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Laboratory of Coherent and Adaptive Optics

Adaptive optic systems for horizontal atmospheric paths

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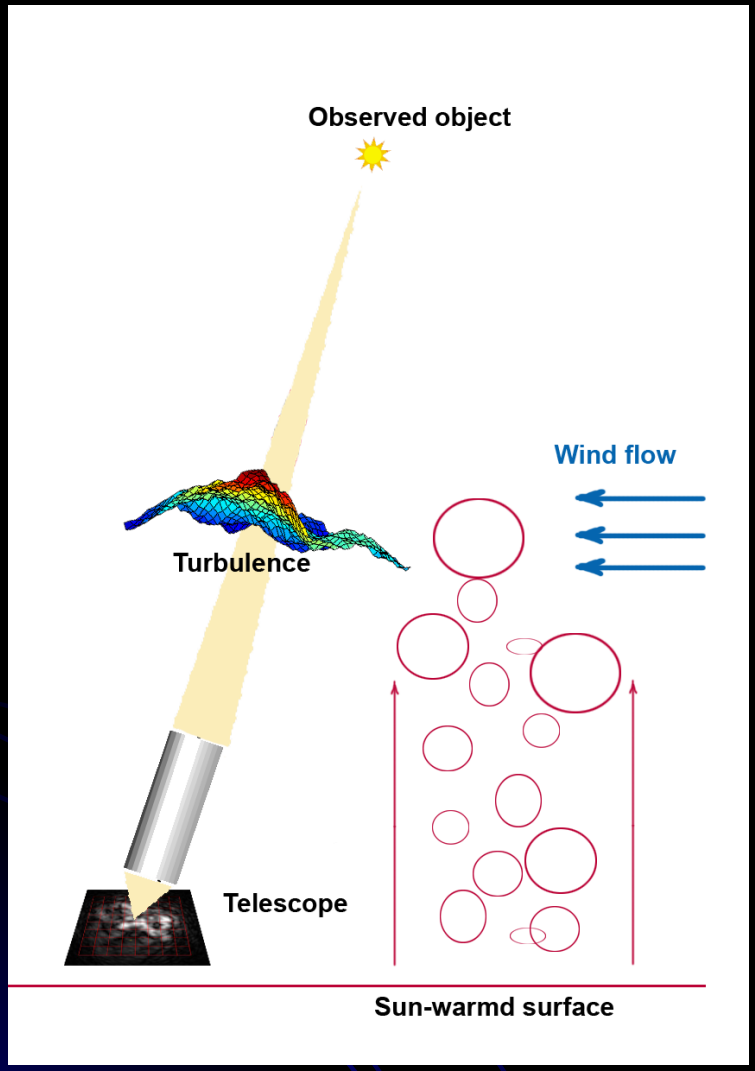
Content

Purpose: To describe basic principles and components of the adaptive Optics (AO) and properties of the horizontal atmospheric path

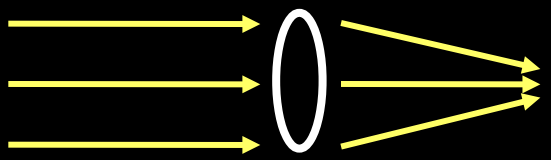
Structure:

1. The main problem in adaptive optics
2. The main concept and components of adaptive optical systems
3. Some of the results of AO systems
4. Examples and results of operating adaptive optical system on horizontal atmospheric paths
5. Conclusion and future works

*Main problem in **adaptive optics***

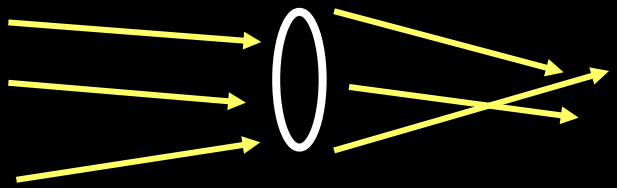


Temperature fluctuations in small patches of air cause changes in the index of refraction (like many small lenses)



Point focus

Parallel light rays

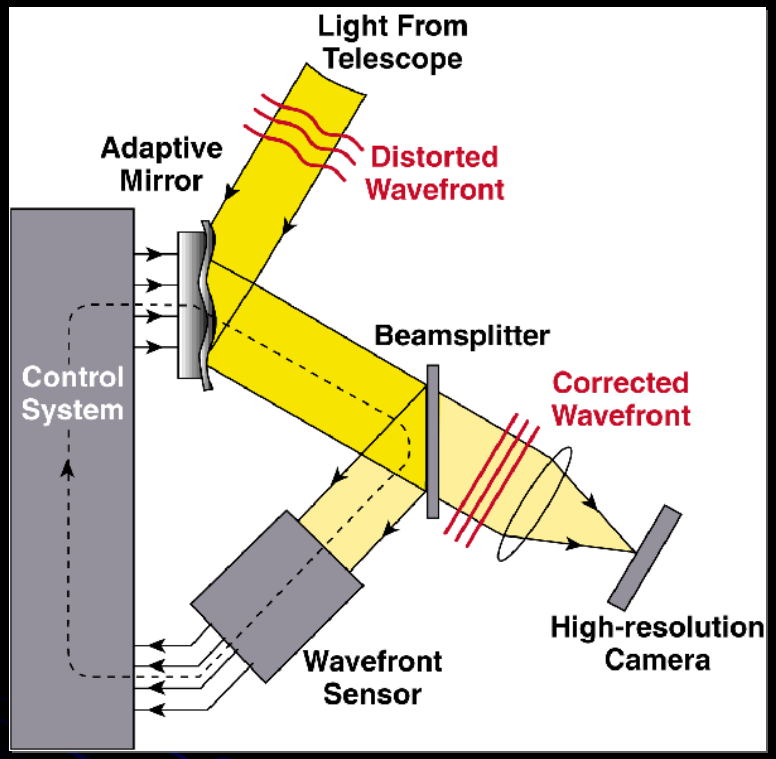


Blur

Light rays affected by turbulence

Turbulence makes stars twinkle and spreads out light

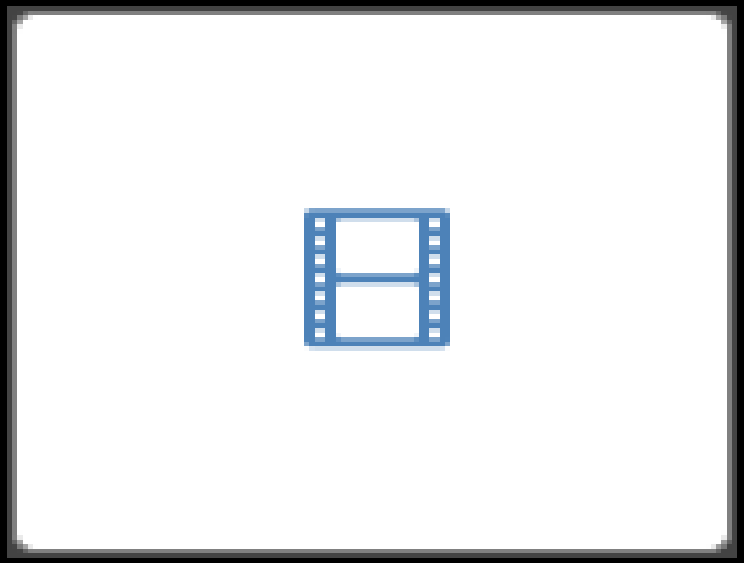
How does an adaptive optics work?



Scheme of an adaptive optics system

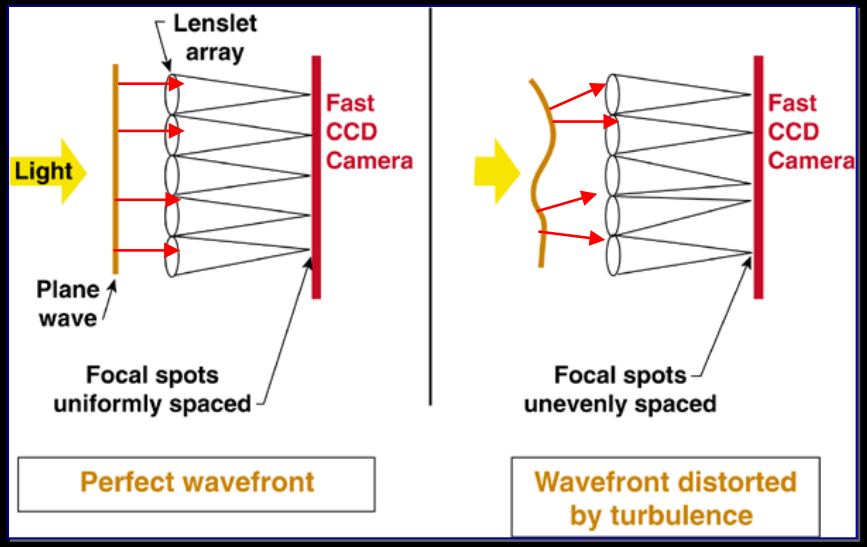
Feedback loop: next cycle corrects the small errors of the last cycle

Distorted wavefront | Deformable mirror shape | Corrected wavefront



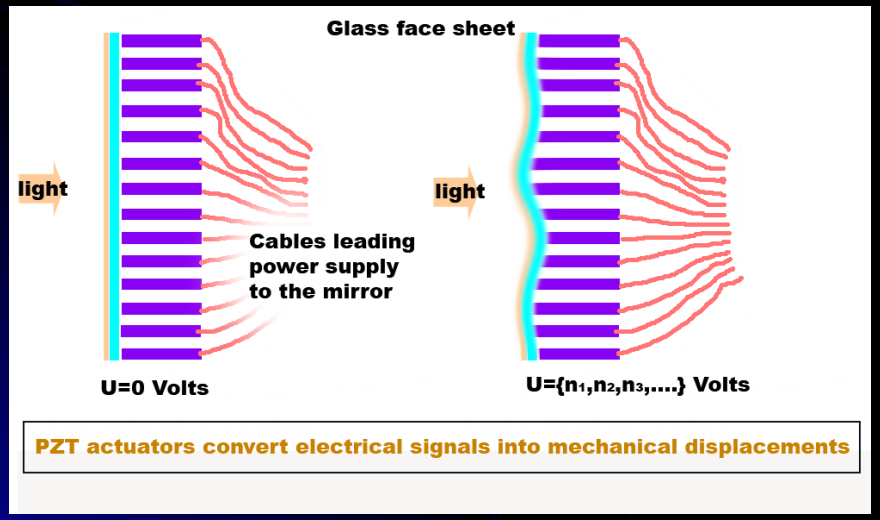
Main components of adaptive optics

How to measure turbulent distortions



Shack-Hartmann wavefront sensor measures the local "tilt" of the wavefront and calculates an approximate wavefront

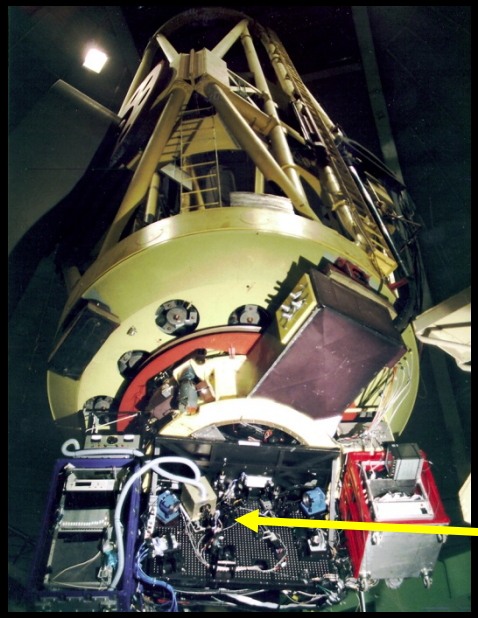
How to correct turbulent distortions



A Deformable mirror corrects optical aberrations in an adaptive optics systems using data from a wavefront sensor

Adaptive optics systems in real telescopes

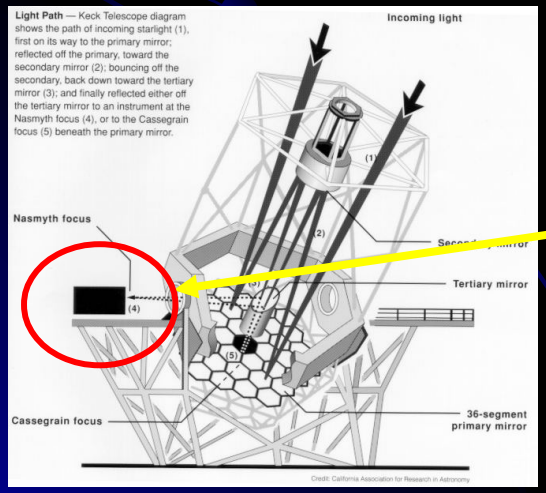
Lick Observatory's 3 m telescope



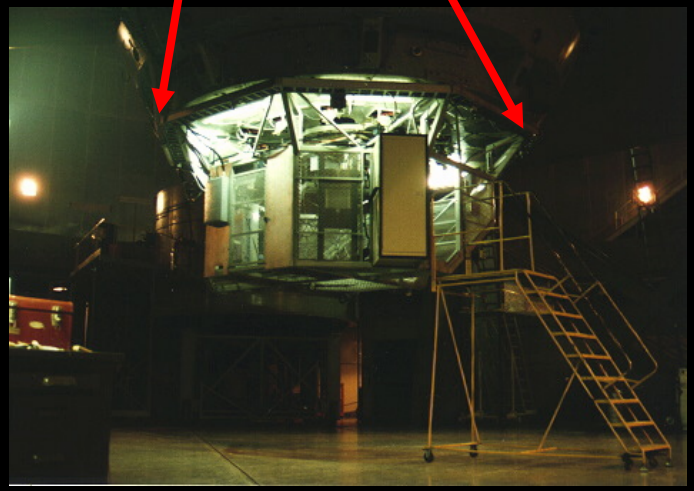
Adaptive optics package below the main mirror

Adaptive optics on the 5 m Hale telescope at the Palomar Observatory

10 m Keck Telescope

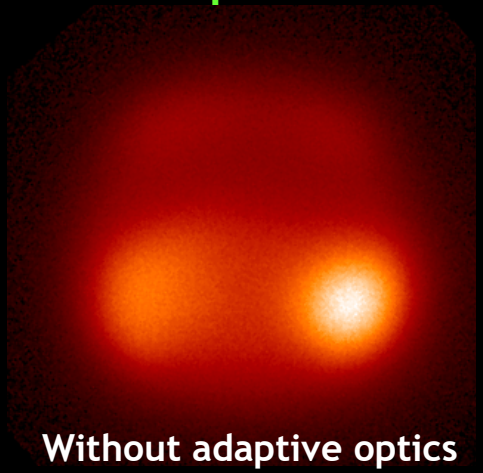


Adaptive optics is here

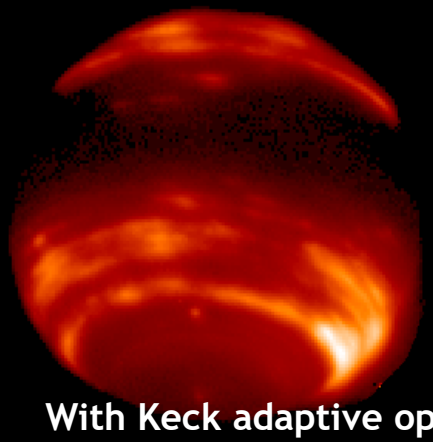


Adaptive optics results

Neptune in infra-red light

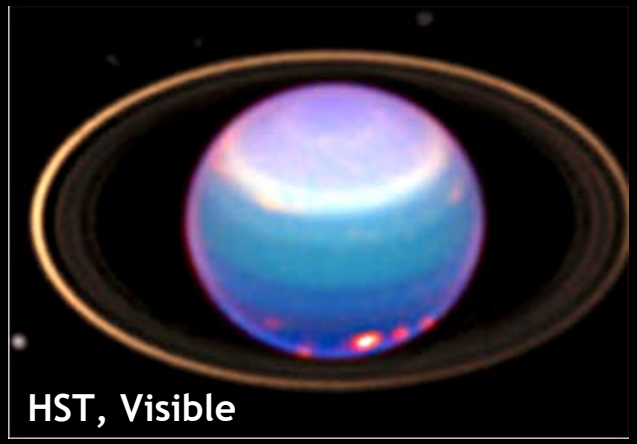


Without adaptive optics

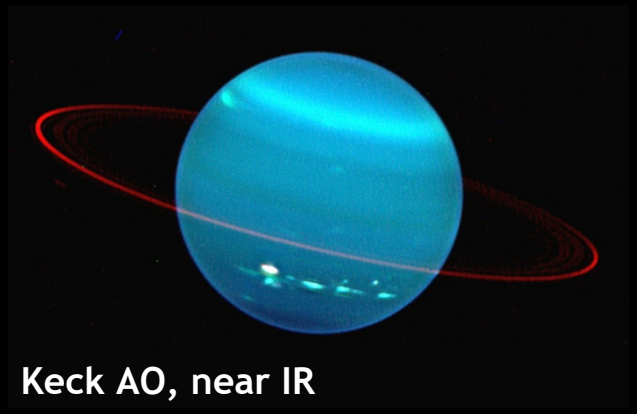


With Keck adaptive optics

Uranus with the Hubble Space Telescope and Keck AO

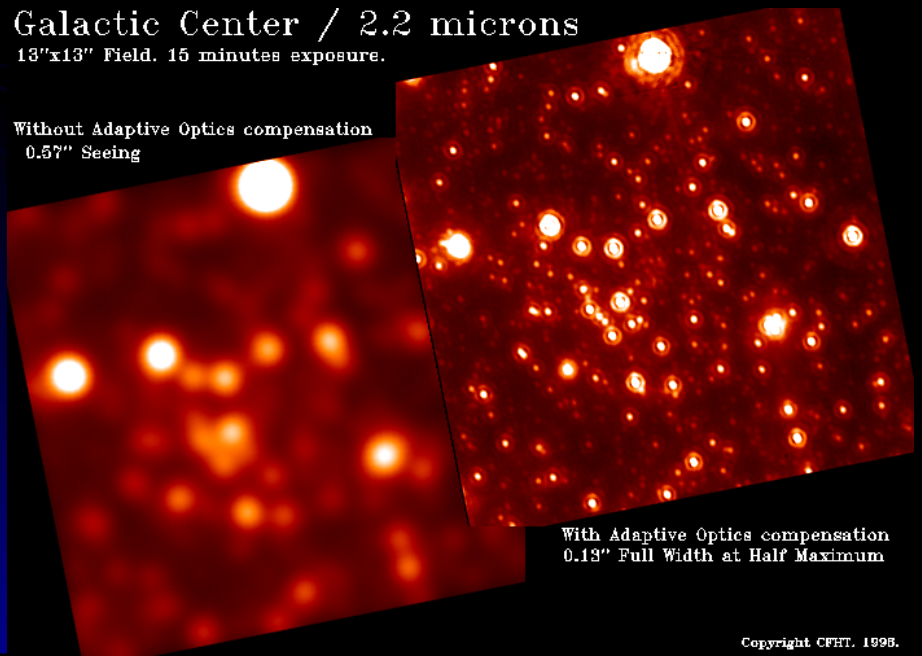


HST, Visible

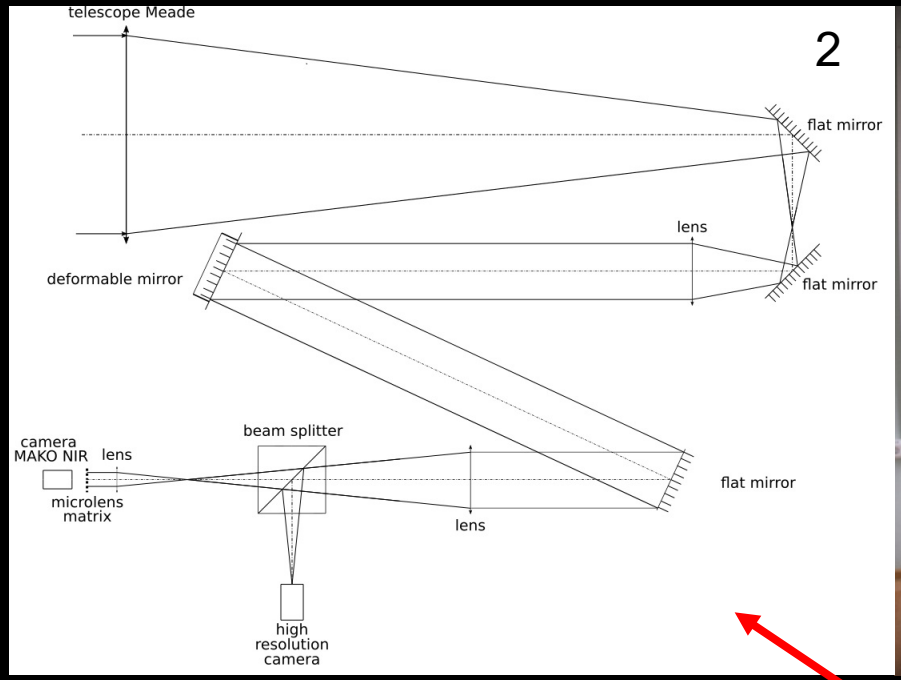


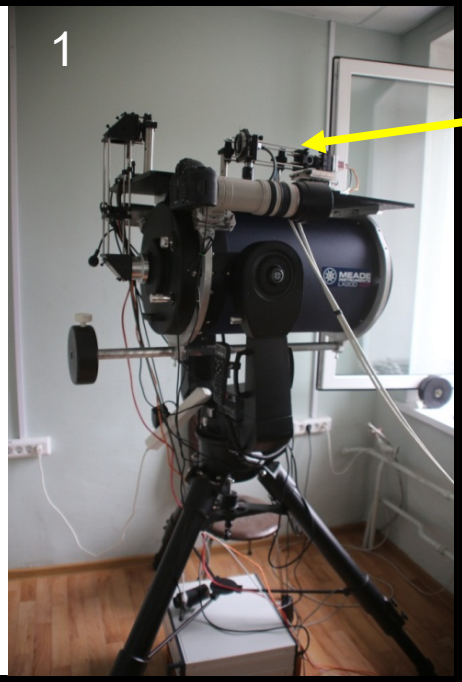
Keck AO, near IR

Canada France Hawaii Telescope



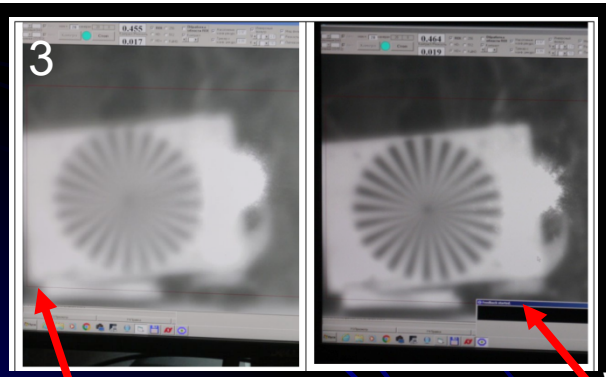
AO for horizontal atmospheric path's





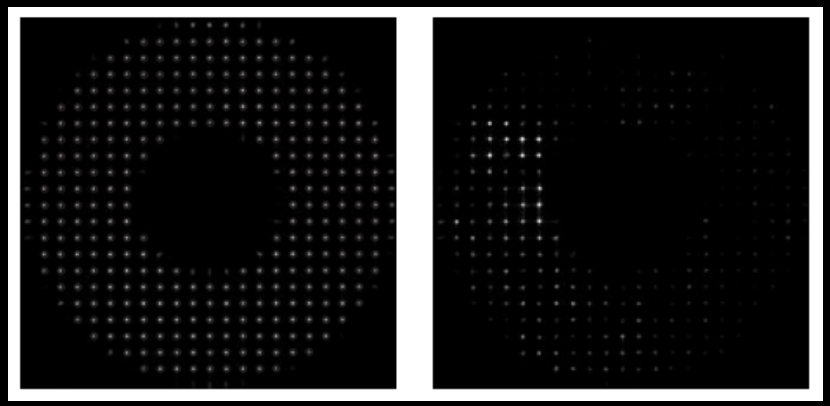
Imaging system for horizontal atmospheric path

Optic scheme



Without AO correction

With AO correction



ideal

real

Future work

- Technical calculation of a two-stage adaptive optical system
- Design a tilt sensor to control tip / tilt mirrors
- A research of the efficiency of using AOS for a small telescope on horizontal paths in image systems


Thank you for attention