Extreme precision Doppler spectrographs

Christian Schwab, 2011

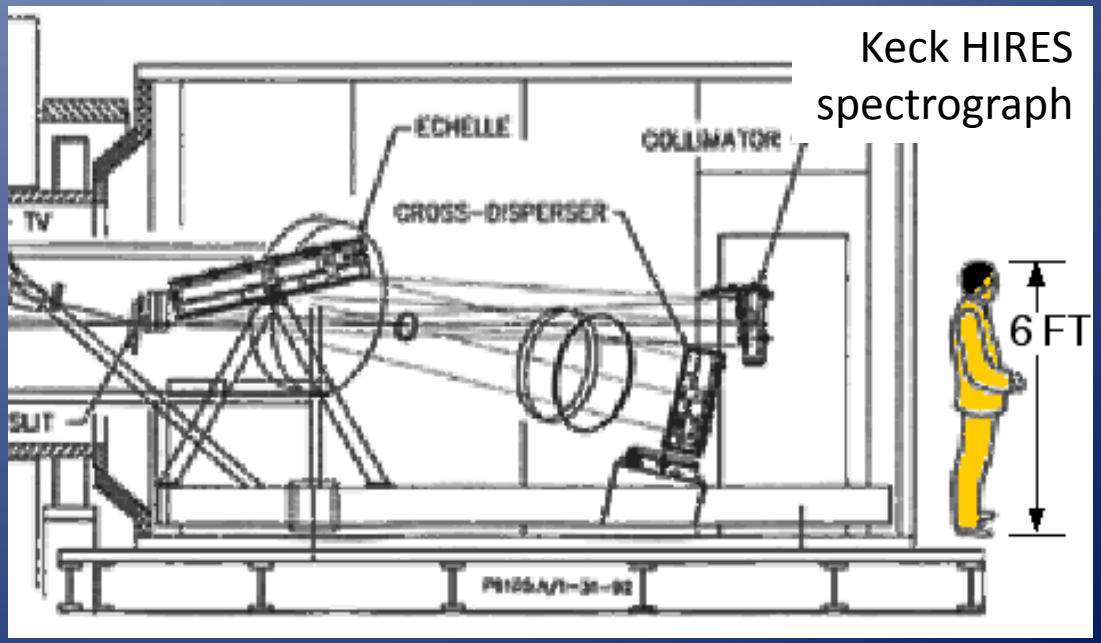
Goal: to characterize Earth-like extrasolar planets in the habitable zone.

Challenge: to stabilize and calibrate high resolution spectrographs to a precision of 3x 10E-10, corresponding to a Doppler signal of 10 cm/s.

3 key areas to improve:
- Illumination stability
- Calibrator coupling
- **Optomechanical stability**
  >>> need size reduction!

A single mode (SM) fiber fed spectrograph has a beam size of < 2 inches.

Current spectrograph size:



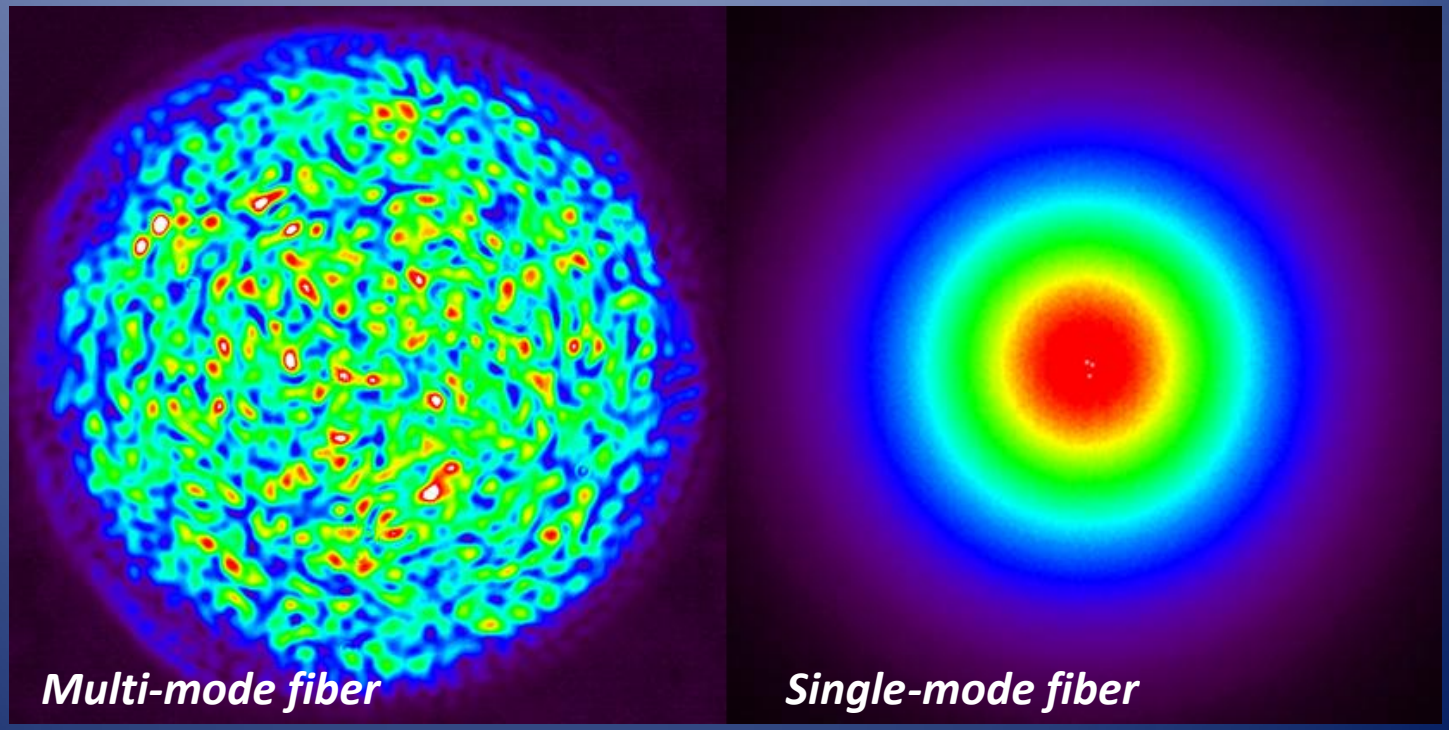
Extreme precision Doppler spectrographs

Christian Schwab, 2011

- **Illumination stability**
- **Calibrator coupling**

>>> need to eliminate modal noise!

A SM fiber produces a 'perfect', invariant Gaussian beam, identical for the starlight and the wavelength calibrator

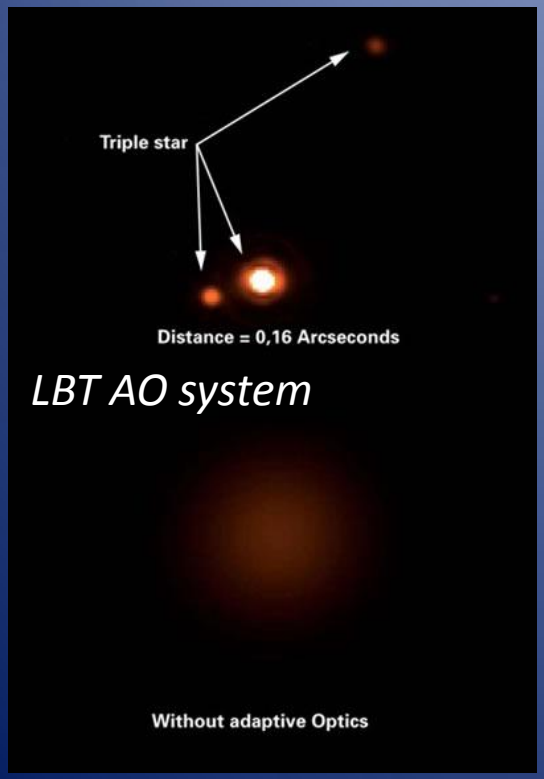


Extreme precision Doppler spectrographs

Christian Schwab, 2011

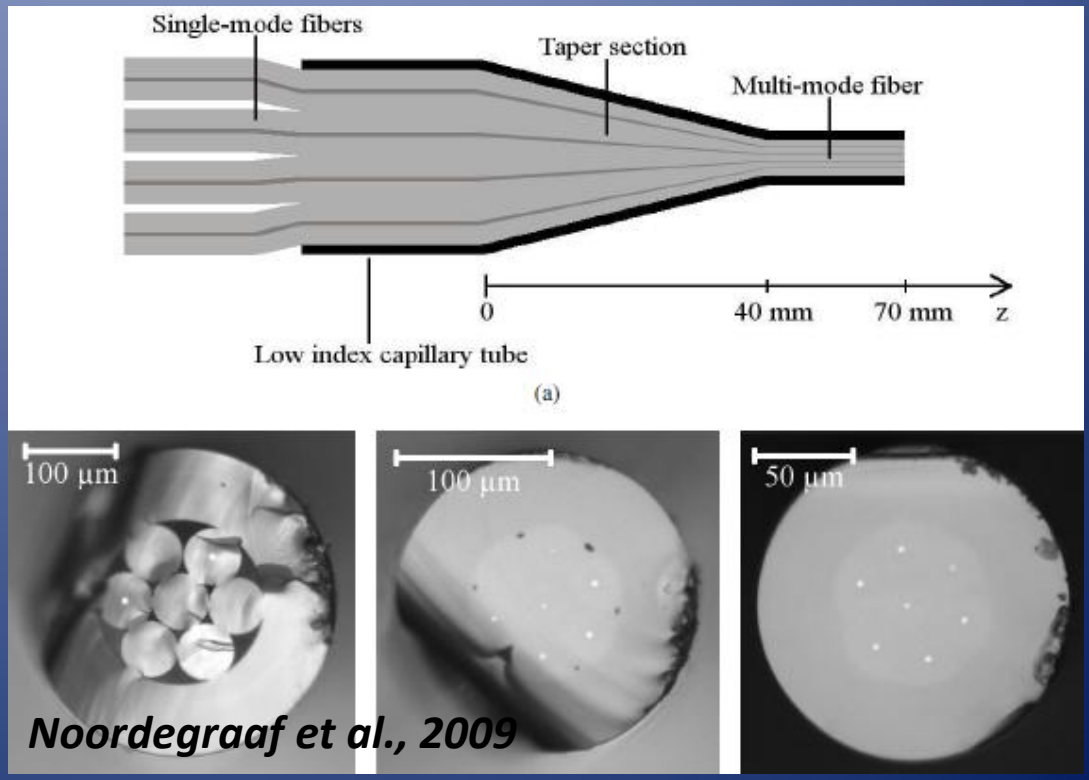
Technical problem: SM fiber coupling efficiency is very low

Photonic lanterns enable efficient coupling of SM fibers to a telescope. This is further improved by adaptive optics facilities that concentrate the starlight into a smaller aperture.



LBT AO system

Photonic lantern:



Noordegraaf et al., 2009

Extreme precision Doppler spectrographs

Christian Schwab, 2011

A single mode fiber coupled spectrograph will provide extraordinary wavefront stability, a very compact design and makes optimal use of new, highly accurate wavelength calibrators, leading to superior Doppler precision necessary for the study of earth-like planets.

SM spectrograph schematic: