News from the Society for Astronomical Sciences
Vol. 17 No.2 (July 2019)

Experience at the SAS-2019 Symposium

by Tom Polakis

I made my third annual trip to the Symposium on Telescope Science in Ontario, California. As in the past three symposiums I attended, it was attended by about a hundred people. I made the trip from Phoenix with Woody and Dolly Sims, and returned with Al Stiewing. Woody and Al are both well-versed in spectroscopy. It was a pleasure to spend six hours in a vehicle with Woody and Dolly, and then six more with Al.

The format of the three days is two 3-hour "workshops" by advanced speakers on Thursday, and many 20-minute talks on Friday and Saturday. There also post-dinner presentations and lunch forums. By Saturday afternoon, my brain was pretty well saturated; I needed to go watch some hockey or something. My little scope in Tempe remotely observed asteroids on all three nights that I was away, thanks to my wife Jennifer faithfully rolling the half-ton roof back and forth.

Thursday: Thursday's morning workshop was held by David Boyd, an expert spectroscopist who made the trip from England. He's a friend of Woody's, so I was also treated to have dinners with him as well. While "workshop" may conjure up images of group participation, these are lectures with slides. Three hours may seem like a lot, but they're not nearly long enough. Knowing next to nothing about spectroscopy, I took several pages of notes during David's talk, many of which had question marks indicating that I need to ask around or look stuff up. His survey of a roomful of advanced amateurs revealed that roughly 30 have spectroscopes, but only five have actually submitted or published results.

Since our scopes are small, we have to settle for low resolution spectra on most targets, and save the high-resolution work for bright stars. David described some popular commercial products, including the pricey Eschelle spectrographs that do both low- and high-resolution spectra. He spoke about the parallactic angle: you want the slit to always be oriented perpendicular to the horizon due to atmospheric dispersion, but an equatorially mounted scope needs a focuser rotator to accomplish this. Again and again throughout the conference, the subject of battling atmospheric effects came up. We are up against much more than just dimming and twinkling.

David spoke at great length about wavelength calibration, and touched on instrumental losses in scopes, cameras, and the spectroscope itself. Atmospheric correction is a topic worthy of its own talk, and he was constrained to get through it in 15 minutes or so. Through the slides, he worked his way from a raw spectrum to something that can be submitted. This is called the exo-atmospheric relative flux spectrum, which ideally is what you'd measure from space. This is fine for many in the room, but it's just a relative spectrum. It doesn't tell us the absolute flux from each of the spectral lines, which is much more useful for astrophysical work. I got the impression that most of the five people in the room who have actually submitted spectra stop at the relative spectrum step.

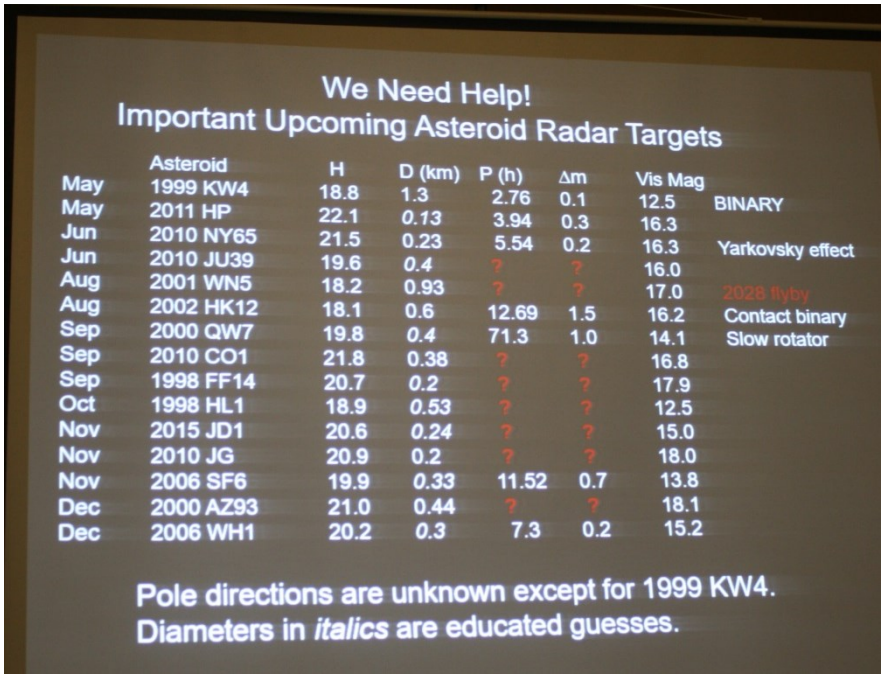
Arne Henden was the speaker for the afternoon workshop. His topic was photometry. He outlined the goals of 10 millimag accuracy and 1 millimag precision, and how to get there. One of Arne's messages, which I have heeded in my work, is that there are a

lot of appropriate targets, so don't try to exceed your equipment's and site's ability. He is a proponent of using anti-blooming cameras, if that's what you currently have. They're digitized to go only to half of the full well, but once you know about that compromise, they are otherwise linear. He pointed out that the calibration images, darks, flats, and biases, all add noise to images, but they remove systematic problems. This subject came up again in the next couple days, as some folks have figured out how to image without dark subtraction or even flats to eliminate these noise adders.

Arne is convinced now that CMOS sensors will take over the field in the near future, and offered a nice comparison slide showing its advantages and disadvantages against CCD detectors. Several people in the room have already made the switch, with positive results. While the amplifier glow in CMOS is a big hurdle to overcome, their much lower read noise is too good to ignore. Another problem is Residual Bulk Image, which is an "after image" of bright stars on subsequent images. Eventually, it is expected that manufacturers will figure out how to produce CMOS imagers for amateurs that are more ready out of the box.

Many speakers throughout the conference brought up possible issues that I realize I've been ignoring in my own work. Arne brought up red leaks in some of the photometric filters, and how to check for them. I am hoping to learn that my Astrodon filters do not have this "feature." Bright-star photometry requires short exposures, which means scintillation affects the results. The solution is to lengthen the exposure by defocusing or other means. He showed some quantitative effects of scintillation based on air-mass, aperture, and exposure time. In the long list of things I should have thought about is photometric measuring aperture contamination, which applies to asteroids. For example, a star that's three magnitudes fainter than the target adds 0.066 magnitudes to the total. For magnitude 15 asteroid, my short exposures won't even show that magnitude 18 star, but it's there, contributing to the total light.

As if the workshops weren't enough for the day, "Evening With The Pros" featured two 1-hour presentations by Lance Benner and Joe Patterson. I skipped the latter, but enjoyed Lance's talk about radar imaging of asteroids using the dishes at Goldstone and Arecibo. Their images of actual shapes can be compared against photometry-derived shape models and occultation results. Of course this only works for earth approachers, but there's a long list of targets for 2019. Here it is:



So that's Thursday, in which I left a lot out.

Friday: The 20-minute technical talks began on Friday morning. I led all of these presentation off with my discussion of lessons learned in three years of asteroid photometry. I got the information out there, and the slides were effective, so I suppose it was a success. The only other person in the room who does asteroid work was Bob Stephens, who is prolific in this field. He followed my talk, speaking about efforts to find embedded rotation periods that are used to find that asteroids are binary. Unlike my scope, which always bounces between three or more targets, Bob's typically follow only one asteroid all night, using as many as six telescopes in Landers, California to cover multiple targets. This high cadence enables them to detect the low-amplitude cycles by beating them to death with overlapping data. He provided a list of 29 very wide binary asteroid candidates that deserve future photometry. Bob spoke about the binary impact crater that surrounds the Bavarian town of Nordlingen. A church in this town is built with suevite, which was formed during the impact.

David Boyd returned Friday to speak about the dwarf nova HS 2325+8205, whose orbital period of 4.66 hours suddenly increased in 2011 by 23 milliseconds, and then stayed that way. The change is not explained well by sudden mass transfer between stars, so why did it happen?

Tom Kaye described an unconventional "brute force" exoplanet search that he conducted from near Sierra Vista. They used a 5-inch Borg lens, and stared at a single 6-degree-square field very near the North Celestial Pole for three years. The 6000 program stars, 300 images per night, and 150 nights per season produced 300 million data points. Using a Box Least Squares algorithm on all of this data produced exactly one exoplanet candidate with a scant 4 millimag transit depth. Tom stated that the Transiting Exoplanet Survey Satellite will surely spell the end of such ground-based searches.

Joe Patterson, who heads up the Center for Backyard Astrophysics, spoke about the ultra-compact binary star AM CVn, the two components of which would fit inside Jupiter. Joe's anecdotes and whimsical presenting style can make it difficult to concentrate on the content, but he did demonstrate

the benefits of being involved long-term. In 27 years, the period decreases by 17 microseconds per year, which he explained as possibly being due to gravitational radiation.

Bob Denny followed with a non-infomercial talk about ASCOM Alpaca. He was the creator of ASCOM back in the late 1990's, which is used today. After a 10-year retirement from involvement, he returned to remove ASCOM's dependence on the Windows operating system, which Alpaca does.

On to the Friday's lunch discussion, which was about photometry. I'll just give a few highlights. It began with a survey of the audience's photometry software packages, which included at least Canopus, VPHOT, LesVe, AstroImageJ, IRAF, MaxIm, and Mira. Whew! I told the room that I'm all but done with VPHOT due to files sitting in the queue issues, and then learned that the other five who use it have no such issues. Timekeeping is more important than I'd estimated. While many of us use Dimension 4, Eric Dose recommends Meinberg, and claims 5 millisecond accuracy.

CMOS photometry was discussed at length. Four people in the room are using it, and getting superior results, but it's still not for the faint of heart. Gary Walker claimed that his 5 millimag errors with CCD have improved to 1 millimag with CMOS. Arne pointed out that two AAVSONet scopes already have CMOS sensors. Richard Berry insists that we need to figure out how to get DSLR photometry to be more plug and play, or the science among amateurs will die with the old folks who are currently doing it. RBI was brought up again, and a deep dive ensued. At exactly the right time, forum moderator John Martin changed gears to suggesting appropriate projects for students and newbies. These include monitoring of SX PHE stars, Barnard's star proper motion, and RR Lyrae maxima.

Friday afternoon presentations led off with Kalee Tock, a teacher for Stanford Online High School. She and her students are capturing atmospheric data with high-altitude balloons. Pixel Flight 3 was slated for June 8. Next up was William Rust, whose presentation was about minimizing "distortion" in guided images. James Synge followed with a description of Project PANOPTES, in which exoplanet transiting telescopes are built for less than $5000. It may be a bit late to get into this game, but the hardware descriptions were interesting.

Friday's sponsor infomercials began with Rick Hedrick, the native Californian owner of PlaneWave Instruments. He showed an impressive plot of sales since the company began in 2006, and followed it by describing an ambitious effort to completely re-locate PlaneWave to a former school campus in Adrian, Michigan. Farah Payan, owner of Woodland Hills Telescopes, described products such as filters and spectrographs that may be of interest to this high-level audience. Bob Denny followed with a promotion of Astronomers Control Panel, and a description of the installation at Great Basin National Park, with which he is

involved. Finally, Steve Bisque described enhancements to TheSky X software, including incorporation of the GAIA DR2 catalogue, pared from 1.3 terabytes all the way down to 90 gigabytes.

I skipped the panel discussion about remote observatories, but was told that it favorably went 90 minutes rather than the scheduled 60.

Saturday: Saturday's technical presentations led off with Steve Conard, who observes occultations by bringing his equipment to college and museum observatories that happen to be stationed along their paths. All four observatories along the 2018 Pluto occultation path were successfully used to record the event, including a central flash event seen from the George Observatory outside Houston.

John Martin from the University of Illinois Springfield followed by updating the status of a survey of luminous stars in M31 and M33, which is now six years along. They have done BVRI photometry of 182 luminous stars during this period. John's short talk was filled with so many insights that I'd think he would be a terrific workshop presenter.

Prolific comet observer Charles Morris spoke about visual photometry of comets, with comparisons to CCD results and their systematic offsets. While he speaks from extensive experience, some of his statements went against the grain of those of us in the audience. He seemed to be insisting that the eyeball can see things that the camera cannot -- or, at least, that the eyeball sees things differently. I think there was something unclear about the definition of the edge of the coma.

Joe Patterson gave an overview of the Center for Backyard Astrophysics. Then he discussed observations of the cataclysmic variable star ASASSN-18ey, which was discovered in March of 2018. Since then, it has been extensively studied, and shown to exhibit superhumps.

Richard Berry rarely follows the script of the symposium, and this year was no exception. He bought a small infrared camera that images around a wavelength of 10 microns. His intention was to image the moon, but he found that objects in everyday life are also of great interest. Since glass is opaque at this wavelength, he kludged together a telescope adapter with a ZnSe lens for afocal imaging. He has been able to measure the temperature of the moon on either side of the terminator, and during a lunar eclipse. The 160x120 pixel FLIR camera costs $399, and attaches to a smart phone. Note that resolution is diminished by a factor of 20 at this long wavelength.

Jerry Foote has been involved with seven others in the design and fabrication of a 3D printed spectrograph body. His talk focused on the mechanical design and construction of the unit. It is based on the LOWSPEC model, and was designed in SolidWorks. There are many materials to select from, each with their advantages and limitations, and they went with ASA, which is a stiffer and more UV-resistant version of ABS. After 58 hours in which 586 layers were laid down, their first unit was completed.

Woody Sims and Bob Buchheim presented their results of monitoring a transient source in M51. Despite the faintness and lumpy background of the spiral arm, they were able to obtain good photometry in V, Rc, H-alpha, and H-beta. Bob described a clever method for modeling and then subtracting the background level by bringing pixel values into Excel.

Most of the poster papers were by Kalee Tock's students from Stanford Online High School. They exhibited at impressive level of maturity in both their experimental work and presentations. Don Bruns briefly described his poster about the gravitational deflection of starlight. They intend to improve on their Eddington experiment from 2017 by sending 15 teams with students out for the 2024 solar eclipse.

Saturday's lunch discussion was about spectroscopy. I sat in the back of the room so as not to interfere with my ignorance of the topic, and tried to absorb what I could.

Wayne Green's presentation was partly about how parallactic angle affects spectroscopic results, but in Wayne's inimitable style, he delved into his impressive insights about anything related to the science of astronomy during his 15 minutes. He touched a favorable nerve when he told the audience that it pays off to learn as much as possible about our atmosphere and to re-learn basic astronomy.

The last of the technical presentations was by John Menke, who has done spectroscopy on the eclipsing binary star AZ Cas. John began with a nice bio of Andy Odell, who passed away in the past month. He showed his results for the star, and encouraged observers to monitor the next eclipse, in May 2022.

I had a Saturday evening banquet pass, which I relinquished to Dolly Sims in favor of riding back with Al Stiewing. The speaker was Emily Lakdwalla.

Planning for SAS-2020

Yes, indeed, there will be a Symposium in 2020. Mark your calendars: the SAS-2020 is planned for June11-12-13, 2020. It will be held in Ontario, California, at the Ontario Gateway Hotel (same venue as this year).

The hotel remodel is progressing. By next year, we will be in the new guest rooms and the lobby and restaurant remodel should be finished.

Start thinking now about the project and results that you'll present at SAS-2020! The Call for Abstracts will be released in the 4th quarter of 2019, and Registration will open in January, 2020.

Reminders for SAS Members ...

Membership Renewal: Even if you can't attend the annual Symposium, we value your support of the Society for Astronomical Sciences, and your interest in small-telescope science.

As an SAS member, you can request a bound copy of the Proceedings (free), even if you cannot register or attend the Symposium.

Symposium Proceedings: Published proceedings from all recent Symposia are freely available in PDF format at the PUBLICATIONS tab of the SAS website (www.SocAstroSci.org).

Symposium Videos: If you missed a recent Symposium, you can watch many of the presentation videos on the SAS website at the PUBLICATIONS tab.

Keeping in Touch: The SAS Yahoo group ("SocAstroSci") is a good way to keep in touch with the members and participants.

Kudos, Criticisms, or fresh Ideas? If you have any questions or ideas for the Symposium, ideas for Workshops or Technical topics that you would like to see, or comments on any other subjects related to the Symposium, please share them with the Program Committee at program@SocAstroSci.org.

Binary Asteroids 5 Workshop

The Binary Asteroids 5 Workshop will be held in Fort Collins, CO, from 2019 Sept 3-5. Early registration and abstract deadlines are fast approaching. Don't delay any longer, late registration rates will go up 33% on August 2.

Early registration ends at 2019 August 1, 23:59 MDT. The cost (USD) is $300 for single and $340 +guest. Late/Door registration is (USD) $400/$440. There is no single-day rate.

You can register by visiting

<http://binaryast5.org>

The special hotel booking rate ends 2019 August 3. There is a link to reserve a room at the conference rate on the web site

The program schedule has been set (subject to change). See who's giving oral and poster presentations and download the abstracts by visiting

<http://MinorPlanet.info/BinAst5/MeetingSchedule.php>

In addition to the presentations, there will be plenty of free time for off-line discussions and poster viewing.

Editor's note: Attendees at SAS-2019 will remember that Bob Stephens showed how lightcurves can provide evidence of very wide binary asteroids. You may have wondered, "since we can use speckle interferometry to detect and measure very close double stars, is there any hope of actually 'seeing' the asteroid satellite by using speckle interferometry?" The answer seems to be "yes" – check out the abstract at

http://www.minorplanet.info/BinAst5/Uploads/GuerreroPena_Abstract_Guerrero_Carlos.pdf

VV Cepheii campaign: new results

Recall that the system VV Cep is a complicated system: a B-star with a disk, in orbit with a supergiant M-star that is probably the source of the accretion disk. It was the subject of an observing campaign a couple of years ago, when the system's eclipse gave a unique opportunity to disentangle some of the features of the system.

A report on some really interesting results was released recently: see https://astrospectroscopy.de/VV-Cep-up-to-date.

Dr. Ernst Pollman shows how the cyclic variation in the "V/R" ratio of the H-alpha line is explained by a straightforward model, in which the accretion disk is precessing with a period of 42 days. The match between the model and the data is pretty remarkable.

There are still some mysteries, however. One would expect that the precession would also lead to a cyclic variation in the H-alpha emission strength. Such a cyclic variation in strength is indeed seen, but the best-estimate period of this cycle appears to be 51 days.

Quite a few small-telescope spectroscopists have provided spectra that contributed to this analysis, including SAS members James Foster and Al Stiewing. Well done, guys!

Student Spectroscopy

The recent edition of the BAV magazine "Spectroscopy" (download from

https://www.bav-astro.eu/images/Magazine_5.pdf)

has an entertaining and enlightening article by Richard Berry, describing a student-spectroscopy experience at Pine Mountain Observatory. There are some insightful ideas about students and scientific outreach in there. Take a look!

Preferred orientation of the spectrograph slit, considering the effect of atmospheric refraction and Parallactic angle

At SAS-2019, Wayne Green and Woody Sims presented a paper describing the influence slit orientation vs. parallactic angle on the spectrophotometry of the continuum of a target. This subject is most relevant to low-resolution slit spectroscopy, where the spectrum can span the entire visible spectrum.

Their paper was a fine presentation of the topic and its relevance to small-telescope spectroscopy, but judging from some follow-on conversations, there were people who needed a more basic tutorial before delving into that paper.

So, here you go:

We view our targets from the bottom of Earth's atmosphere. In addition to absorbing and scattering light, the atmosphere also refracts (bends) the light. Since the index-of-refraction of air is different for different wavelengths, the bending is different for different colors of light. The atmosphere acts like a weak prism; hence, any exo-atmospheric object (a star or planet) will appear to us as a little spectrum, with blue light at the top and red at the bottom).

A nice sketch of the atmospheric dispersion effect is at: https://astronomyconnect.com/forums/articles/zwo-atmospheric-dispersion-corrector-product-review.34/

This effect is also the reason that you can sometimes see the "green flash" along the upper limb of the setting Sun: atmospheric refraction has spread the Sun's image into a little spectrum, blue at the top and red at the bottom. As the lower (red) parts sink below the horizon, you're left with only the blue limb above the horizon – the "flash".

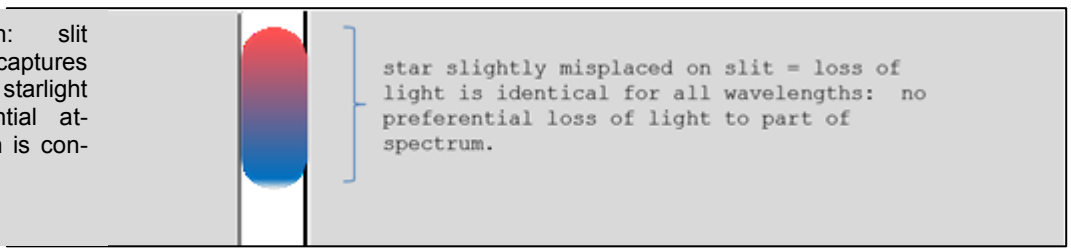
The way that this affects your spectroscopy is a bit tricky to visualize. Atmospheric differential refraction will spread each star image at the slit plane into a tiny rainbow. Blue light is refracted somewhat more than red light, so the star's image will have a blue edge (away from the horizon) and a red edge (toward the horizon). The angular extent of this differential refraction is not trivial: for a sea-level observatory aiming at 60 degrees from zenith (2 air masses), blue rays (4000 Å) will separate from red rays (7500 Å) by almost 3 arc-sec. This can have a large effect on the intensity vs wavelength profile (in effect, the slit-transmission vs. wavelength). This effect can push the blue light or the red light, or some of each "off" of the slit, depending on how the star image lands on the slit, and on the pointing direction.

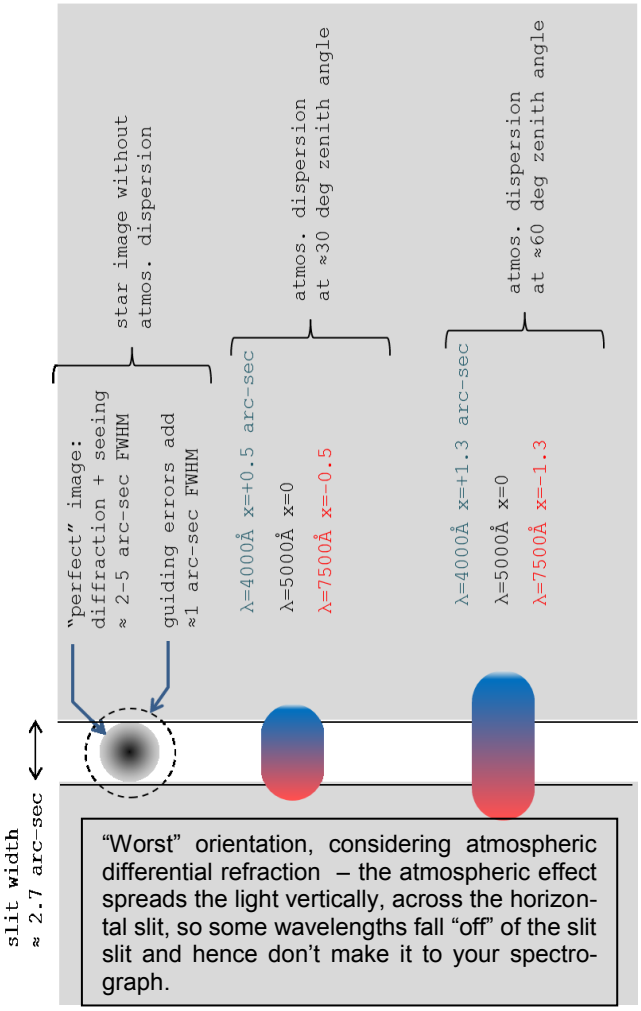
The atmospheric differential refraction effect spreads the star image perpendicular to the horizon. From the standpoint of spectrophotometry, the worst case is to have your slit oriented cross-way to the atmospheric refraction effect (i.e. slit "horizontal", parallel to the horizon). The worst-case situation is illustrated on the next page.

From the standpoint of spectrophotometry, the optimum situation is to have the slit oriented vertically (perpendicular to the horizon), so that the atmospheric dispersion spreads the light "along" the slit, rather than "across" it (see the sketch below).

With your telescope on an equatorial mount, you'll need to rotate your slit (or spectrograph) in order to achieve this desired orientation – the rotation is a function of pointing direction. The desired slit orientation is related to an old concept in spherical astronomy called the "parallactic angle". It is tricky to calculate, but the concept is straightforward: to minimize this effect on your spectrophotometry, put the slit so that is running vertically when aimed at the target.

Preferred orientation: slit runs vertically, so it captures the entire range of starlight even when differential atmospheric dispersion is considered.





"Worst" orientation, considering atmospheric differential refraction – the atmospheric effect spreads the light vertically, across the horizontal slit, so some wavelengths fall "off" of the slit slit and hence don't make it to your spectrograph.

Obviously, the higher in the sky you are aimed, the less of an effect this differential atmospheric refraction (dispersion) will be: at the zenith it is zero (to first order).

There might be practical reasons that you need to deviate from the optimum situation. Maybe you don't have an instrument rotator, so that adjusting slit orientation is a tricky manual affair, and you'd rather just leave it in a fixed orientation. Perhaps your telescope mount doesn't track very well, so you may prefer to align the slit to run in the RA-direction. That way, tracking errors will move the star along the slit, rather than across it. You lose less light to tracking errors that way. But in many parts of the sky, this puts the slit in almost the "worst case" orientation from the atmospheric dispersion standpoint. Life is full of decisions ...

A routine method of determining your Instrumental Response profile requires making a spectrum of a known "Reference star" that is close in the sky to your target. This practice can – to some degree -- reduce the worst effects of atmospheric dispersion on your resulting spectrum continuum profiles. However, the result will – to some degree – depend on the two objects having similar spectra, and being similarly centered on the slit.

You can't really evaluate the effectiveness until you look at the resulting spectra. If the blue end of your target spectrum looks "odd " (usually a weaker continuum than expected at the blue end), then this atmospheric dispersion + parallactic angle effect has probably bitten you. Whether the discrepancy is an issue or not, depends on your science goals. My personal experience is that for low-res spectra of Be stars, the BeSS will accept spectra that display a bit of continuum discrepancy, because they still provide a useful picture of the star's state and activity. But you'll probably get a little constructive feedback about the continuum shape, too.

As a further complication, many telescopes (and spectrograph optics) have some chromatic aberration which most adversely affects the blue end of the spectrum. This compounds the atmospheric effect.

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As a member, you receive:
• Discounted registration fee for the annual Symposium.
• A copy of the published proceedings on request each year, even if you do not attend the Symposium.

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