that and the other thing, you want to make

observing a personal experience. For you, I'd recommend a Dobsonian telescope. These are often nicknamed light buckets.

They're literally a giant tube that has a mirror on one end, the end closest to the ground, an eyepiece ¾ up the tube. Light goes in, reflects ¾ the way back up the tube, hits a tilted mirror and comes out to an eyepiece that is convenient for looking through for your standard, standing up adult.

They're easy, easy, easy to use. There's some new gadgets that make them actually great tools for learning the sky. You can get these encoders that you start off by turning everything on, and it will say, "point at" and it gives you some really, really bright star and you say, "okay, I'm there." Then it tells you, "point at this other really, really bright star," you point at that and it says, "okay, I now know what you've done setting up this telescope."

After you've set it up, you tell it, "I want to look at this faint object I can't see through my finding scope". It will give you little arrows that say sway your telescope to the right, pull it up toward the centre of the sky, and it will help you find these fainter objects. You're still looking at only spending a few hundred objects and you can open up all sorts of faint galaxies and really broaden your experience.

Fraser: What kind of sizes will these be?

Pamela: I'd actually recommend getting the largest telescope you can comfortably lift. For most people this is going to be a 6" diameter mirror. Dobsonian telescopes also come in smaller sizes like 4" and they grow all the way up to as much as 30" or a metre in diameter.

Fraser: I actually used one last summer. Someone invited us to a star party and they had a 25" in Dobsonian. It was 16 feet long, you had to use a stepladder to get up to the top and look through the eyepiece. So they get big.

Pamela: They're absolutely amazing. I've seen some of the owners of these telescopes do the craziest things. They'll be fine-guiding up at the top and decide "okay, I'm leaning over the ladder a little bit too much" and they'll *bunny-hop the ladder* to get it closer to the telescope it's the most insane thing I've ever seen, just done for the sheer pleasure of being able to observe better and for scaring all the amateurs around them.

Fraser: So 6" Dobsonian telescope is good. And Dobsonian is named after the inventor, right? This is the one that's sort of counter-balanced, it's got a nice flat stand on it, looks like someone just took a tube and it's sort of held and you can just move it around , it's all manual, there's no electronic gears or anything that goes on. You're looking at a couple hundred dollars, right? $200, $250, not that expensive.

Pamela: It all depends what kind of size you're going after. You can spend up to $500-$600 once you throw in things like a case, getting the encoders, and all that sort of stuff. But

it's still, given how much you can spend on a personal telescope, it's not that great an expense.

Fraser: With a 6" telescope what can we see?

Pamela: Here you're going to start being able to see things like all the Messier objects, who will pop out of the sky at you. You'll be able to chase M51, the Whirlpool Galaxy, you're going to start being able to see the Lagoon Nebula, the Eagle Nebula. All of these objects are going to be opened up to you, and you might even start being able to see colour in these objects if you're in really dark skies.

Fraser: You can see bands on Jupiter,

Pamela: Oh yeah.

Fraser: Saturn's rings, Uranus, Neptune

Pamela: You can see the ice caps on the poles of Mars.

Fraser: Venus

Pamela: Has phases

Fraser: Yeah, that's true. And the Moon is outstanding.

Pamela: Yes.

Fraser: The craters on the Moon, some of the amazing shapes, some of the walls and crater rims and seas… it's quite something.

Pamela: And you can get filters for these telescopes that allow you to use them to safely look at the Sun. So you're not limiting yourself just to night time observing. You can also get one of these filters and start observing our nearest star.

Fraser: So I think that definitely, with a 6" telescope, knowledge of the sky, you're able to move around, look at different objects, you can see with your own eyes pretty much every major thing that you'll see pictures of from Hubble or those kinds of things.

But there are other different kinds of telescopes. You'll see the one – I forget what it's called, it's a Meade one…

Pamela: One of Meade's most popular telescope is the LX200 series. It's a GO-TO telescope, they're made out of Schmidt-Cassegrain optics which means you have a mirror that is as though you took a sphere of glass and cut off a section of it. They also have a glass corrector plate up at the front so when you go to look in the front tube of the telescope you see this glass plate. Embedded in the centre of the glass plate is a secondary mirror.

So the light goes through the corrector plate, hits the spherical mirror, goes up to the little mirror in the centre of that corrector plate and then goes out through a hole in the bottom of the mirror. You can then put an eyepiece, a camera, a CCD – anything you want, down below the bottom part of the telescope.

These are great telescopes if you're starting to do astrophotography, if you want to start getting into imaging with all sorts of different types of digital cameras, and they're good, rugged systems in general.

Fraser: And they're easy to hold and carry because they're much smaller, right?

Pamela: Yes, they have a very short focal length, so the distance between the front of the telescope tube and the back of the telescope tube is going to be much smaller.

Unfortunately with these telescopes you're starting to add things like the corrector plate, the driver system. These systems often come with motorized drives that automatically track objects as they move across the sky. All these things are going to add weight, and time that it takes to set up the telescope. With a Dobsonian you just go out and plunk it on the ground.

Fraser: Right, but with the Dobsonian you've always got that problem of you point it at some object, especially with some higher magnification, tell your friends to come look and they say "I don't see anything" and that's because the rotation of the Earth has moved your field of view, so you're always trying to put it back into view.

Pamela: You do a lot more babysitting with a Dobsonian.

Fraser: Yeah. And you don't get that with one of these automated tracking ones.

Pamela: But the Dobs take no time to set up, whereas I have, on occasion where I was on an uneven surface and had a really cheap compass with me, spent an hour trying to get a Schmidt-Cass to work in a logical function.

So you're going to add weight the system, you're going to add set up time to the system, but the rewards you get are you can now mount a camera on your telescope and your telescope will now quite happily track objects across the sky.

The GO-TO systems on many of these telescopes will also allow you to just type in the name of the object that you're interested in and it will automatically move the telescope to that object.

Fraser: I'll be there's controversy about that. I bet some people think, "in my day we chased down our nebula on our own we didn't use some computer" but there's something to be said for punching in numbers and having the telescope just move around and go "okay, here's Saturn." It can get pretty tiring, looking through the spotting scope, jiggling the

telescope, looking through the spotting scope and trying to find the object. So once you've got a computer just tracking everything down for you so quickly, it's a real pleasure.

Pamela: It really is, and it allows you to go after objects that don't have any bright stars near them that you can star-hop to. It allows you to go after moving objects that you may not know exactly how to find three hours later because they've moved too far across the sky. The computers inside these telescopes can find things without having to star hop and can track fast moving objects if they have the correct software and it just opens up new parts of the sky that you couldn't get to on your own.

Fraser: So how much are you looking at to buy one of these?

Pamela: Here you're starting to look at $1000 up to tens of thousands of dollars depending on what system you go after and if you're looking at something that will do decent astronomical imaging. You can get stuff under $1000 but it's the type of stuff that might leave you less satisfied and less likely to use it.

One of the problems with a lot of these systems is a negative experience will cause you to leave your telescope in closets for years at a time. You pull it out, you call your friends over, you try to find some really cool, neat object in the sky, you can't find it, you can't get it set up, you spend forever trying to align it, nothing works, you don't use it for 4 more years. Then your kid's like "hey, there's a telescope in your closet!" so you pull it out, the kid tries, fails and it goes back in the closet.

You don't want to have that experience. Start with a Dob, and once you've sold yourself on buying a computerized telescope, buy the biggest aperture with the nicest mount you can get. A lot of people get cheap on how much money they spend on the mount, the part that holds the telescope up and steers it across the sky. The mount, in some ways, is the most important part because if it doesn't work, the entire system stops functioning in a logical way and you're lost among the stars.

So invest as much as you can, and you're going to have a much better experience for it.

Fraser: Now, can we talk just for a second about what's wrong with buying one of those cheap, $100 telescopes from Wal-Mart.

Pamela: Well… where to start…

A lot of them have really chincy drive systems, really chincy mount systems. So you're out there, you're slewing the telescope across the sky by hand and the whole system is wobbly. You look through it, you sneeze… the entire system starts oscillating and now you have Saturn bouncing left to right, left to right across your field of view. That's not something that's fun to look at unless you're trying to get motion sick.

Fraser: And you have to over-correct, right? Where you know how much the mount will push back on you, so you move it beyond the field of view and then when you let go of the telescope it will sort of swing it back so that you are always having to over-compensate for the give in the mount. It drives me crazy.

Pamela: Yeah, it can get really annoying really fast, and again you have a negative experience, it goes and lives in the closet.

Fraser: What about the optics?

Pamela: The optics can be completely random. Sometimes you're going to get lucky and get a telescope that happened to have come off the assembly line at the exact right moment of the exact right day of the week, and it's perfect. But other times you're going to get optics where everything that's not in the very centre of the field is a little bit distorted. Where the shape of the objects in the field isn't completely true, where things are either sort of tucked in towards the centre and the middle, sort of like a pin cushion shape, or they bulge out like a barrel shape. All these different aberrations can come in if someone hasn't taken the time to very carefully check all of the optics before it gets shipped off to whoever you're buying it from.

Fraser: But if you've already got one of those, you've already made that mistake, I think there's something to be said for taking it out and having another go with looking around the sky. But there's also something to be said for just saying, "don't bother, buy a Dobsonian, you're going to have a much more rewarding experience."

Pamela: Honestly, one of the things I've done that's made a lot of those cheap telescopes much more pleasant to use is I stick them on my camera tripod. I have a really heavy duty camera tripod. I can point all over the sky with it – it doesn't track or do anything like that, but it's stable. So if I find a 'scope that has half-way reasonable optics and I just want to take a quick look at Saturn with a school-group that has a cheap school telescope, I bring my camera tripod and try it out and I usually get a much more positive experience.

Fraser: Yeah. Now, this is one of those dangerous hobbies where things get expensive. Where can this go on the high end?

Pamela: Ohh… you can easily spend $50-$60 thousand. One of the rules of thumb is if you have a hobby that you're deeply invested in, the amount of money you spend on the equipment for the hobby is going to be roughly equal to the amount of money you spend on a car. So if you add up the cost of all your astronomy equipment (if you're an astronomy freak) and you look at the price of your car, those two numbers are going to be roughly the same.

So, I happen to drive a beat up, used Jeep that I love dearly, and not own a telescope. I'm not quite sure what that says about me other than perhaps I'm still paying off student loans. But, the systems that I'd want, there's this mount called a Paramount. It

runs about $15,000 but that sucker will track anything and the pointing is perfect. You tell it "I want to look at the Red Spot" and it can centre to the level of looking at exactly the right spot on Jupiter. It has amazing pointing and you can stick big telescope tubes on it.

So you go out, and you buy the exact optical system you want, plunk it on and you're off and running.

Of course, the optical tube I want is, again, in the tens of thousands. There's a system called a Richey-Chretien. It's not generally found at the low-end at all. They have mirrors that are hyperbolic in shape, which is very, very hard to make, which drives up the cost of the telescope. But they don't have a corrector plate, so you have this great flow of air between the mirrors and that cuts down on thermal problems. You also have perfect seeing, a completely flat field of view. These are all a lot of technical terms… let's just say, these telescopes make me very happy and make great images and this is the type of telescope that pretty much all professional telescopes are made.

Fraser: Let's say you do have a telescope and you haven't used it in a few years. What can you do to do some simple maintenance on it and get it back running?

Pamela: The best thing you can probably do is go out to your local astronomy club's star party night with your telescope tucked under your arm and say, "here, can you help?"

You're going want to do a couple of specific things. You're going to want to collimate it, which is a way of aligning the optics. You're going to want to learn how to align it on the north star and how to align your finding scope and your main telescope so you can use the finding scope to find things more easily.

So you want help collimating it, and you want someone to teach you those two different skills of aligning your telescope and aligning your telescope on the north star.

Fraser: So the collimating is turning those little screws that will be on the telescope to make it so the optics are all lined up properly.

Pamela: Right.

Fraser: That sounds like something that could go horribly bad.

Pamela: It can go horribly bad, which is why I say go find someone to show you. There are all sorts of websites that will walk you through all of the steps, but sometimes it's just nice to have a mentor there to help you.

Fraser: I guess it's just like tuning a piano.

Pamela: Exactly. If you tune it a little bit wrong, you can actually do permanent damage, but that usually involves turning a screw hard enough that you know you're doing something wrong.

Fraser: What about cleaning it? I'm sure the glass can get scratched…

Pamela: The way optics are cleaned at a lot of professional observatories is with ethel alchohol. It evaporates off clean, and if you have something that's kind of stuck on, human breath works wonders. You just sort of go "hhhh" (Pamela breathes onto her mic). Do that, steam up your optics, and there's special optical tissues that you can buy – they'll have them at photo stores – and you can use those as well as camel brushes to get off any chunks that had the misfortune of landing on your optical system.

Fraser: But definitely don't use cotton or toilet paper or

Pamela: Don't use your shirt, don't use paper towels, don't use toilet paper… all these things are going to ruin your optics. Whatever you do, don't use Windex.

Fraser: Yeah, they'll have little pieces of them that'll scratch. Great.

I think this is one of those episodes where we want to hear your stories. Let us know how it went. Did you get some gear? Did this encourage you to go out and take your binoculars out… let us know what happened. We'd love to hear from you.

Pamela: So enjoy the sky. There's lots of neat ways to enjoy it, either naked-eye or with really expensive telescope systems. Find what makes you happiest and go for it.

This transcript is not an exact match to the audio file. It has been edited for clarity.