Eight billion light years

Telescopes: **AS110/1650** and **Telementor** (C63/840 mm)
Eyepieces with AS110:
ATC K40 - ATC Kellner, f=40mm, (41×, 61′)
O-25 - CZJ Ortho, f=25mm, (66×, 38′)
A-16 - Zeiss Abbe Ortho, f=16mm, (103×, 28′)
Eyepieces with Telementor:
ATC K40 - ATC Kellner, f=40mm, (21×, 2.0°)
TMB16 - TMB Mono 16, f=16mm, (53×, 35′)
A-16 - Zeiss Abbe Ortho, f=16mm, (53×, 54′)
O-15 - Vintage Zeiss Ortho, f=15mm, (56×, 45′)
A-10 - Zeiss Abbe Ortho, f=10mm, (84×, 34′)

Mount: Zeiss 1b
Accessories: Baader 1.25” zenith prism
Location: Říčany
Time: 2016/11/20 16:50-17:30UT (AS110), 2016/11/20 19:50-21:20UT (Telementor)
Weather: Clear sky with medium haze, later improved to slight haze.

Not every night one can observe an eight billion light years distant object through a small telescope. In the beginning of December 2016, blazar **CTA-102** in Pegasus underwent a strong outburst, reaching $V = 11.8$ magnitude at its maximum on December 1^{st}, making it well within the limits even of tiny aperture telescopes. Its redshift $z = 1.037$ is placing this quasar to 8 Gly distance in conventional cosmological models based on general relativity.

I could not pass this opportunity. As I did not want to take chances, there was no warranty that the quasar was still that bright, I set my largest refractor, Zeiss AS110, the very first clear evening immediately after I returned from work.

Equipped with a chart from the Sky&Telescope web page, it took me about 30 minutes to localize the quasar and to make myself sure that I indeed saw it. As the atmospheric conditions were not the best, it was quite a difficult target. Under optimal sky, I’m able to detect in this 110mm refractor stars down to 14.5-14.6 magnitude without prior knowledge of their existence. This night, nearby $V = 12.9$ star was near the detection limit at 66× and 103×. Even with concentrated averted vision it was popping in for short moments only. I could not see $V = 14.0$ star at all. Quasar seemed to have about the same brightness, or more precisely about as difficult to spot as the $V = 12.9$ star. My estimate for the quasar visual brightness was therefore about $V = 12.9$ at 17:20 UT, with an obvious caveat that the brightness estimations of faint threshold objects are prone to large uncertainties.

This was calling for giving it a try with my 63mm Telementor. Who knows when another opportunity will be to see such distant object next time. On good night, I’m able to spot $V = 13.0$ star at the east edge of M57. The quasar seemed to be just within the reach.

For now, I had to go home. I was left in charge of three kids for this evening and the quasar had to wait until all of them were sleeping in their beds.

When I was out, Pegasus was much lower. Fortunately, the sky got a little bit more clear and the haze was visibly smaller than it was during my observation with AS110.

I knew the observation is not going to be a trivial. Therefore, I put the Telementor tube on driven mount Zeiss 1b.

At the end, it took me about 90 minutes during which I saw quasar several times. The problem was not to see it, there was indeed something in the area popping in with averted vision for very short periods. The problem was to make myself sure that these glimpses were coming from the quasar and not from some nearby star. The nearest stars where too faint, about $11^{th} - 12^{th}$ magnitudes, and they too required concentrated averted vision to be spotted. They were best seen at higher magnifications but they were too far, if they could even fit the eyepiece field of view together with the quasar. Wider shorter focal eyepiece, like my former 10mm Delos, would be very useful. Nowadays, my widest eyepieces are orthoscopic ones with much narrower field of view.

I have used two independent estimations of quasar position based on two different nearby star patterns. In addition, I was changing eyepieces and magnifications quite often. I was surprised to see that TMB monocentric 16mm was showing those faint stars at the limit of visibility with more authority than Zeiss ZAO-I 16mm eyepiece. I was not expecting any visible differences between those two state-of-the-art eyepieces. Yet, it was there. The effect was quite subtle, it required precise focus, for which I moved always the telescope to a brighter $V = 7.8$ magnitude star. I exchanged the eyepieces many times during this session, and the effect seemed to be there consistently.

For a fun, I plugged in shortly also vintage Zeiss 15mm orthoscopic eyepiece. The lack of coatings is supposed to introduce about 20% light loss equivalent to 0.2 magnitude drop. Yet, the faint stars were still very well defined.

I suspected the quasar several times in both 16mm eyepieces. The problem with the 16mm monocentric eyepiece was its tiny field of view. I could not get the reference stars in the same field of view with the quasar. Orthoscopic eyepiece was better from this point of view. I could get in the same field of view both star patterns I used for localization of quasar.

My experience told me that threshold stars are better visible in larger magnifications. I spent significant time at 84×, trying to confirm the presence of the quasar. I manage to see stellar point several times at the estimated position of the quasar. This gave me a pretty good confidence that I indeed spotted this 8 billion light years distant spectacle. This was not a 100% confidence, unlike the case of observation through 110mm refractor where I had not doubt. That is way it took me hour and half with Telementor to build good confidence. Anyway, nothing more could be done I as the Pegasus was already setting down.

Alexander Kupčo

P.S.: Blazar CTA-102 brightened even further during December and reached almost magnitude 11.0 in its peak. I have observed it more clearly through 63mm Telementor on December 29. My estimate of quasar's visual brightness from that night was $V = 10.9$. Next night I gave a try with my smallest refractor, Zeiss E50/540. The quasar was a little bit fainter, it required concentrated averted vision and it was more difficult to spot than nearby $V = 11.3$ star.