Artificial Sky Above Vyškov

Why Observations Can Be Considered Uselles

Who? F. Hroch

From? ÚTFA, MU, Brno

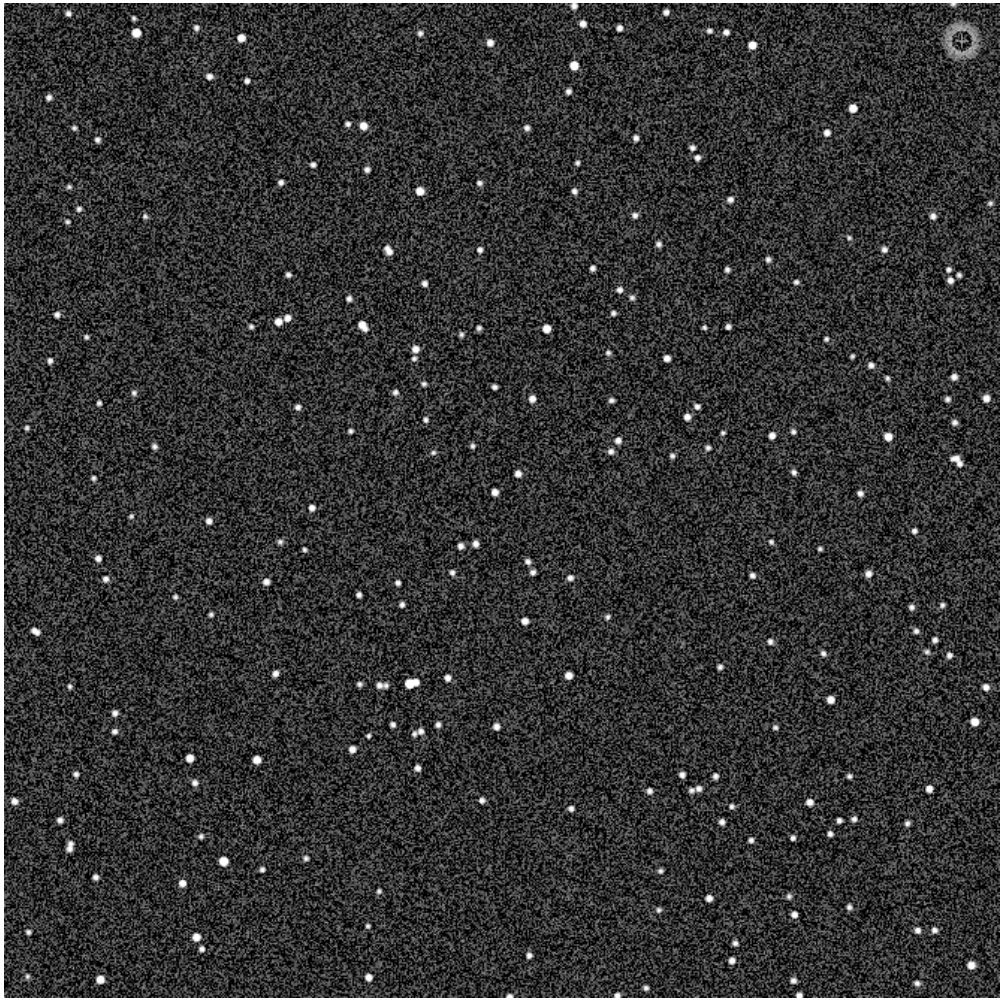
Purpose

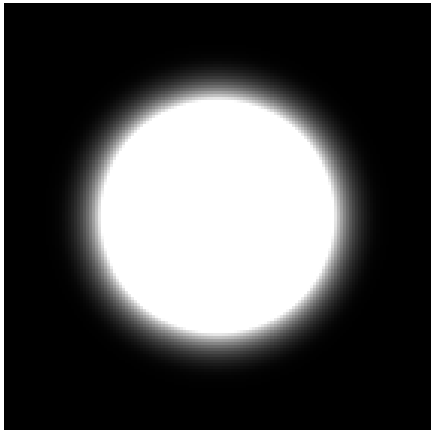
"My hovercraft is full of eels"

- Testing of algorithms (calibration, grow-curves)
- Modelling of atmospheric effects (seeing, extinction)
- Colour transformations of filters (not completed yet)
- Light curves of variable stars
- Photon rate prediction
- Inspecting unexpected problems

PSF by Gauss

Space Quality



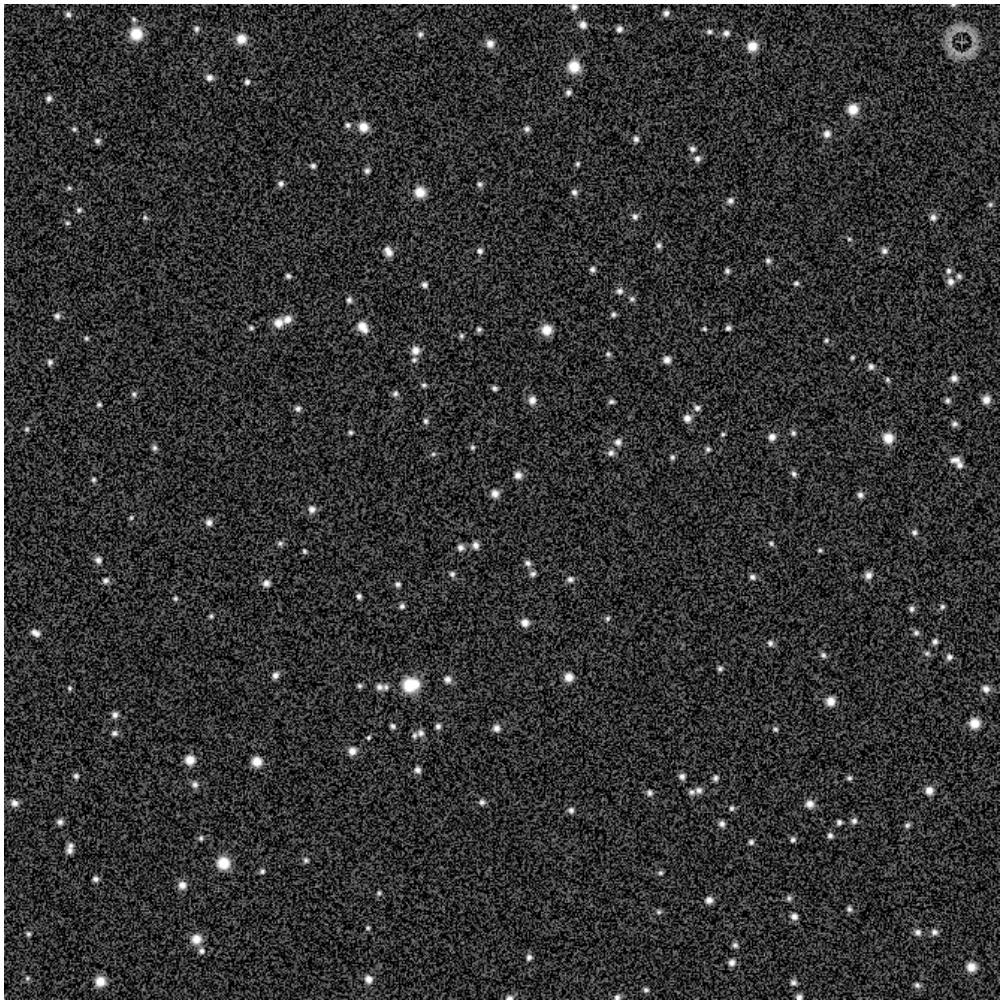


$$e^{-r^2/2r_0^2}$$

r_0 is half width at half of maximum of a point spread function (PSF)

Moffat's PSF

Photographic Quality



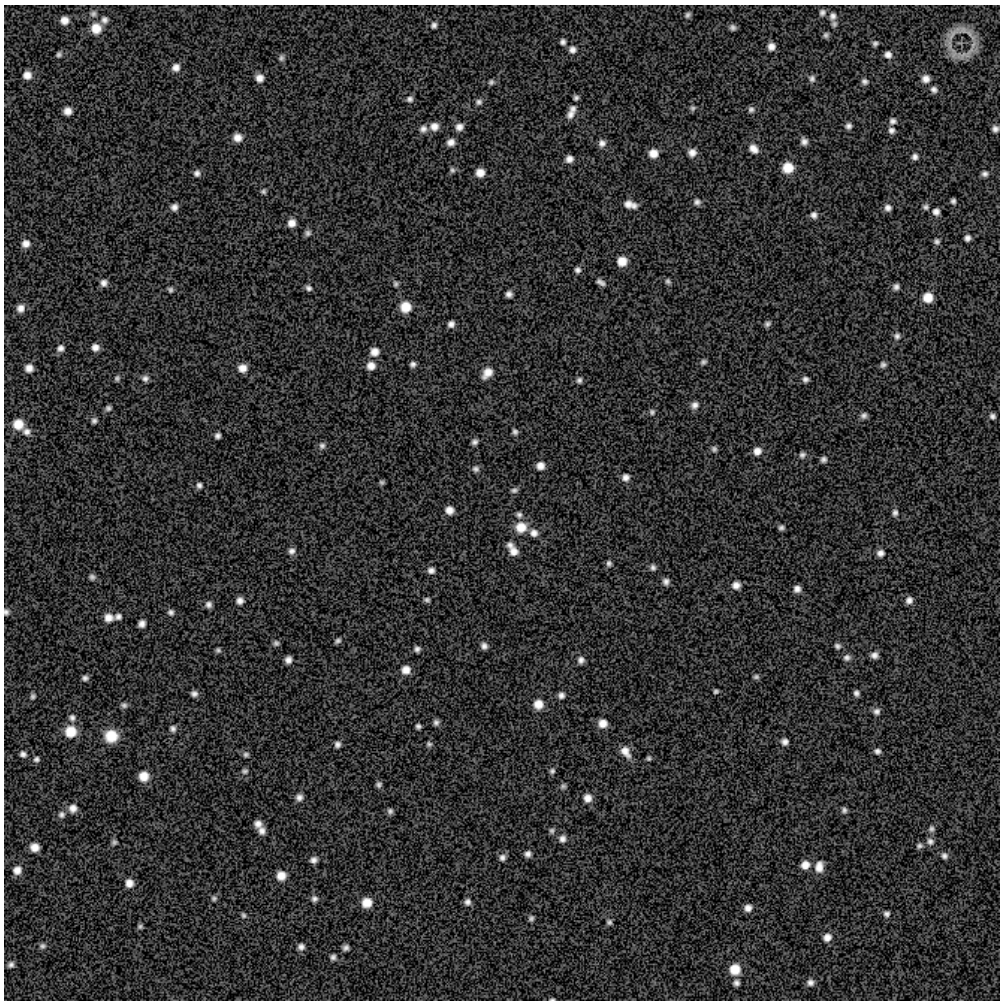
$$\frac{1}{(1 + r^2/r_0^2)^{-\beta}}$$

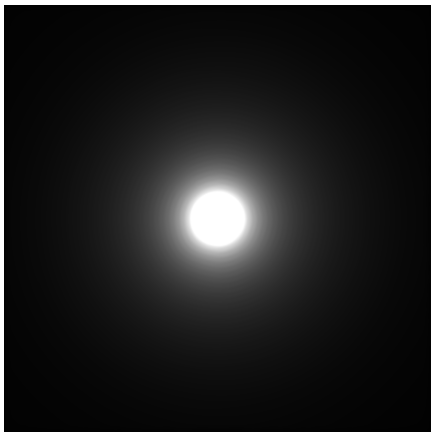
$$0 < \beta < \infty$$

$$\beta \neq 1$$

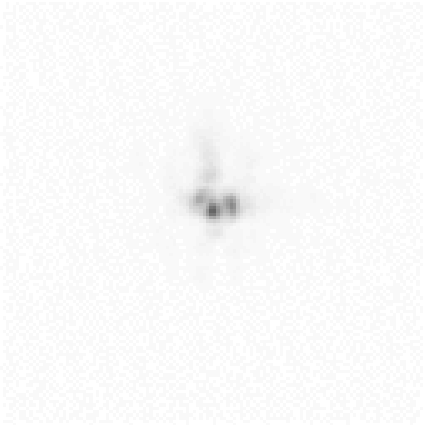
Seeing

https://en.wikipedia.org/wiki/Astronomical_seeing





ζ Boo



Convolution For Seeing

Seeing Spread Function

- Airy function (r is star centre distance):

$$I_A = \frac{J_1^2(r)}{r^2}.$$

- Seeing spread model:

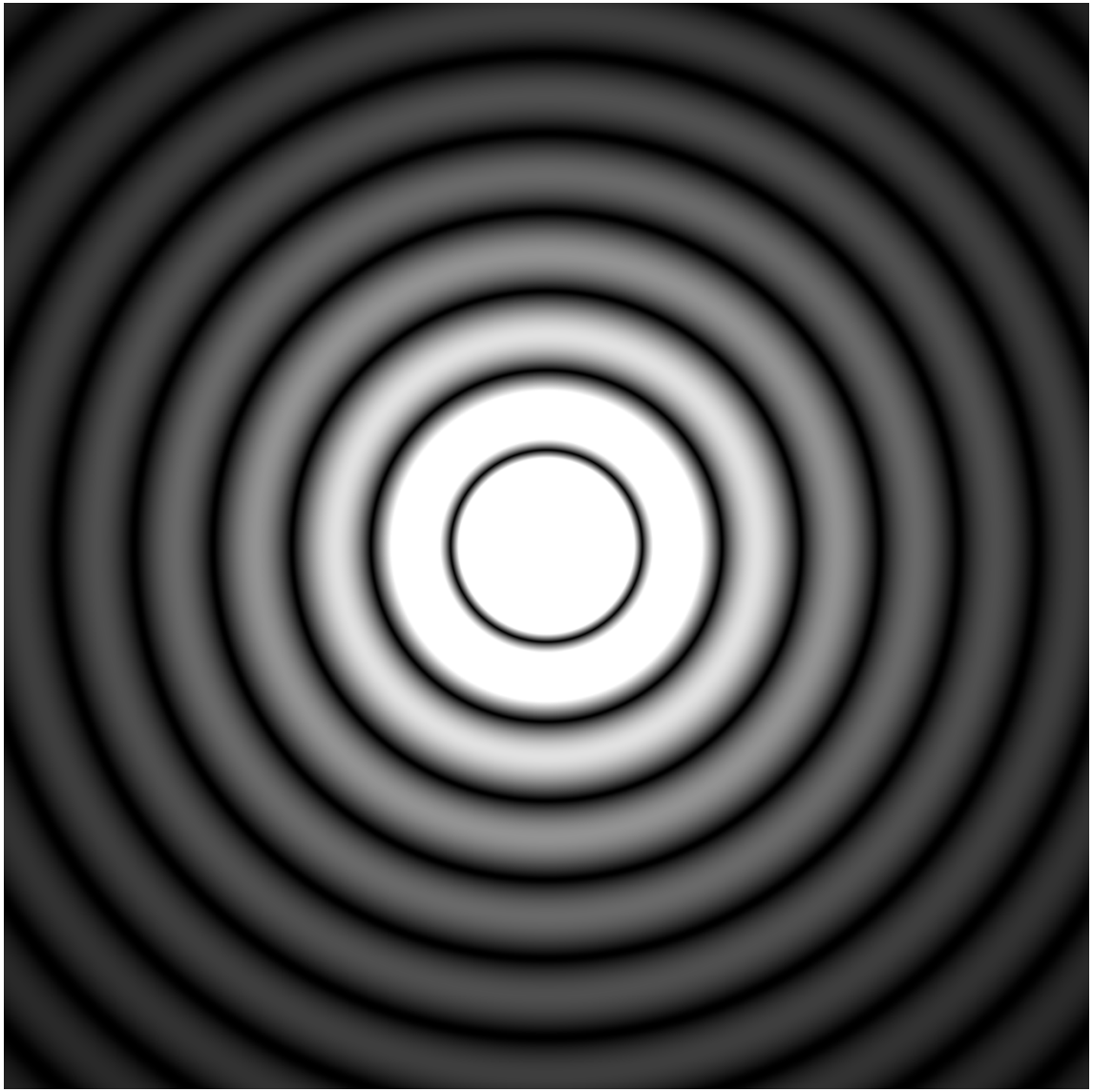
$$I_S = \mathrm{e}^{-(x^2+y^2)/2r_s^2},$$

- Convolution of them:

$$I_S \star I_A = I(u,v) = \int I_S(x-u, y-v) \cdot I_B(x,y)\,\mathrm{d}x\,\mathrm{d}y$$

Airy Function

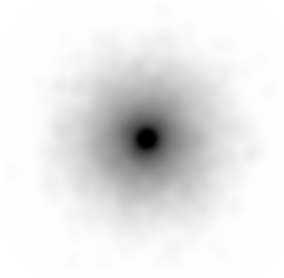
$J_1^2(r)/r^2$



Methods Of Convolution

FFT Being Faster Atmosphere

- Random shift of Airy disk and accumulation:



- Direct convolution (duration 2h)

$$h_{ij} = \sum_{kl} g_{k-i,l-j} f_{kl}, \quad i,j = 1,\ldots$$

- Fast Fourier Transformation (duration 20s)

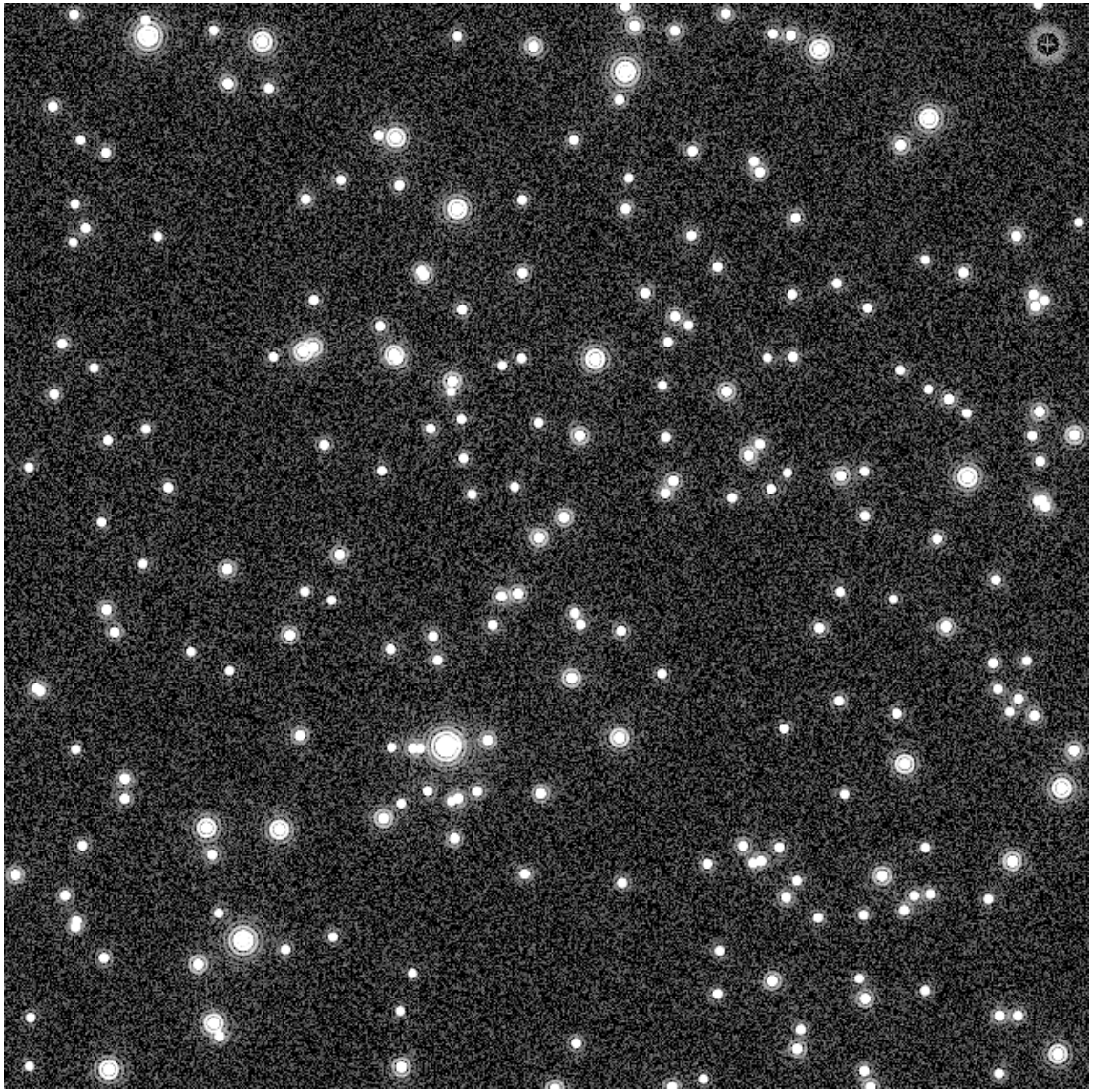
$$\mathcal{F}(u) = \int f(x)\, \mathrm{e}^{2\pi \mathrm{i} x u}\, \mathrm{d}x$$

$$h(x) = \int g(u-x) f(u)\, \mathrm{d}u \quad \equiv \quad \mathcal{H} = \mathcal{F} \cdot \mathcal{G}, h = \mathcal{H}^{-1}$$

$$h(x) = \int \mathcal{F}(u) \cdot \mathcal{G}(u)\, \mathrm{e}^{-2\pi \mathrm{i} x u}\, \mathrm{d}u$$

Virgin Diffraction

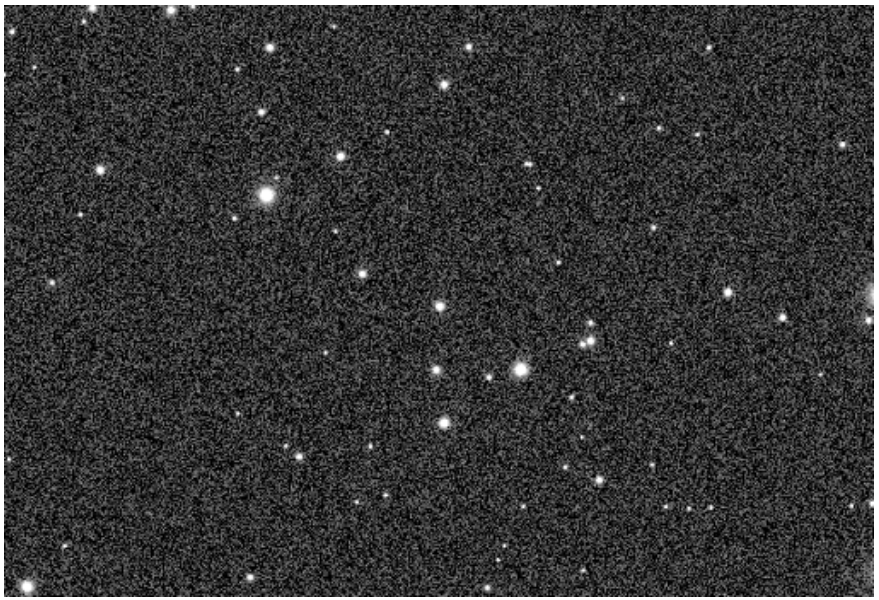
$\varnothing = 14$ cm



Frames Of Blazar 0716+71

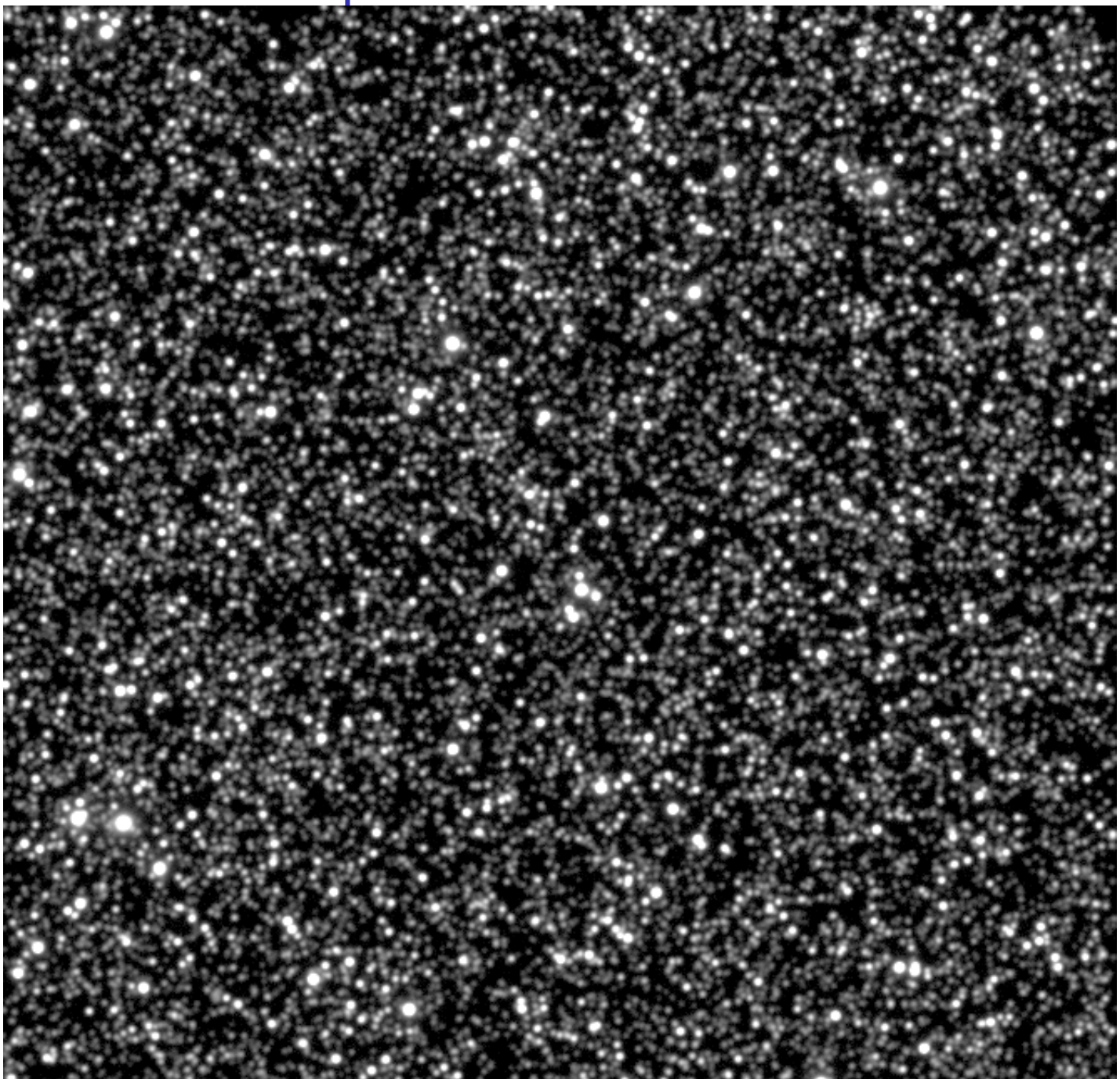
A Cruel Reality

MonteBoo

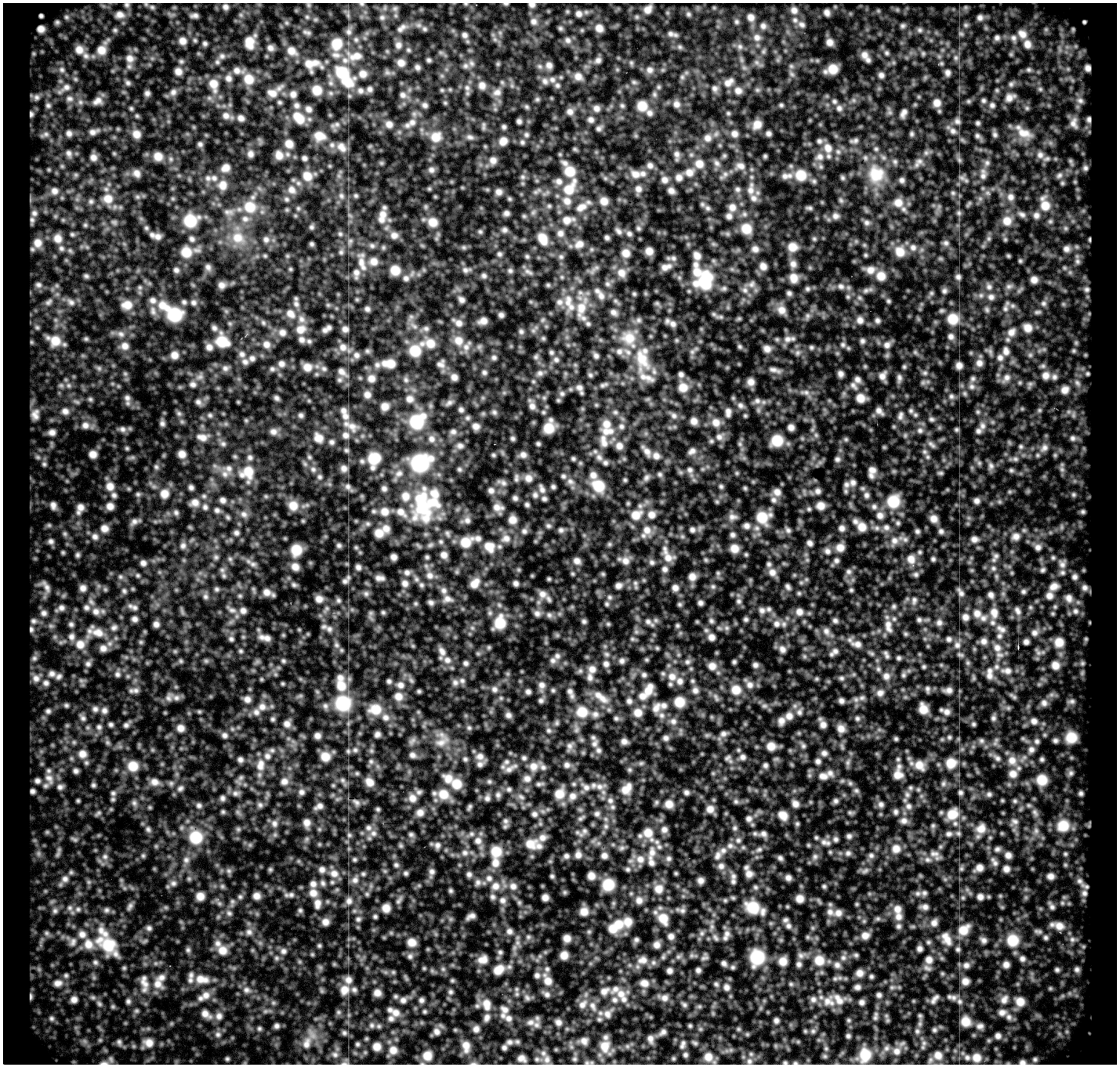


Artificial

Artificial Deep Field

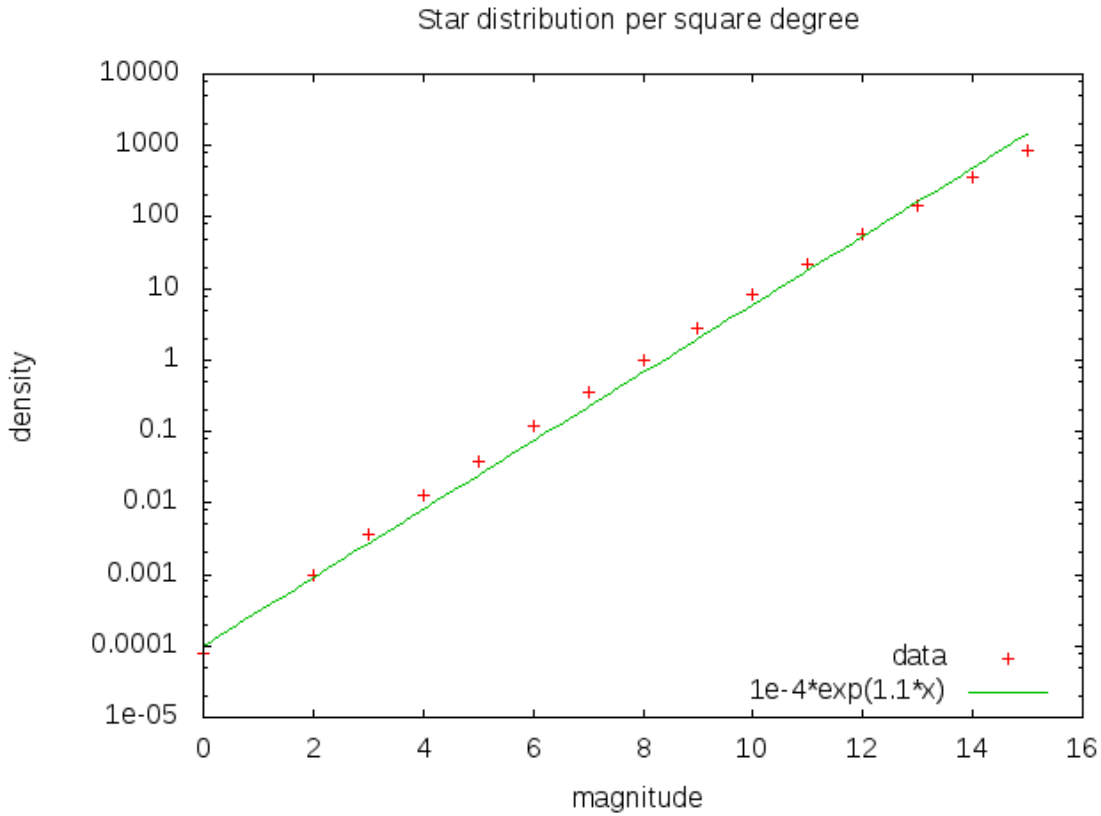


SMC – DK154



Star distribution

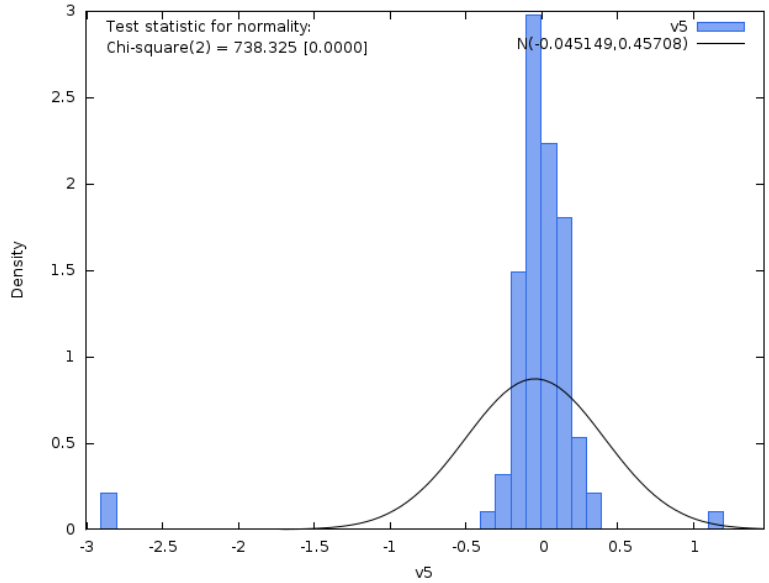
http://www.astronomycafe.net/qadir/q1257.html

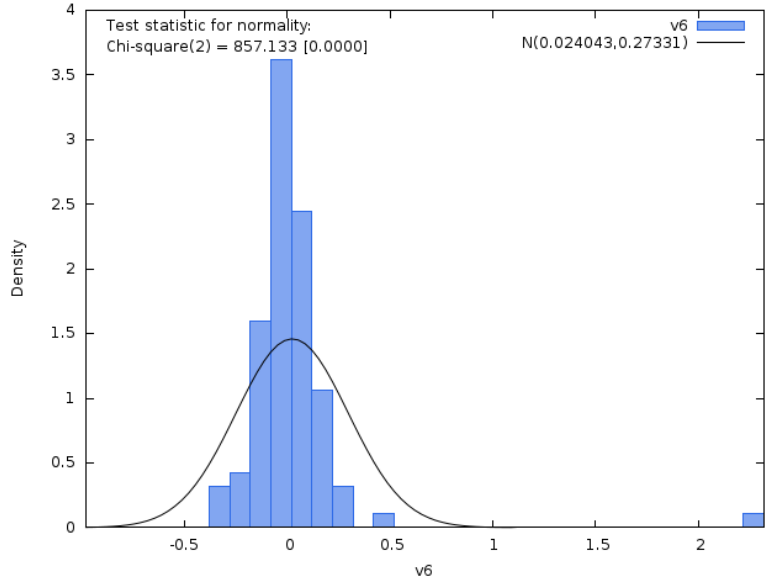


$$\Sigma(m) = 10^{-4}\, e^{1.1m} \quad [\square^2]$$

Precision Of Astrometry

RMS = 83 mas

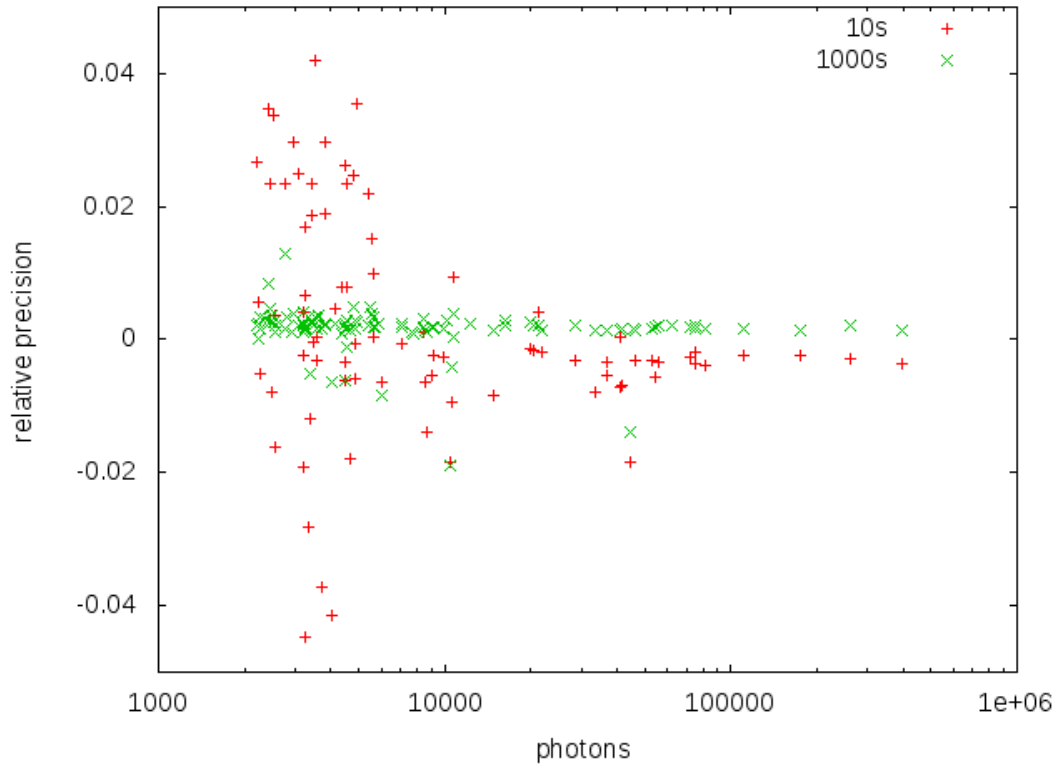




sign test (total, RA+, Dec+): $94/47.0,\ 45 \pm 3.4,$

Photometry

Systematic Error Beats Random Ones



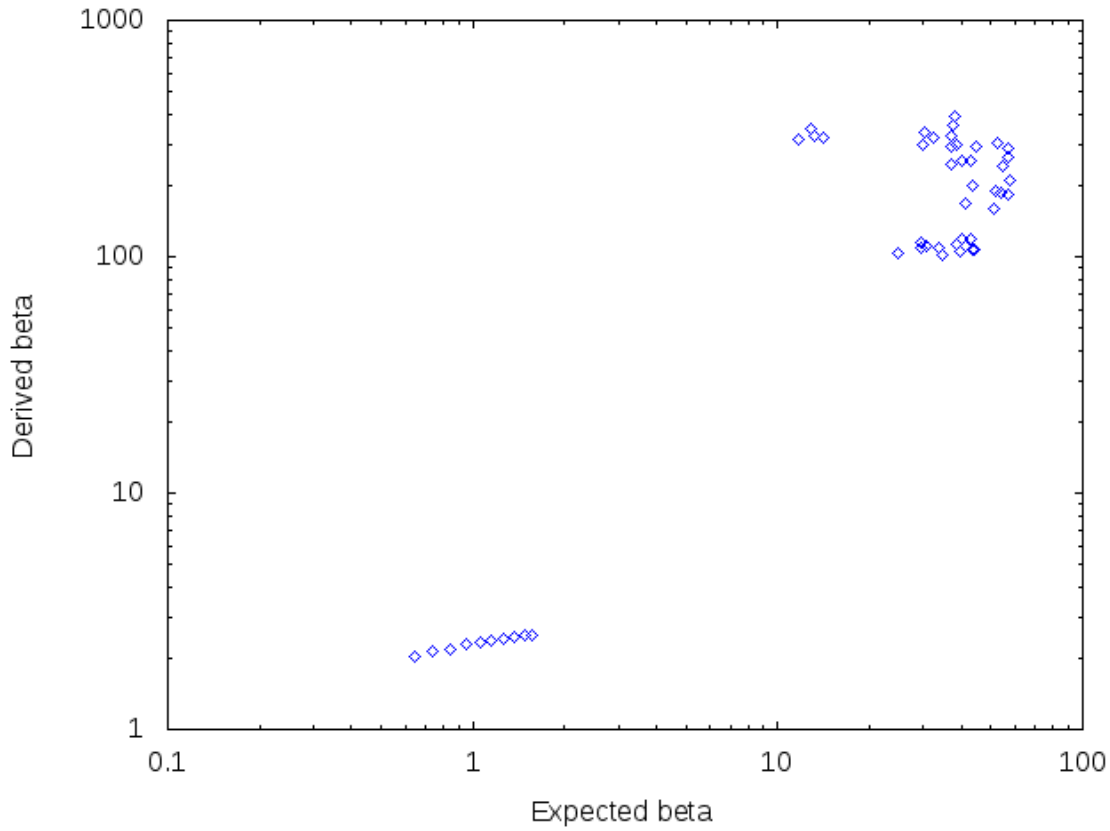
Relative photon rates:

$1.0881 \pm 7 \cdot 10^{-7}$ (1000 s), $1.0895 \pm 3 \cdot 10^{-5}$ (10 s)

$1.0362 \pm 2 \cdot 10^{-4}$ (10 s, grow)

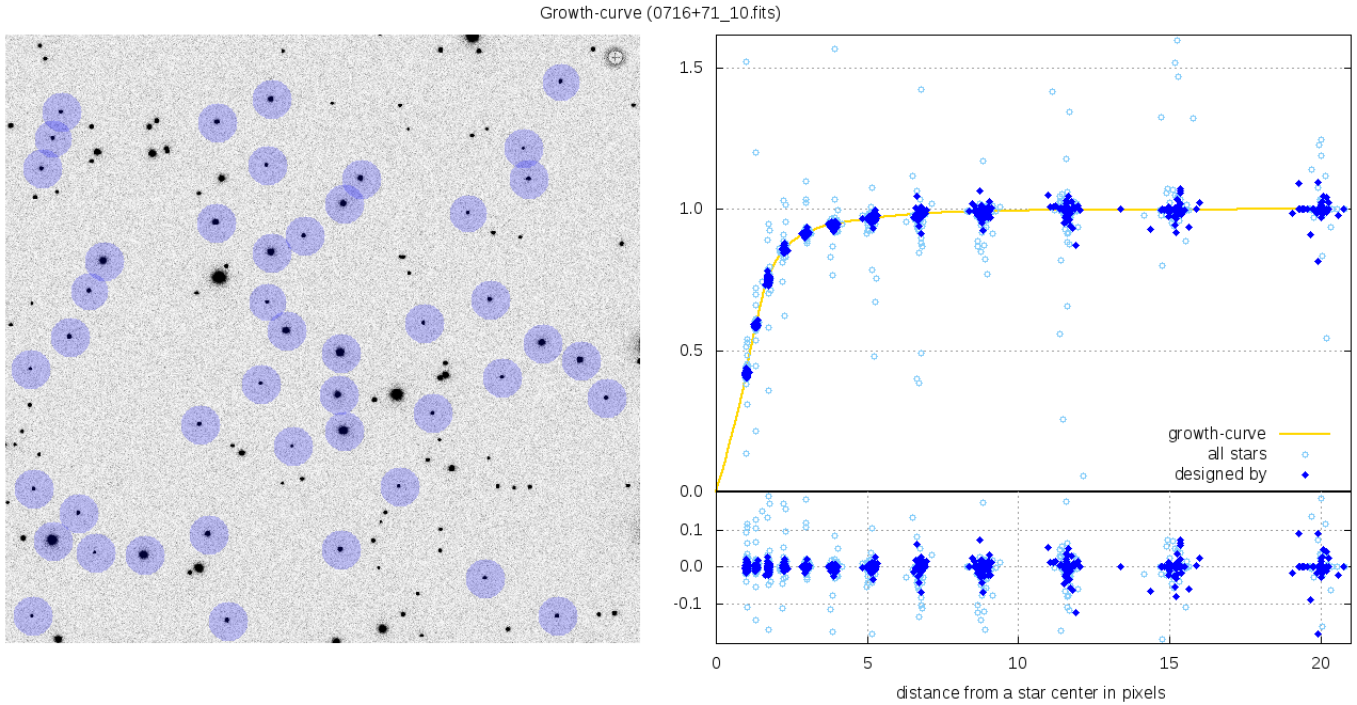
Moffat's bifurcation

Sigmoid Curve Secret



Growth Curve

The Cure Of Aperture Photometry



Modelling Atmosphere

The Starry Night By Vincent van Gogh's

- Airmass (z zenith distance):

$$X = \frac{1}{\cos z}$$

- Extinction (scattering, absorption):

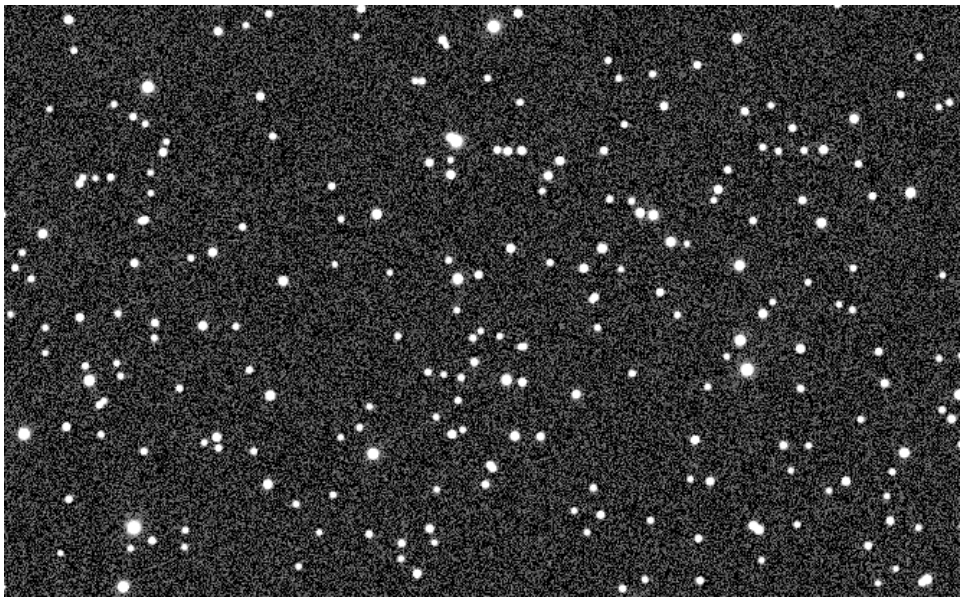
$$F(X) = F_0 \, \mathrm{e}^{-kX}$$

- Seeing (Mr. Fries theory):

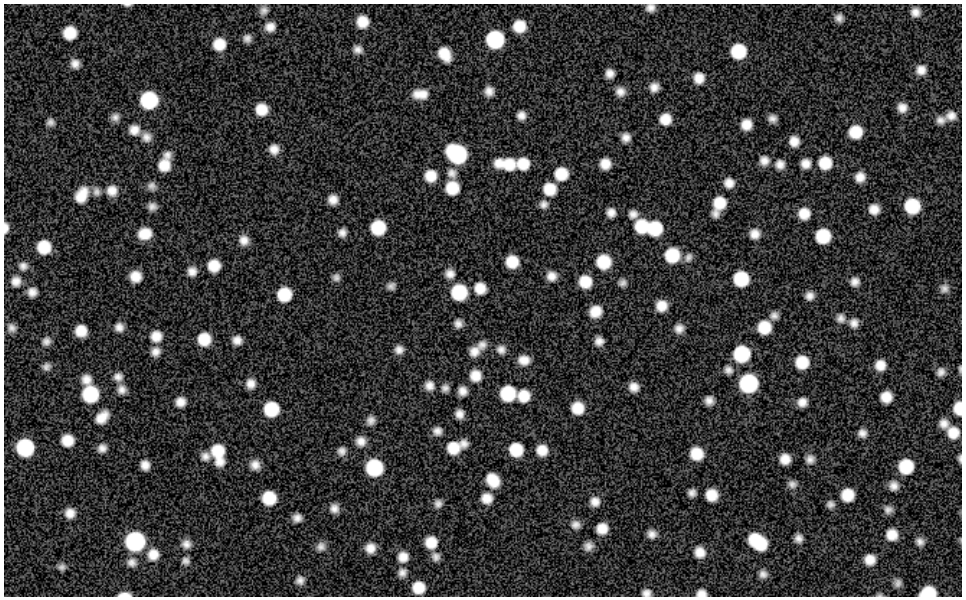
$$r_0 \propto X^{0.6}$$

Seeing spread

Airmasses $X = 1, 3$



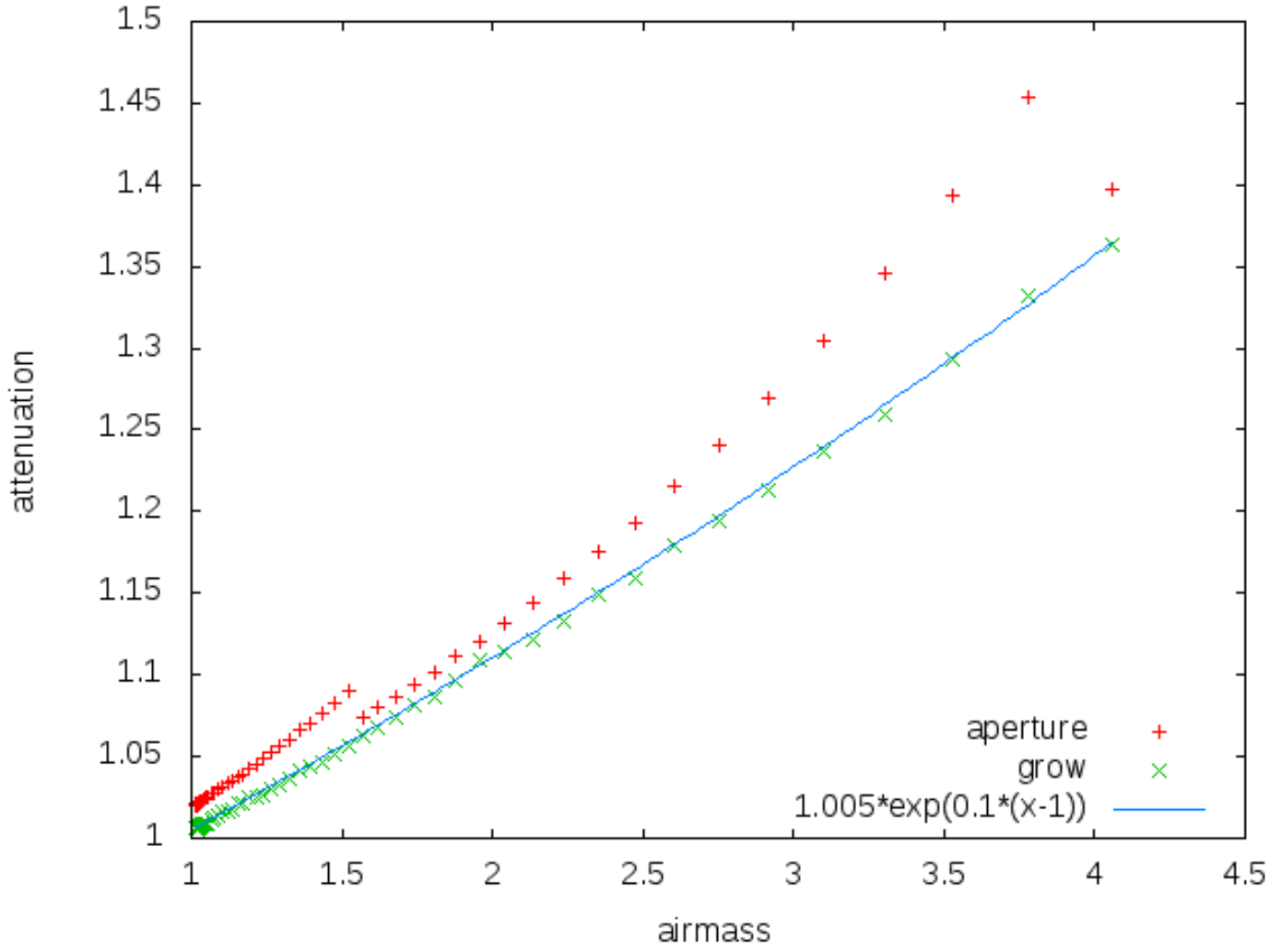
(zenith)



(20° above horizon)

Extinction curve for $k = 0.1$

Aperture overflow



The End

This Is The End

Consider This As The End Of . . .

Thank You Very Much

`http://www.physics.muni.cz/~hroch/artific.pdf`