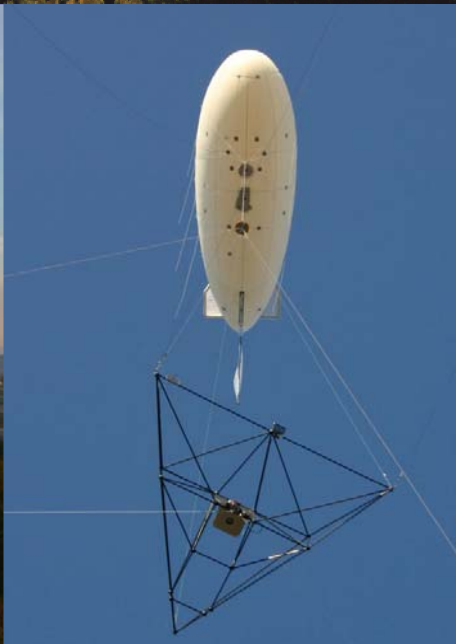
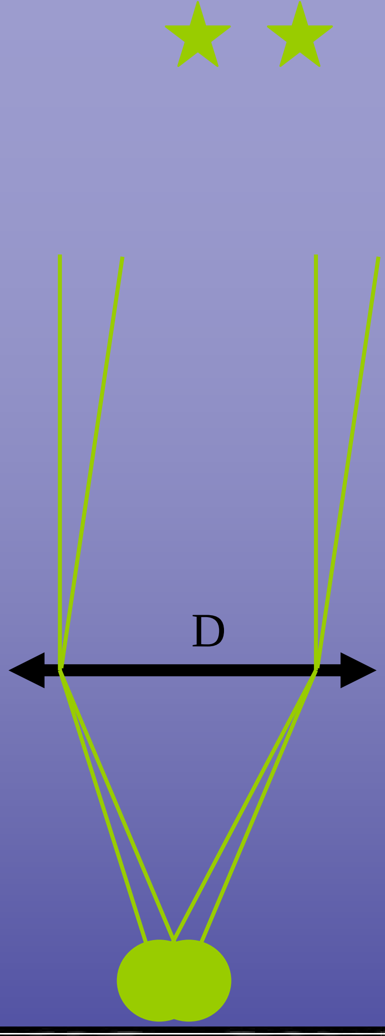
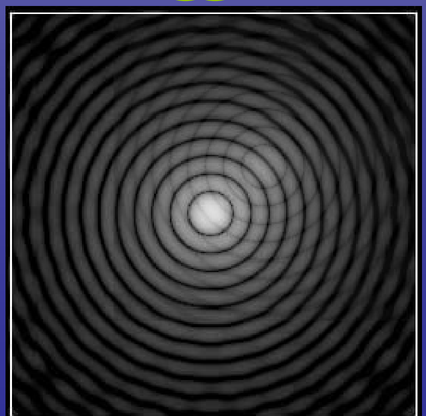
High Angular Resolution



The Rayleigh criterion





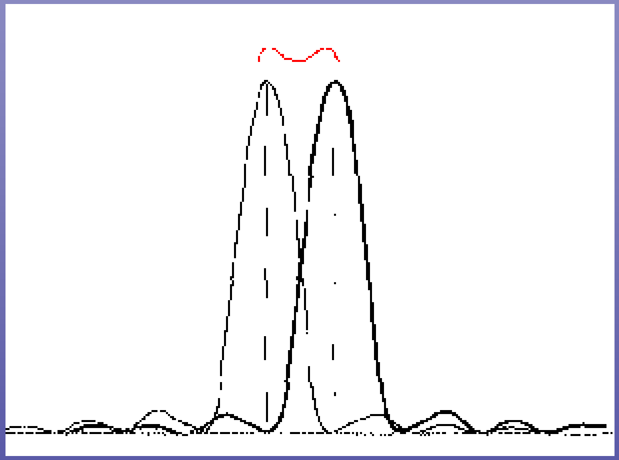


Fig1: The sum of the two peaks gives two individual peaks

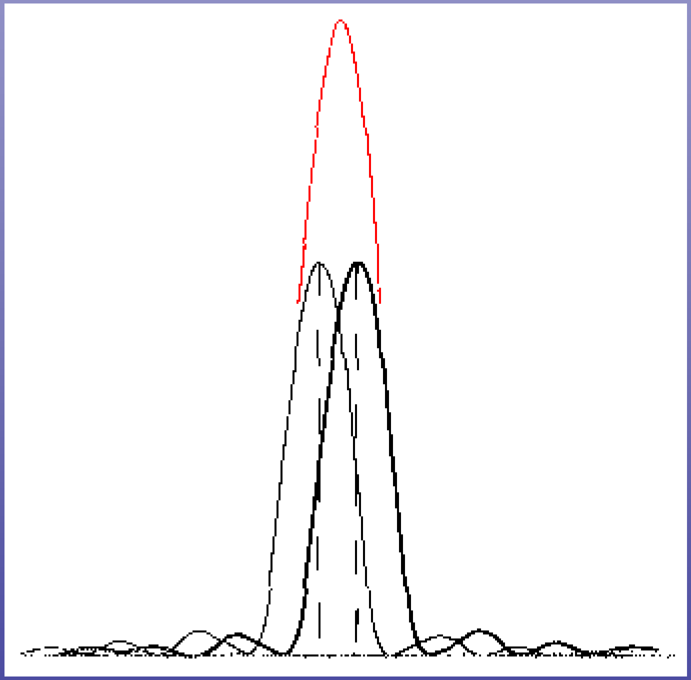
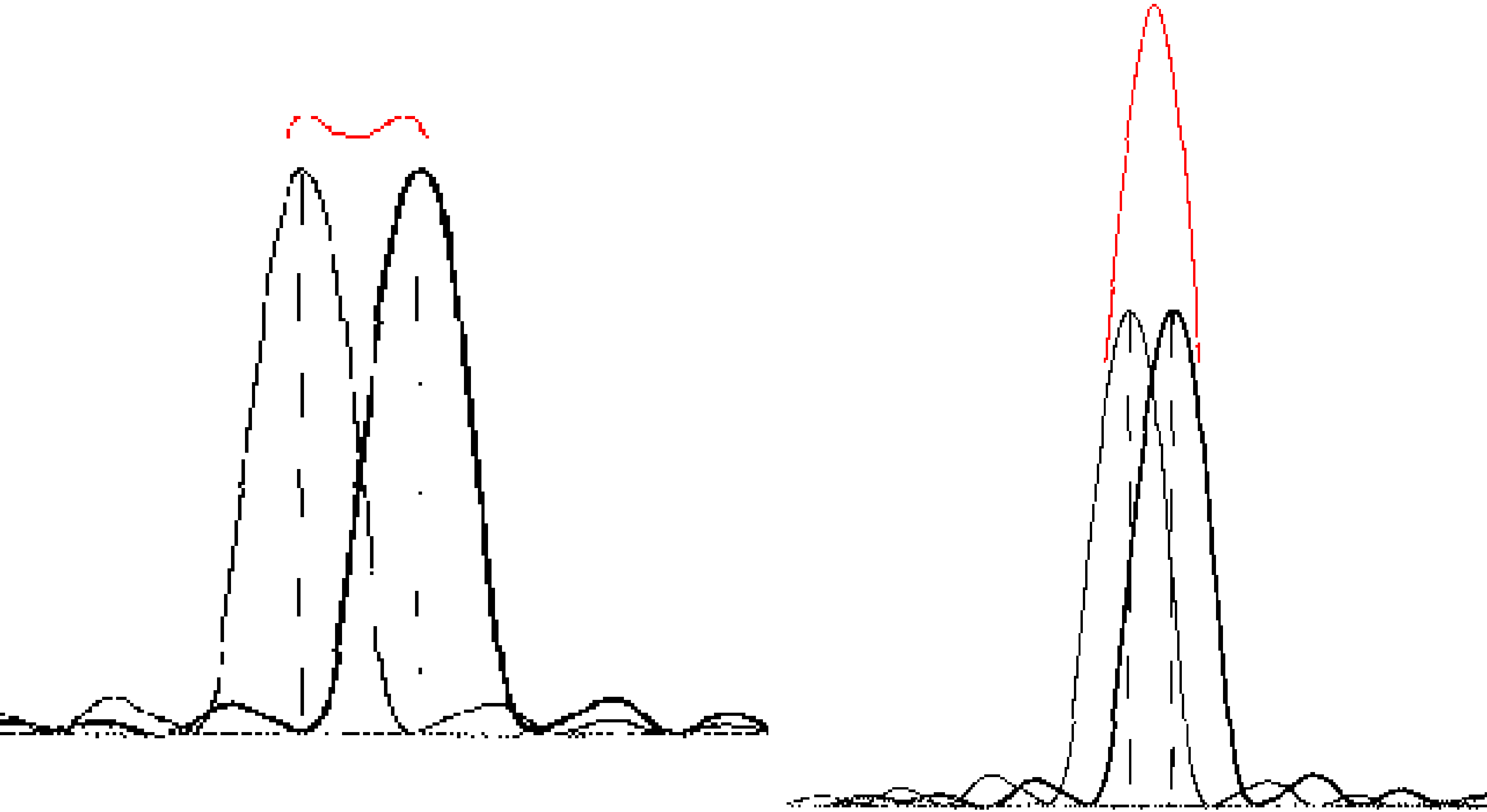
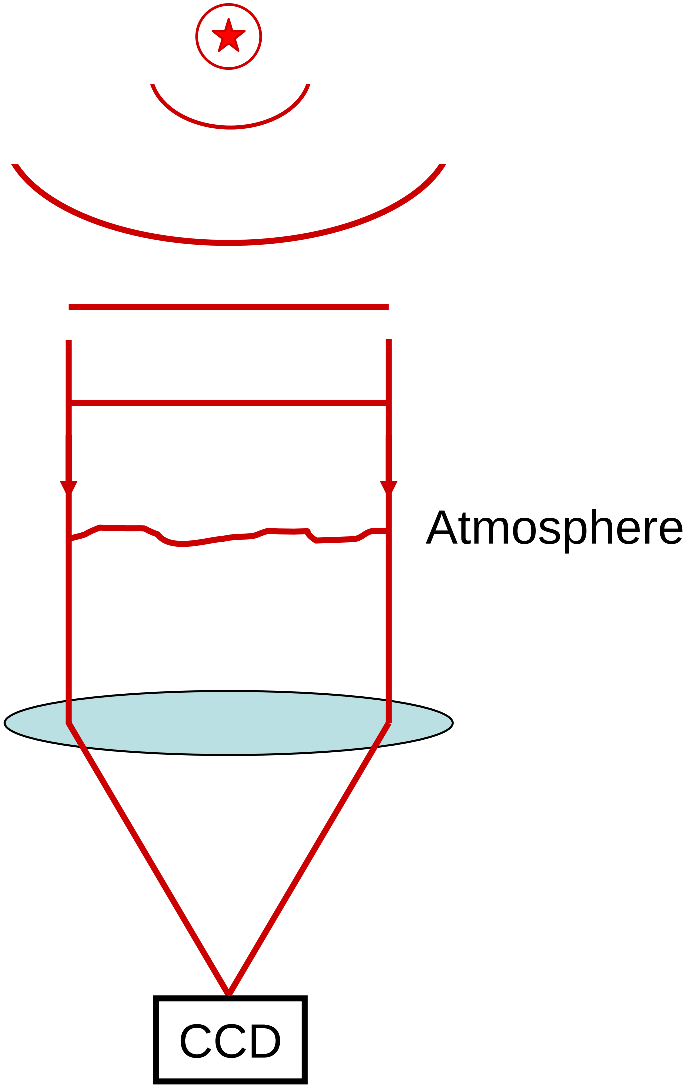


Fig2: The sum of the two peaks merges into a single peak

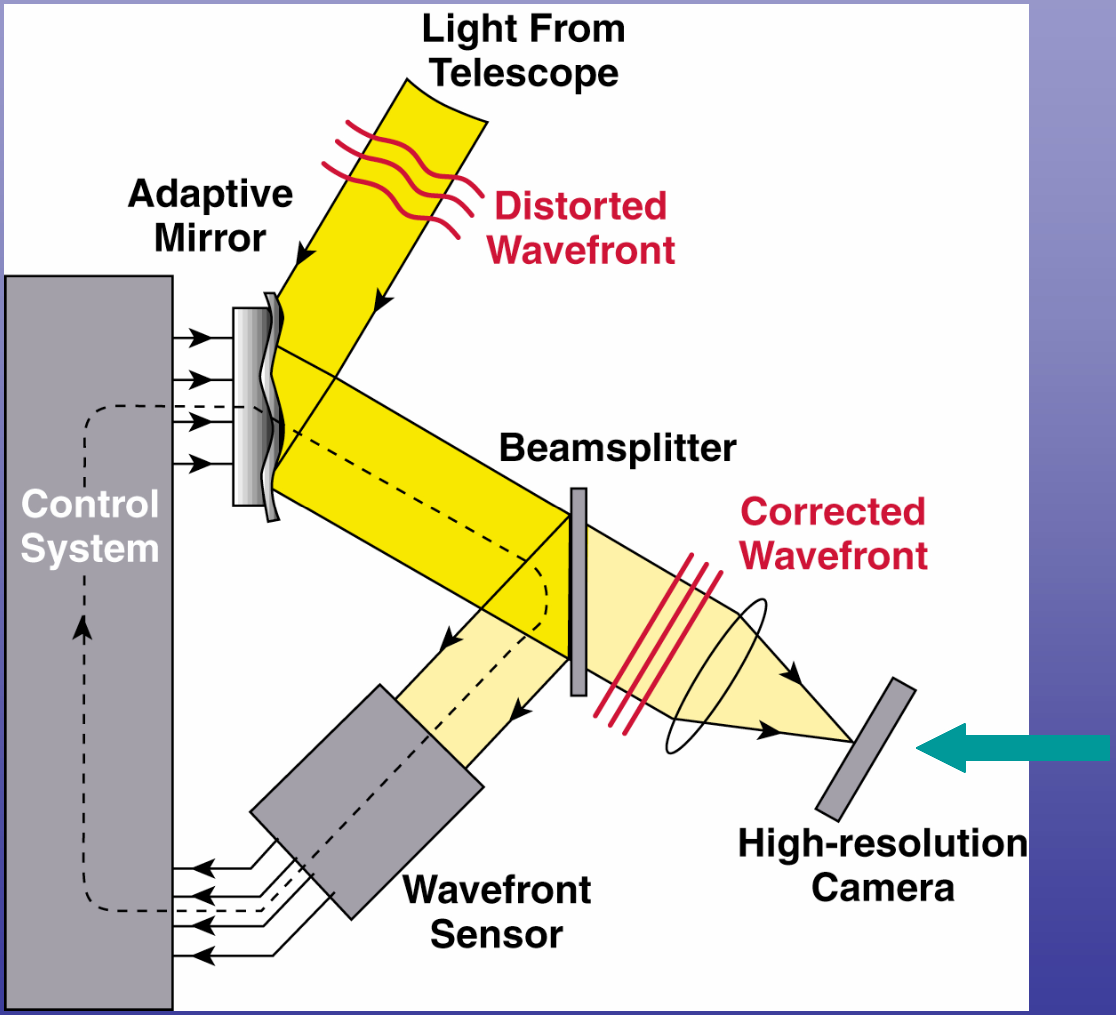
The focal of the telescope doesn't change the resolution limit



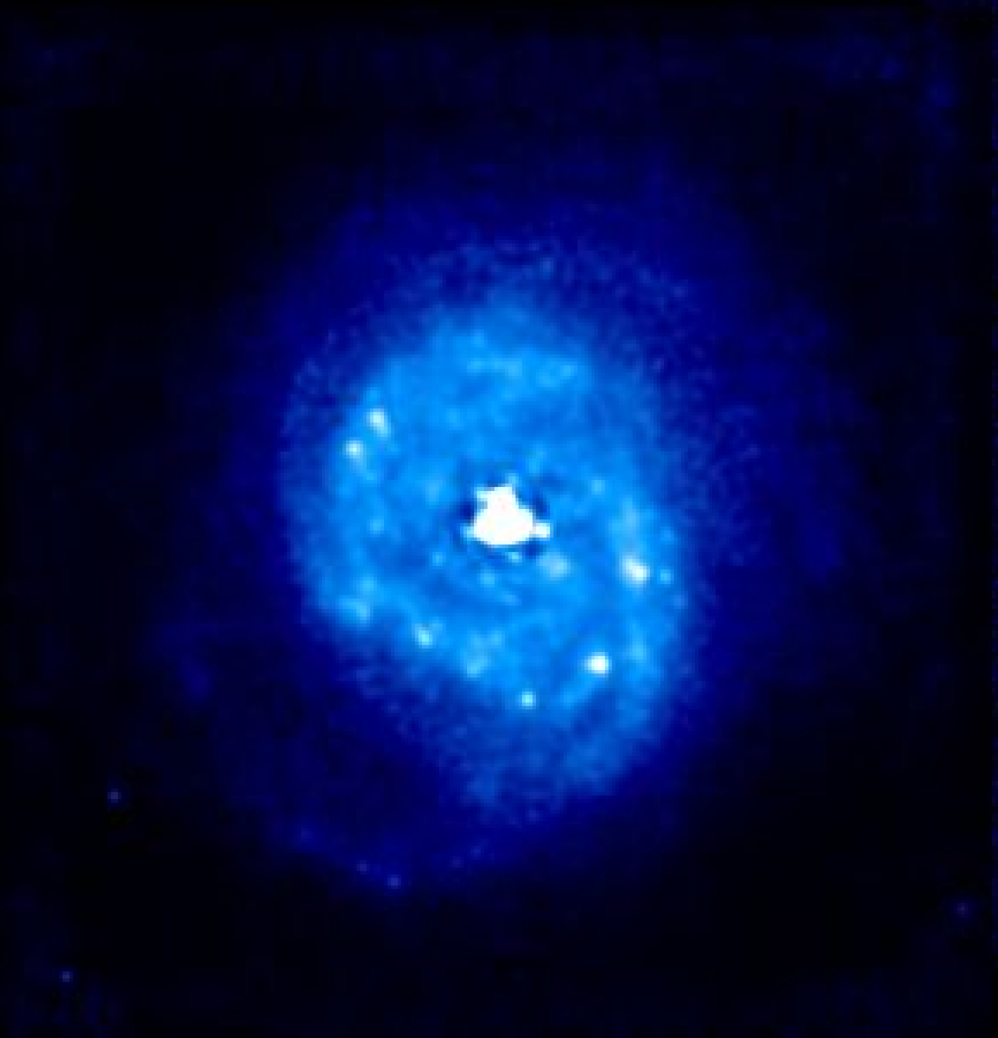
the resolution is limited by atmospheric seeing



The Adaptive Optics System

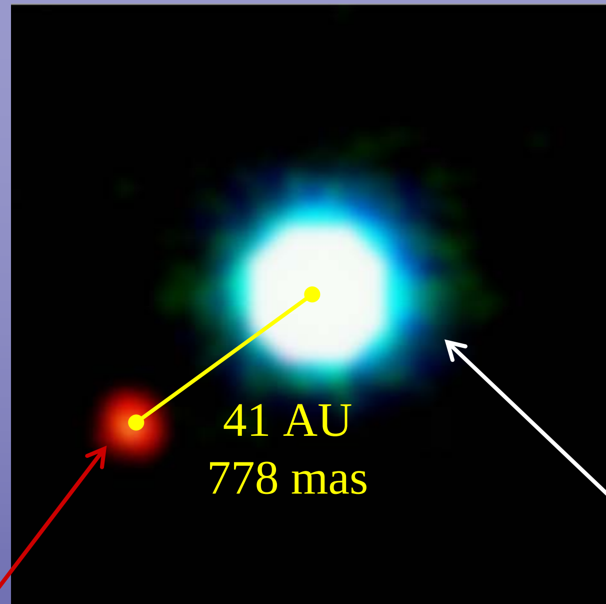


The galaxy NGC 7469 observed with and without Adaptive Optic (PUEO, CFHT)



First image of an exoplanet

(NACO adaptive-optics)



planet

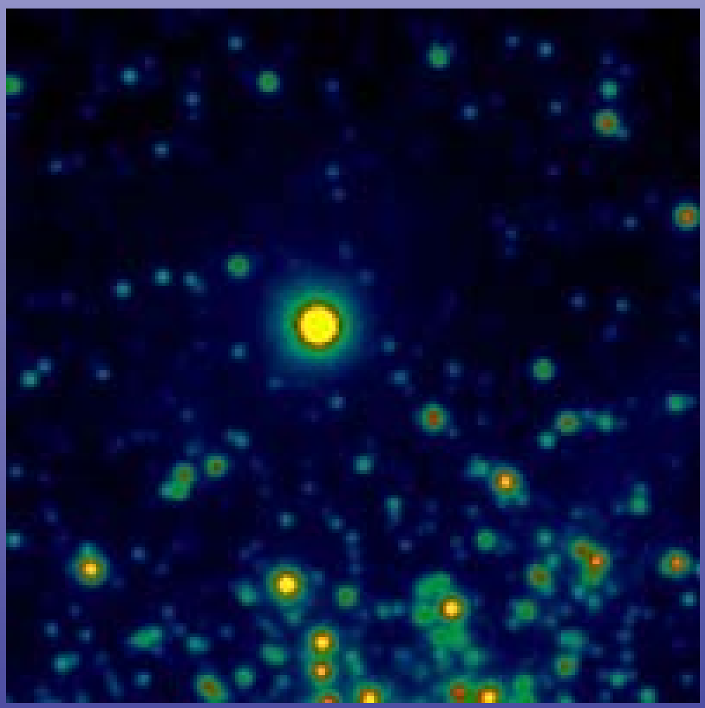
Star (Brown Dwarf)

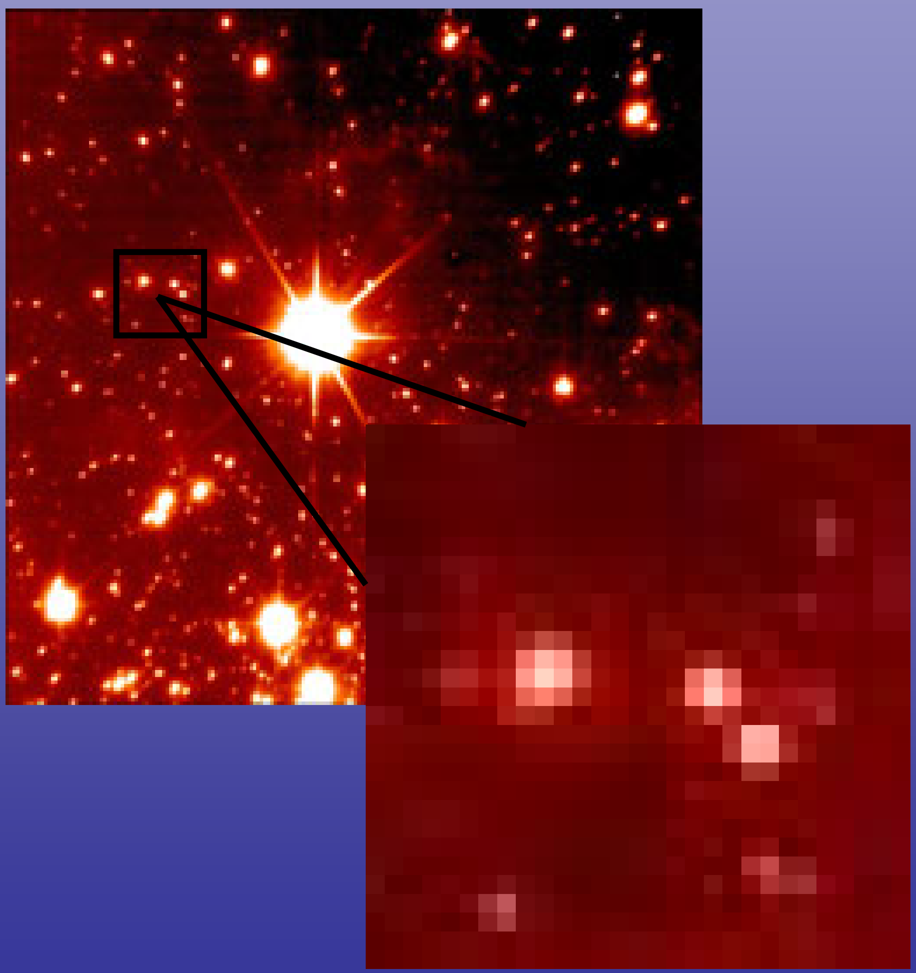
Name	2M1207 b
Discovered in	2004
Mass	5 (± 1) M_J
***-Planet Dist. (proj.)**	41 (± 5) *AU*
Radius	1.5 R_J

Name	2M1207
Distance	53 (± 6) *pc*
Spectral Type	M8
Apparent Magnitude	J = 13.00
Mass	0.025 M_{sun}
Right Asc. Coord.	12 07 33
Decl. Coord.	-39 32 54

CHAUVIN G., et al. 2004, A&A, 425, L29

The limit of the adaptive optics





All the things we know about stars and exoplanet come from the spectroscopy

ELODIE spectrum

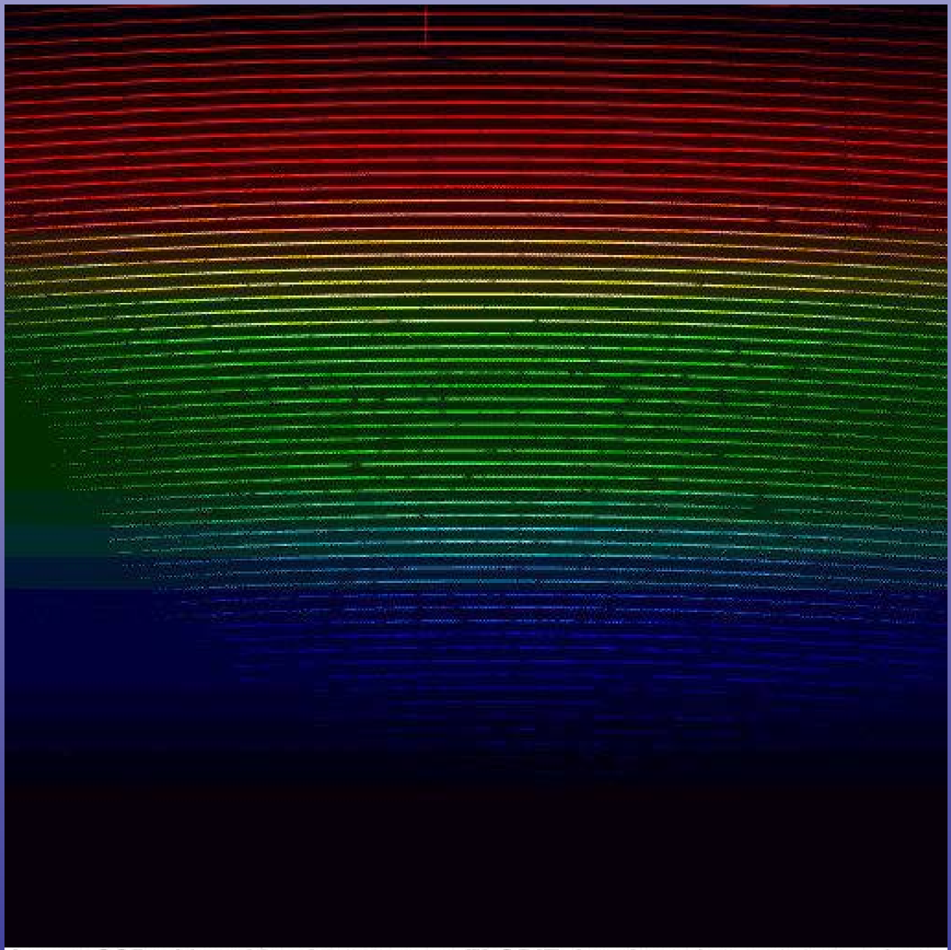
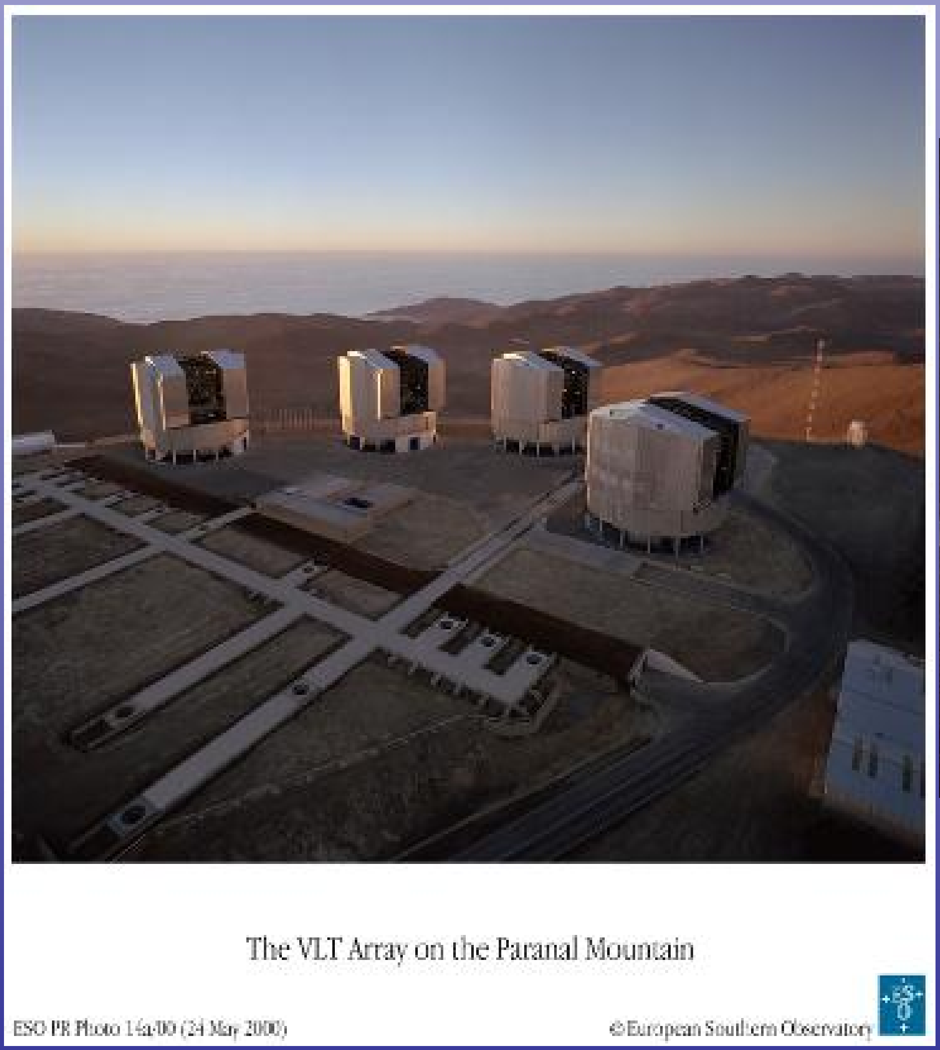
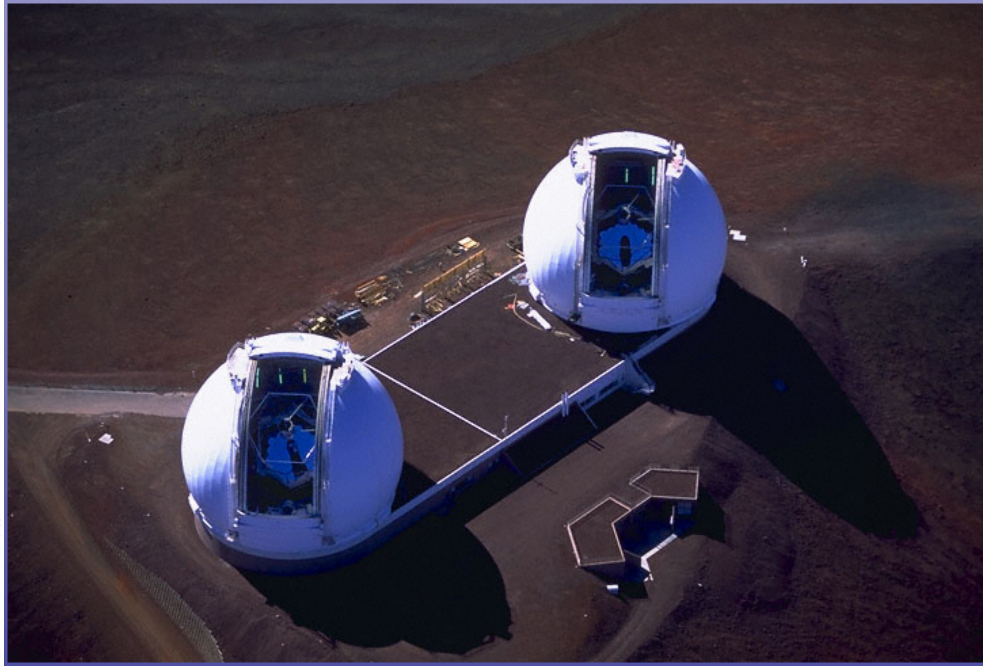


Image CCD 1024x1024 obtenue avec ELODIE. Les 67 ordres correspondant à la fibre étoile sont visibles. Les couleurs affichés correspondent approximativement au domaine spectral couvert (3850 - 6850 Å).

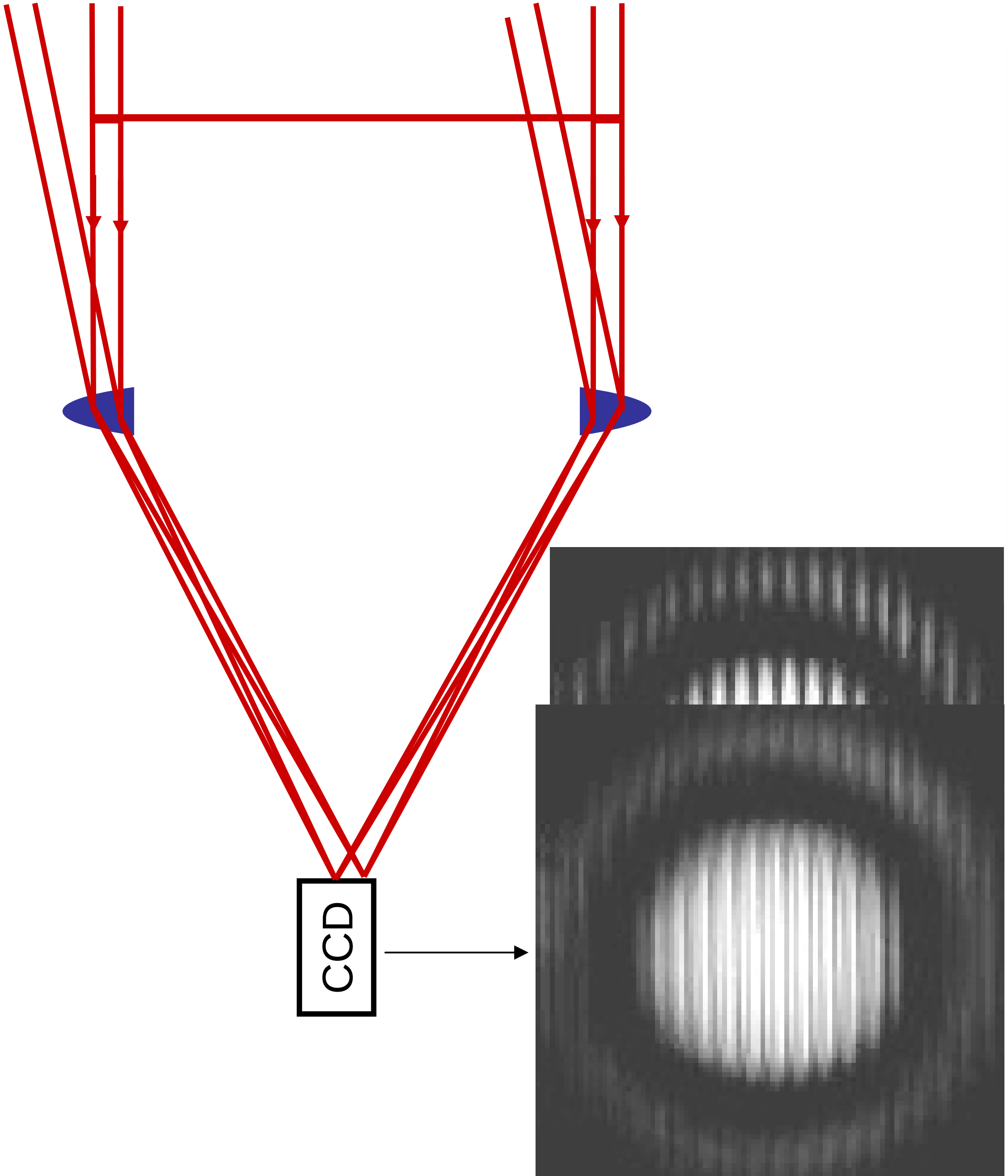
Interferometry

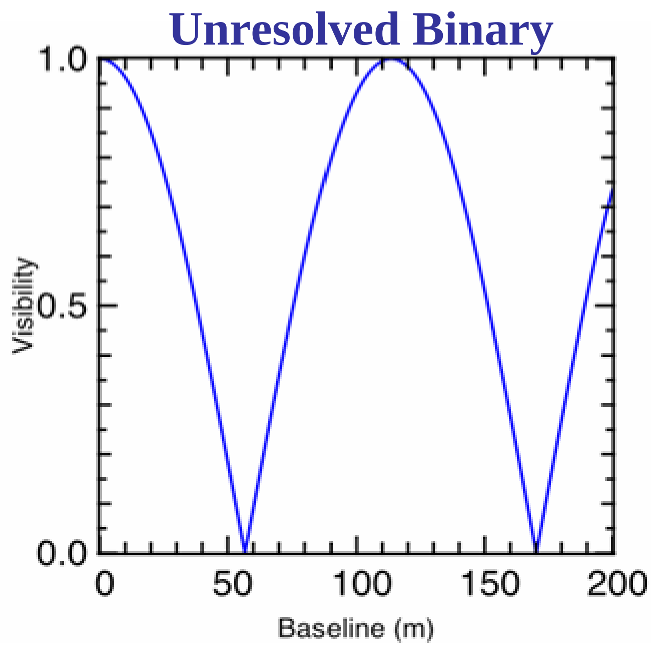
First steps toward the image of stars





Principle of the interferometry

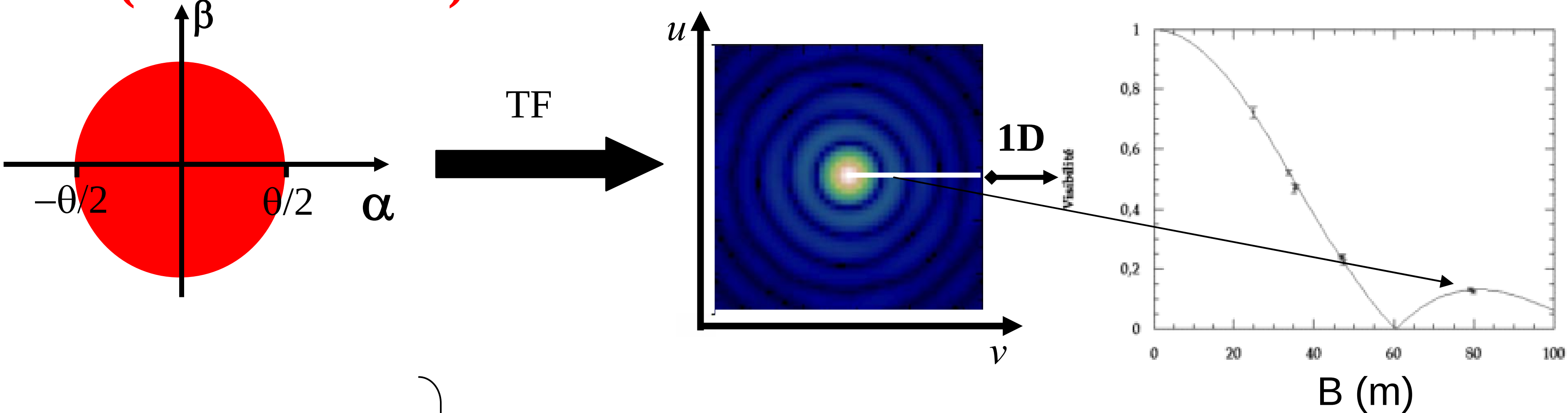




Van-Cittert Zernike theorem

$$V(u,v) = \frac{\int\int I(\alpha,\beta)\exp^{-2i\pi(\alpha u+\beta v)}\,d\alpha d\beta}{\int\int I(\alpha,\beta)d\alpha d\beta}$$

Star (Uniform Disk)



$$I(\alpha,\beta) = Io \text{ if } r = \sqrt{\alpha^2+\beta^2} \leq \frac{\theta}{2}$$

$$I(\alpha,\beta) = 0,\ otherwise$$

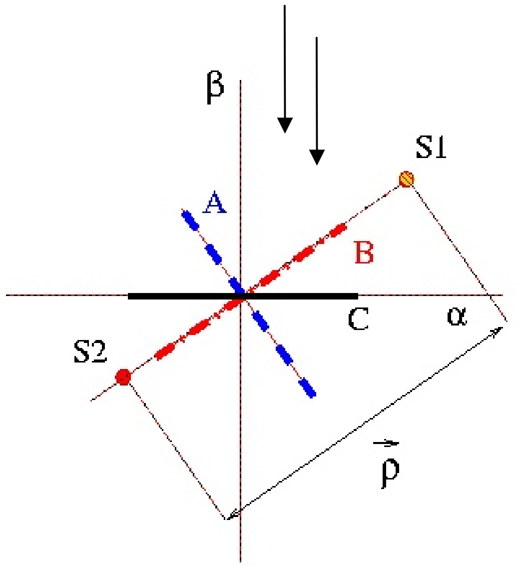
TF

$$V(B) = \frac{J1(\pi\theta B)}{\pi\theta B} \quad \text{with } B = \sqrt{u^2+v^2}$$

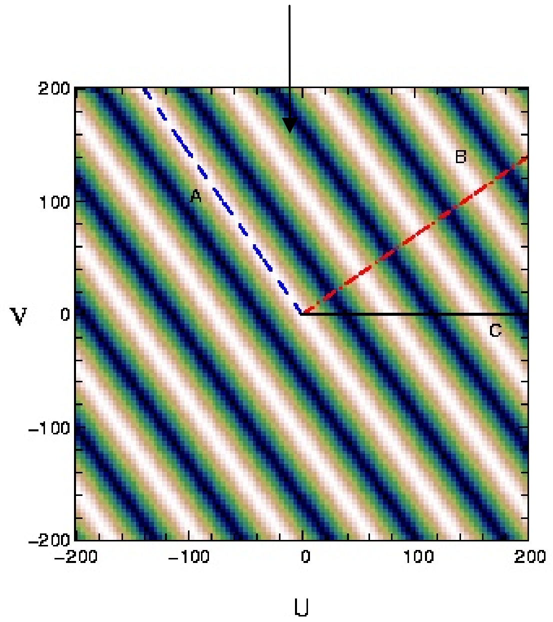
Star diameter: $\theta = 1.22\lambda/B$

Binary (unresolved)

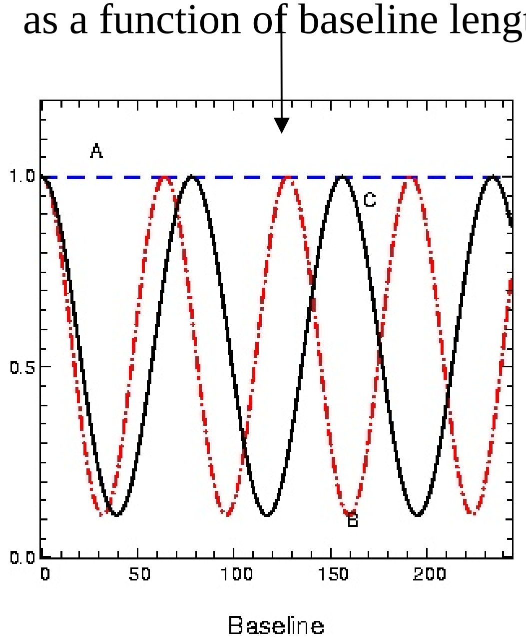
Projection of baseline in the plane of sky



The visibility amplitude squared in (uv) plane

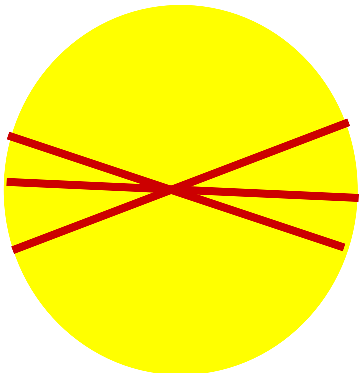


Squared visibility curves for three baselines
as a function of baseline length

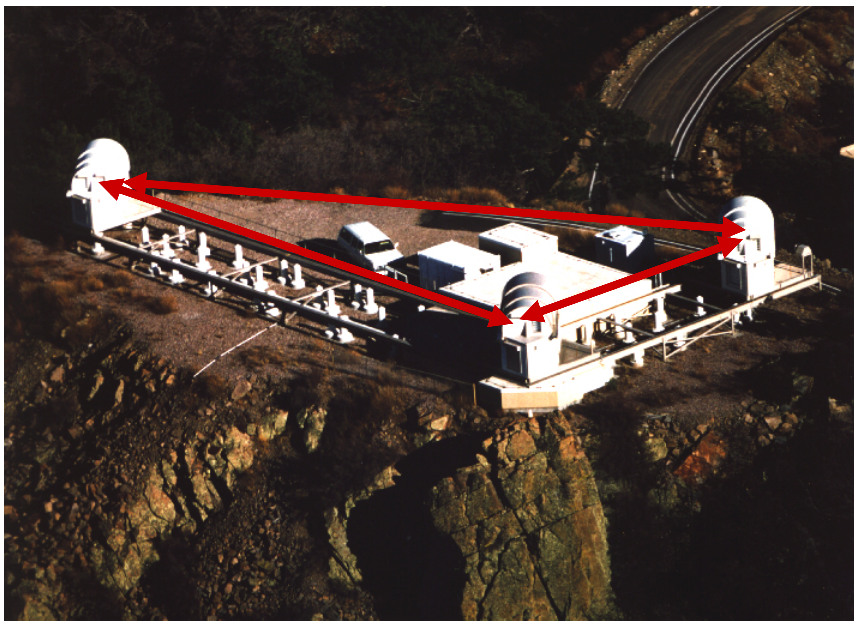


J.P. Berger 2006

Closure Phase



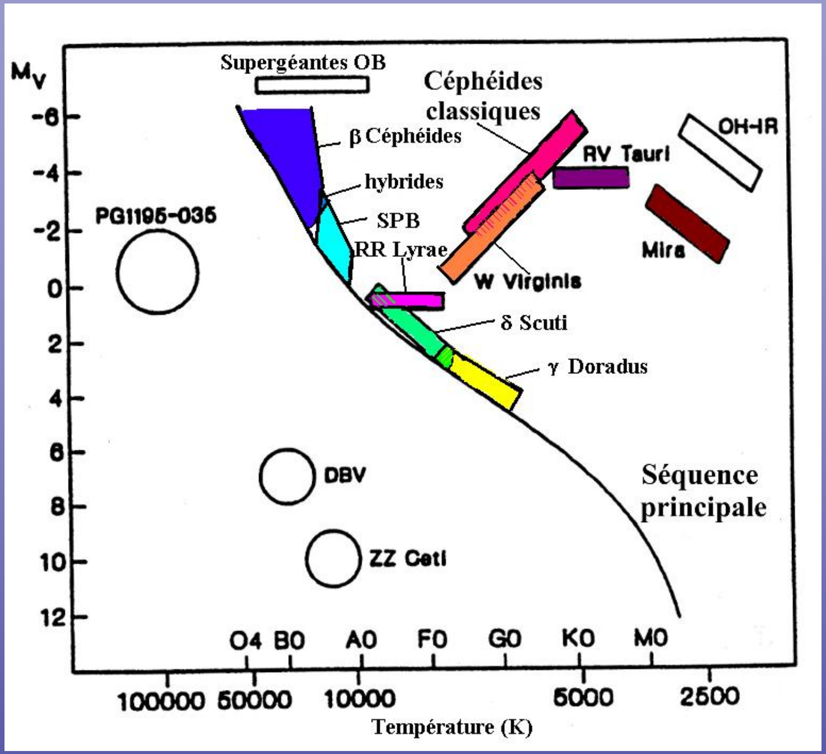
Phase closure :



Observed phases		Star phases		Atmosphere phases
$\Phi(\mathbf{A}-\mathbf{B})$	$=$	$\Phi_{obj}(\mathbf{A}-\mathbf{B})$	$+$	$[\Phi_{atm}(\mathbf{B}) - \Phi_{atm}(\mathbf{A})]$
$+\ \Phi(\mathbf{B}-\mathbf{C})$	$=$	$\Phi_{obj}(\mathbf{B}-\mathbf{C})$	$+$	$[\Phi_{atm}(\mathbf{C}) - \Phi_{atm}(\mathbf{B})]$
$+\ \Phi(\mathbf{C}-\mathbf{A})$	$=$	$\Phi_{obj}(\mathbf{C}-\mathbf{A})$	$+$	$[\Phi_{atm}(\mathbf{A}) - \Phi_{atm}(\mathbf{C})]$

$$\Phi_{\text{clôture}} = \Phi_{obj}(\mathbf{A}\text{-}\mathbf{B}) + \Phi_{obj}(\mathbf{B}\text{-}\mathbf{C}) + \Phi_{obj}(\mathbf{C}\text{-}\mathbf{A}) + \mathbf{0}$$

Observation example of mira stars with IOTA



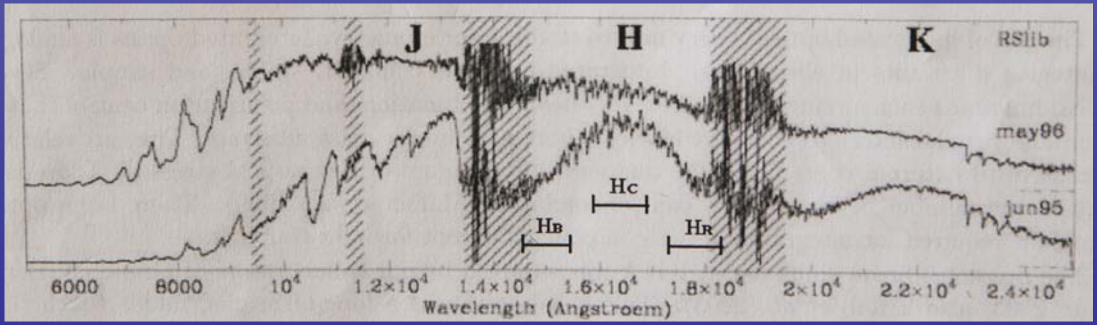
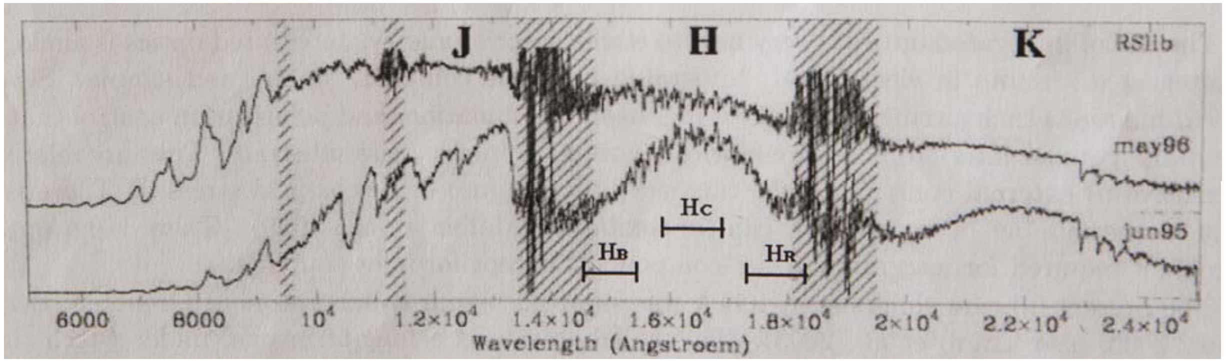


Fig. 1 : Characteristic spectrum of Mira stars (Lancon & Wood 2000)

Les modèles



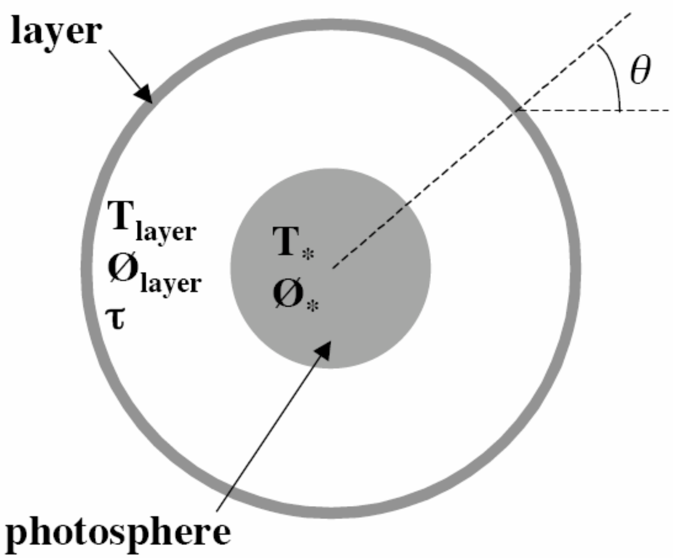
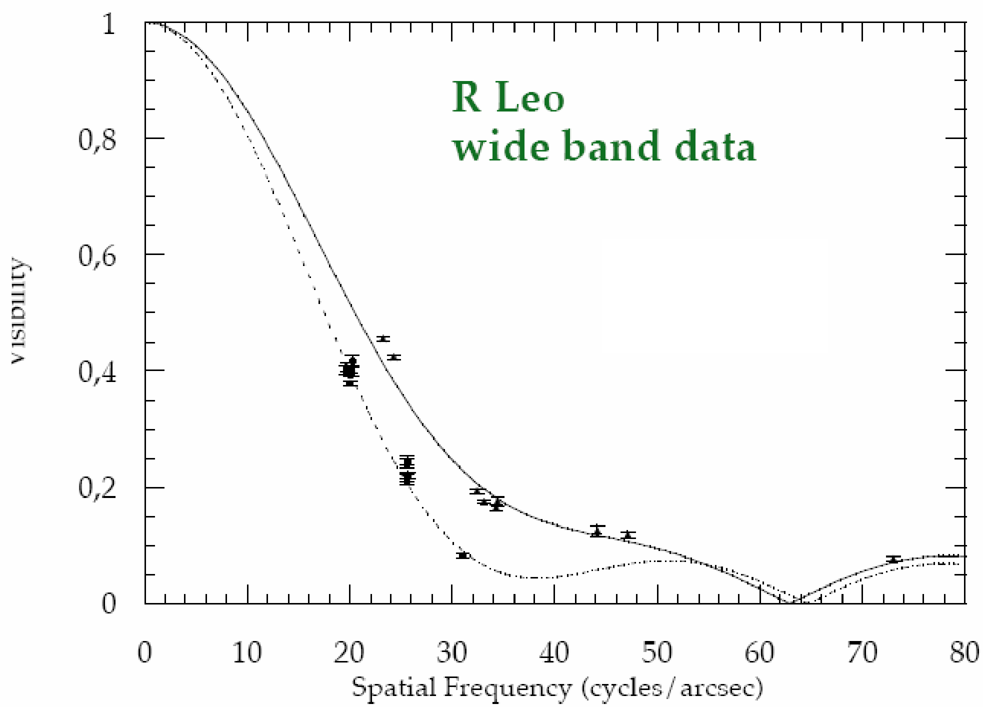


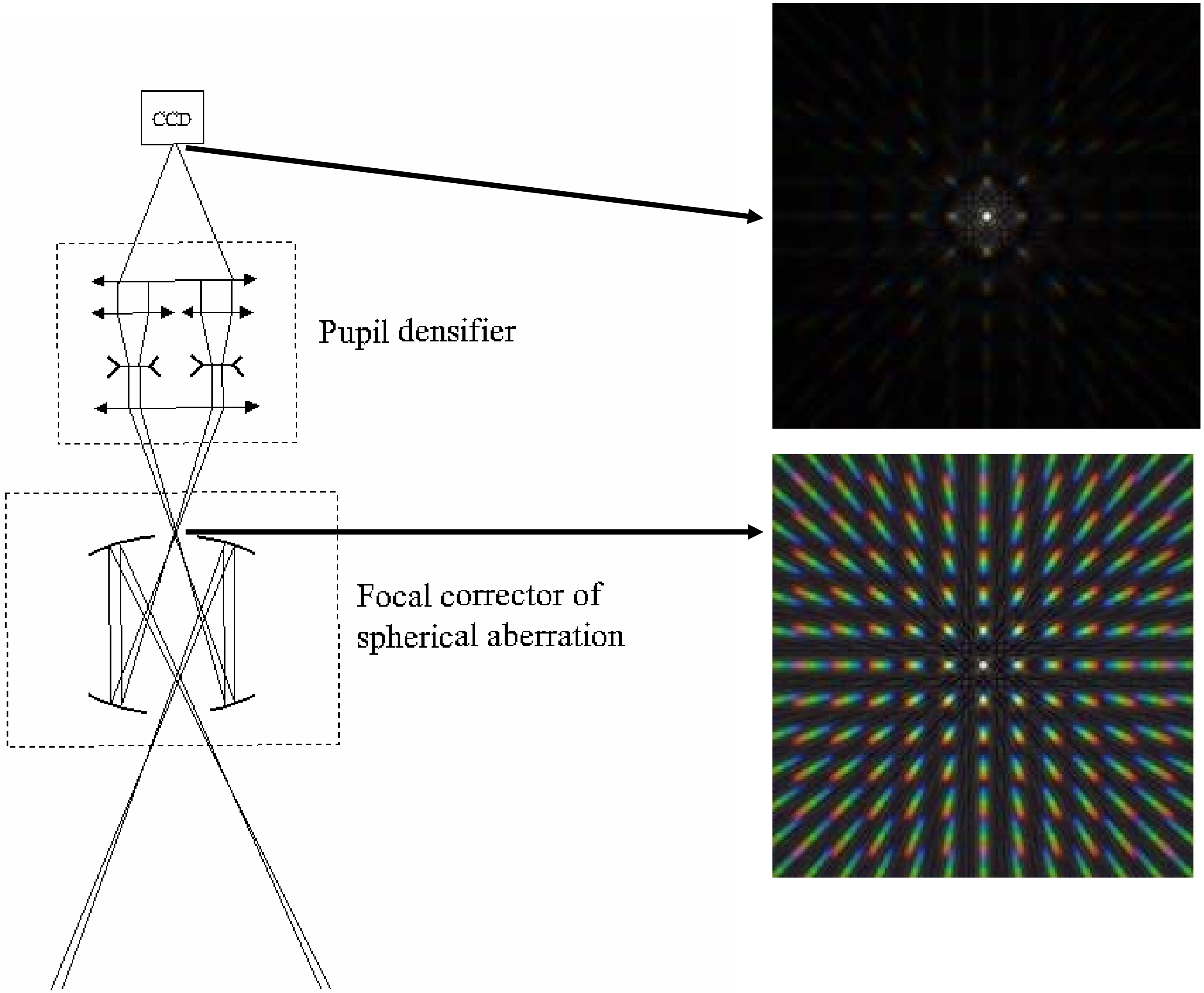
Fig. 2. Model of the star surrounded by a thin molecular layer. θ is the angle between the radius vector and the line of sight at the layer surface.



Perrin et al. 2004, A&A, 426, 279

Carlina

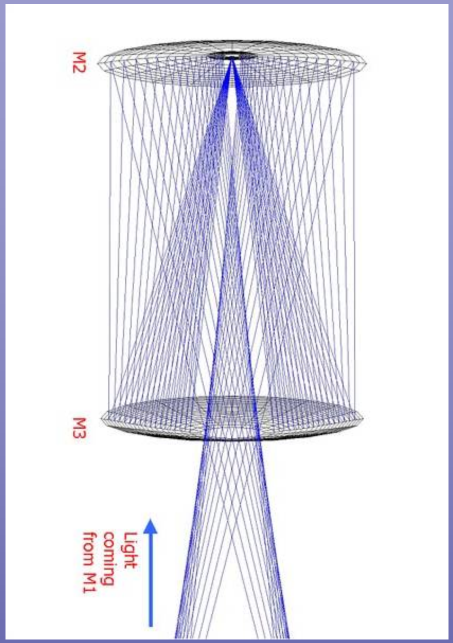
Optics in the gondola

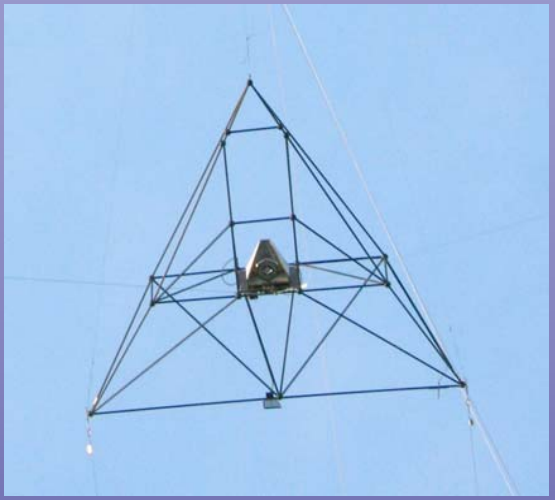


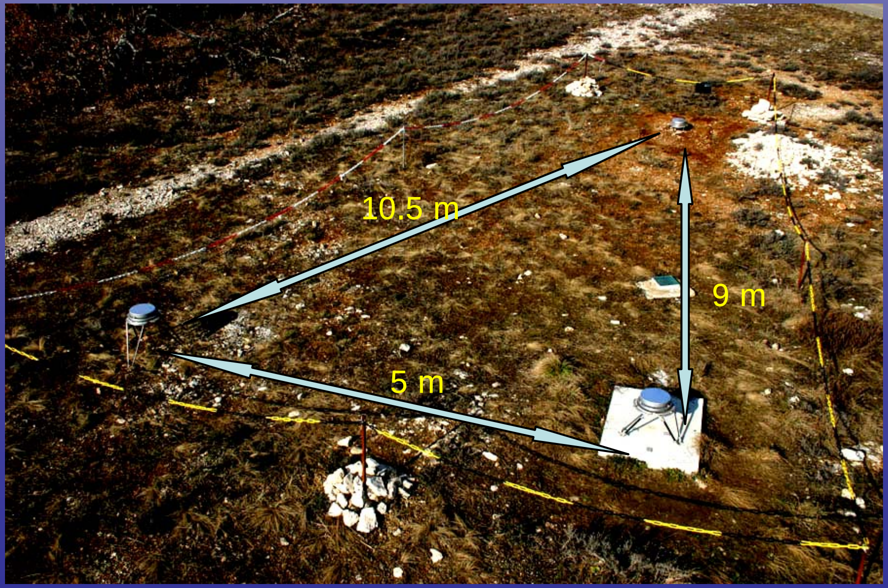

Balloon at 140 m


First fringes
0.5 ’

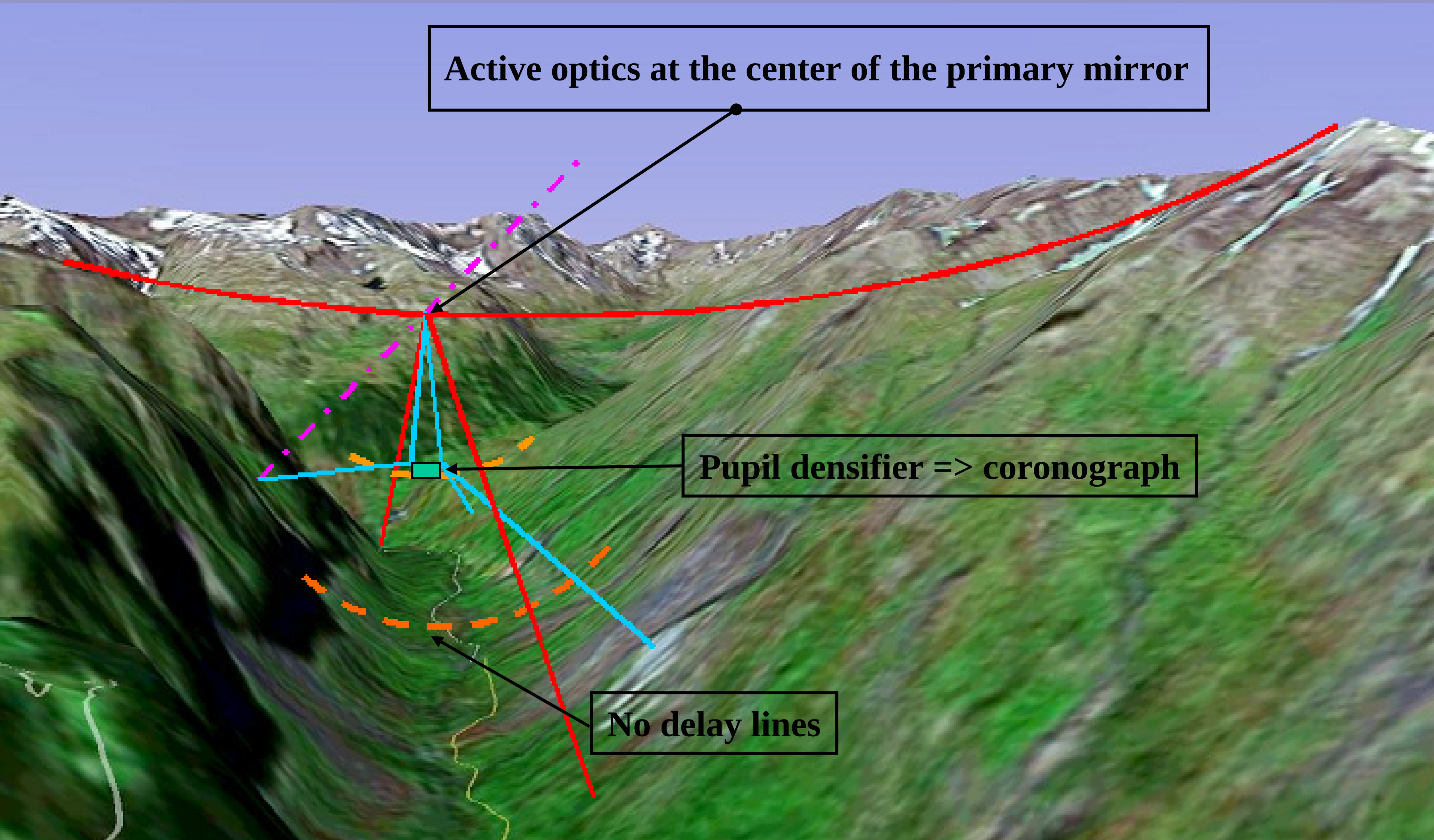
The corrector of spherical aberration (Mertz)







Conclusion



Active optics at the center of the primary mirror
Pupil densifier => coronograph
No delay lines