In early May of 2009, I took delivery of a new Tele Vue 24 mm Panoptic eyepiece, and when I realized I had a modest variety of other quite good eyepieces of similar focal lengths in inventory, I decided to do a comparison test. I ran the test on two different nights, with two different telescopes, a Vixen 102 mm f/9 fluorite doublet and an Astro-Physics 130 mm f/6.3 "Gran Turismo" triplet apochromat.

The eyepieces for part 1 were as follows:

24 mm Tele Vue Panoptic, bought new in May 2009. Multicoated with "green" multicoatings.

24 mm Celestron Erfle, bought used circa 2000. Barrel marked "Japan". Appears to be magnesium fluoride coated.

24 mm Brandon, bought used circa 2000. This is the model with the long eyecup. Brandon coatings are a bit of a mystery to me, they don't look like regular magnesium fluoride.

25 mm University Optics orthoscopic, bought used circa 2000. This is an Abbe-type orthoscopic of the kind that University Optics has been importing for decades, an older model with magnesium fluoride coatings.

Vixen 8-24 mm Zoom Lanthanum Eyepiece, bought used circa 2000, used at the 24 mm setting for these tests (except as noted). Multicoated with "green" multicoatings.

It never rains but it pours: In the five days between the two parts of the comparison I acquired *another* 24 mm eyepiece, which I used for part 2 of the field tests in addition to the five above.

24 mm University Optics Koenig, bought used in 2009. Multicoated with "green" multicoatings.

I performed part 1 of this comparison on the evening of May 11, 2009, from my yard in Palo Alto, using a 102mm f/9 Vixen fluorite refractor. The sky was clear with some developing haze. No seeing turbulence was visible at the low magnifications (37x or 38x) delivered by these eyepieces in this telescope, though later in the evening I briefly tried 184x and found Airy discs visible but in constant motion.

The Vixen fluorites are superb instruments -- I have four of them and am delighted. The f/9 focal ratio of the 102 is relatively

undemanding on eyepieces, though a hair more so than the common f/10 or f/11 of commercial Schmidt-Cassegrains.

Let it be clear that this is not a test of resolution: If I want to see fine Martian surface detail in a four-inch refractor at 38x, I should buy an old Ramsden eyepiece and spend the rest of my accessory budget on drugs -- or perhaps move to Deimos. Yes, I could have Barlowed up the magnification, and some people will and do, but as a matter of fact I don't own a Barlow powerful enough to bring any of these eyepieces up to the 1-mm-exit-pupil range where most people say critical planetary magnifications begin, on most of the telescopes that I regularly use.

Nor is it a test of eyepiece photon throughput: The difference between four air/glass surfaces coated with magnesium fluoride and perfection is only about an eight percent difference in throughput, which is less than a tenth of a stellar magnitude. I suspect the whizzy coatings on the Panoptic and the Vixen Zoom provide some of that tenth-magnitude advantage for the viewer, but I doubt I can see it.

Finally, let it be clear that this is a test of these particular eyepieces. Manufacturing variations may mean that the next one down the production line, or next year's model, may be noticeably different, and no one should expect eyepieces of the "same" design from different companies to perform the same way, either.

The first parts of the test were simple. I compared apparent fields of view and eye relief, and I have added in results for the Koenig obtained at a later date.

The 24 Panoptic was the clear winner on apparent field, which was a relief, because I had bought it largely on the strength of it being advertised to have as much field of view as you can get in a 1.25-inch barrel. (That plus an exit pupil near 4 mm makes a nice combination for my shiny new Astro-Physics 130 mm f/6.3 "Gran Turismo" refractor, used in part 2, below.) The Erfle was a close second -- no surprise there. The Koenig was third, the Brandon was fourth, with a noticeably wider field than the fifth-place Abbe orthoscopic, and the Zoom Lanthanum was sixth.

Wide fields of view are useful for aesthetically pleasing views of large objects, and also for finding things, though at less than a meter focal length, any of these eyepieces would do for finding things: They all gave the Vixen an actual field of at least a degree, which is more than enough to work with any reasonable finder for getting things into the field of the main telescope.

For eye relief, the winner -- longest eye relief -- was the Vixen Zoom, followed closely by the Abbe orthoscopic. I could probably wear glasses and observe with either of these eyepieces. The Koenig might have had enough eye relief to allow glasses for some. The other three had much shorter eye reliefs, enough to make glasses impossible to use, or to cause worry about mascara on the eye lenses at public nights. I in fact do not wear my glasses when I observe, and if I ever wear mascara other than for midnight screenings of Rocky Horror Picture Show, you may be sure I am not going to admit it here, so none of the eye reliefs were a problem for me.

For uniformity of test conditions, and to avoid having to keep fussing and guiding with the light undriven altazimuth mountings I use in my yard, I ran tests on Polaris. Remember, I did part 1 before I had acquired the Koenig.

The first issue was how gross image quality varied with position in the field. Well-made examples of almost any eyepiece design can give decent images at the center of the field, but what about at the edge? I set up with Polaris centered, then focused, and wiggled the telescope around to see.

Although the Airy disc was nowhere near visible at only 38x, the Panoptic gave a uniformly round and small image no matter where the star was in the field, even as it was in the act of disappearing behind the field stop. Score one for Al Nagler.

I was expecting the Erfle to show off-axis aberration, and I was not disappointed. The small round star image at the center became larger near the edge. A little fussing showed that the main problem was field curvature -- the Erfle could be refocused to produce a much smaller image at the edge of the field, but even after doing so some astigmatism remained -- the image there was elongated radially on one side of best focus and elongated tangentially on the other side. That behavior is classic astigmatism, and also classic Erfle.

The Brandon was much better behaved -- no visible effect of field curvature, and much less aberration at the edge of its narrower field than at the edge of the refocused Erfle. It looked to me as if the main off-axis aberration of the Brandon was coma.

The Abbe orthoscopic had a touch more aberration at the edge of its still narrower field than did the Brandon at the Brandon's edge. The aberration appeared to be a touch of astigmatism, and again there was no sign of field curvature.

The Vixen Zoom had a field of view only a bit more than half the diameter of the Panoptic, but it had excellent images all across its narrower field, round and in focus from edge to edge.

As I switched eyepieces back and forth, I was trying to make at least qualitative comparisons of how bright the diffuse glow was that closely surrounded Polaris in the field. This is *not*, be it noted, a test of coating transmission; rather, it is a test of how much light is scattered by stuff in the optical path, including scattering in the atmosphere and at the surfaces of the objective lens itself. Differences seen using different eyepieces might say something about the quality of the polish and coatings on the eyepiece lenses.

I changed eyepieces many times during the evening, so I hope no eyepiece was unduly disfavored by changes in atmospheric transparency. In any case, the Panoptic and the Vixen Zoom appeared to have rather small amounts of glare, the Erfle might have had rather more, and the Brandon and the Abbe orthoscopic might have had less glare than the Panoptic or the Zoom.

I should also mention that at no time during part 1 or part 2 of these tests did I see any form of chromatic aberration: Both objective and eyepieces were color-free, on and off axis, in the combinations tested here.

Next I tried a more critical test. Polaris is a double star: Could I see the companion with any of these eyepieces? I had not noticed it while observing, and I am pretty sure I would not have noticed it if I had not run up the magnification to find out where it was. But the 8 mm setting on the Vixen zoom showed the companion clearly (as did a 5 mm Pentax Orthoscopic I dropped in to double check), and rather to my surprise I could hold the companion, though not steadily, in all of the test eyepieces, once I knew where it was. It was most obvious in the Brandon and Orthoscopic (tie), somewhat less so in the Panoptic and Vixen Zoom (also tie), and even more difficult in the Erfle. Those results corroborate my observations on the brightness of the scattered-light glow near Polaris, since the main reason why Polaris B is tough is because it is much fainter than its bright neighbor.

I performed part 2 of this comparison on the evening of May 16, 2009, from the outer parking lot of Henry Coe State Park, near Morgan Hill, California, using an Astro-Physics 130 mm f/6.3 "Gran Turismo" triplet refractor. The sky was clear with some developing haze. Seeing was very good -- at high magnification, the Airy disc and a ring or two were always visible and slightly in motion.

The AP-130 is a splendid instrument.

I did not attempt to repeat the "diffuse glow" tests, but I speculate that since the Koenig has "green" multicoatings similar to the Panoptic and the Vixen Zoom, it will exhibit a similar degree of diffuse glow.

There were no surprises in the appearances of images across the field of view at f/6.3 instead of f/9. The Panoptic still had excellent images all the way across the field. The Zoom at 24 mm was beginning to show a little aberration at the edge of the field, but was still better than at the edge than any other eyepiece except the Panoptic. The Erfle's field curvature was still the dominant aberration, but the astigmatism was more noticeable. The Koenig had a flat field with what appeared to be a mixture of coma and astigmatism at the field edge, but with a smaller image size there than the Erfle, even when the latter had been refocused for best image at the edge. (Note again that the Zoom's apparent field was on the small side.) The Brandon and the Abbe Ortho's aberrations were more evident, but each had less visible aberration at the edges of their smaller fields than did the Koenig at the edge of its larger one.

The conclusions are qualitatively the same at both f/9 and f/6.3.

The Panoptic wins on field of view, and at f/9 and f/6.3, it delivers immaculate images all across its field. If its correction is as good with faster objectives, it should be an outstanding eyepiece for low-magnification views at f numbers from 5 to 7. Too bad it doesn't have a bit more eye relief. But it certainly deserves a place in my eyepiece case.

The Brandon and the Abbe orthoscopic won on minimal scattered light. At the focal ratios of the telescopes I usually use, these eyepieces are not ones you would usually pick for observing low-contrast planetary detail, so in some sense, who cares? On the other hand, some people use eyepieces with Barlow lenses, so they might, and perhaps there are a few kinds of deep-sky objects, such as dense clusters, in which low glare is an issue. The Brandon's wider field than the Abbe orthoscopic makes it the better of these two. I have a full set of Brandons in my case and I am glad of it.

The Koenig is a contender, at least down to f/6.3. Its wide, flat field and low level of aberration make it very useful as an eyepiece for finding or for general low-magnification viewing. I have plenty of big telescopes and so don't mind devoting some of my equipment

budget to expensive eyepieces, but if I were more budget-conscious I would sell the Panoptic and keep the Koenig in its place: In my opinion, the wider field and sharper edge images of the Panoptic are rather past the point of diminishing returns for performance versus cost. (I should mention that I bought the Panoptic new at $259 whereas the used Koenig cost me $70.) Notwithstanding, perfectionists like me will prefer the Panoptic if they can afford it.

The Vixen Zoom is impressive. I carry one because its zoom range includes the focal lengths at which I observe galaxies with most of my telescopes, and I have found that very small adjustments in magnification make a great deal of difference in observing these targets. Furthermore, with many of my telescopes, its longest focal length provides enough field of view to work well with a finder, so that I do not need to change from a "finding" eyepiece to a "viewing" eyepiece for galaxy work. And as this test showed, its image quality and freedom from glare are very good.

The Erfle design has been made obsolete by more recent developments, but for that very reason, any Erfles you find on the market are likely to be inexpensive. With your attention fixed at the center of the field, the Erfle's edge-of-field aberrations at f/9 are not terrible and the wide field is spectacular. Think "budget eyepiece" here.