Demonstrating Predictive Wavefront Control at Keck II:

Simulating a Pyramid Wavefront Sensor

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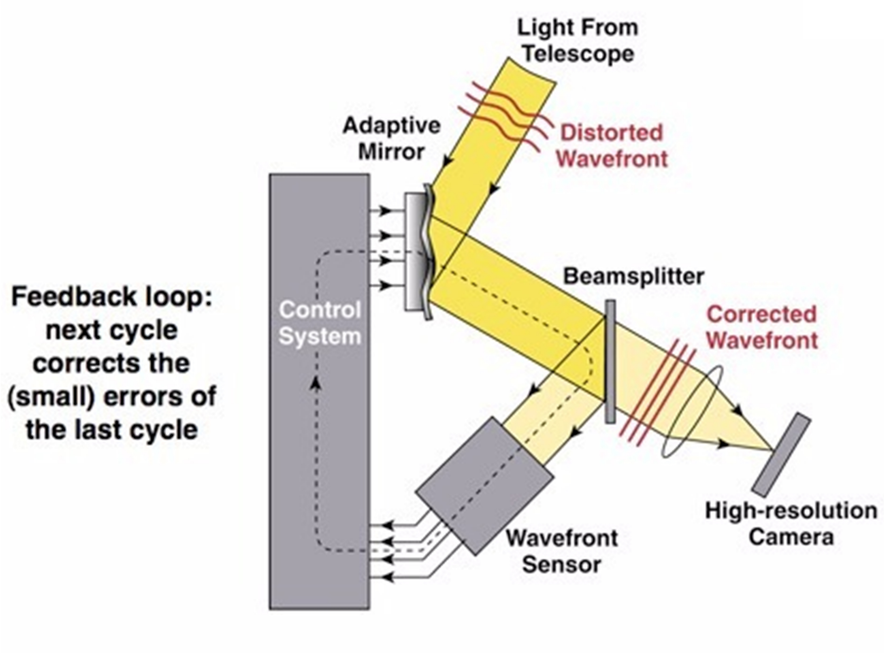
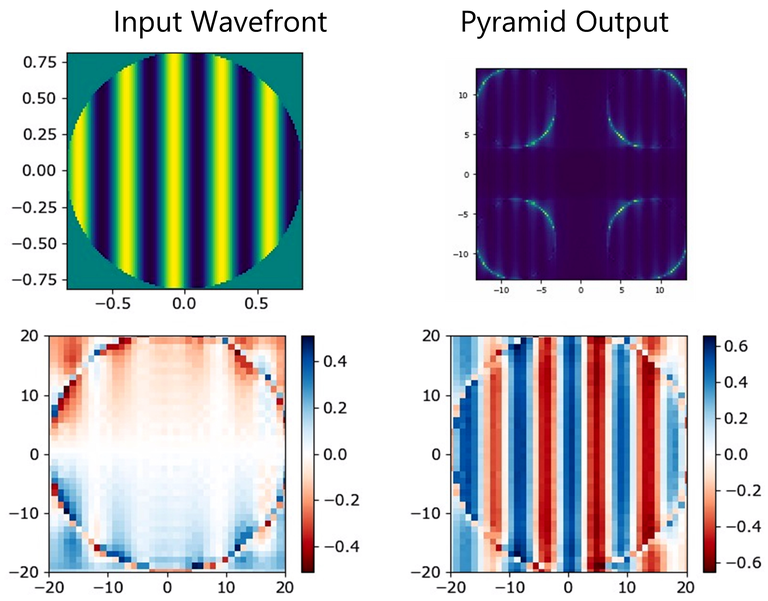
About Adaptive Optics (AO)

- Set of techniques to reduce aberrations due to atmospheric turbulence
- Improved imaging, but not sensitive enough to (for example) find low-mass exoplanets
- Can be improved using predictive wavefront control: mathematical tools to optimally predict future wavefront
- Our task this summer: implementing a predictive wavefront control system for the Keck telescopes!



Source: http://www.ucolick.org/~max/History_AO_Max.htm



x and y direction wavefront slopes

The Pyramid Wavefront Sensor

- A major part of Keck's upcoming hardware upgrade is a pyramid wavefront sensor
- Takes in wavefront at its tip, propagates along its four sides to generate four sub-images.
- Linear combinations of sub-images provide slopes in x and y directions, from which commands sent to a deformable mirror to fix the next measurement
- An accurate simulation of the pyramid is essential to quantify the benefit of predictive wavefront control

Results & Next Steps

- Successfully made a full simulation of a PWFS! Incoming wavefront, resulting pyramid image, and the slopes of the wavefront in the x and y directions are shown to the left.
- Built using optics backend from HCIPy (High Contrast Imaging in Python); have submitted contribution to it on Github.
- Hope to add deformable mirror interaction, speed up simulation to create a full feedback loop and explore the potential of predictive control further.

References

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