

# **OPDs, PSFs and Aperture Spatial Resolution and Photometry**

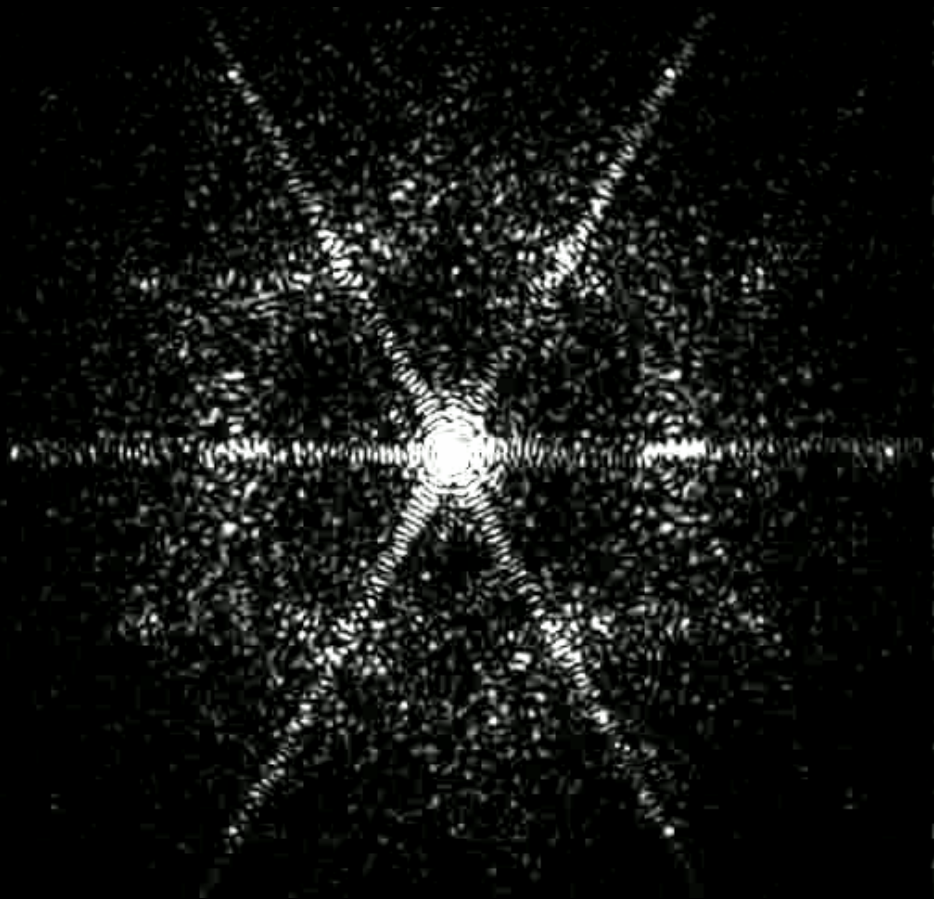
*Arne Ardeberg and Peter Linde  
Lund Observatory*

# **OPD-based K and V band PSF On-axis (Euro50 case)**

**Time sequence: 3 s  
Frame interval: 2 ms**

# OPD-based dynamical PSFs (Euro50)

Time sequence interval: 2 ms FOV: 1.2 arcsec On-axis Adaptive optics optimised for K-band



K-band (2200nm)

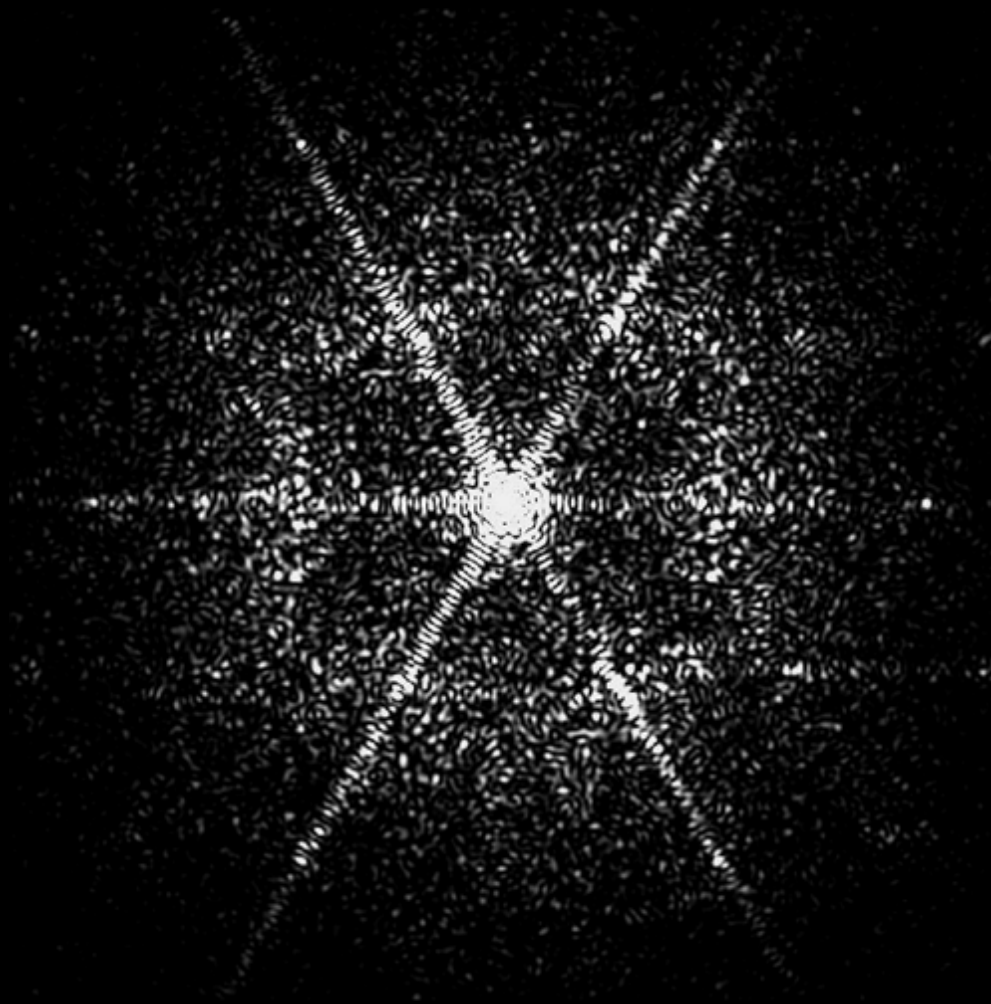


V'-band (550nm)

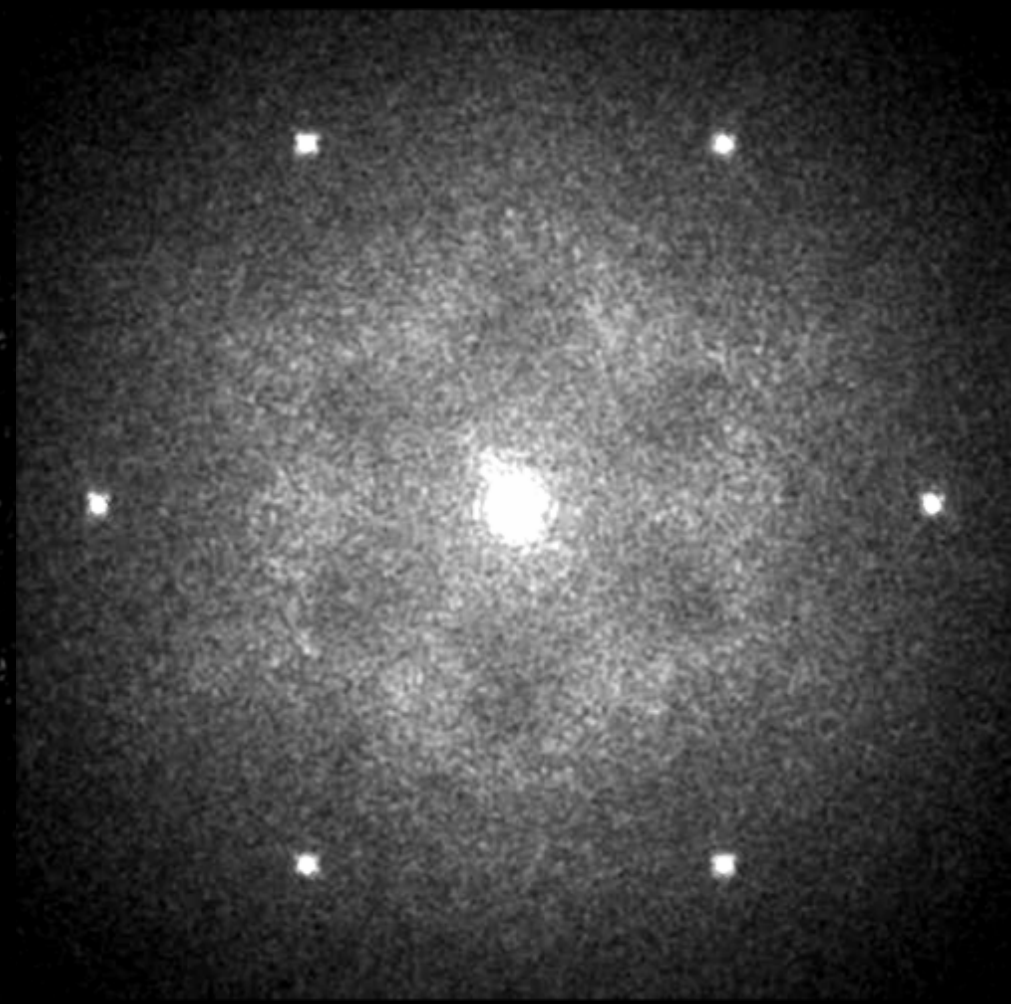
Monochromatic

# OPD-based point spread functions (Euro50)

Average of 1500 images FOV=1.2 arcsec



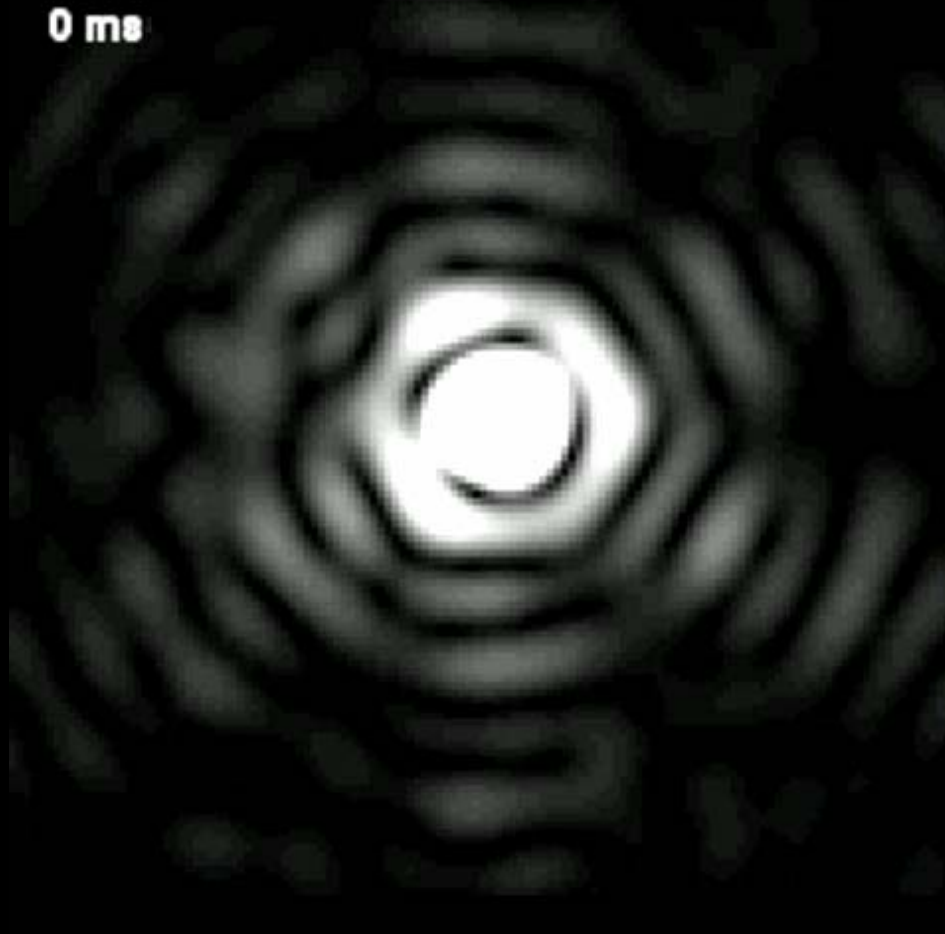
K-band (2200nm)



V'-band (550nm)

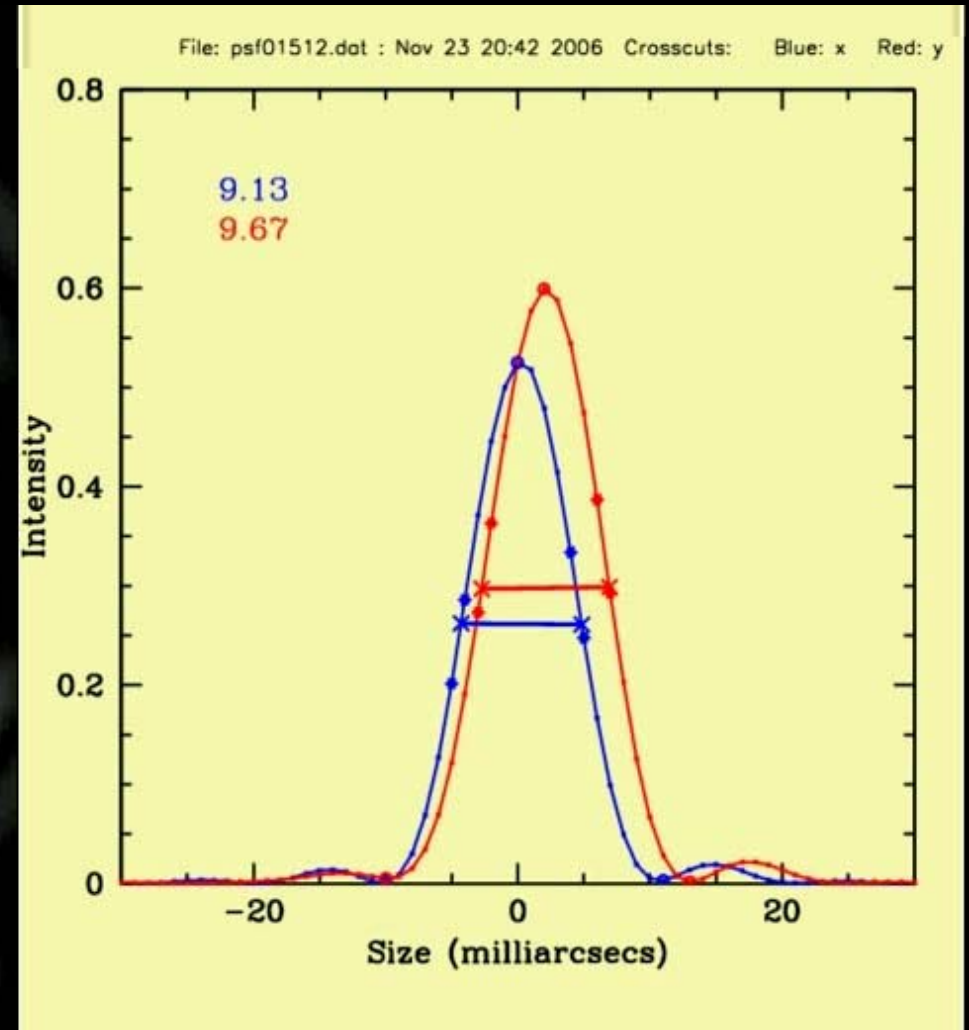
# OPD-based dynamical PSFs (Euro50)

Time sequence interval: 2 ms Adaptive optics optimised for K-band



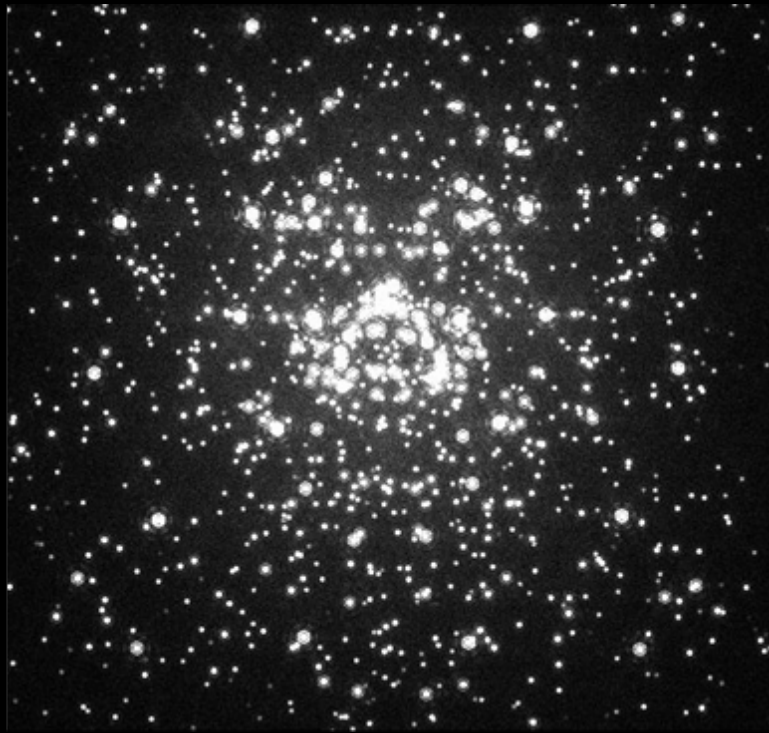
K-band core

FOV=0.13 arcsec

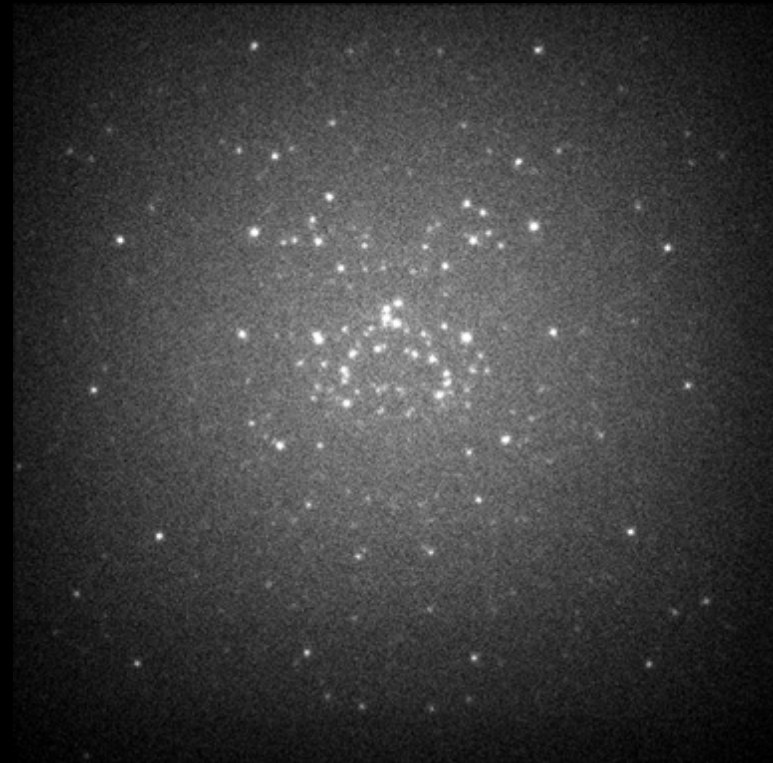


K-band cuts in x and y

# OPD-based cluster images (AO for K-band)



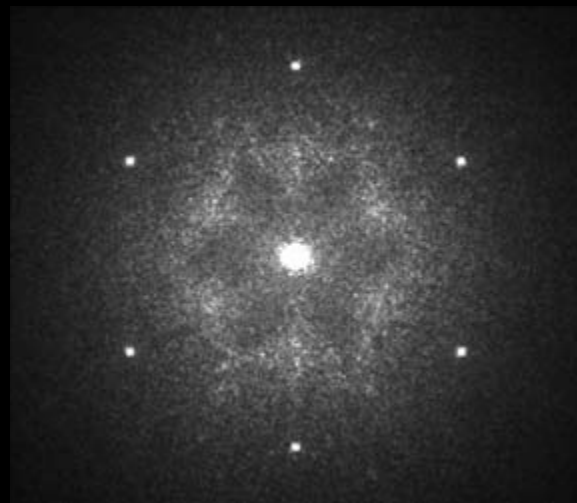
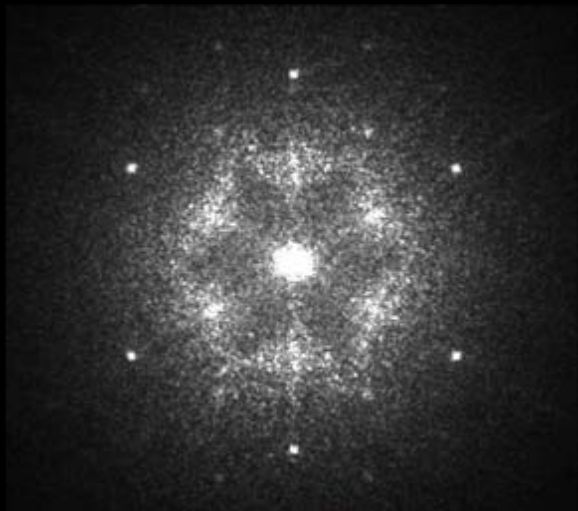
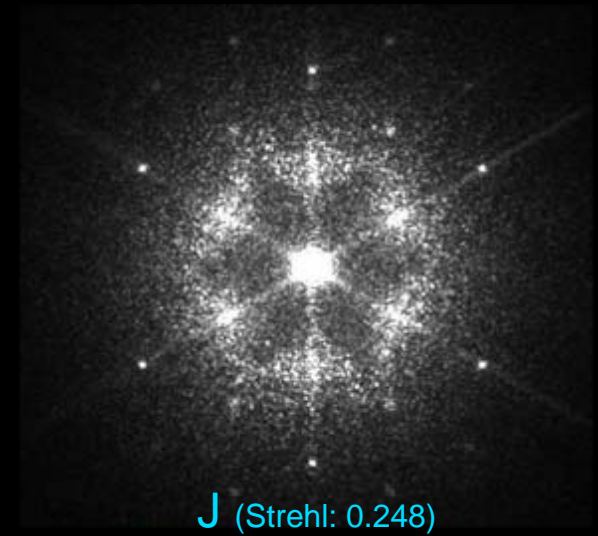
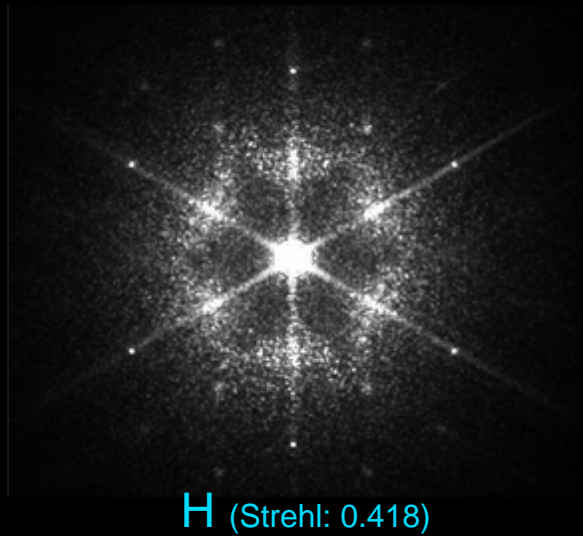
K-band



V-band

PSF performance in VRIJH bands with  
Adaptive Optics optimised for K band

# PSFs in different bands, AO in K band (time averaged) (Euro50)





# VRIJHK PSFs; average of 300 OPDs; AO in Kband



GIF

animation

Wavelength

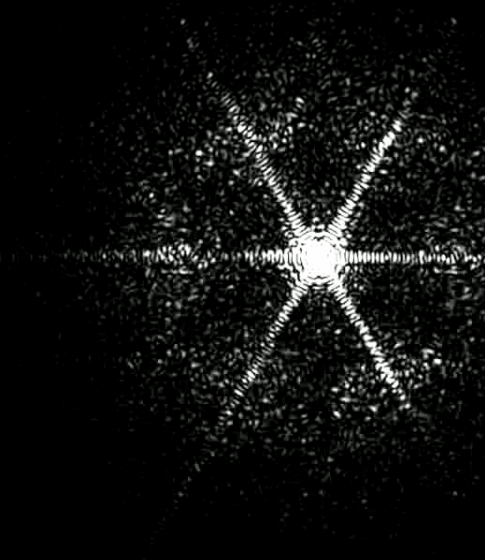
scaling

included

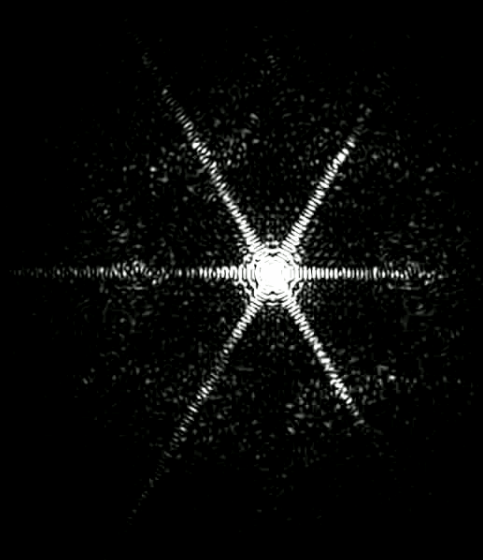
PSFs in the  
L, M and N bands

# L, M and N PSFs (time sequence, AO in K band)

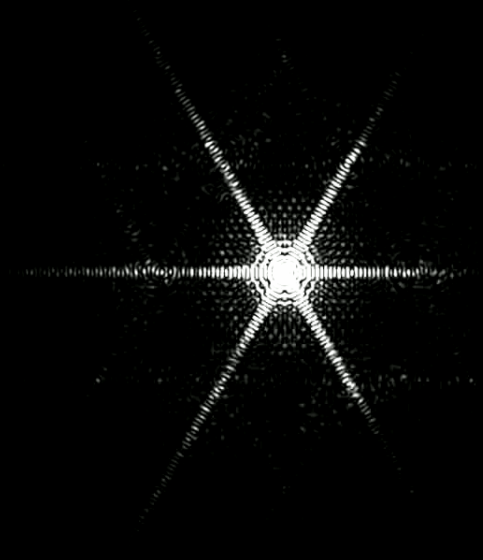
Time sequence interval: 2 ms FOV: 1.2 arcsec On-axis AO optimised for K-band (Euro50)



L band

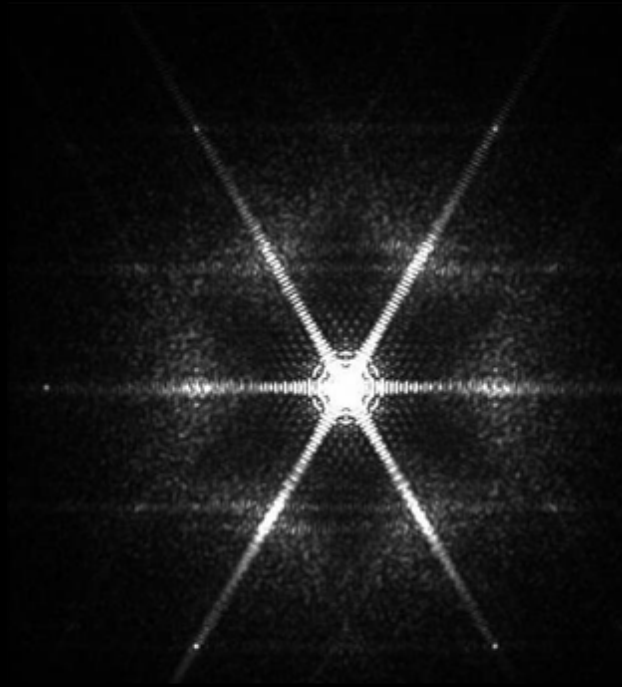


M band

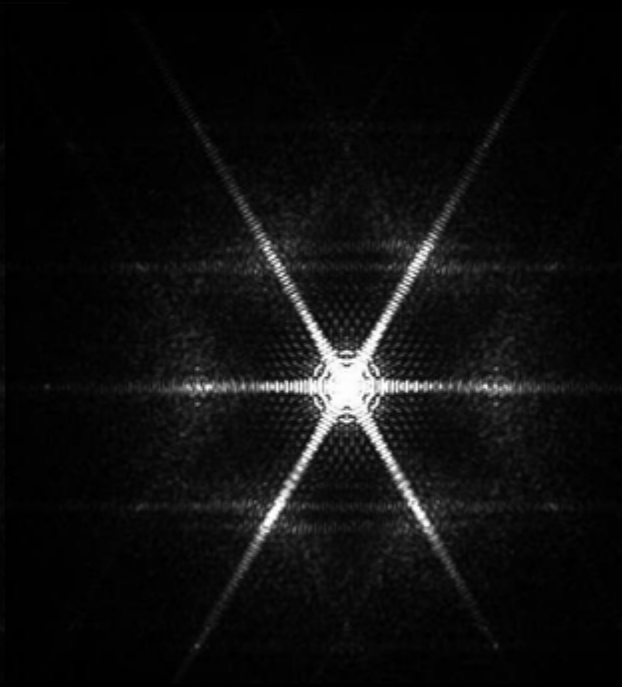


N band

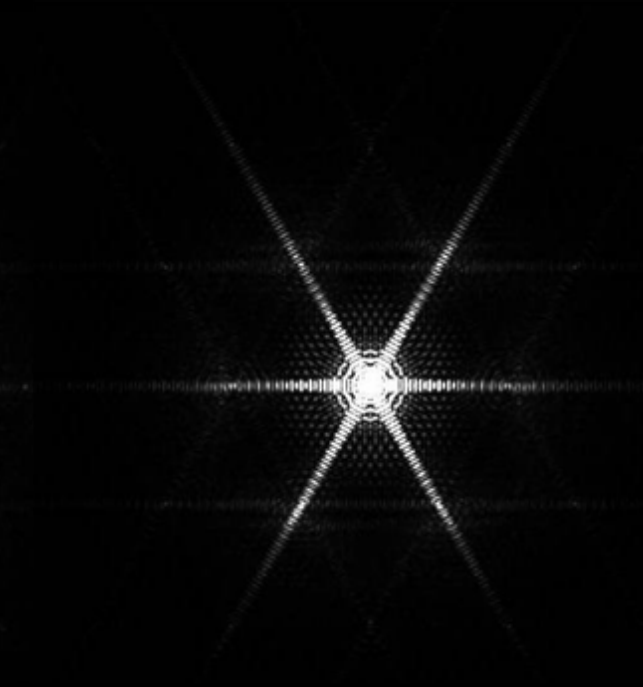
# L, M and N PSFs (time averaged, AO in K band)



L

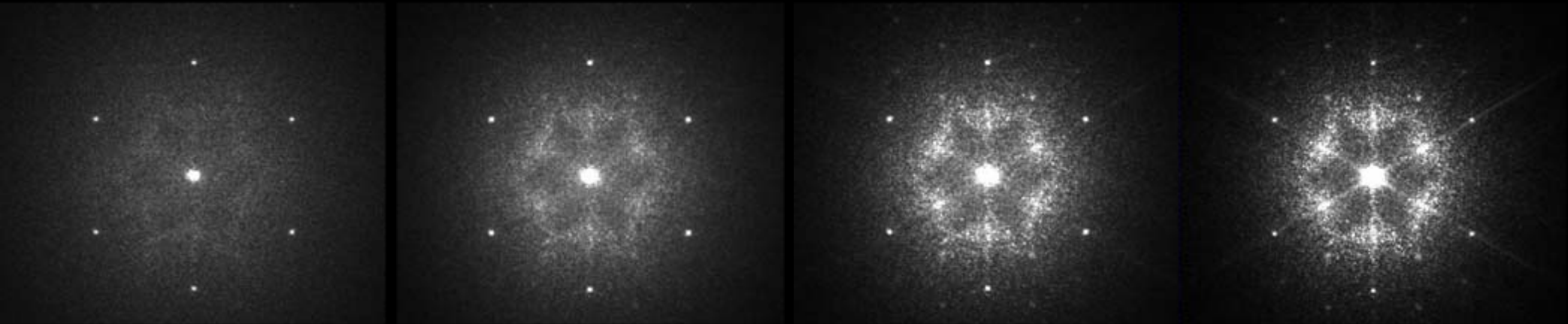


M



N

# OPD-based averaged PSFs: Johnson bands (Euro50)

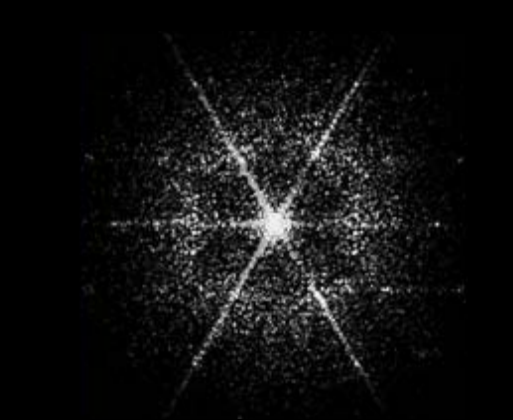


V (550nm)

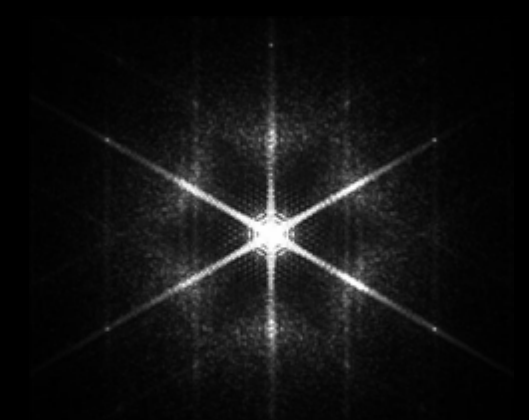
R (700 nm)

I (900 nm)

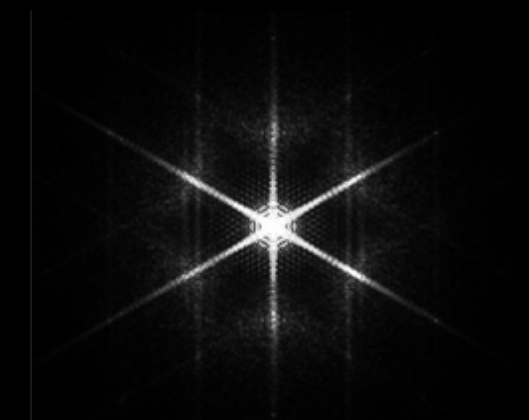
J (1250 nm)



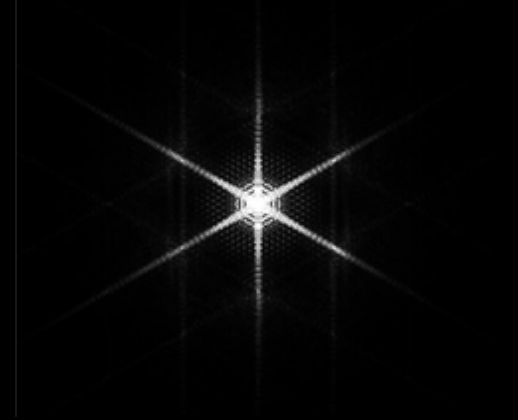
K (2200nm)



L (3400 nm)

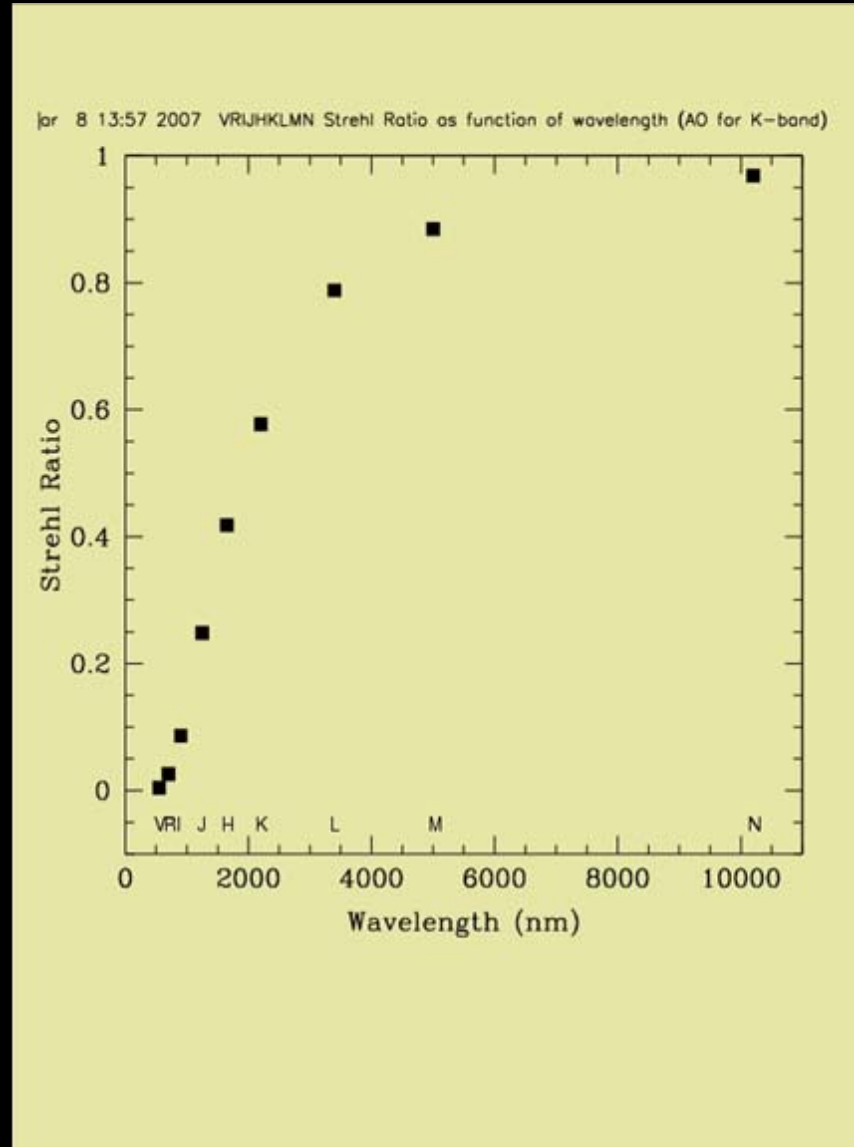


M (5000 nm)



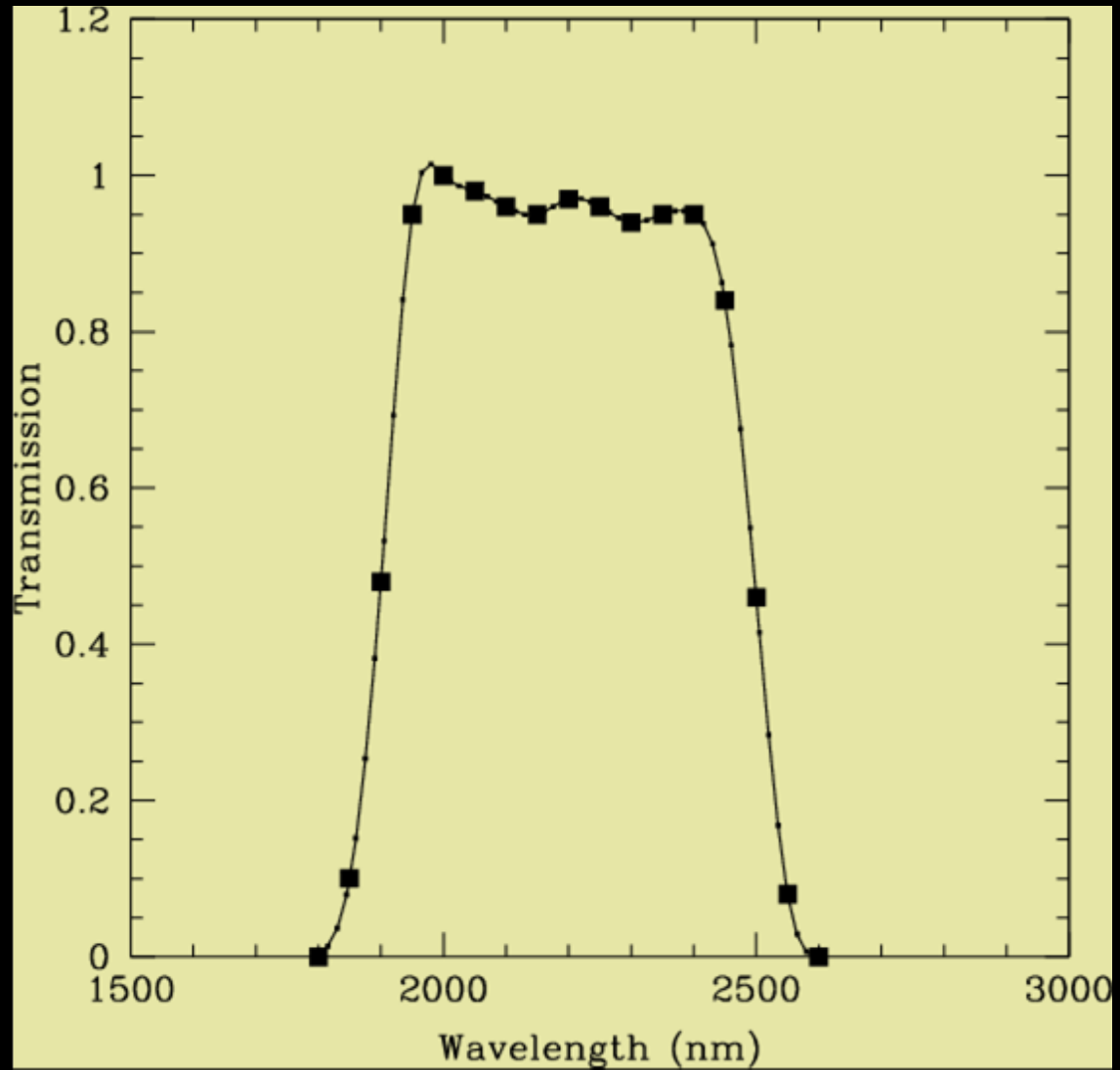
N (10200 nm)

# Strehl Ratio as a function of wavelength (AO in K band)



Averaging over the K band

# K filter transmission curve



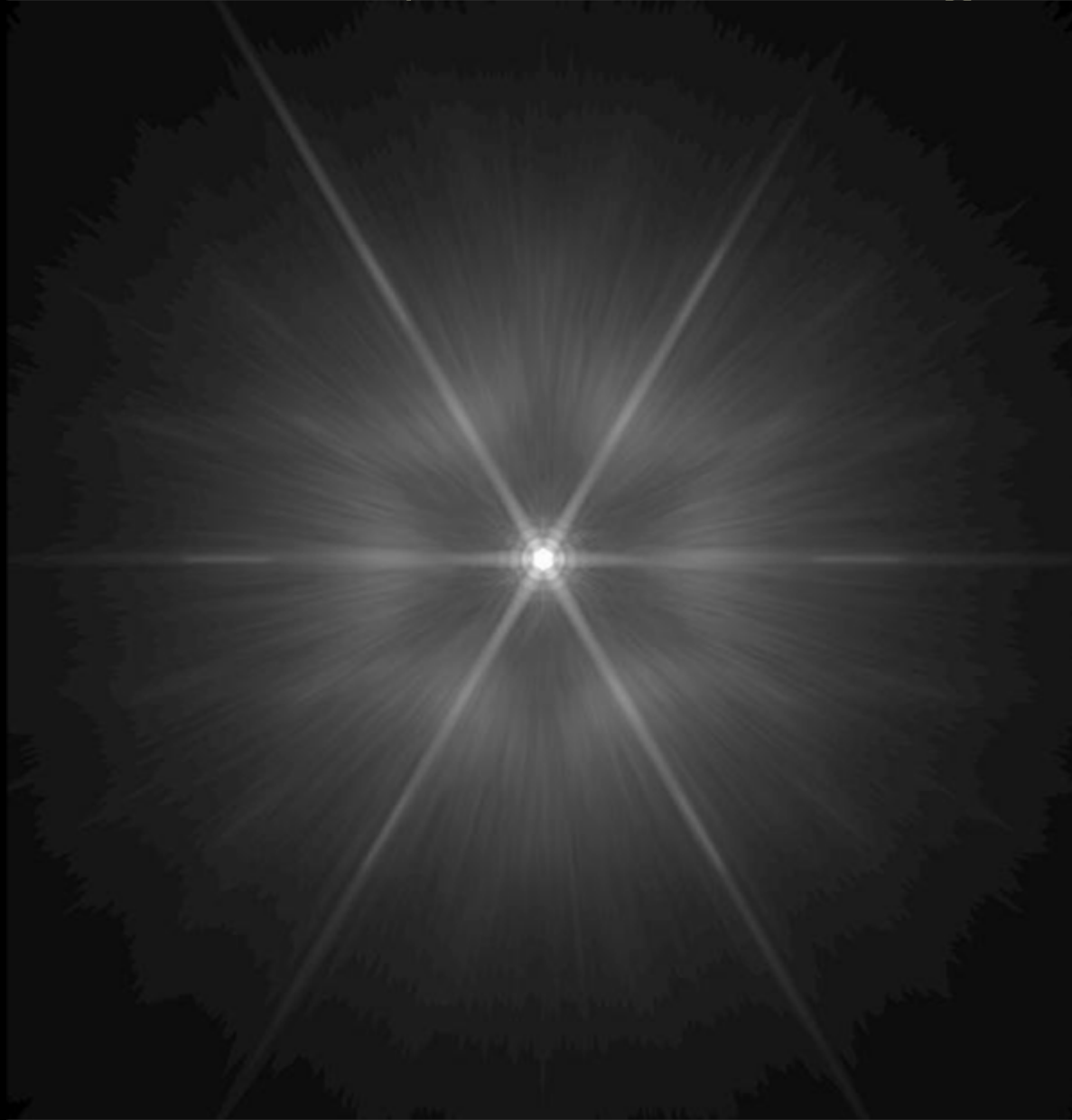


# Euro50 K-band PSF (time and wavelength averaged)



Weighted filter,  
54 points with  
15 nm interval  
(Asiago)  
1500 OPDs (3  
seconds)  
Strehl: 0.60  
Linear grey  
scale

# Euro50 K-band PSF (time and wavelength averaged)



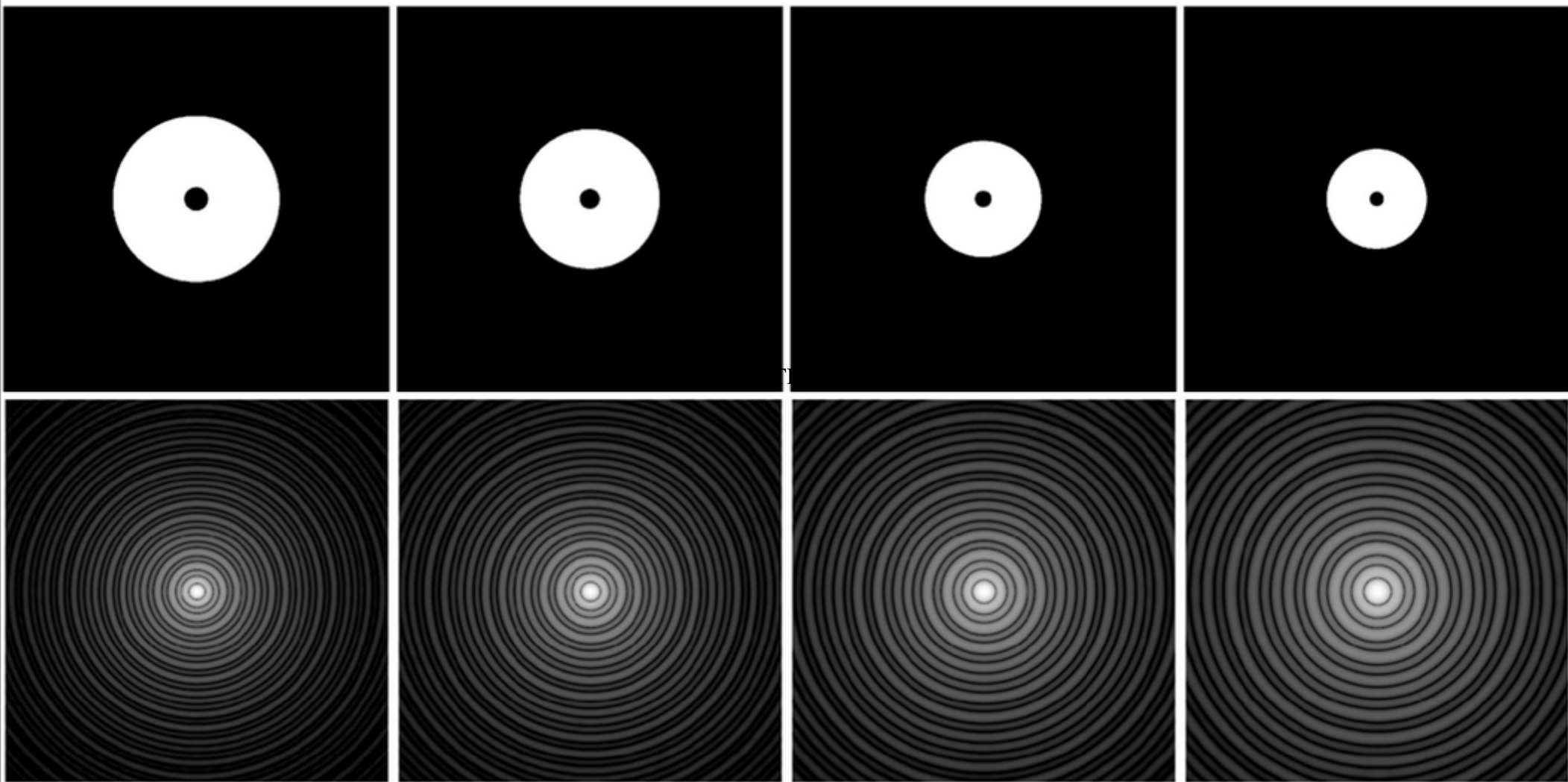
Weighted filter,  
54 points with  
15 nm interval  
(Asiago)  
1500 OPDs (3  
seconds)  
Strehl: 0.60  
Log grey scale

# Conversion of OPD-based data to ESO apertures

# Tested aperture configurations

Apertures

(inner hole 1/7 of aperture)



Fourier  
Transforms

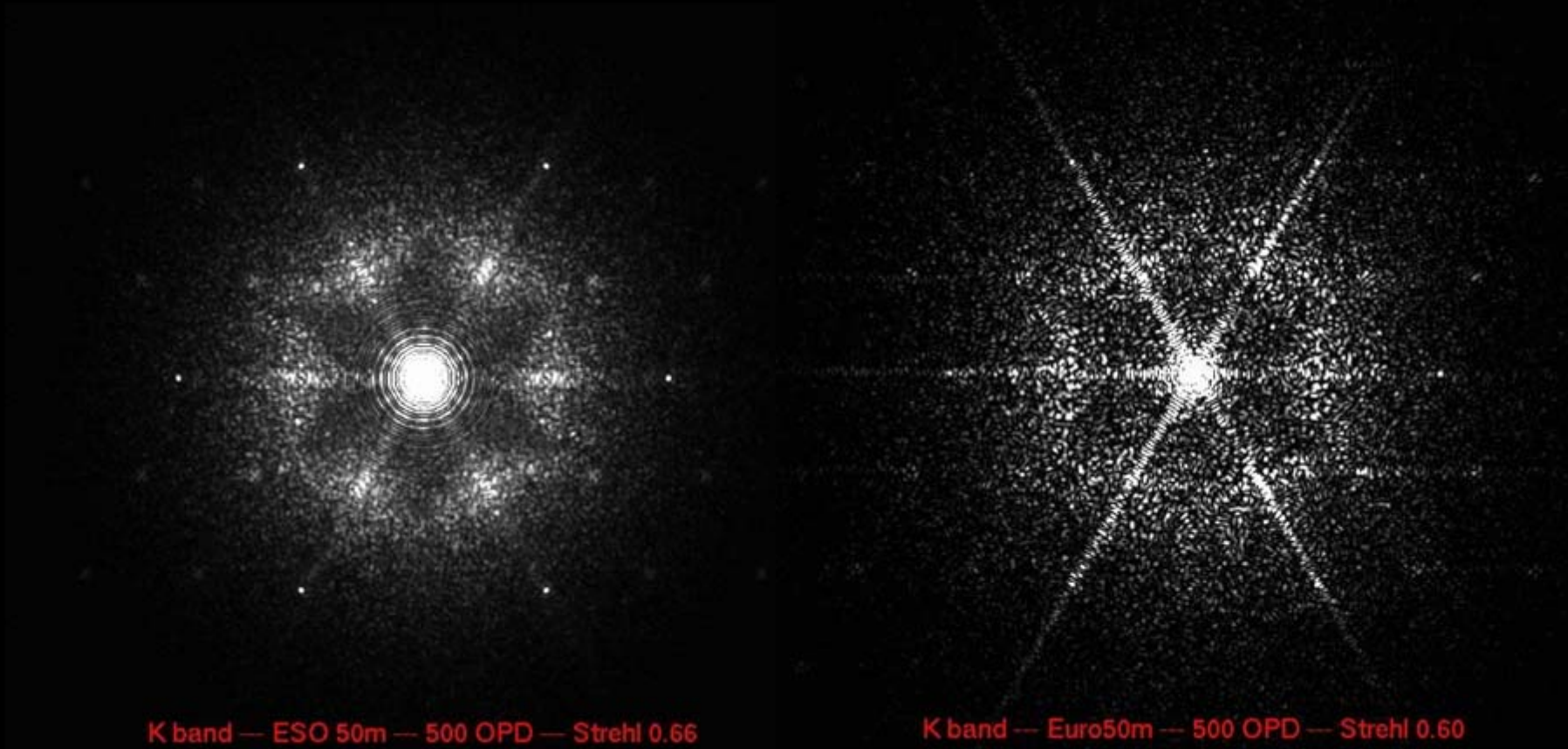
50 m

42 m

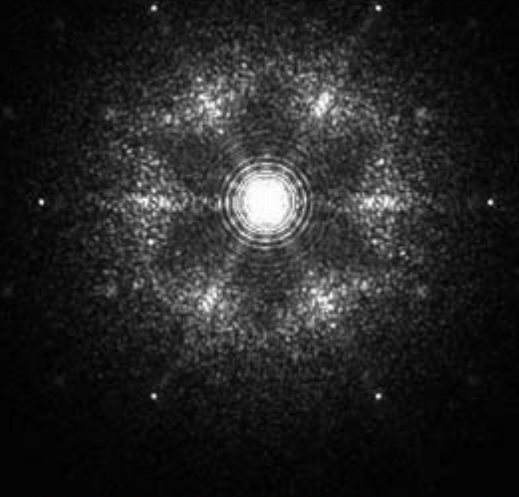
35 m

30 m

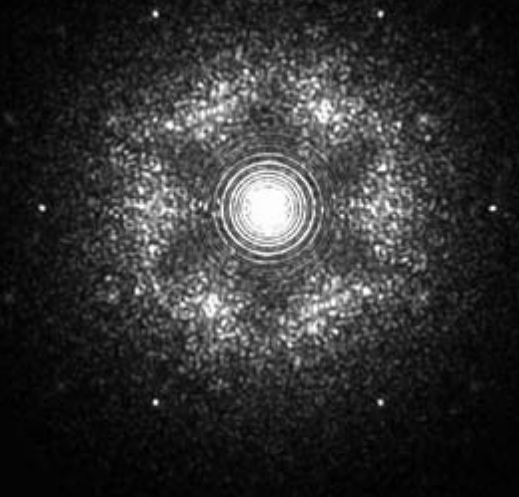
# Round aperture vs. hexagonal (50m, time averaged)



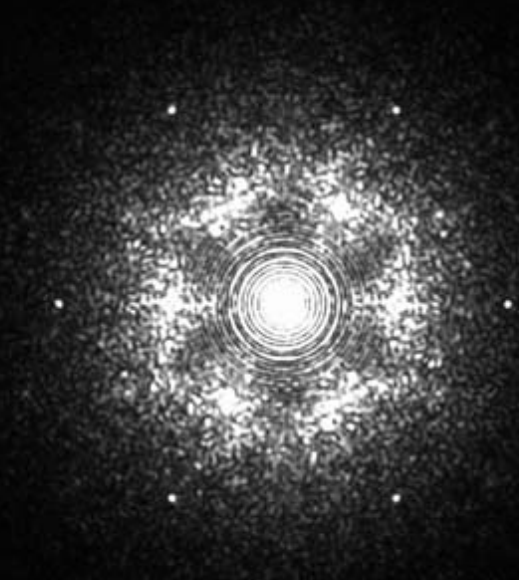
# Resulting ESO PSFs (time averaged)



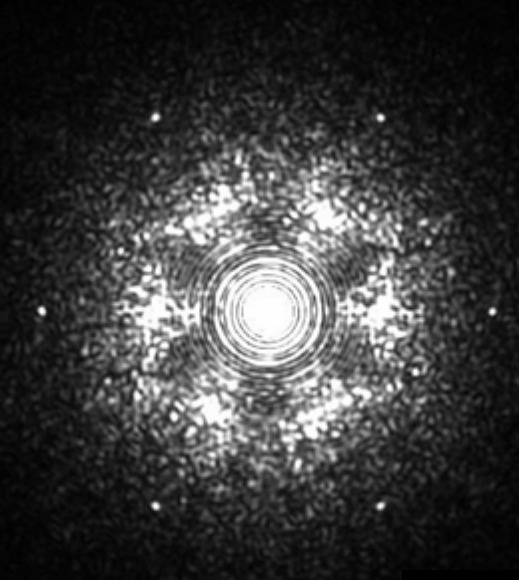
K band — ESO 50m — 500 OPD — Strehl 0.66



K band — ESO 42m — 500 OPD — Strehl 0.71



K band — ESO 35m — 500 OPD — Strehl 0.71



K band — ESO 30m — 500 OPD —

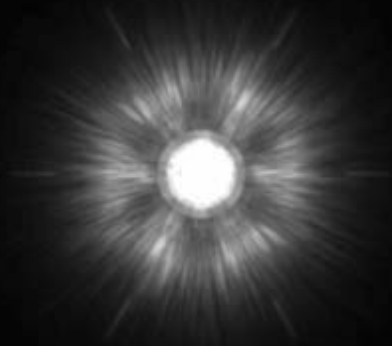
# Comparison Euro50 ESO50 ESO42 ESO35 ESO30

K band --- Euro50m --- 500 OPD --- Strehl 0.60

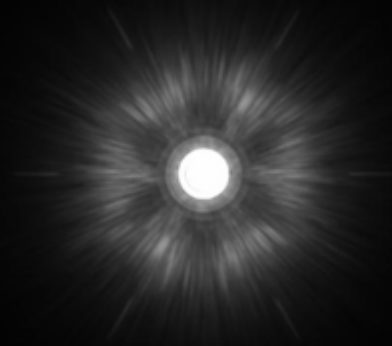
Euro50 OPD-data combined  
with ESO round apertures  
time and wavelength averaged



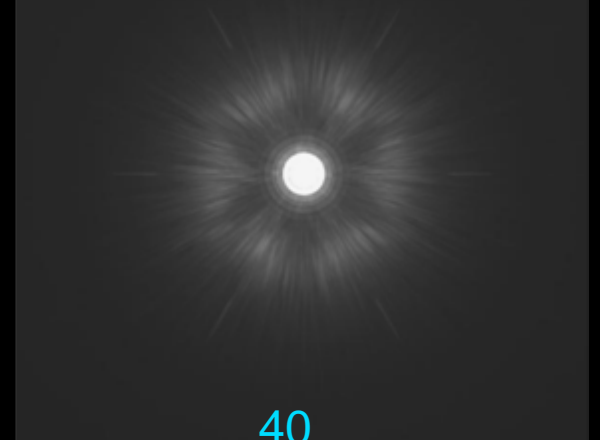
# OPD-based PSFs: 3 sec integration, K full band



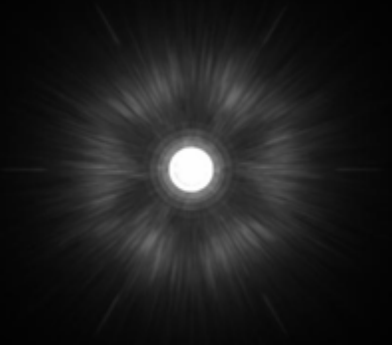
30



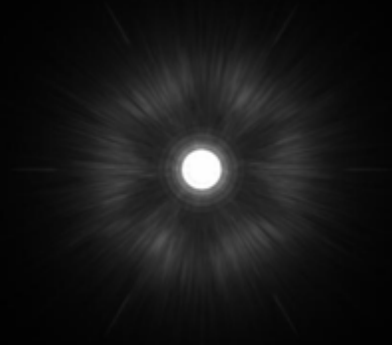
35



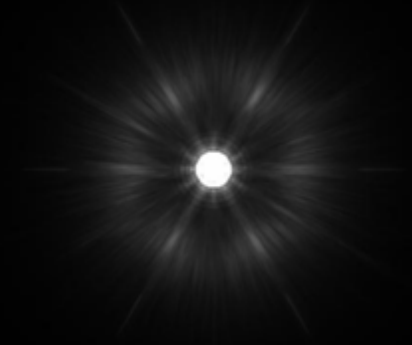
40



42



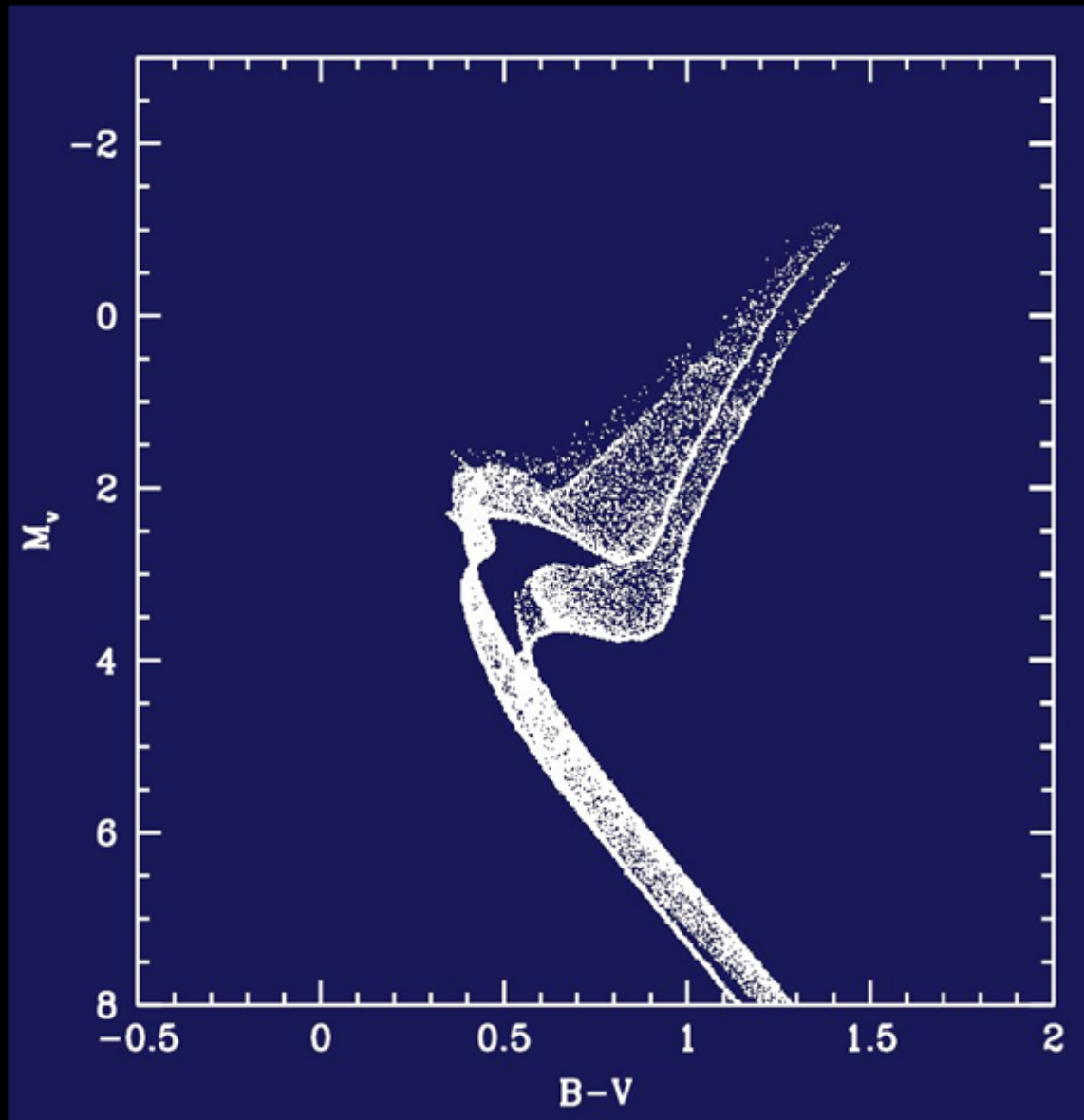
45



50

# Input stellar population as defined in BV

65 % 3 Gyr,  $[Me/H] = -0.3$ ; 35 % 9 Gyr,  $[Me/H] = -1.1$

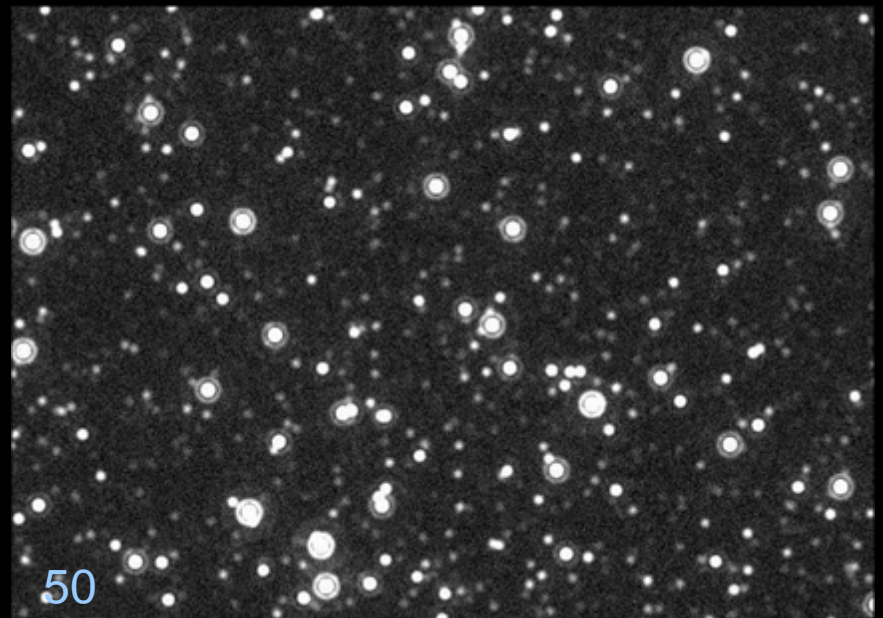
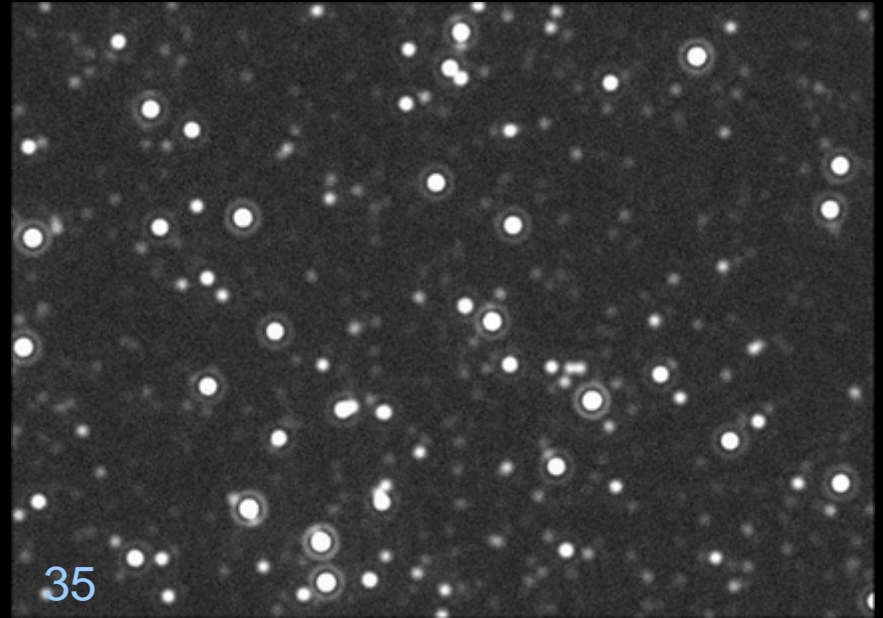
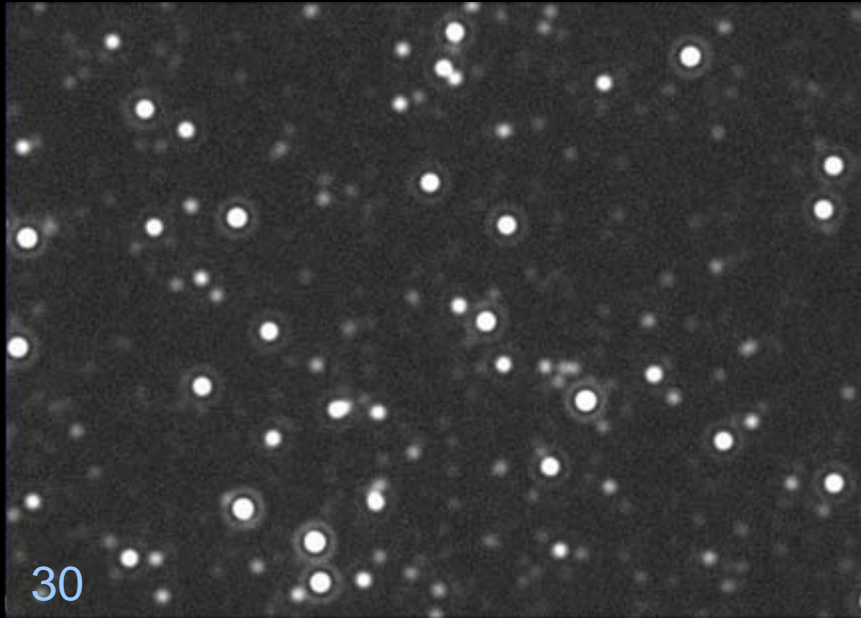


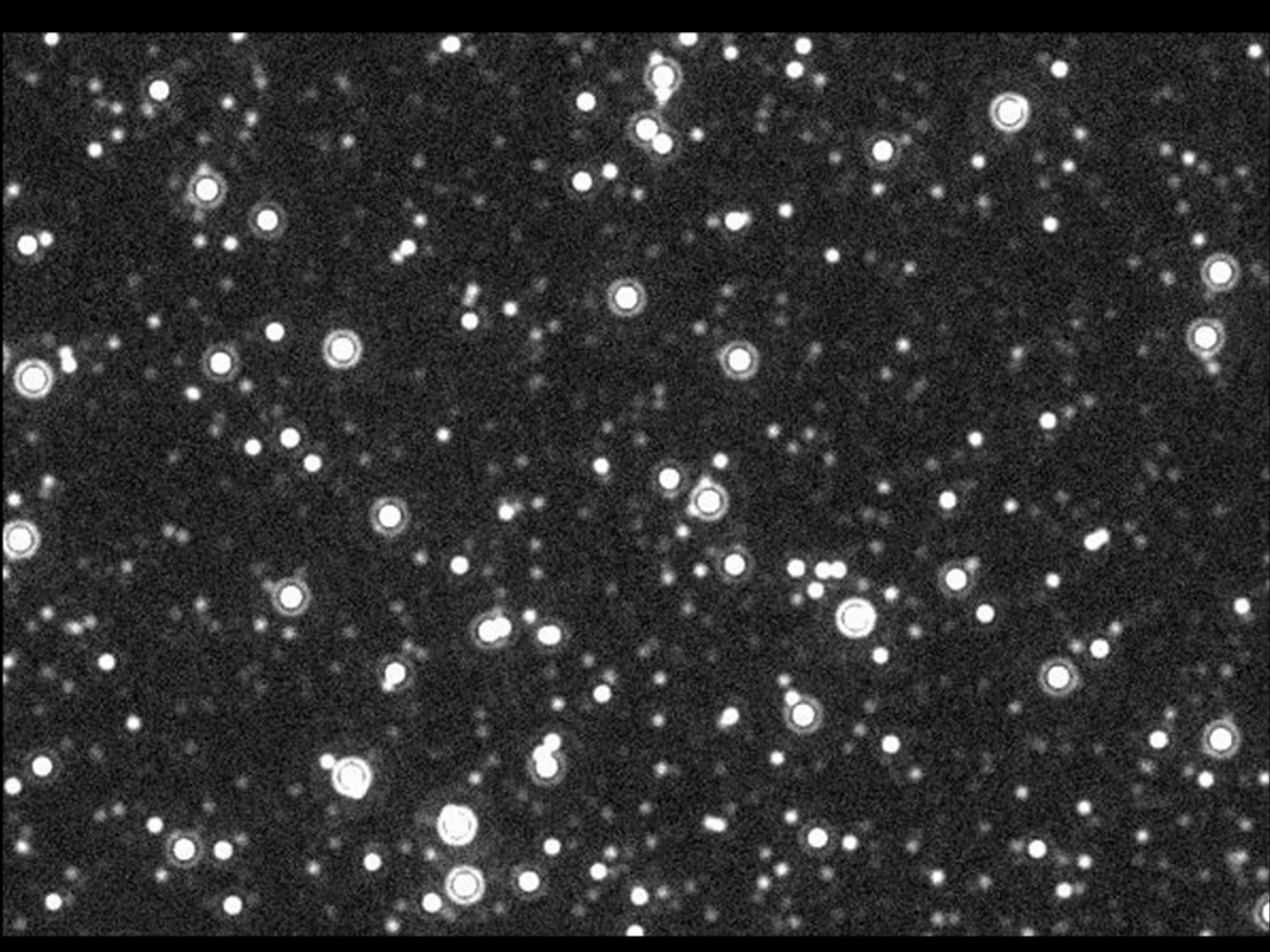
# Configuration parameters

- **Conversion to K with Koorneef calibr (A&A 1983)**
- **Stellar density set to 22.3 mag/arcsec<sup>2</sup> in V**
- **Pixel scale: 2 milliarcsec per pixel**
- **Sky background: K=14 (OAN-SPM, Mexico, etc)**
- **Exposure time: 36 000 seconds**
- **Intensities compatible with ESO ELT exp. meter**
- **Three different PSF types (OPD, analytic, Airy)  
(integrated over K band)**

# Comparison: Apertures

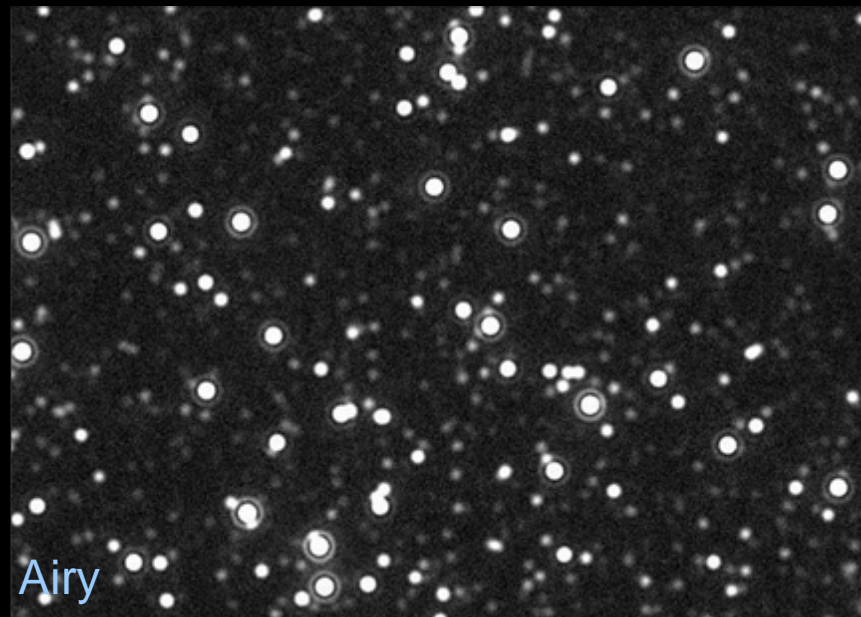
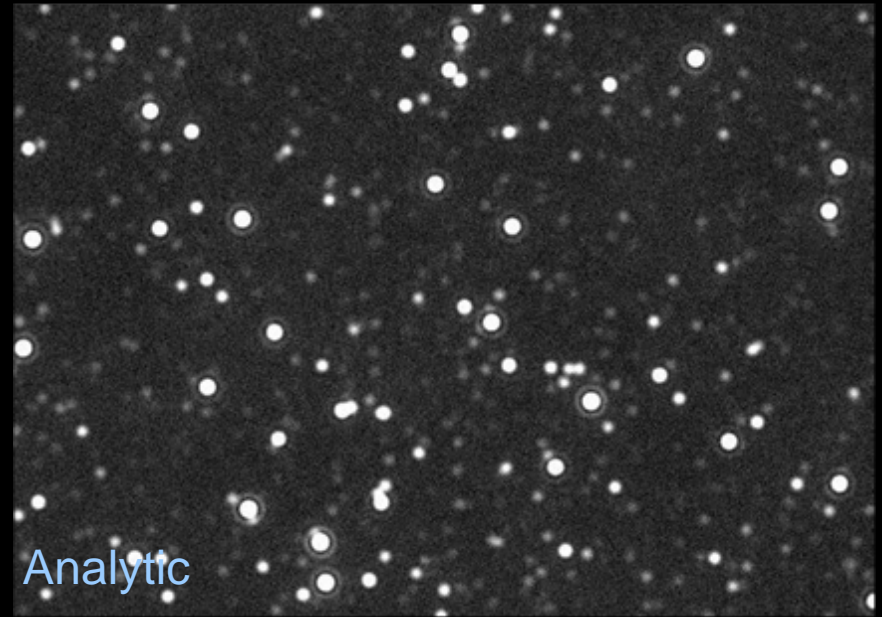
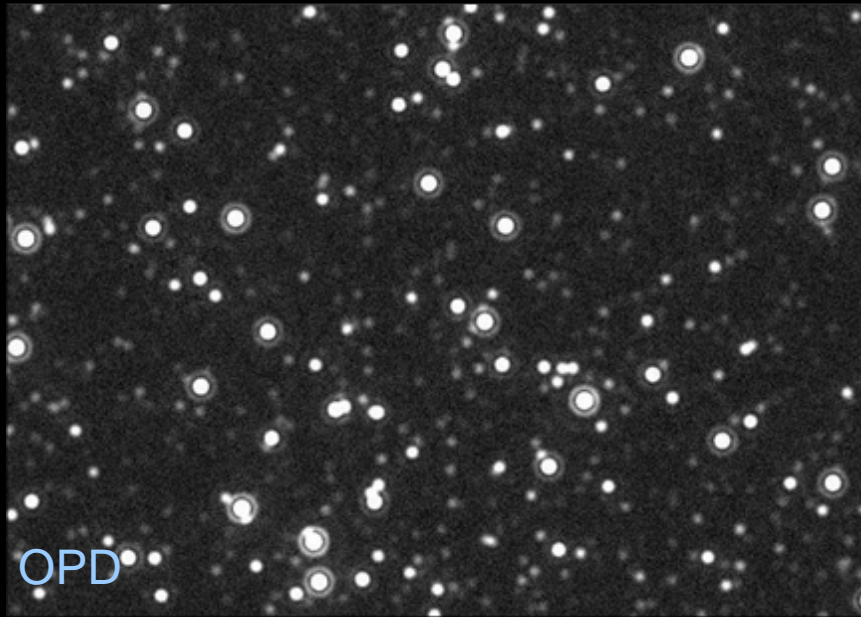
Apertures 30-50 m K field 8 Mpc FOV: 1.2 arcsec

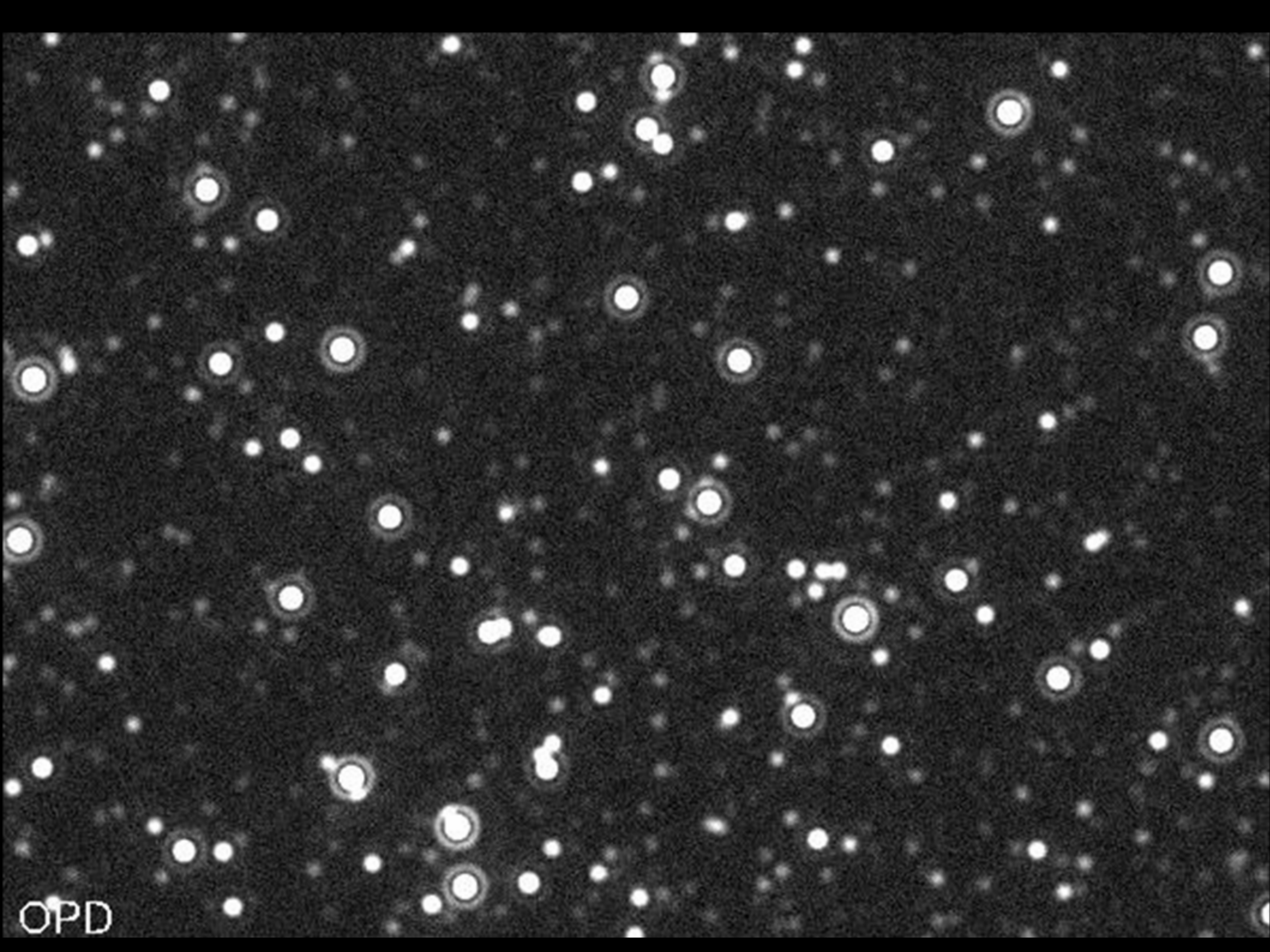




# Comparison: PSF type

Types: OPD, analytic, Airy    K field    8 Mpc    FOV: 1.2 arcsec





OPD

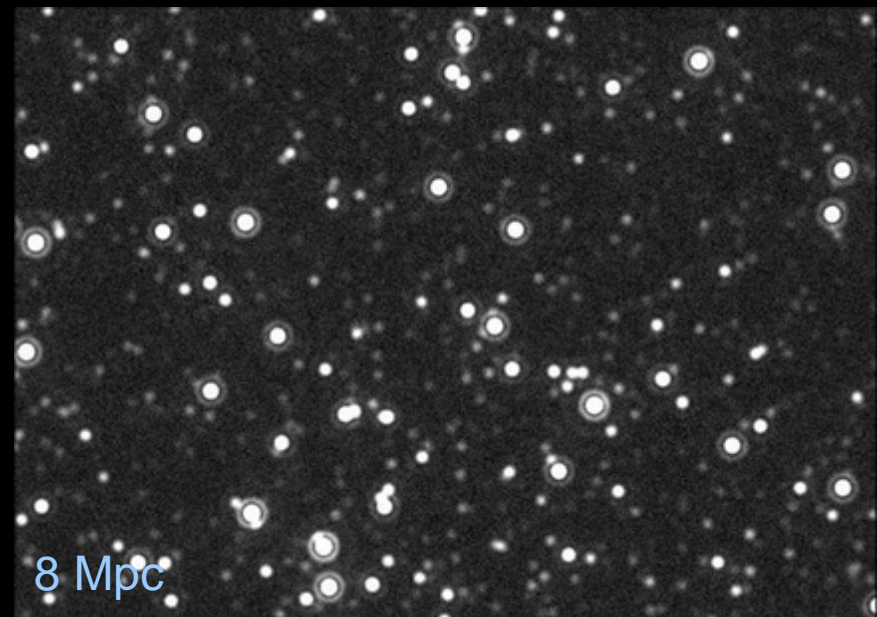
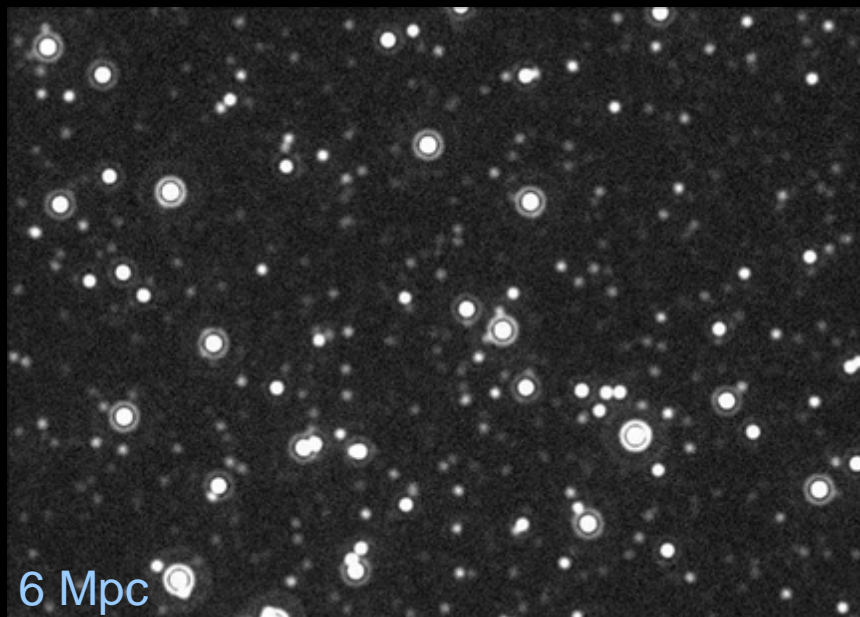
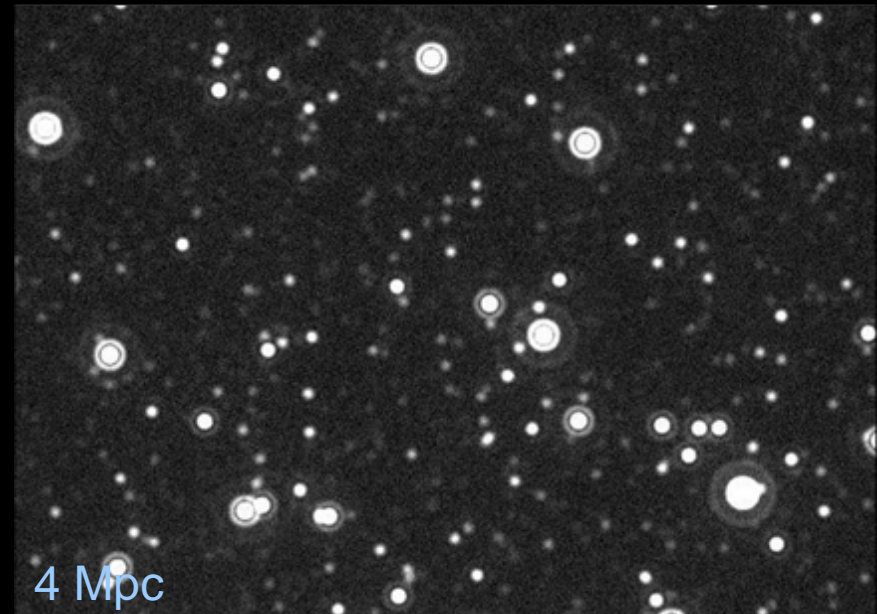
# Comparison: Distance

ESO 42m

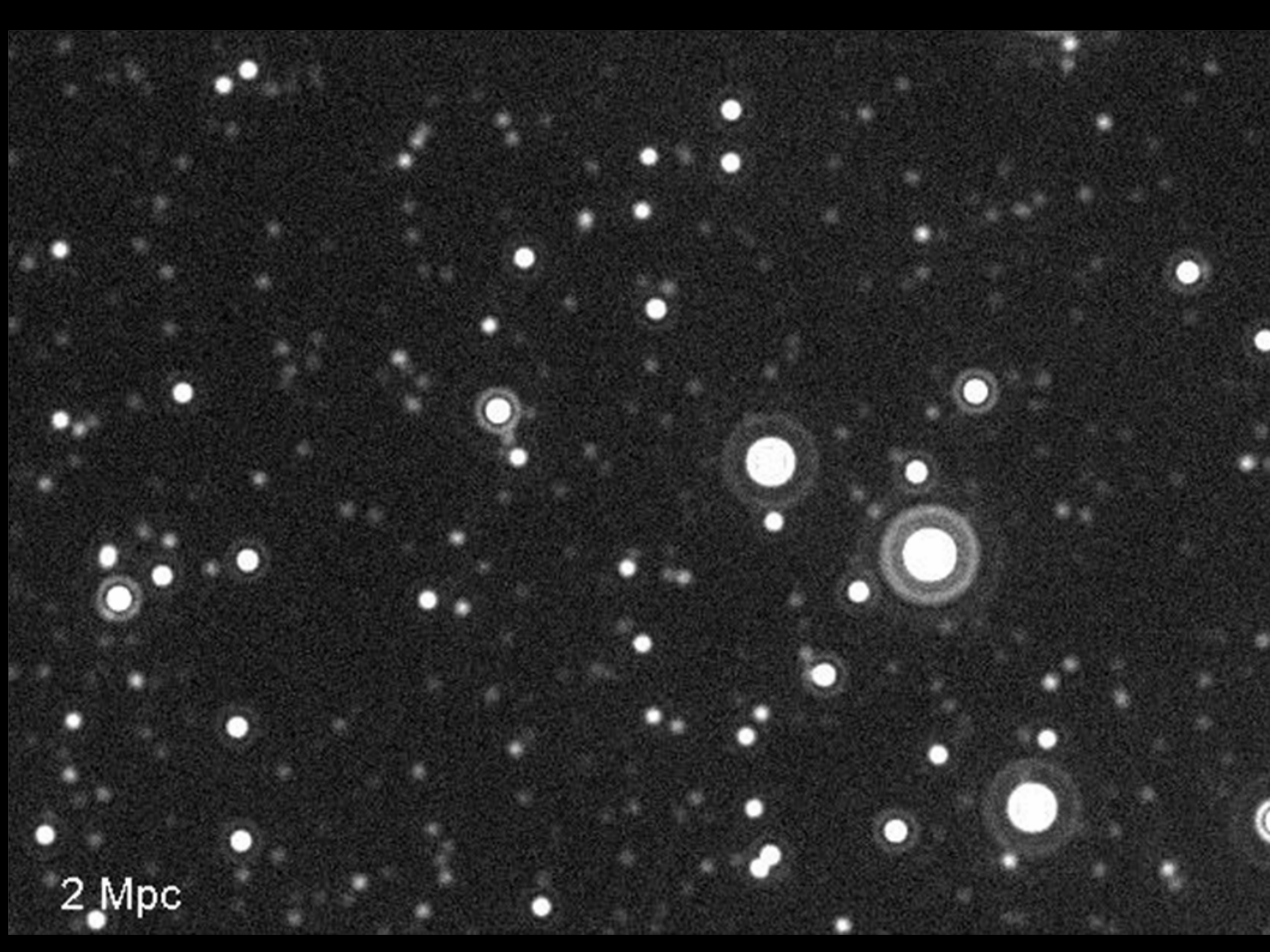
PSF: OPD

K field

FOV: 1.2 arcsec



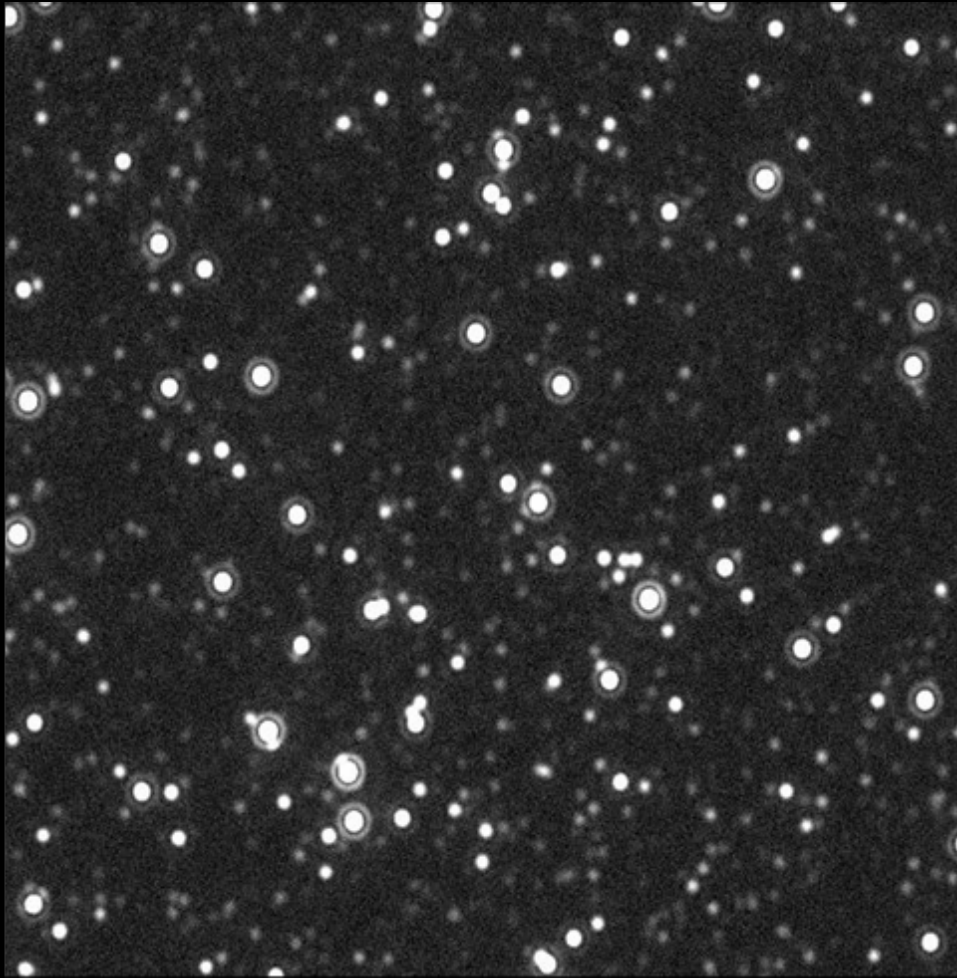




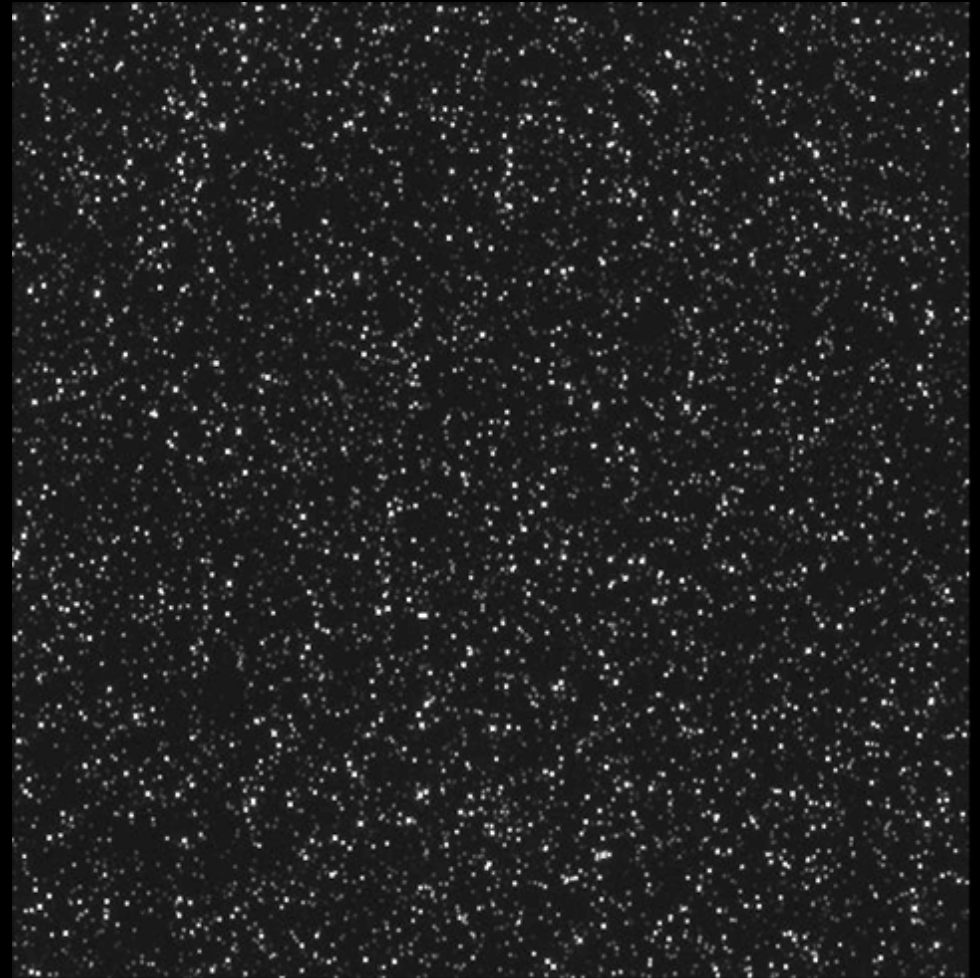
2 Mpc

# Comparison K and V' field

ESO 42m 8 Mpc FOV: 1.2 arcsec

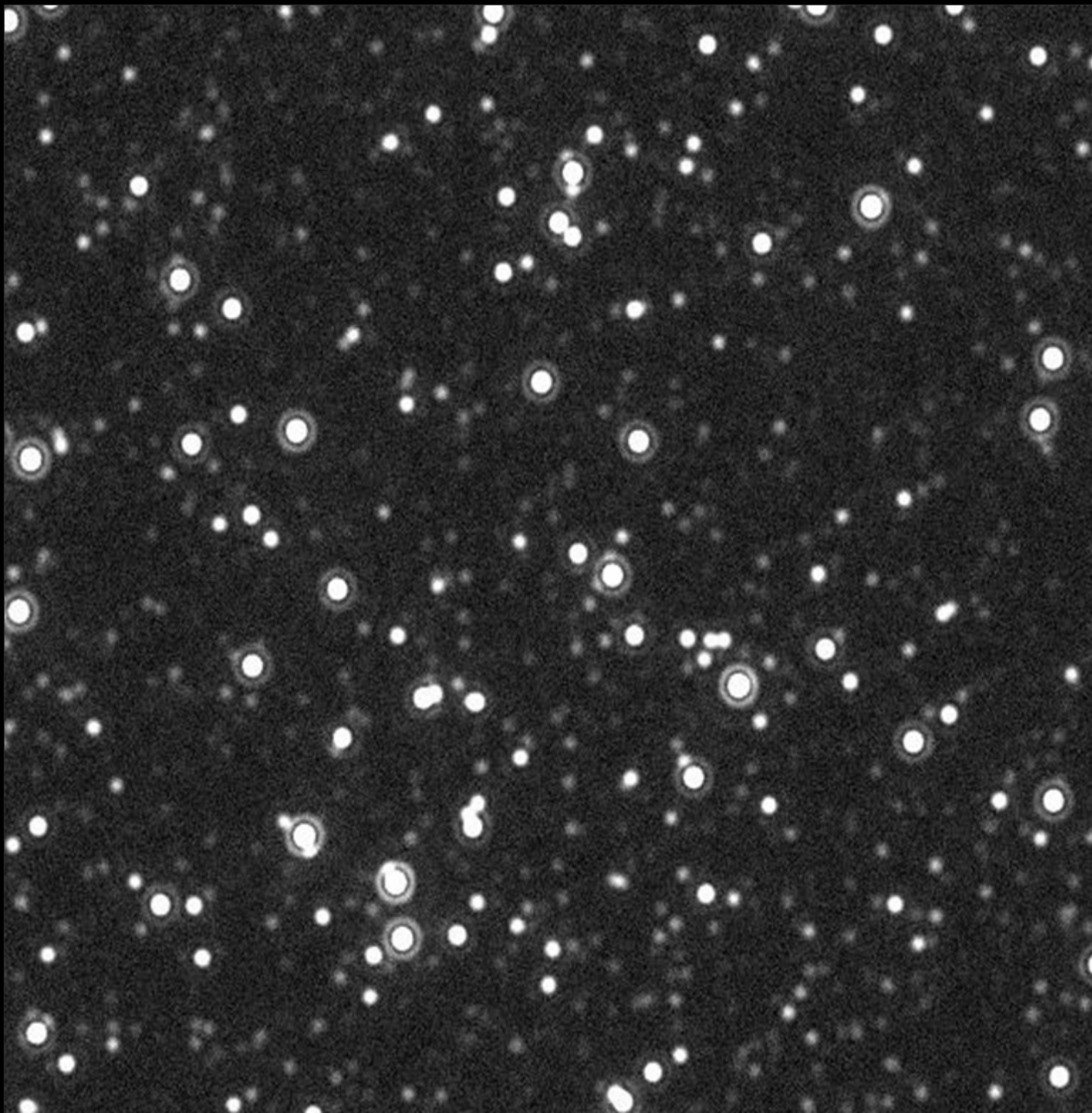


K band



V' band

K  
vs.  
V

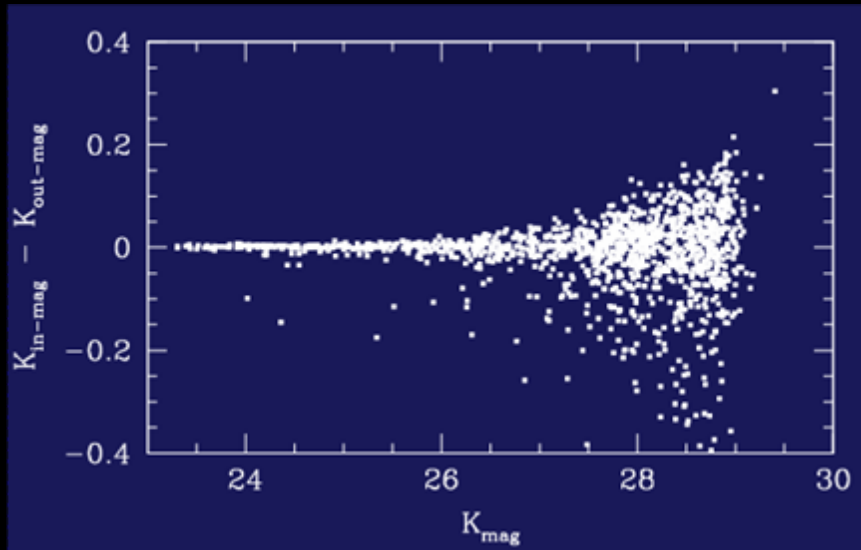


# Crowded Field Photometry

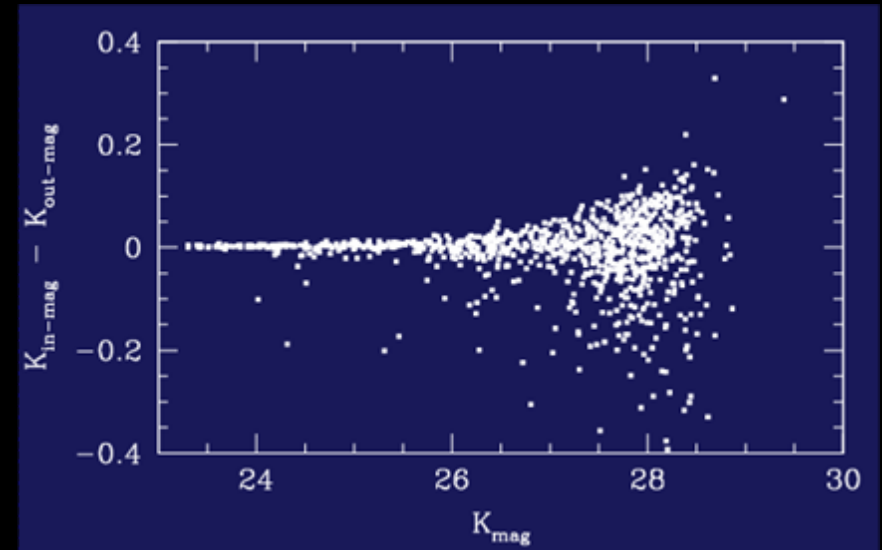
- **DAOPHOT algorithm**
- **PSF extracted from same field at 2 Mpc**

# Comparison: Photometry for various apertures

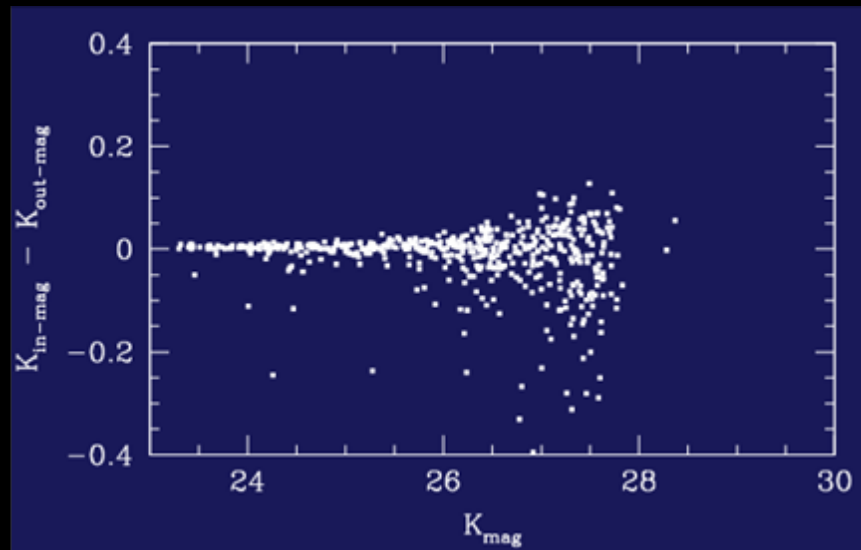
Apertures 30-50 m K field Distance: 8 Mpc



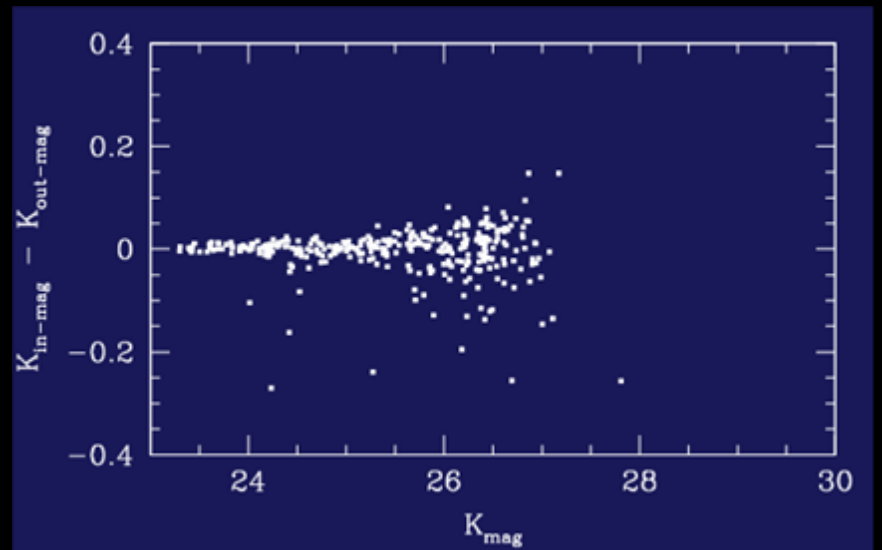
ESO50



ESO42



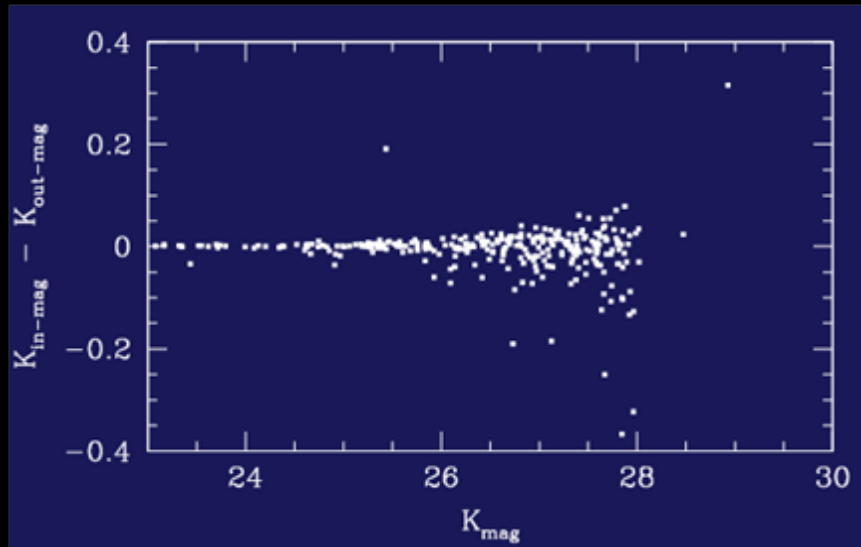
ESO35



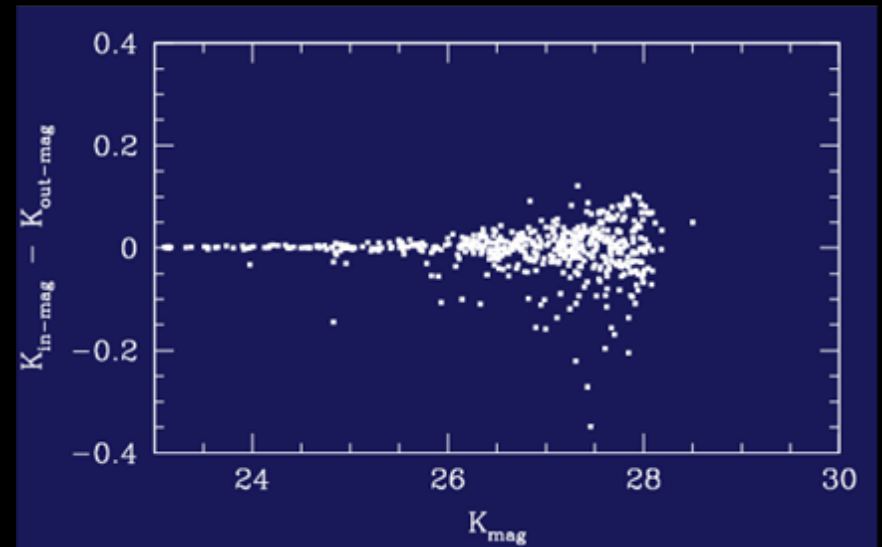
ESO30

# Comparison: Photometry for various distances

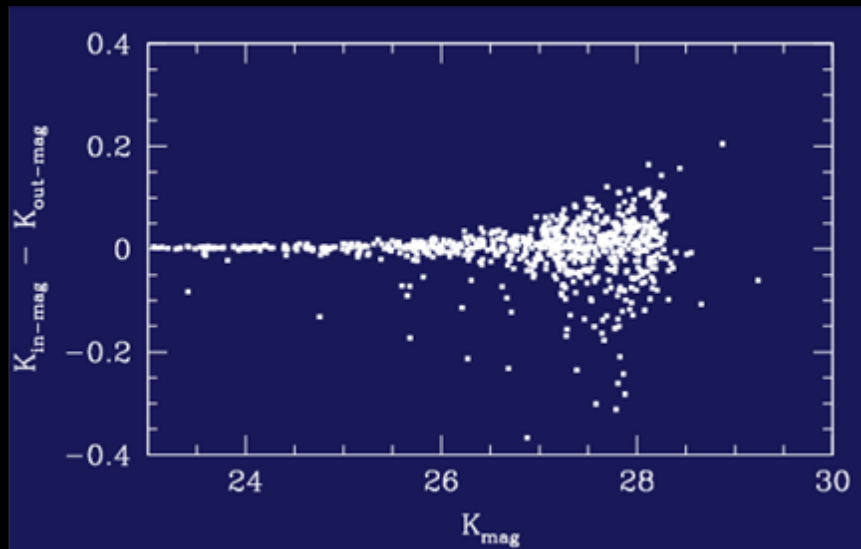
Aperture 42 m K field



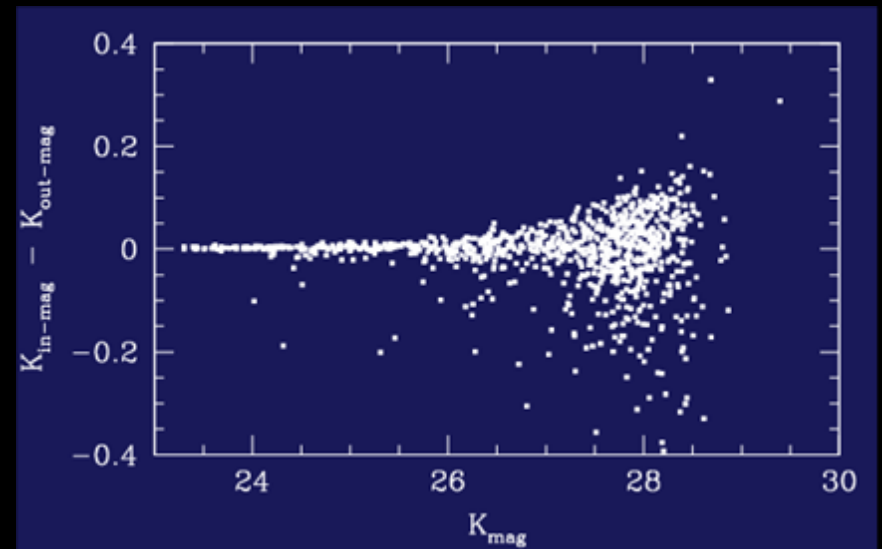
2 Mpc



4 Mpc



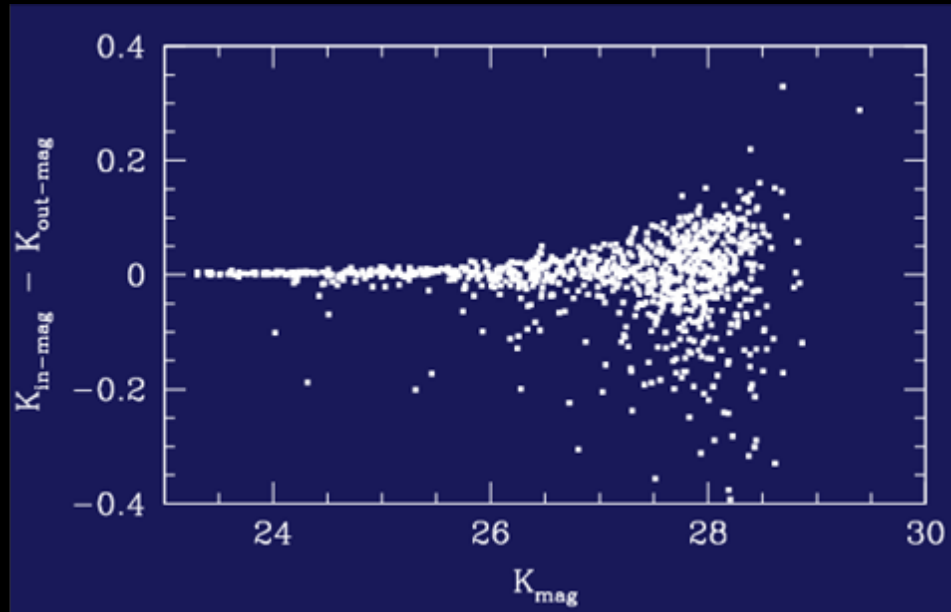
6 Mpc



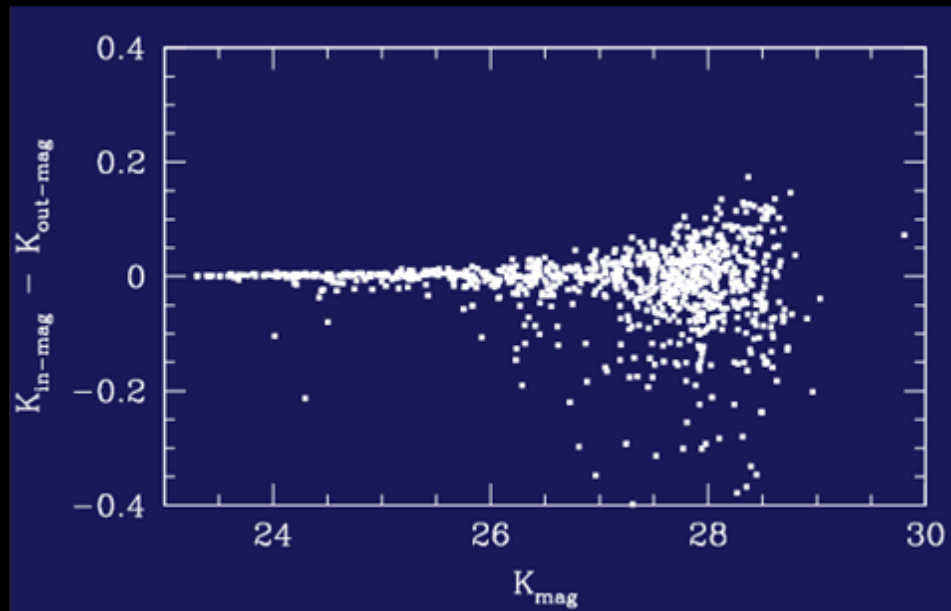
8 Mpc

# Comparison: Photometry for various PSFs

Aperture 42 m    Distance 8 Mpc    K field



OPD-based image



Airy-based image

# PSF as a function of

- **time**
- **field position**

**Ready to go**

**1008 CPU Computer (6-8 teraflops/sec)**