RSpec Real-Time Spectroscopy

An Astronomy Path Less Taken

By Rick Hiestand

Sometimes the path less taken turns out to be wonderful, and this is the story of one such path. I have actively participated in and enjoyed amateur astronomy for almost 20 years now, but several years ago I got an itch to do something new with my telescope and camera. By that time, I'd been imaging for about five years – enjoyed it, and even got pretty good – but … still … imaging just wasn't as exciting as it had been when I first committed to that aspect of astronomy.

Not only did I want to regain the sense of novelty that the hobby had once offered, but I had also long wanted to try my hand at some form of elementary science with my telescope. Like many, I had, over the years, heard about a 1.25-inch filter cell that contained a special diffraction grating that split starlight into a rainbow "spectrum." As I read up on the topic, I discovered that amateur astronomers were using remarkably simple equipment to do amazing things with these gratings. By simply screwing one into their cooled-CCDs, filter wheels, DSLRs or even video cameras, they were able to study the composition of various stars via the spectrum that the little diffraction grating helped to reveal.

I Googled around a bit and saw that it was, indeed, not just experts who were doing spectroscopy. "Average Joes" like me – guys and gals with skills no greater than mine – were getting really neat results. I decided that this was the direction I want-ed to go. I wouldn't just observe and photograph the stars, I would study them! So, I bit the bullet and ordered a Star Analyser grating (**Image 1**), which accessory cost less than a good eyepiece.

First Spectrum

On my first night out, I screwed the grating into my astronomical video camera, pointed my scope towards Vega and was rewarded with a bright rainbow image on the video display. I was aided in this first effort by an excellent piece of software named "*RSpec*," produced by Field Tested Software. *RSpec* displayed the rainbow and – in real-time – produced an intensity graph. So far, so good. But, what did it all mean?

The next morning, still bleary from my first night of real astro science, I played back the video that *RSpec* had captured and noticed that there were small dips in the graph (see **Image 2**). I knew from my reading that these dips were absorption lines from the Hydrogen in the atmosphere around Vega. I couldn't believe it. On my first night out, I was observing the gas around a star. Wow!

Hey, This Science Stuff is Very Cool!

Since that first night out, I've gone on to capture spectra of lots of fascinating objects. And, I've greatly deepened my understanding of the stars. Now, I don't
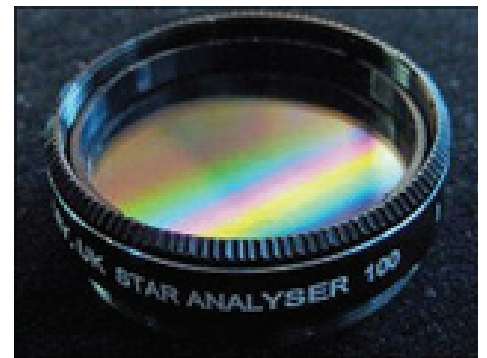

Image 1 - The author's Star Analyser 100 Diffraction Grating.

just look at the stars, I study and even understand them in a way I never thought I'd be able to.

Remember when you first observed M42? Maybe your experience was like mine: Through a small telescope, it looked like a faint, boring cotton ball. But, as you learned more and more about the nebula, what you saw in the eyepiece became more and more interesting. Knowing the scale, composition and remarkably dynamic nature of the Orion Nebula adds context to that familiar scene – even drama! The same thing happens when you dive into spectroscopy. You start reading more, learning more, and enjoying your visual observing more.

Since catching the spectroscopy bug, I've use the diffraction grating and *RSpec* software at every opportunity, and I am still amazed that, with my small Stellarvue 102ED refractor and a simple video camera, I can detect and identify critical properties of objects that are mind-numbingly distant.
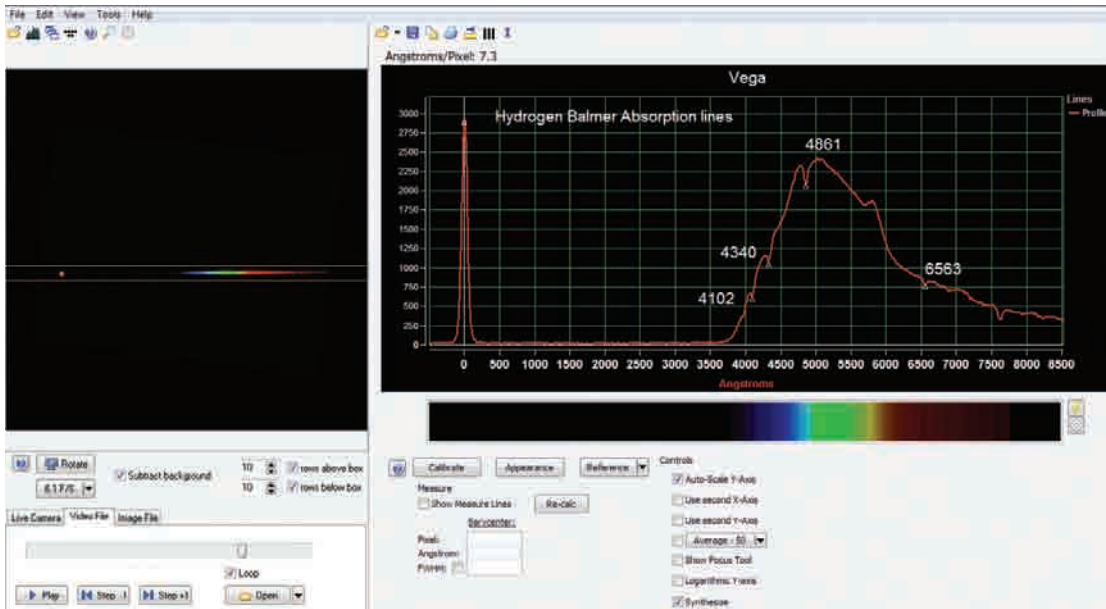
Image 2 - Screenshot of RSpec displaying spectrum and resulting graph produced by Vega.

Spectroscopy Made Simple

I've used the Star Analyser grating with my video camera and also my SBIG single-shot color CCD camera (although I use color cameras, they are not required; monochrome cameras work just as well), and the *RSpec* software has made every step very easy, even for a newcomer like me. Frankly, I'm not the kind of guy who enjoys reading manuals. Who does!? The good news is that *RSpec* is accompanied by a comprehensive set of on-screen tutorial videos. It's like having a trusted expert con-

stantly at your side, providing step-by-step private instruction. With help from these videos, I was able to quickly get up to speed.

RSpec makes the steps to extracting scientific data surprisingly easy. As demonstrated by Image 2 (Vega), you initiate the analysis by simply drawing a box (the orange lines) around the spectrum in the left hand window. *RSpec* then extracts an intensity graph to the right-hand window. The x-axis in this initial view is in pixels. The big peak at x = 0 is the star itself. To the right of that, the graph represents the intensity of the spectrum, including a big dip from the Hydrogen Balmer line.

With a few clicks, you can convert the x-axis from pixels to Angstroms, after which step you've got scientific data that reveals the physical properties of the targeted star or planet. As you quickly master *RSpec*, you'll discover that there are many exciting projects you can conduct from your backyard. Collect the colorful and varied spectra of each of the O, B, A, F, G, K and M star types. Or, detect the methane atmosphere on Neptune. See the glowing carbon-soot emission lines of a Wolf-Rayet star. Or, identify the critical properties of novae. There is a seemingly endless number of projects you can enjoy, enough to hold even the most jaded astronomer's interest!

But Wait, There's Still More!

Or, even more stunning, you can determine a supernova's type and measure the speed at which its shell is expanding. Last fall, my friend Matt Lochansky captured a supernova using a video camera and an 8-inch Schmidt-Cassegrain telescope from his driveway in a suburb of Durham, North Carolina, two days before the full moon. The large dips shown in **Image 3** are ionized Silicon, the presence of which identifies it as a Type Ia supernova. Using the wavelength of the dips on the x-axis, Matt used simple algebra to calculate their Doppler shift, which revealed that the supernova shell is expanding at 22,000,000 miles/hour. This is the kind of science in
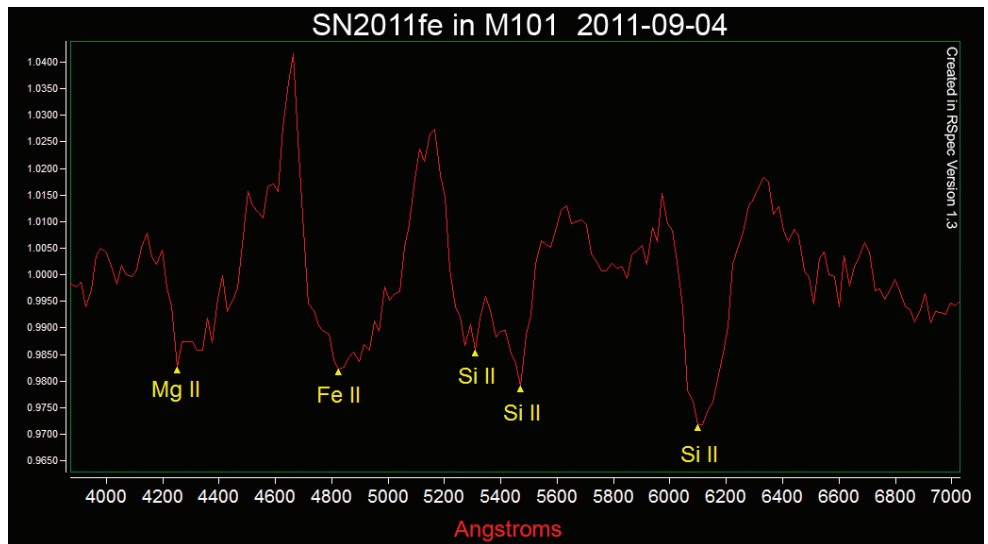

Image 3 - Spectrum analysis of SN2011fe, captured by Matt Lochansky.

which you can be an active participant from a location no more exotic that your own backyard. Yes, its time to unleash that inner scientist!

I know that you're probably thinking the same thing I did: "Oh, I couldn't figure out how to do spectroscopy. And, anyway, I don't have good enough equipment for that." But, trust me on this, it's not hard – if a knuckle-dragger like me can do this, you can too. And, if you hit any snags, there are very active on-line communities that welcome and support spectroscopy newcomers.

A Tool for Beginners and Professionals Alike

The *RSpec* software was written by Tom Field of Field Tested Software. The program is highly polished and easy to use. Frankly, I have yet to find a bug. But, what I have

found is that, as I've grown in my understanding of spectroscopy, *RSpec* has grown with me. The software is far more than a toy for beginners. Seasoned experts use the software daily, including some working in pro-am collaboration on ground-breaking projects. And still, *RSpec* remains remarkably inexpensive.

I've always dreamed of doing real science with my telescope, and thanks to the affordable combination of the Star Analyser diffraction grating and *RSpec*, that dream has been fulfilled. And along the way, my understanding of the science behind the stars has grown by leaps and bounds. When you are actually touching data that you captured yourself, even the most obscure scientific journals begin to make sense. So, join me in spectroscopy. I'm sure you'll have a wonderful time! **ATT**