Can we observe spherical photon orbits in near-extremal Kerr black holes?

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In the gravitational lensing by a black hole, since there exist a spherical photon orbits around the black hole, we can observe, in principle, a series of images that correspond direct light ray, ray winding the black hole once, twice, etc. Detection of the series of images would be a strong evidence that the lens object is a black hole. However, it is hard to observe the series of images of winding light ray. Because the Weyl curvature around the black hole generates the shear of a null geodesic congruence along the winding ray, then the shear induces the expansion of the congruence, therefore the brightness of the images decrease exponentially as the light ray winds.

As is well known, the radius of the co-rotating photon circular orbit on the equatorial plane approaches the horizon radius in the extremal limit of the Kerr spacetime. In this limit, we see the near-horizon geometry with long throat structure admits enhanced symmetry. Thanks to the symmetry enhancement, the Weyl curvature components that generate shear of the congruence along the spherical photon orbits near the horizon vanishes. Then, we show that there exists a null geodesic congruence with vanishing expansion along light rays that wind the near-extremal Kerr black hole. Therefore, we can observe the series of images of lensing by the near-extremal Kerr black hole. It means that the near-horizon geometry is accessible by the observation of the winding light rays.