Amateur Astronomy Magazine

The Essential Journal for Amateur Astronomers Around the World!

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Uncle Rod's Cracker Barrel

Article and images by Rod Mollise

Unk Takes the Fingerprints of the Stars

As y'all have no doubt gathered if you've met me, or even if you have just been reading my column in Amateur Astronomy for a while, I am not the world's most serious amateur astronomer. Oh, I am serious about having fun with astronomy, muchachos. And I am serious about showing other people how to have fun in our avocation. But doing Real Science as part of my amateur astronomy career? No. Not until lately, anyhow.

I am an astronomy educator at a university, but I've kept that part of my involvement in the science more or less separate from the amateur side of life. When I'm wearing my amateur hat, I just like looking at pretty stuff and taking pictures of pretty stuff. As an amateur, I approach astronomy as a descriptive discipline, like the zoologists of old who spent all their time collecting butterflies. The serious stuff is for the classroom.

That's just changed a little bit. I don't think I will suddenly and completely stop being that most amateur of amateurs when I am out on the observing field hanging with my buddies and oohing and ahhing over M13, but, as I wrote here not long ago, change is sometimes good in astronomy. Doing different things is the way to avoid burnout.

So it was that when I got an email from Tom Field, author of the RSpec spectroscopy software asking me if I'd like to try his program and Robin Leadbeater's Star Analyser diffraction grating, to try my hand at taking stellar spectra, I didn't say "no." It actually sounded like fun. I've long been interested in stellar evolution and spectral classification, and have been teaching the basics of those things for going on two decades. Emailing with Mr. Tom, it dawned on me I had never got out and taken stellar spectra of my own with my own telescope. Maybe it was time to get a little more hands on.

Not that I wasn't skittish about making it all work. A look at Tom's RSpec website, "Real Time Spectroscopy," (http://www.rspec-astro.com/) clued me in that this was one powerful program. Reading there, and looking at the posts on the RSpec Yahoogroup revealed people are doing stuff like taking the spectra of quasars and demonstrating their redshifts with the aid of the software. Unk? About as far as I've gone is showing undergraduates how to use a simple spectrometer to look at the emission spectra given off by discharge tubes in a warm, quiet classroom.

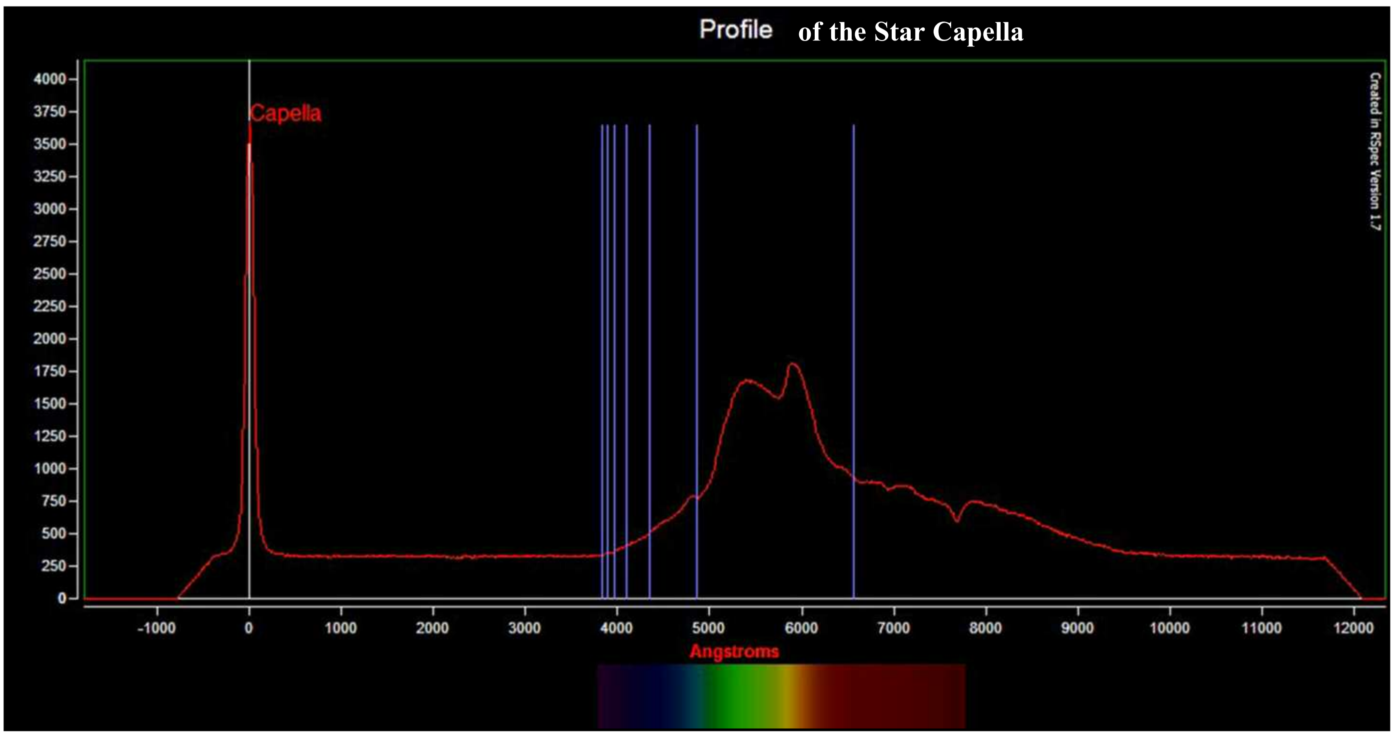
The Star Analyser 100 1.25" filter cell and looking through the cell at the grating and spectra

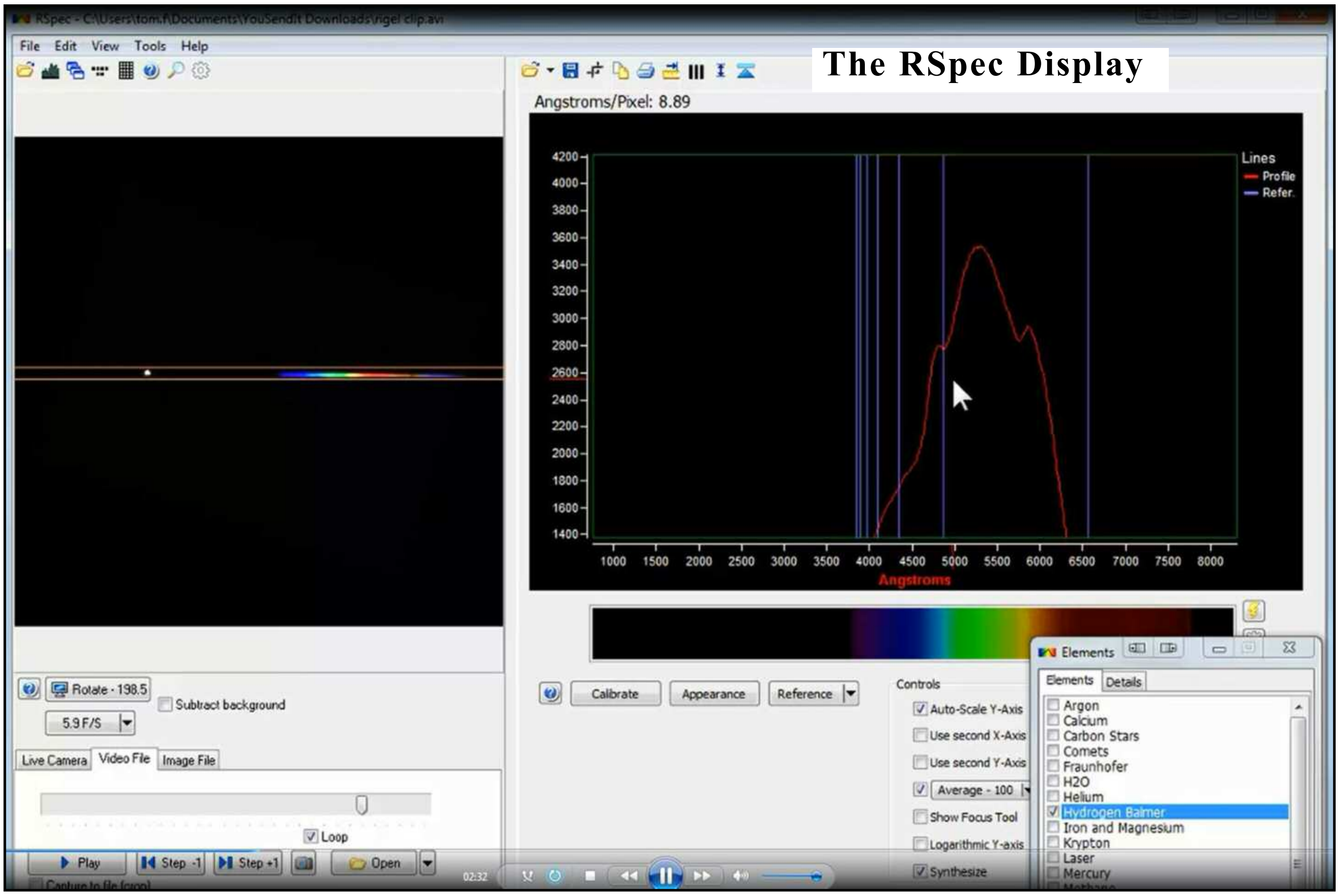
Mr. Field, however, assured me I could do it, gave me instructions for downloading the program from his website, and got the grating, a 100-line job (http://www.rspec-astro.com/star-analyser/), on its way to me. I hoped he was correct, because I suddenly found myself getting right excited about taking stellar spectra.

When I got Tom's program downloaded and installed, I was relieved to find that while it was obviously very capable and featured a ton of options, it was also amazingly user friendly. Its interface is very well designed, and it was easy for me to figure out basic operation of the software. That was the good. The bad, as you might expect, was that the weather took a turn for the worse as soon as the Star Analyser 100 grating arrived.

Luckily, Mr. Field had sent me a sample image of Vega and its spectrum to play with, so I was able to sit down and get acquainted with the program indoors. RSpec was resoundingly easy to use in Chaos Manor South's dining room, but I suspected it would be a different story out on a dark field in the middle of the night when I began taking my own spectra. Before I could even think about doing that, though, I had to decide which camera to use with the Star Analyser and RSpec.

What I had on hand was an SBIG ST2000 CCD, a Mallincam Xtreme, a couple of Canon DSLRs, a webcam-like ZWO ASI120MC planetary camera, and my old Meade color DSI. Tom





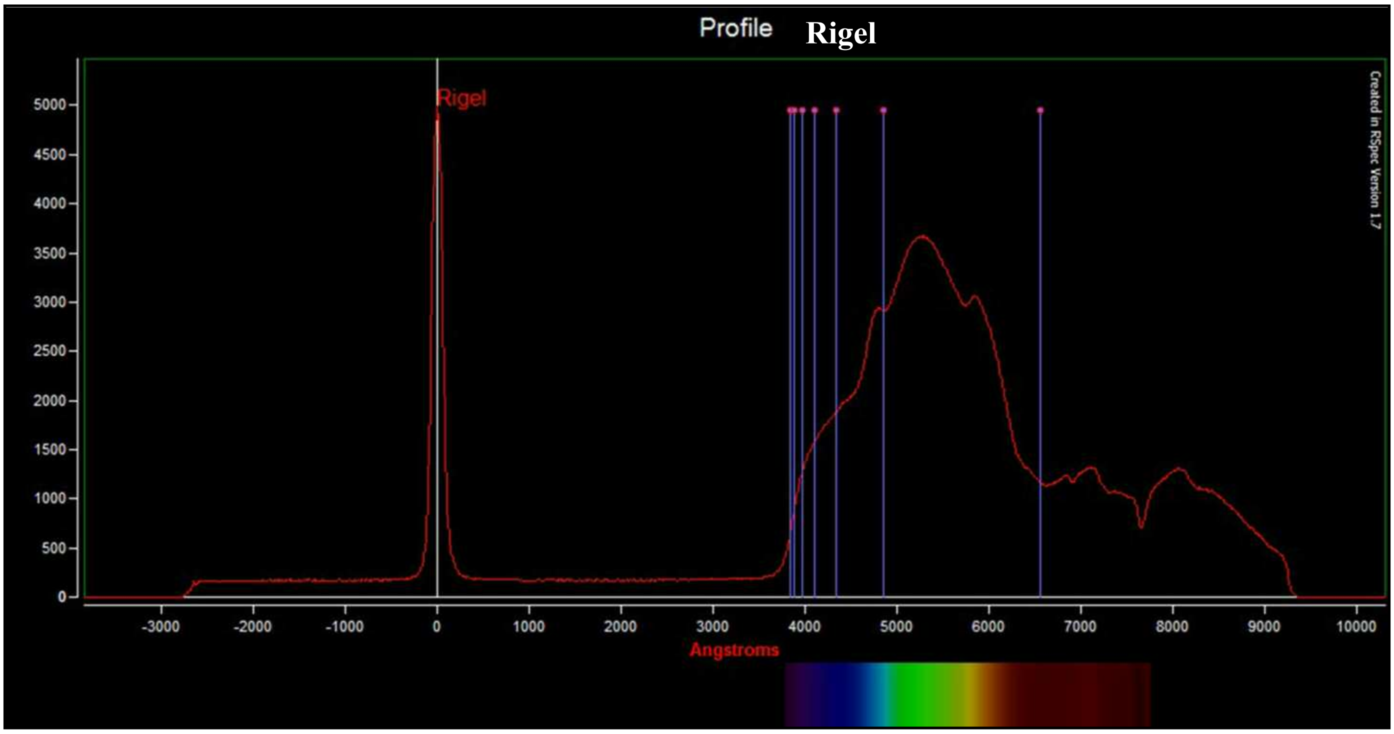
The RSpec Display

suggested the Mallincam might be a good place to start, but I demurred. I'd have had to involve a frame-grabber and software to convert the Xtreme's analog video to digital form. As for the still CCDs and the DSLRs? I thought any of them might be a bit of a handful in the beginning. Well, what about that ZWO? People are using them for everything from the Moon and planets, to hydrogen alpha imaging of the Sun, to deep sky astrophotography. Why wouldn't it work as a spectrograph? (If'n you are new to this stuff, a spectrograph is an instrument that takes images, spectrograms, of spectra, the pretty rainbows.)

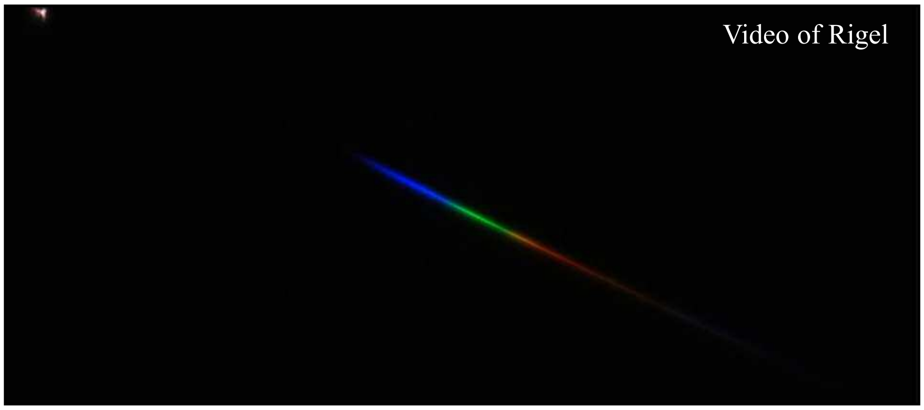
It appeared it would work with RSpec—the program recognized the camera/driver, anyway. As soon as I plugged it into the PC, RSpec's video module began displaying video, and indicated it was ready to record.

When I finally got clear skies on a clear but cold January Friday, I loaded up the telescope, mount, camera, and laptop and headed for our club dark

C-8 Rear cell setup with flip mirror



site. Which scope? My most used SCT, a Celestron Edge 800, "Mrs. Emma Peel." As long as your telescope can achieve focus with a camera, it will probably work with RSpec and the Star Analyser grating, but my sense is that more focal length is probably better than less for this application. The mount was my Celestron VX GEM, which is light and easy to tote around and has great tracking and go-to.



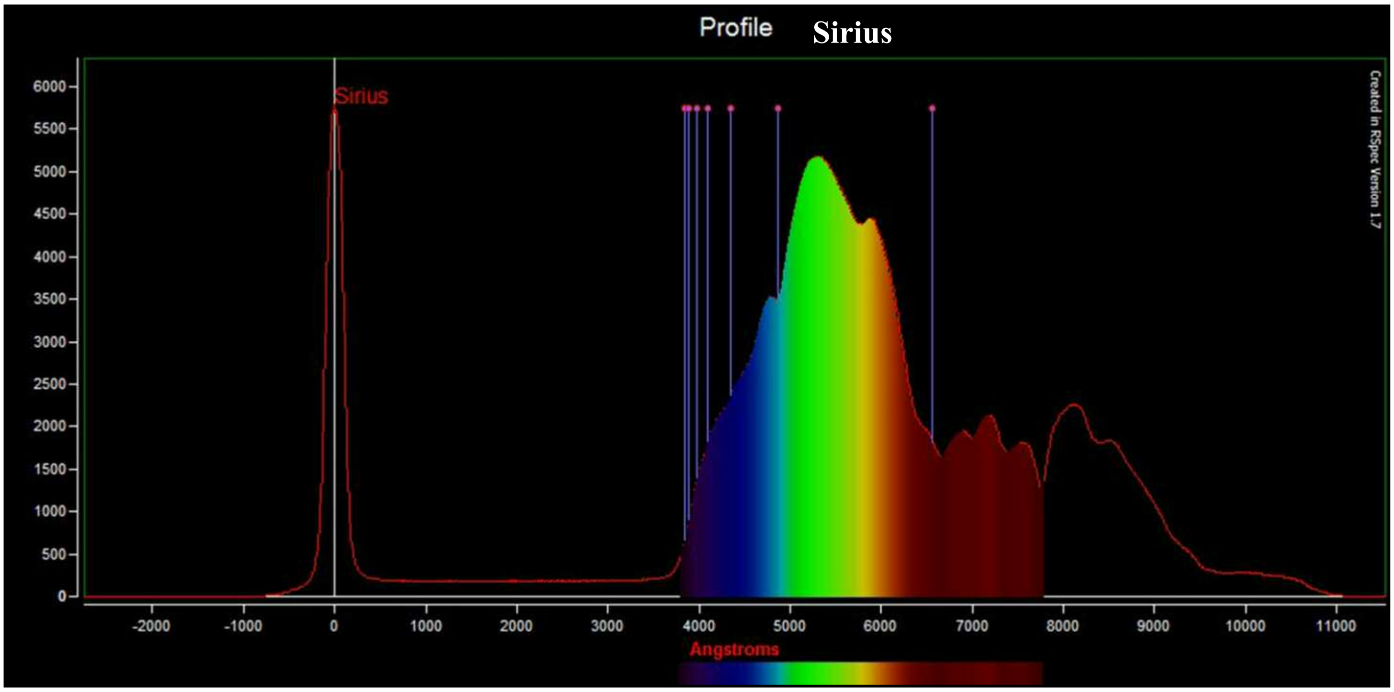
The sky was almost 100% cloud-free when I pulled onto the club field, which was a good thing for observing, if not such a good thing for comfort. I glanced down at the temperature display on the dashboard of the truck. 39F already and the Sun wasn't even down yet. Bundled up in my heaviest coat, the one that allowed me to survive Bath, Maine one winter, I got to work assembling the telescope, mount, and camera.

The setup on the SCT's rear cell was the almost the same as what I use for lunar and planetary imaging: Meade flip mirror screwed onto the rear port, 12mm reticle eyepiece in its focuser, and the ZWO in the camera port. The Star Analyser grating, which comes in a standard 1.25-inch filter cell, was screwed onto the camera's 1.25-inch nosepiece. The only difference from my planetary rig was that the camera went directly into the flip mirror without a Barlow. I figgered a smidge over 2000mm would be enough focal length for spectroscopy.

Why did I use the flip mirror? The ZWO's chip is small, 1/3-inch, and even without a Barlow and with accurate go-to, I thought the flipper would make star centering easier. With the flip mirror in place, I flip the mirror down, center the target in its eyepiece, flip the mirror up, and the object is guaranteed to be in the field of the camera. In addition, the flip mirror is set so what's in focus in its eyepiece is in focus in the camera with maybe just a little fine-tuning required.

Alright, time to get to work. Tom Field suggests starting with Vega or another bright star of spectral type A (y'all still remember "Oh Be A Fine Girl Kiss Me," I hope). When you are calibrating your spectra later, you will need to find the star's h-beta line, and that is strong and obvious in A stars, and especially in bright Vega. Alas, Alpha Lyrae was within 10-degrees of the western horizon, and given the seeing—even higher altitude stars were twinkling like crazy—was a no-go. What then? Rigel was perfectly placed in the east. It's a B type star, not an A, and the Balmer lines are not as prominent in its spectrum, but I reckoned it would do.

The most surprising thing? Despite the cold and my relative inexperience with RSpec, I had no trouble getting the star onscreen. Centered Rigel in the reticle eyepiece. Flipped the mirror up. Lit-off RSpec, hit the Live Video tab, and there was Rigel. What was really cool, though, y'all? In the main display



area of the program, I was seeing the graph of the star's spectrum—live. So, that's why Tom calls his program "Real Time Spectroscopy."

It was far too cold to make me want to play with Rigel's spectrum out on the field, so I recorded it for later processing. One thing was obvious without processing of any kind; the graph was showing plenty of the dips that represent absorption lines. It was clear the simple rig was picking up a fair amount of detail in the star's spectrum.

Before mashing RSpec's record button on, I centered the star a little better on the program's video display and placed it within the two movable bars that are used to bin the image for the best image scale. I positioned Rigel on the left and its rainbow on the right using the program's rotate tool slider (star on left and spectrum on right is the normal format for spectroscopic images, and that's the way your stars and spectra need to be for RSpec to work right).

I fired off 15-seconds of video of Rigel, took another sequence as "insurance," and began pondering what else to shoot. Alnitak was nearby, and while it's even hotter than Rigel and has even less prominent Balmer lines, I went for it anyway. I followed up with a cooler star, Capella, since it was bright and nearby, and finally got an A star with Sirius, a natural, though he was low in the sky and hopping around like mad in the poor seeing. I hoped RSpec's image-averaging feature could fix that.

What then? It was now truly, no fooling, honest-to-god c-o-l-d. I'd chugged about half a Monster Energy Drink earlier, and had set it aside while I was doing my spectroscopy. I went back to it now and was not exactly surprised to find what was in the can was a Monster slushy. Chaos Manor South's warm den was sounding better and better. Especially when the next cold front began to push in at mid-evening. Ice was forming on my equipment cases, scope, and me. Time to load up and skedaddle.

Back at home at Chaos Manor South with the gear unloaded, I was happy to be out of the cold and sipping "sarsaparilla." Scanning the cable channels revealed Friday night TV is a wasteland, with nothing at all on 300 plus freaking channels. I settled for another amazing (uh-huh) episode of Finding Bigfoot and was soon snoozing in my chair.

Come Saturday morning I was ready to start on what I figgered would be the real work of spectrometry with RSpec, processing the sequences I'd taken. First, however, I needed some instructions. RSpec really doesn't have any yet. Mr. Field has writing a manual on his to-do list, but tells Unk that thus far he's been too busy getting the program working as well as possible to get to that. In lieu of a manual, there is a series of excellent instructional videos on the web you can access from within the program. I watched the videos and made up my own shorthand list of instructions on how to calibrate spectra.

When RSpec is running, you open your video file, and once more rotate the image with the slider control till the star is on the left and the spectrum on the right (RSpec records raw video, so your rotation of the star in live mode is not preserved). When that's done, you again position the star and spectrum inside the two mouse-movable bars on the video display for correct image scaling. If the graph isn't moving around too much, you can just pause it, scroll through it with a slider to pick out a particularly nice frame, and proceed to calibration. If it is jumping around due to seeing, you might want to click the "average" box to steady it down a bit before choosing a frame and beginning calibration.

Calibration is the heart of your task. You've got a spectrogram of your star, a graph showing dips that represent absorption lines. However, the X-axis of the graph is in pixels, not angstroms, and is useless for figuring out which lines are which, which lines represent which elements, that is. You fix that by calibrating your spectrogram, changing those pixels to angstroms (or nanometers if'n you prefer).

Despite my fears, calibration turned out to be easy. Step one is to open the calibration window, natch. You then click on the peak in the graph formed by the star's image, the big spike on the graph on the left. Next, and a little trickier, you have to click on the dip on the star's spectrum that represents the hydrogen beta absorption line. That is not difficult if your star has a prominent line at the h- beta wavelength. While Rigel didn't show as prominent a line as Vega would have, it wasn't too hard to pick out the h-beta absorption line. How do you know which dip in your graph is the one for the h-beta line? It should be the first big valley to the left of the spectrum's peak. Calibration done, click "apply" to get to the moment of truth.

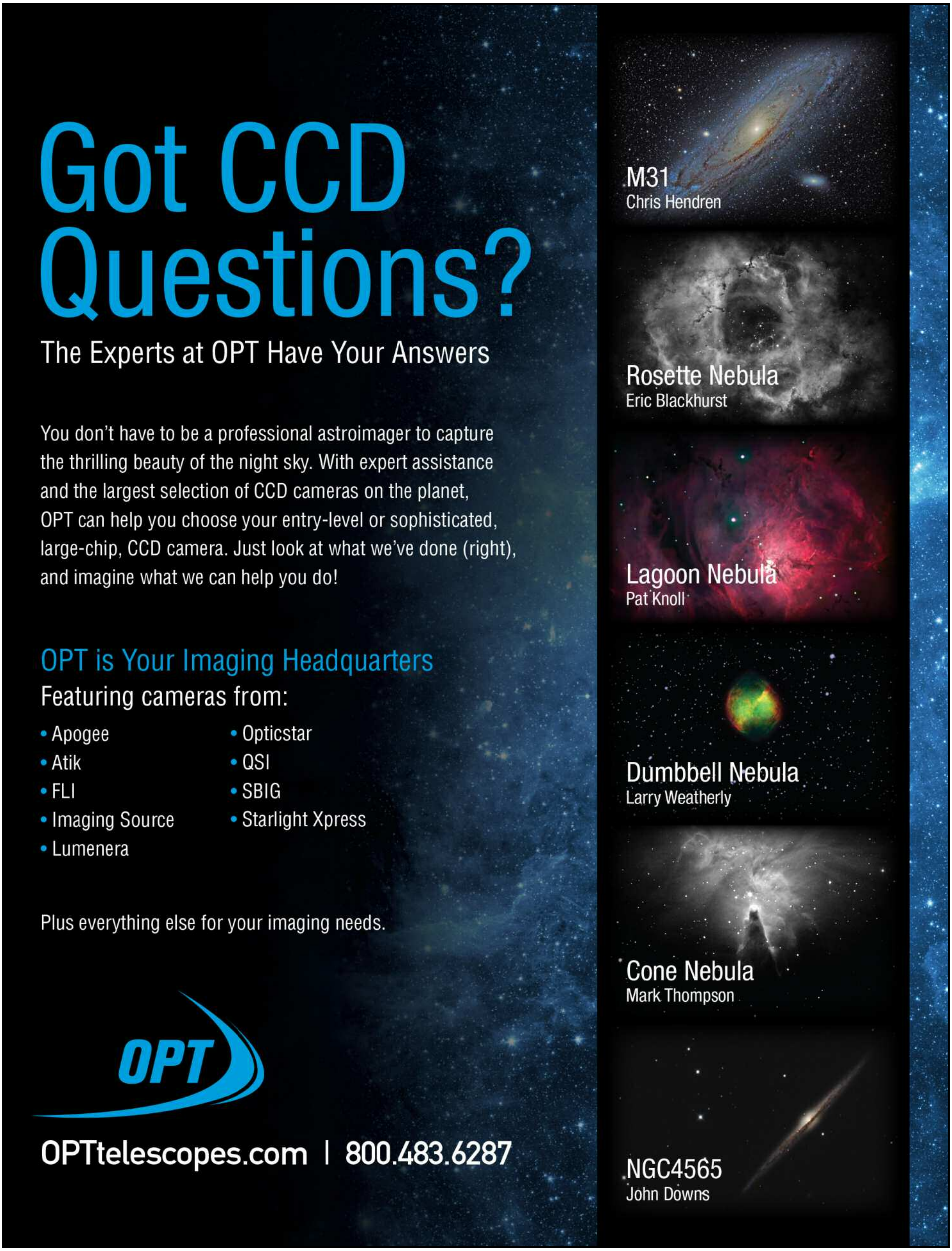
To find out if you did good nor not, you mash the "elements" button in the toolbar up top (three vertical lines). In the window that appears, select "Hydrogen Balmer Series." That makes vertical lines representing the good old Balmer lines appear overlaid on your spectrogram (the graph). Does the hydrogen beta line (you can run your mouse over the lines to identify them) pass through the dip you identified as the hydrogen beta line on the graph? Do the other Balmer Series lines coincide with dips on the graph? If so, you are in like Flynn.

My results? Purty good. Maybe not perfect, but purty good, though some of my dips didn't quite line up perfectly with the superimposed lines. I suspect that was mostly due to seeing. Unk's fumble-fingeredness in clicking in the right spots on the graph was also no doubt responsible for some of the error.

What next? Once you're calibrated, you can go on to identify the other lines in your spectrogram. RSpec provides libraries of professional spectra for comparison purposes as well as a selection of elements (the vertical overlaid lines) in addition to the Balmer Series. Your finished spectra, which RSpec calls "Profiles," can be saved, exported, and printed.

What you do with your profiles after you have them is up to you. It's fun just to be able to see for yourself how spectroscopy works, and to marvel at the fact that you can see what the stars are made of using your little telescope. There are also opportunities for amateur spectroscopists to contribute to science. Amateur spectra of transient phenomena like novae and comets can be particularly important, since the pros sometimes don't have time to get data—or enough data—during those fleeting events.

To say I was thrilled with my results with this incredible program and grating would be an understatement, muchachos. I was frankly dumbfounded by how well and easily RSpec and the Star Analyser worked. Will this lead to Uncle Rod becoming more science-centered in his amateur astronomy? Well, I wouldn't say that, but I will say I am having a wonderful time taking the fingerprints of the stars.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