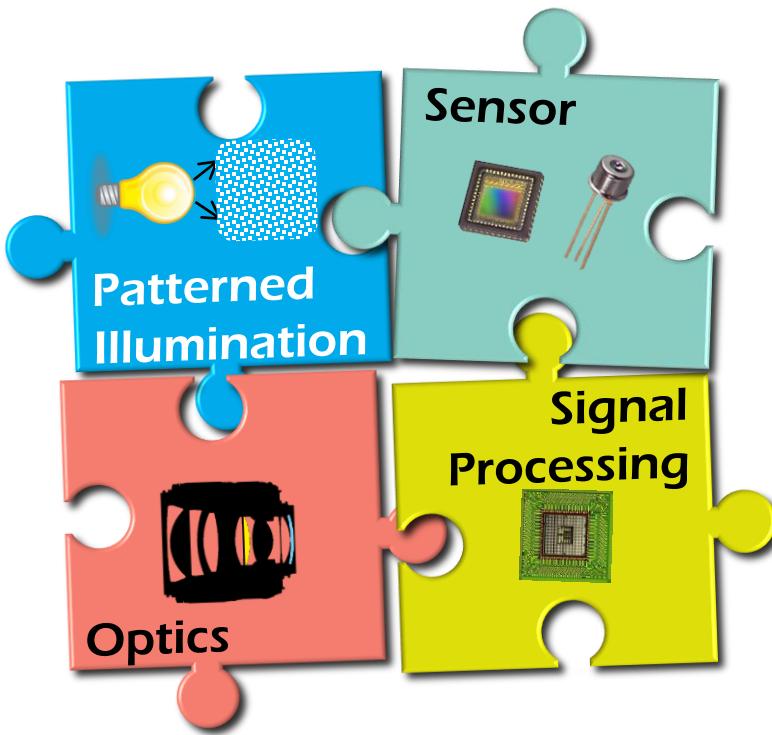


# *Pushing the limits of imaging using patterned illumination*

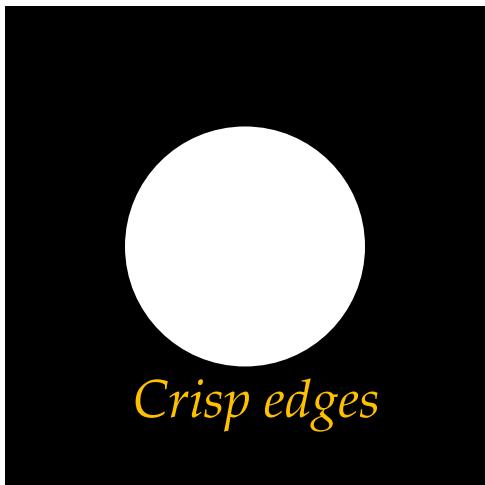


**Seeing “more”  
with unmatched clarity**

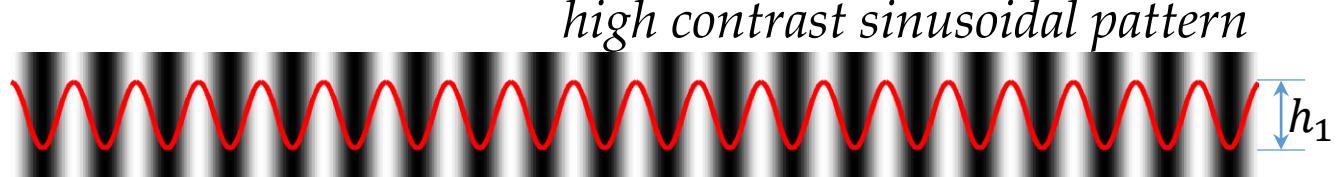
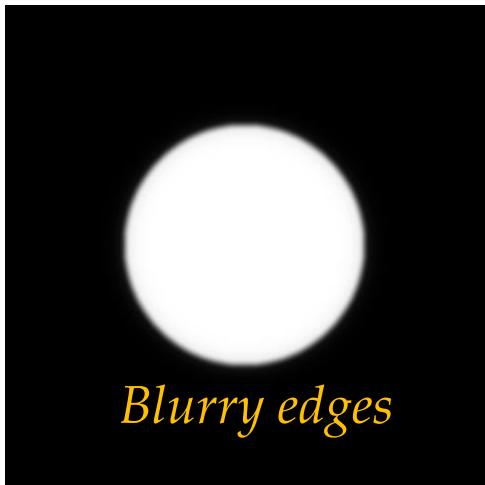
*Prasanna Rangarajan  
[prangara@smu.edu](mailto:prangara@smu.edu)*

*Acknowledgement*  
Dr. Predrag Milojkovic (DARPA DSO)  
Dr. Marc P. Christensen (SMU)

# Consequence of optical blur



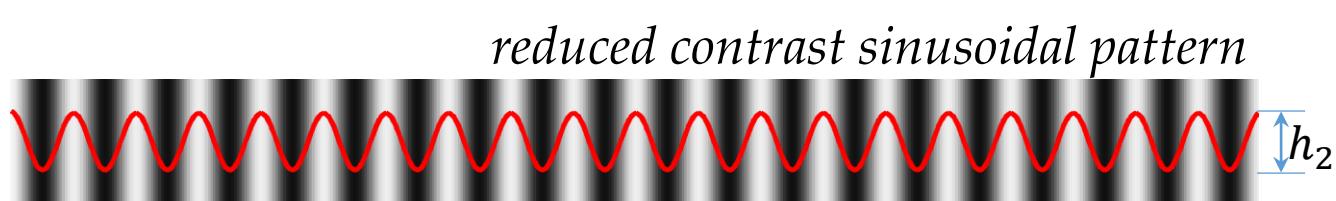
**Imaging  
optics**



*high contrast sinusoidal pattern*

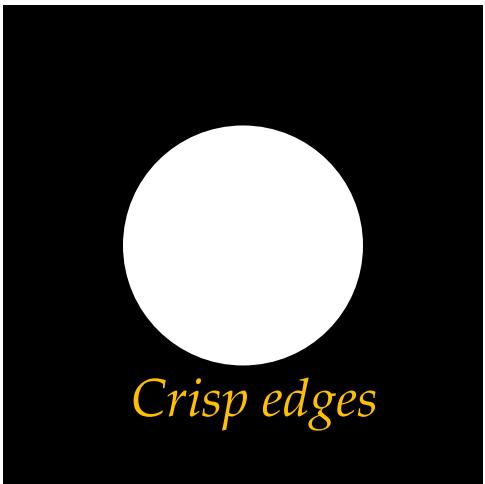


**Imaging  
optics**



*reduced contrast sinusoidal pattern*

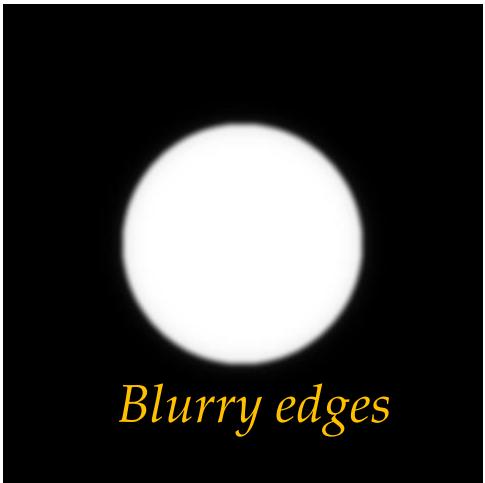
# Consequence of optical blur



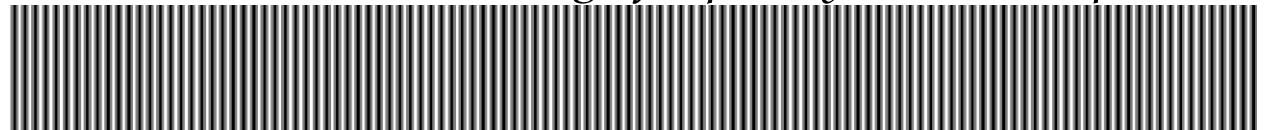
*Crisp edges*



**Imaging  
optics**



*Blurry edges*



*high frequency sinusoidal pattern*



**Imaging  
optics**

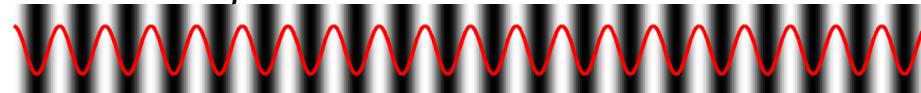
*unresolved sinusoidal pattern*



**Fact:** Spatial detail lost to optical blur is lost for good

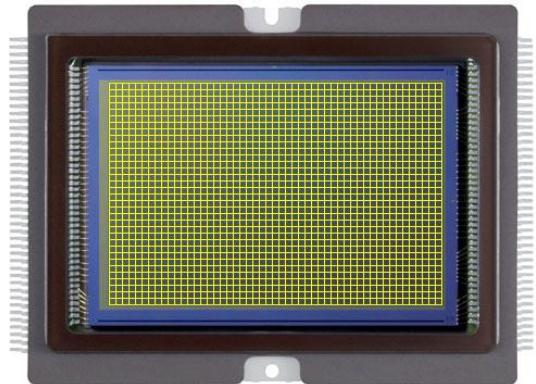
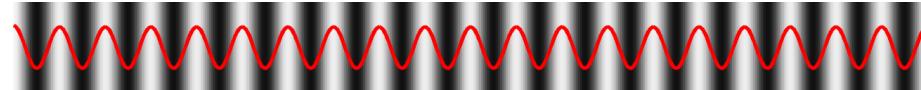
# Consequence of pixel size

*Sinusoidal pattern*



**Imaging optics**

*Optically blurred sinusoidal pattern*

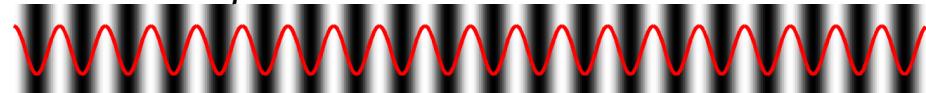


**Large pixels**



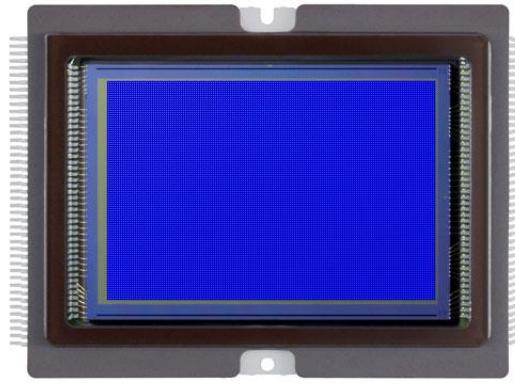
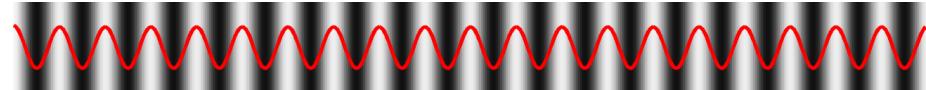
*Detected pattern*

*Sinusoidal pattern*

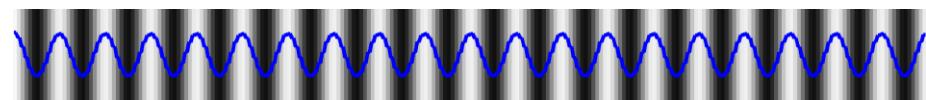


**Imaging optics**

*Optically blurred sinusoidal pattern*



**Tiny pixels**

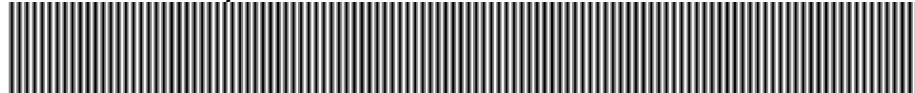


*Detected pattern*

**Fact:** Smaller Pixels  $\Rightarrow$  more megapixels  $\Rightarrow$  accurate reproduction of detail

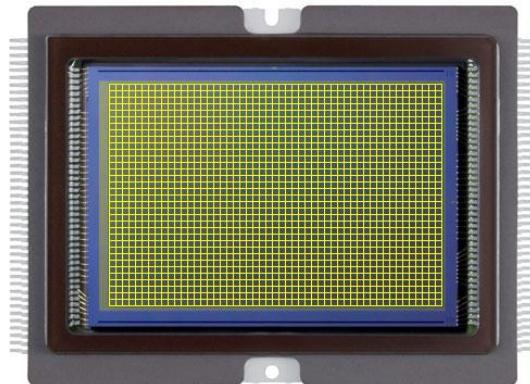
# Consequence of pixel size

*Sinusoidal pattern*



**Imaging optics**

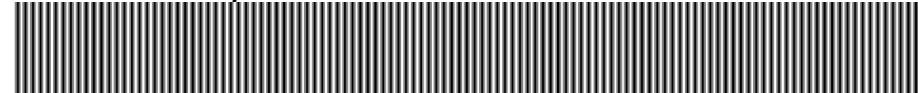
*Optically blurred sinusoidal pattern*



**Large pixels**

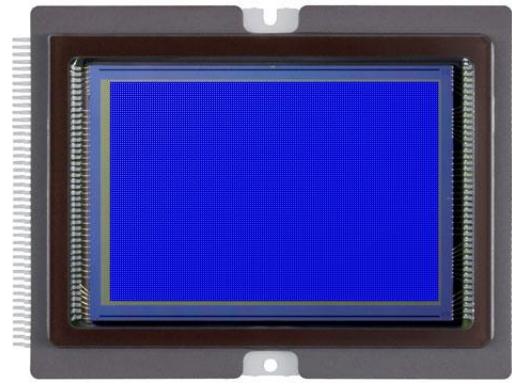
*Detected pattern*

*Sinusoidal pattern*



**Imaging optics**

*Optically blurred sinusoidal pattern*

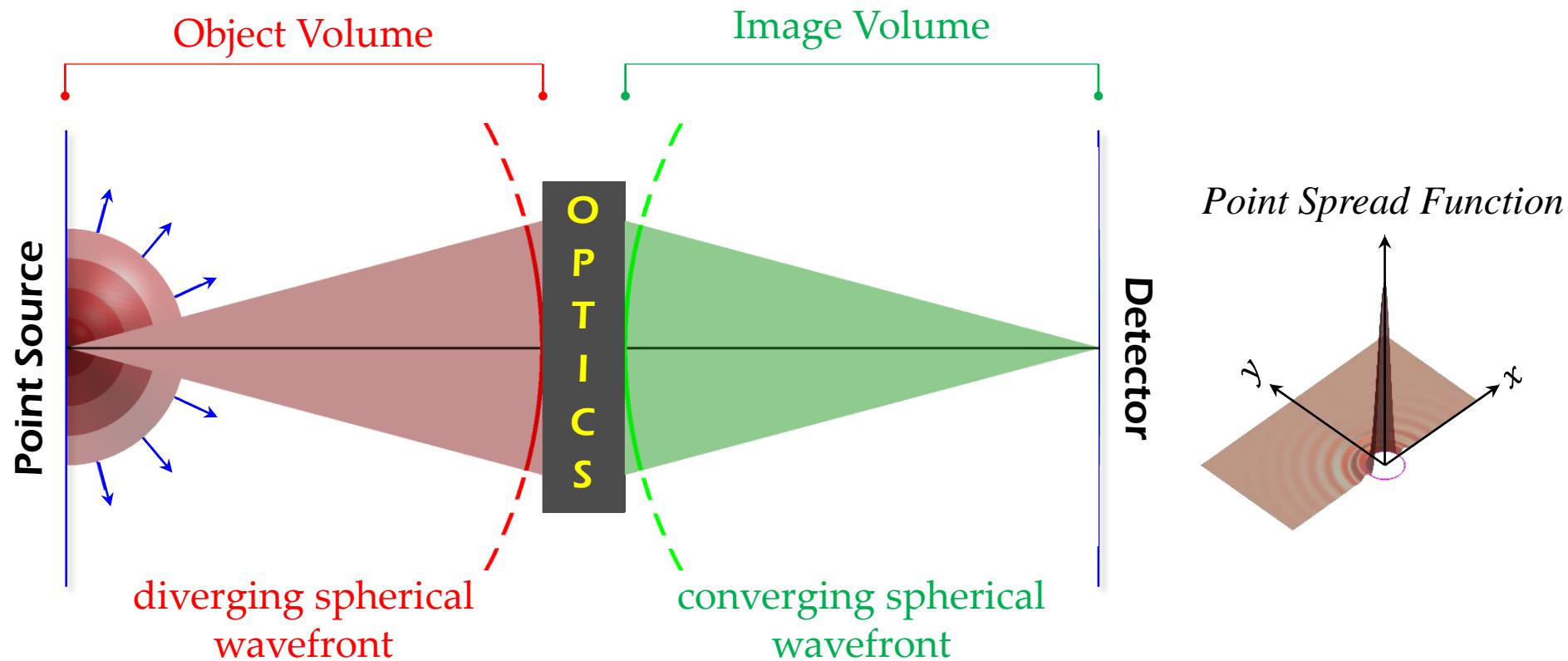


**Tiny pixels**

*Detected pattern*

**Fact:** If the optics can't resolve it, you can't sense it !!

# Source of optical blur



**Fact:** A point object/source does not produce a point image !!

Reference:

1. J. W. Goodman, Introduction to Fourier Optics (McGraw-Hill, New York, 1968)

# Why not build better optics ?

**Leica Noctilux – M 0.95/50mm ASPH**

- 8 lenses in 5 groups



\$10900

**Leica Summicron – M 1.4/50mm ASPH**

- 8 lenses in 5 groups



\$4000

**Leica Summicron – M 2.0/50mm ASPH**

- 6 lenses in 4 groups



\$2295

**Leica Summarit – M 2.5/50mm**

- 6 lenses in 4 groups



\$1495