Astronomical Observing Techniques 2019: Exercises on Adaptive Optics (Due on 20 May 2019 at 11:00)

May 15, 2019

1 Resolution

a) Calculate the theoretical resolution (in arcsec) of a 3.6-m telescope observing at a wavelength of 500 nm (assume no atmosphere).

b) The Fried parameter (r_0) of the atmosphere is 20 cm at a wavelength of 500 nm. Calculate the resolution of the telescope (in arcsec) looking through the atmosphere.

c) What is the resolution (in arcsec) at 2 μm under the same conditions as in question b)?

2 AO Basics

A particular site has a median Fried parameter of 9 cm during the month of August.

1. Estimate the expected FWHM for a long exposure image of the uncompensated seeing disk in U band, I band, and K band.

2. Above what wavelength will the images in an optically perfect 1-m telescope be unaffected by turbulence?

3. For an AO system in K band, for this situation, compute the Greenwood time delay (i.e., the atmospheric coherence time) imposed by ground-layer turbulence alone (average wind velocity of 15 km hr^{-1}) and again by tropospheric turbulence alone (average wind velocity of 110 km hr^{-1}).

3 Understanding AO

1. Adaptive optics can improve the resolution and SNR for many different instruments. However, there are certain science targets and observing strategies for which AO does not have an added benefit. List a number of science cases/observing strategies for which you would not have any added benefit from adaptive optics?

2. Why is it easier to do AO for near-infrared wavelengths compared to optical wavelengths?

3. Ground-level conjugate AO is a simple AO configuration in which the only deformable mirror in the system is conjugated to the ground layer. Explain why removing only the effects of the ground-layer turbulence should improve the seeing disk over a relatively wide field of view.