Three little tricks for dealing with an image

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Overview

Destriping

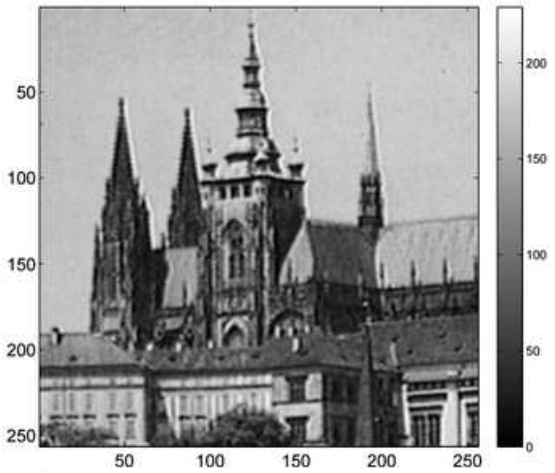
Patterns removal in Fourier space .vs. in real space

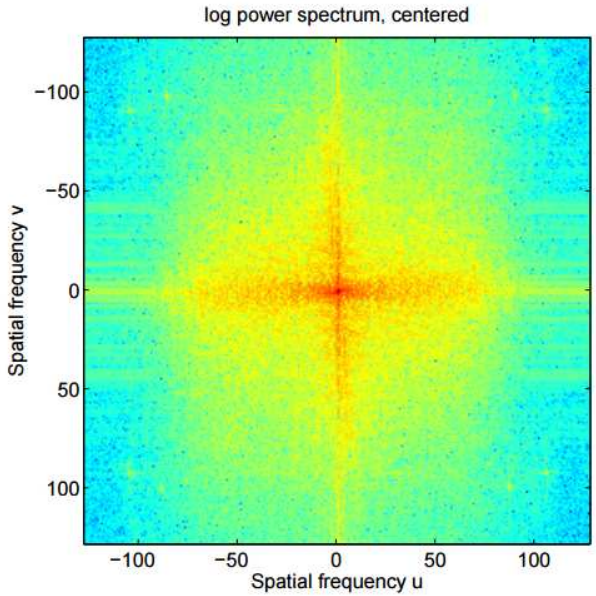
- Power spectrum
- 2D discrete function g(u,v) defined on an $M \times N$ grid,

$$G(m,n) = \frac{1}{\sqrt{MN}} \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} g(u,v) e^{-2i\pi(\frac{mu}{M}+\frac{nv}{N})} \tag{1}$$

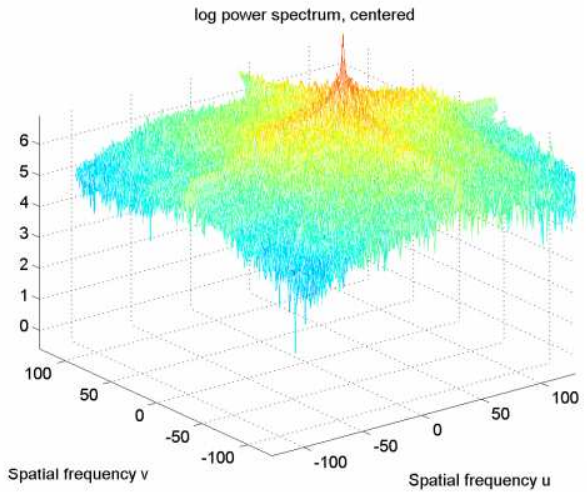
- |G(m,n)|: power spectrum,
- log(|G(m,n)|) to show small intensities better.

Destriping





image

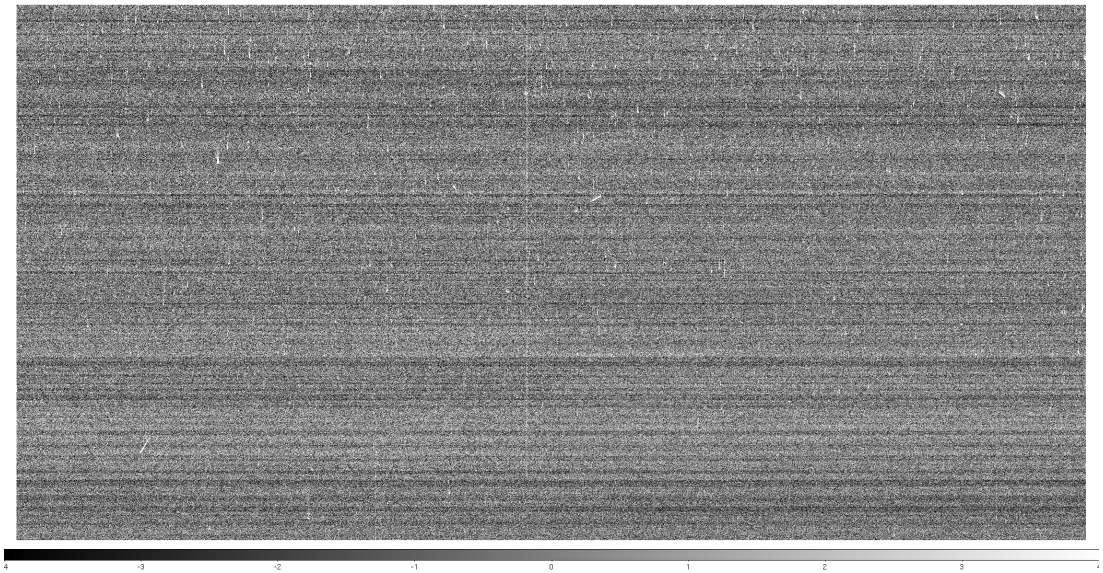


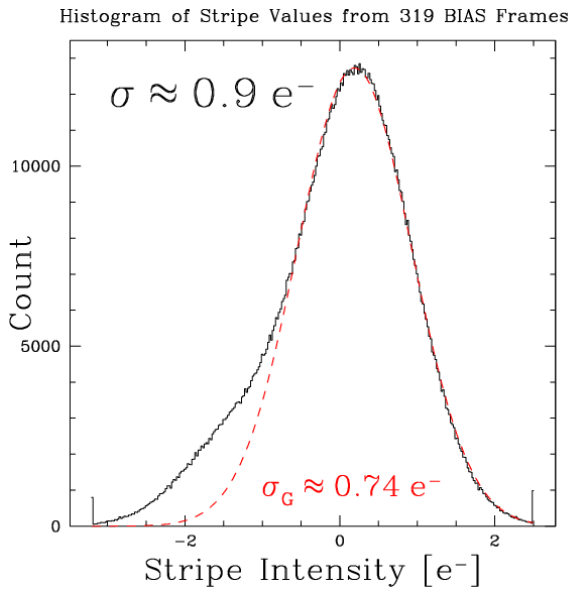
mesh

Destriping

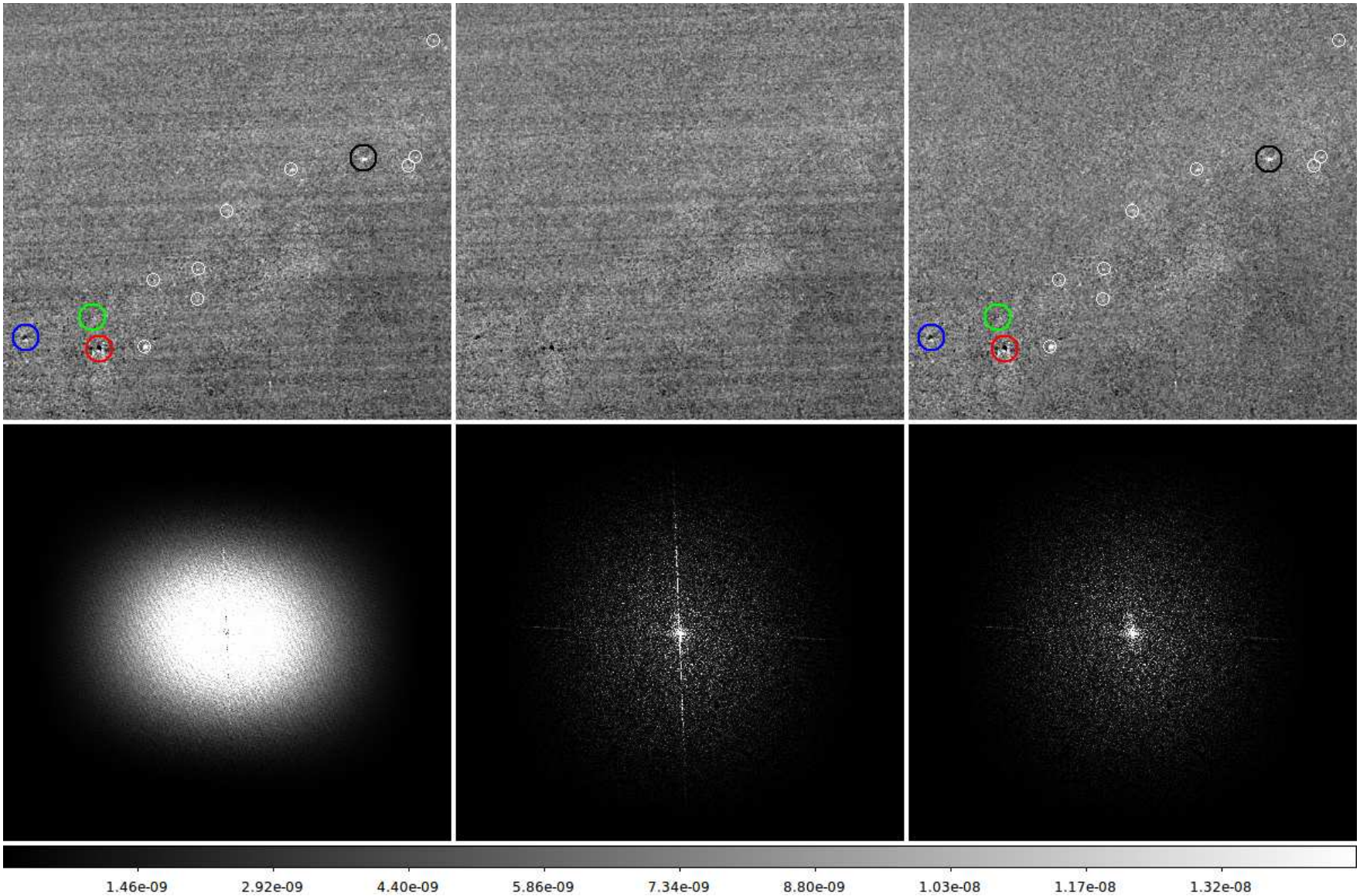
Patterns removal in Fourier space .vs. in real space
Example: Removal of Bias Striping Noise from Post-SM4 ACS WFC

Row-correlated noise due to the CCD Electronics Box Replacement (CEB-R); CEB-R includes a circuit (ASIC), the voltages suffer from low-frequency noise, at 1mHz to 1Hz (Loose 2011); there is one reference voltage from the ASIC that is used to offset the signal.

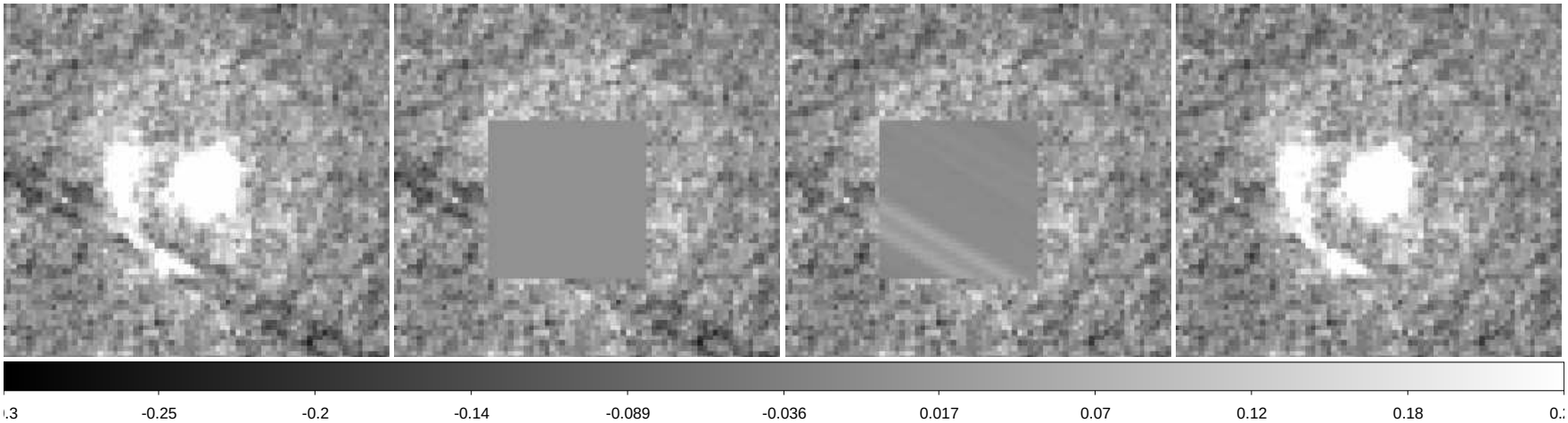




Destriping–example, HST ACS/WFC POLV Q map (M82)



Destriping–example, HST WFC3/UVIS (SN 2014J)



- Source extract / mask – DFT – mask in power spectrum – IDFT – Add back sources
- Easier to mask in power spectrum
- Mask the source will improve the quality

Subsampling

- removing a sample aliquot
- preparation and measurement from an individual sample or the aggregate sample submitted for analysis
- Goal: Obtaining a representative sample
- Primary concern: homogeneity
- The smaller the sample aliquot, the greater the risk of achieving subsampling errors

Subsampling

- Image-Space Interpolation
- Nearest neighbour (Box – $*$ sin)
- Linear interpolation (Triangle – $*$ sinc^2)
  always positive, goes to 0 not very fast; attenuate high freq and deform low freq
- Spline interpolation ($*$ $rect_T(t)$ for n times) N-th order of sinc function, looks line a Gaussian shape with steep slopes.
  expensive to compute, often 3rd order, noise - bringing high freq
- Fourier based kernels Hanning, Hamming (truncated cosine function), Hyperbolic tangent kernel...

Subsampling

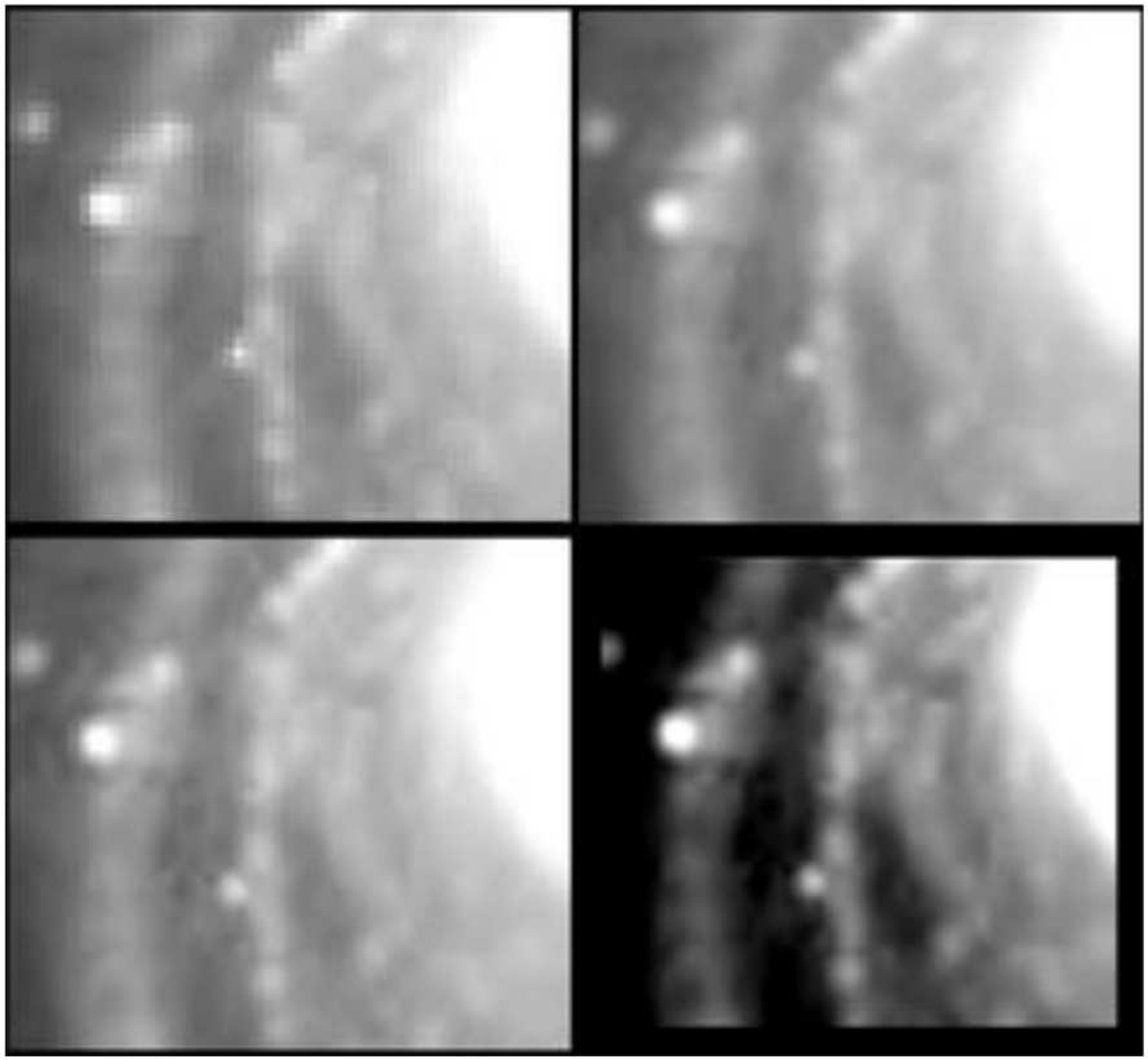
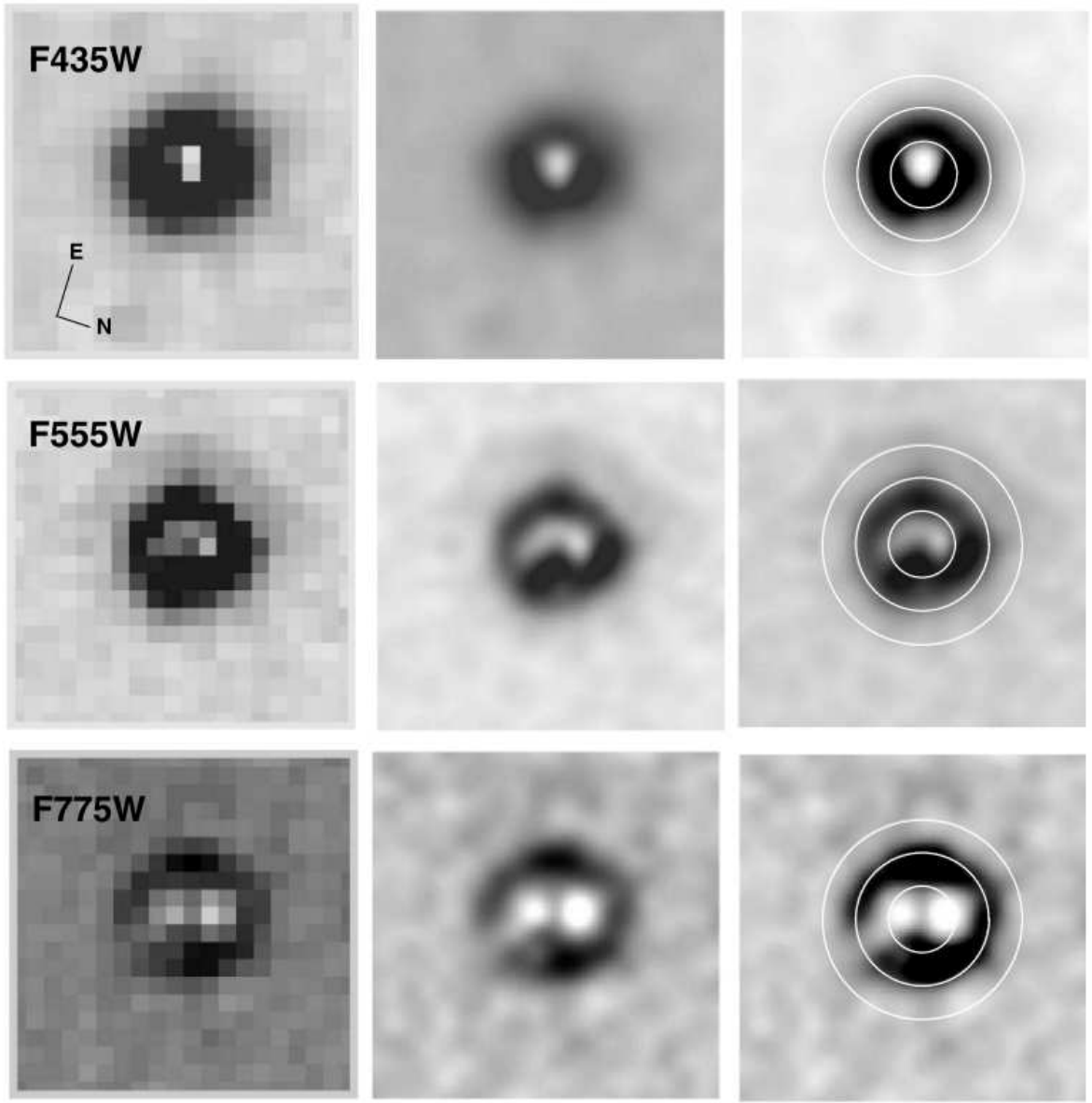


Figure 3: Various interpolation schemes. Top left is nearest neighbour, top right is linear, bot - tom left is cubic spline and bottom right is hyperbolic tangent.

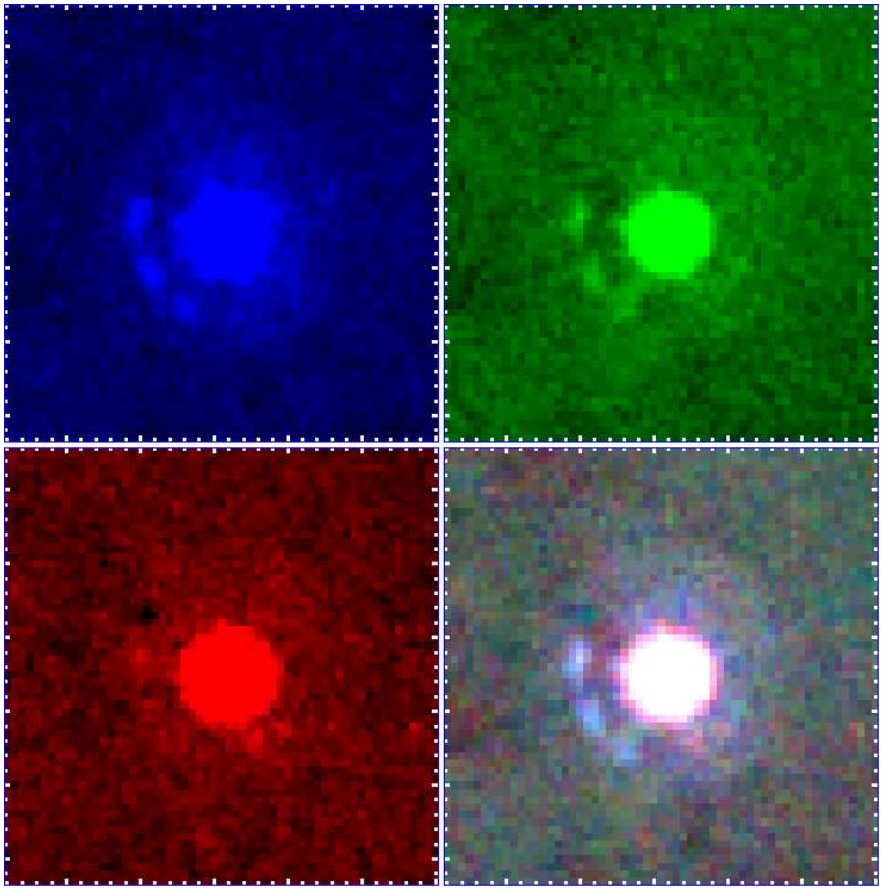
Subsampling-example HST ACS/WFC (SN 2006X)

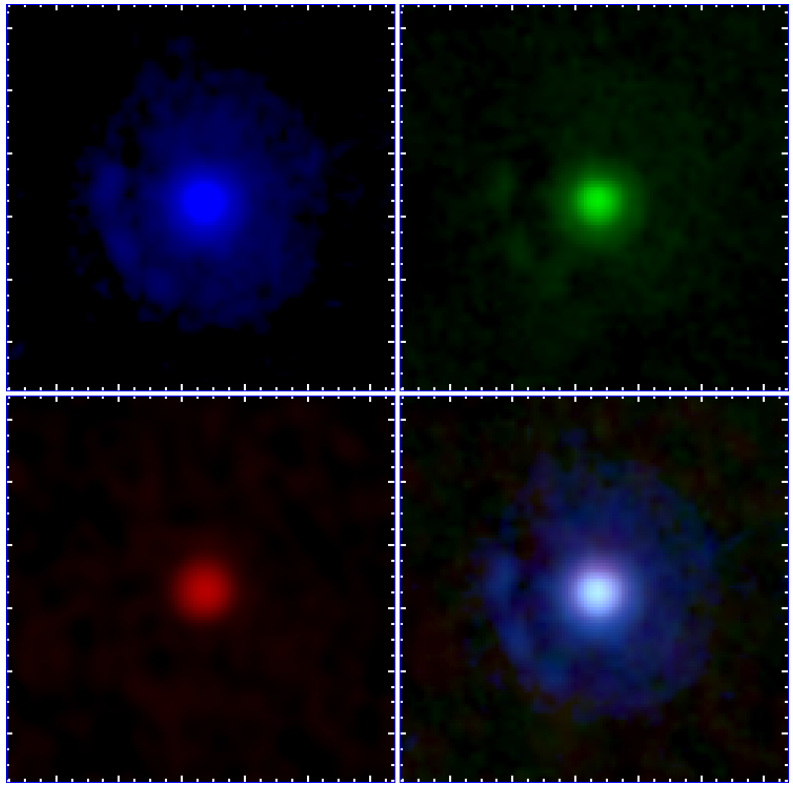


from 1 pixel
to 8×8 pixels

FIG. 4.—PSF-subtracted *HST* ACS images of SN 2006X (taken on 2006 December 24) with a $0.53'' \times 0.53''$ field surrounding SN 2006X. The supernova is at the center of each frame. Left panels show the residual image of SN 2006X obtained by subtracting the local bright Star 1, whose central flux is scaled to that of the supernova; middle panels display the residual image after resampling from 1 pixel to 8×8 pixels; and in the right panels there are circles of radius 2, 4, and 6 pixels to guide the eye.

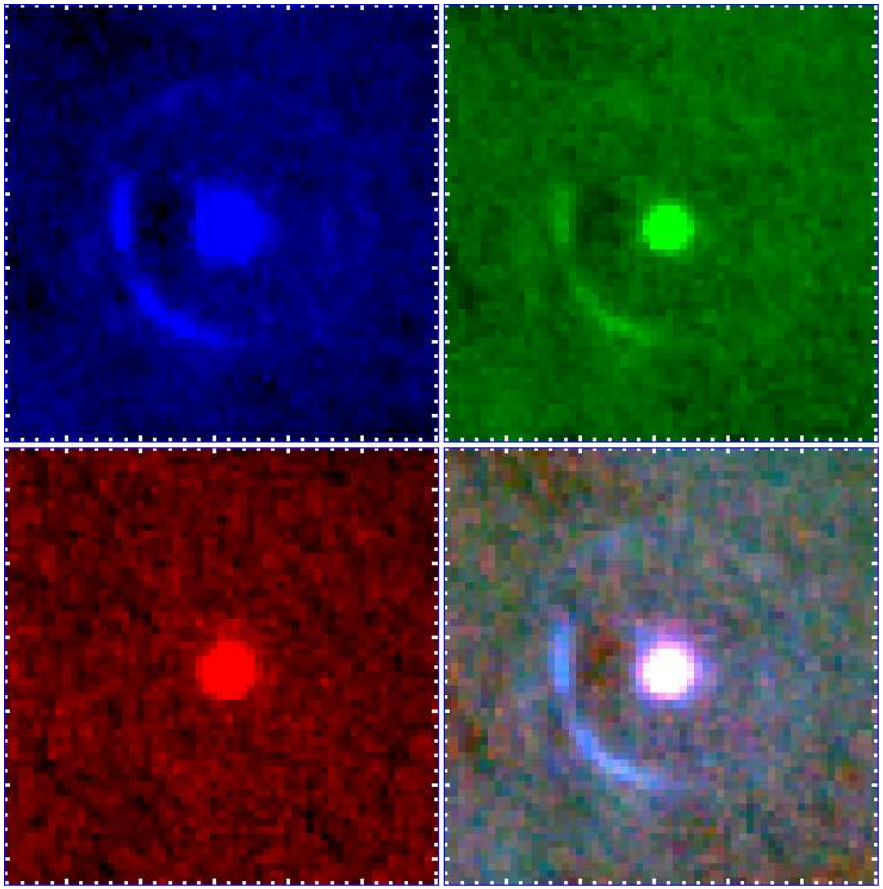
Subsampling–example, HST ACS/WFC (SN 2014J)

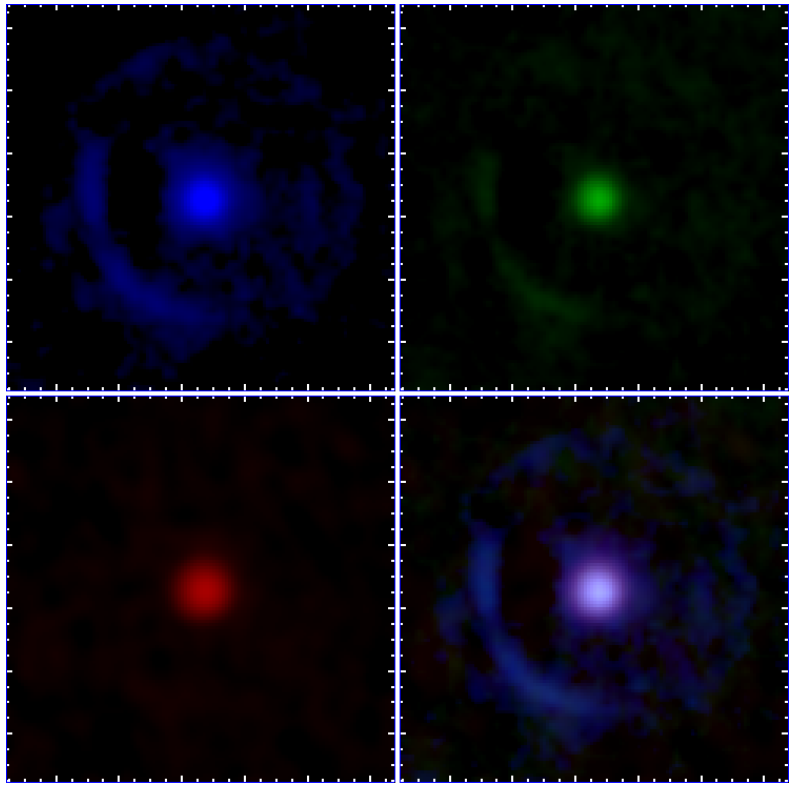




from 1 pixel to 5×5 pixels

Subsampling–example, HST ACS/WFC (SN 2014J)



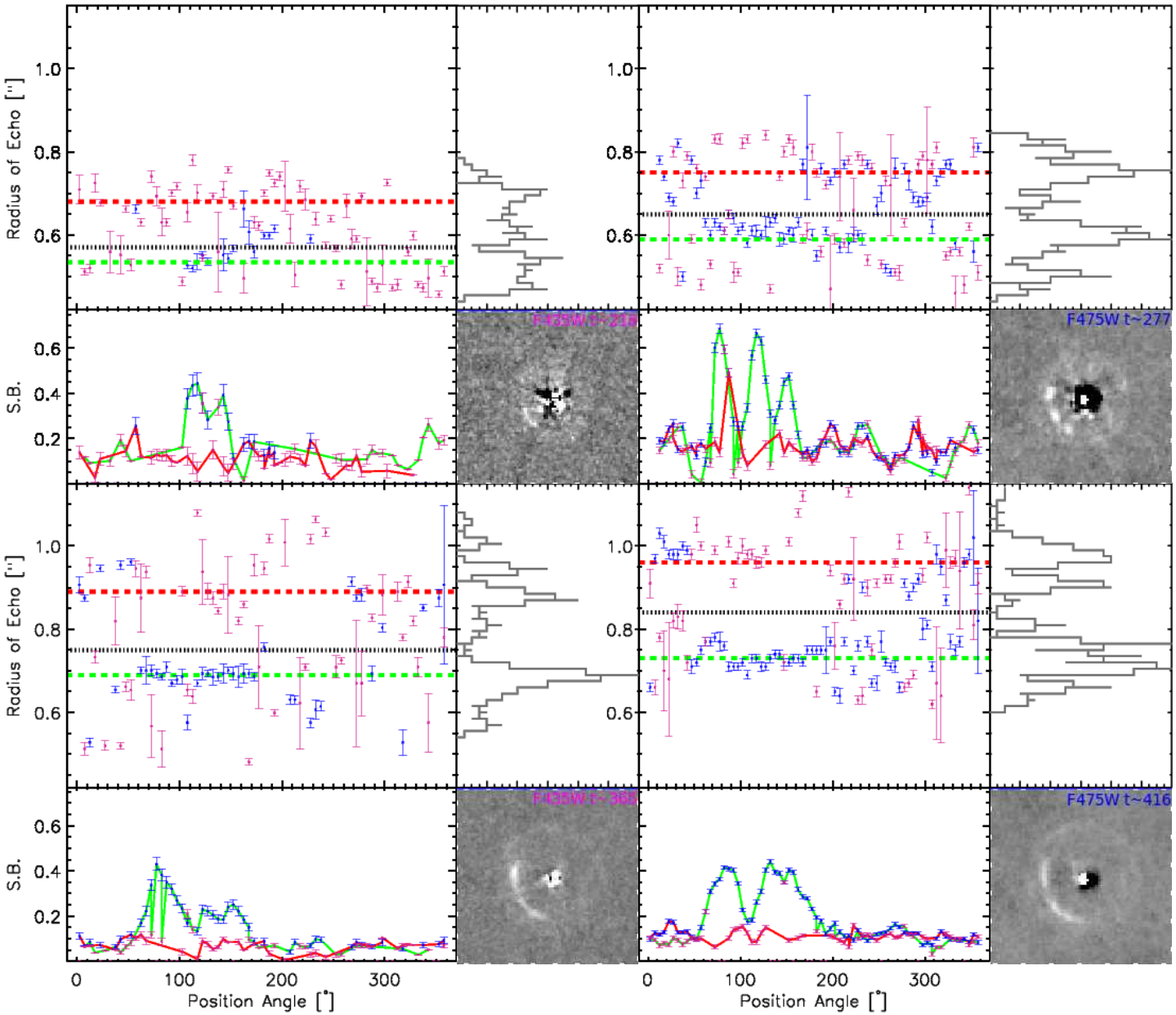


from 1 pixel to 5×5 pixels

Local maximum determination (1D)

- peakfinder.pro
- A peak is a local maximum, which has derivative zero.
- Consider "a peak", derivatives are positive to its left, and negative to its right.
- Weight of each peak:
  # of positive derivatives to its left +
  # negative derivatives to its right.

Subsampling-example, Light echoes of SN 2014J



Summary

- Destriping: Patterns removal in Fourier space .vs. in real space
- Subsampling: Obtaining a representative sample / Homogeneity
- Local maximum determination: Calculate the derivatives