Medical Image Processing for Diagnostic Applications

Sinograms and Fan Beam Geometry

Online Course – Unit 36

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Topics

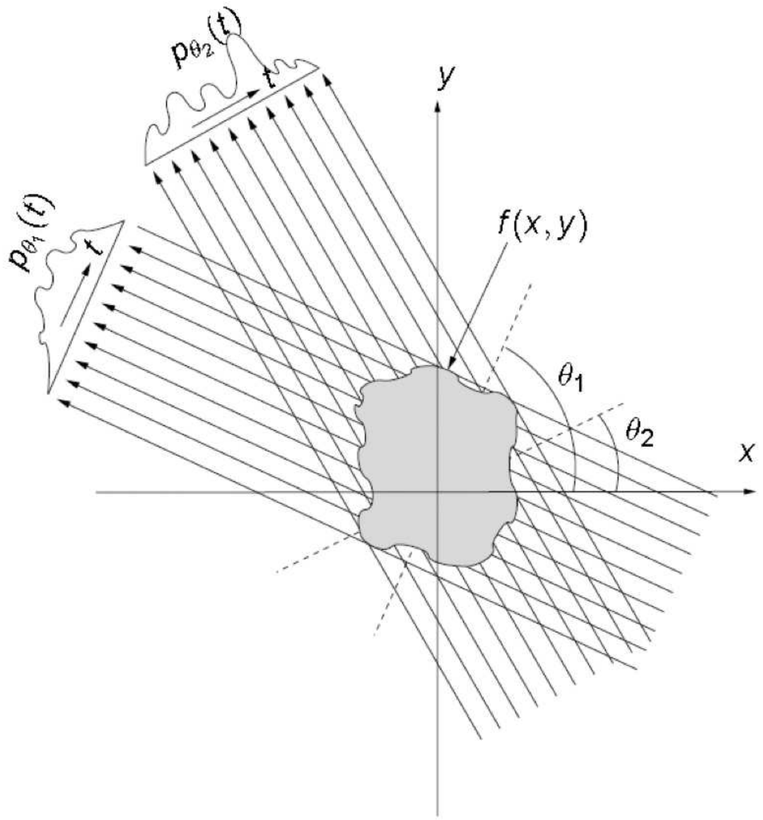
Sinograms

Fan Beam Geometry

Summary

- Take Home Messages
- Further Readings

Parallel Beam Geometry



(https://en.wikipedia.org/wiki/File:Emi1010.jpg)

Figure 1: Parallel projection scheme with two different angles θ_1, θ_2 and the object $f(x,y)$

A *sinogram* ...

- ... is a method to visualize all projections in one image.
- ... contains all information to reconstruct one slice.
- ... is also called *“fanogram”* in fan beam geometry.
- ... is a popular method for visualization with narrow detectors.

Parallel Beam Geometry: Sinogram

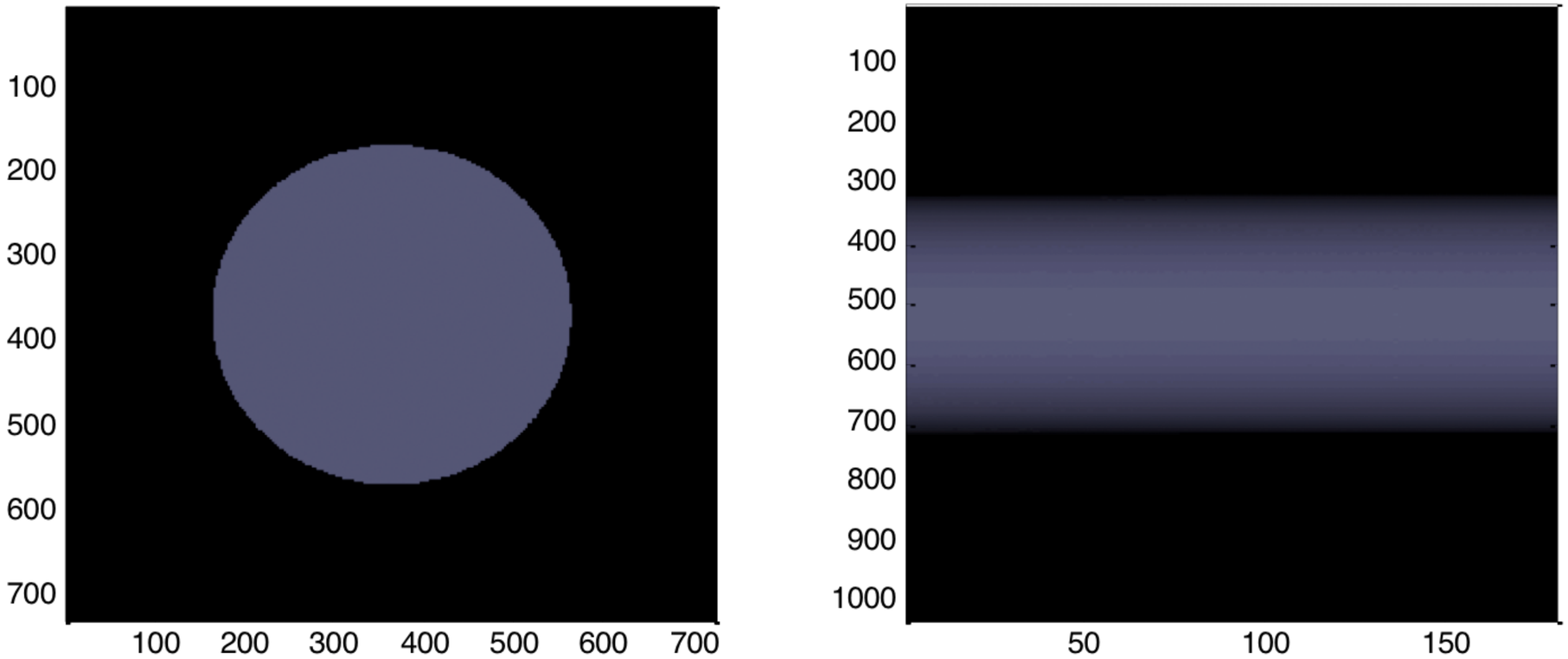


Figure 2: Circle phantom (left) and its sinogram (right)

Parallel Beam Geometry: Sinogram

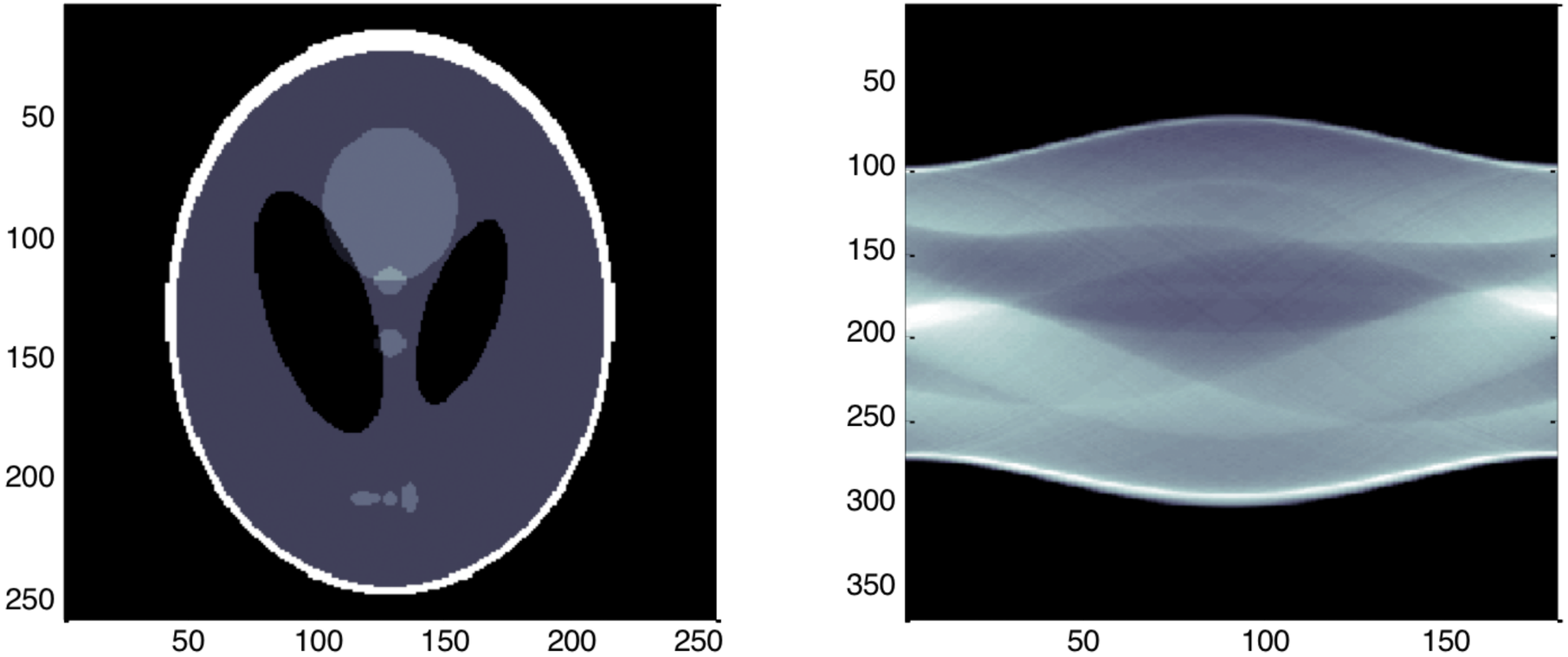


Figure 3: 2-D Shepp-Logan phantom (left) and the corresponding sinogram (right)

Parallel Beam Geometry: Sinogram

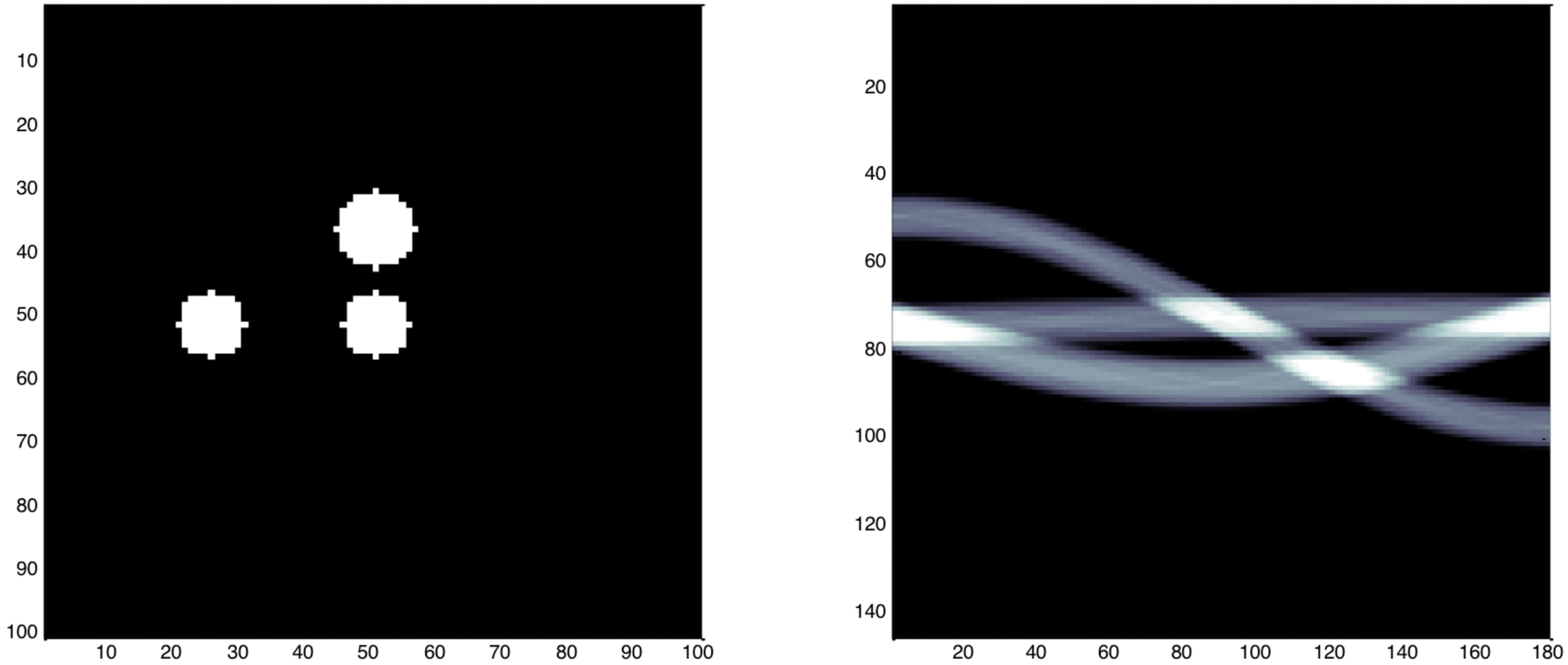


Figure 4: Several small objects (left) and their path in the sinogram (right)

Fan Beam Geometry

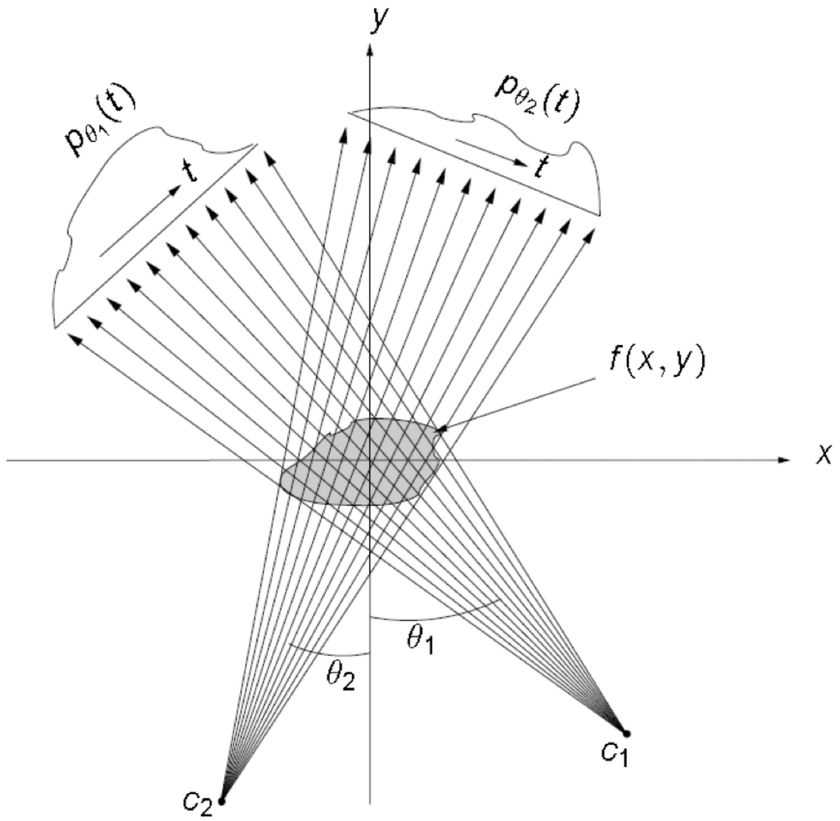
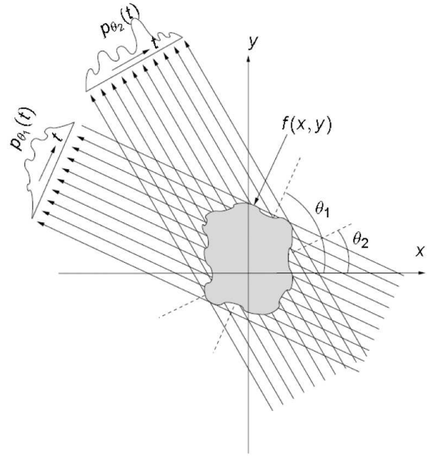
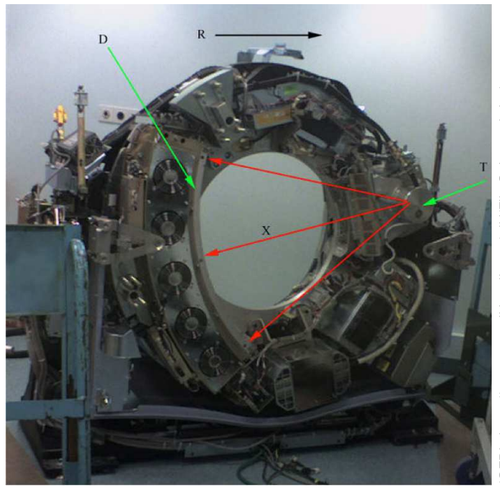


Figure 5: Fan beam projection scheme with two different angles θ_1, θ_2 and the object $f(x,y)$





(GFDL: https://commons.wikimedia.org/wiki/File:Ct-internals.jpg)

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Fan Beam vs. Parallel Beam

- Parallel beam algorithms cannot be applied directly anymore.
- We do not have a central slice theorem anymore.

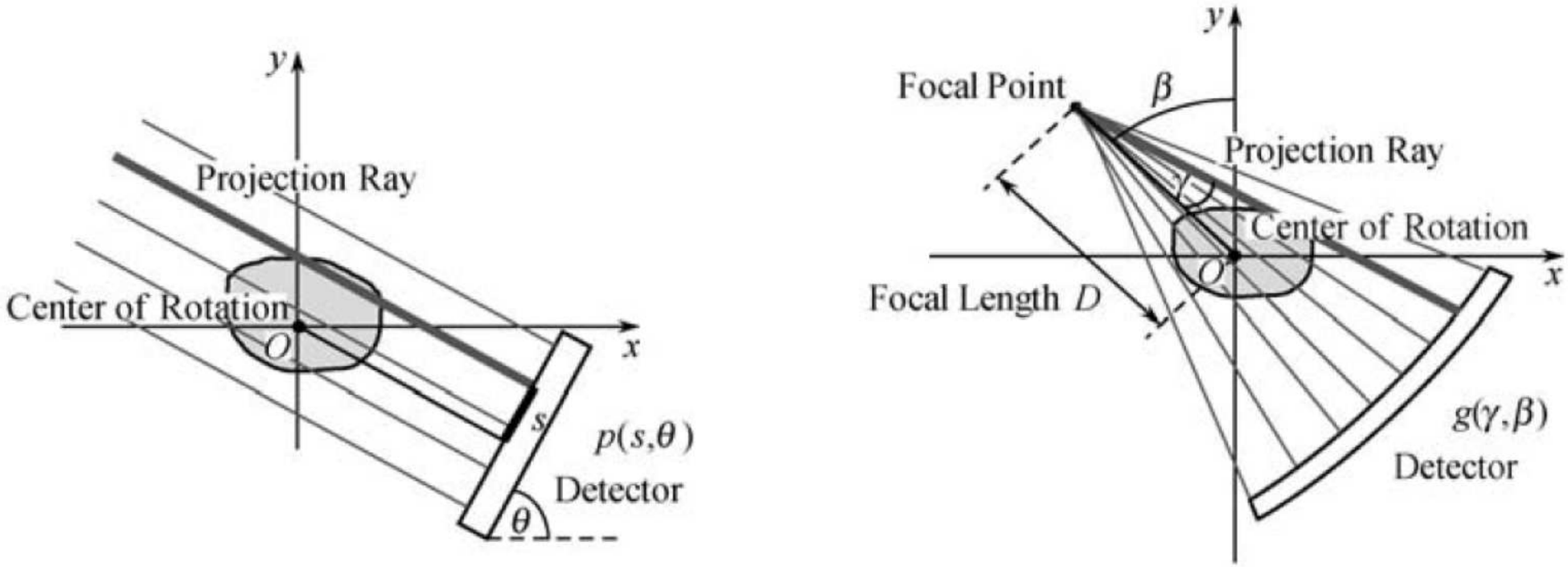

Figure 6: Parallel beam projection with a flat detector (left) and fan beam projection with a curved detector (right) (Zeng, 2009)

Point Spread Function (PSF): Parallel Beam

- Draw a line through the reconstructed point that is perpendicular to the detector.
- Repeat this for every detector position.
- In this case, the point spread function is shift-invariant, i. e., every reconstructed point shows the same pattern.

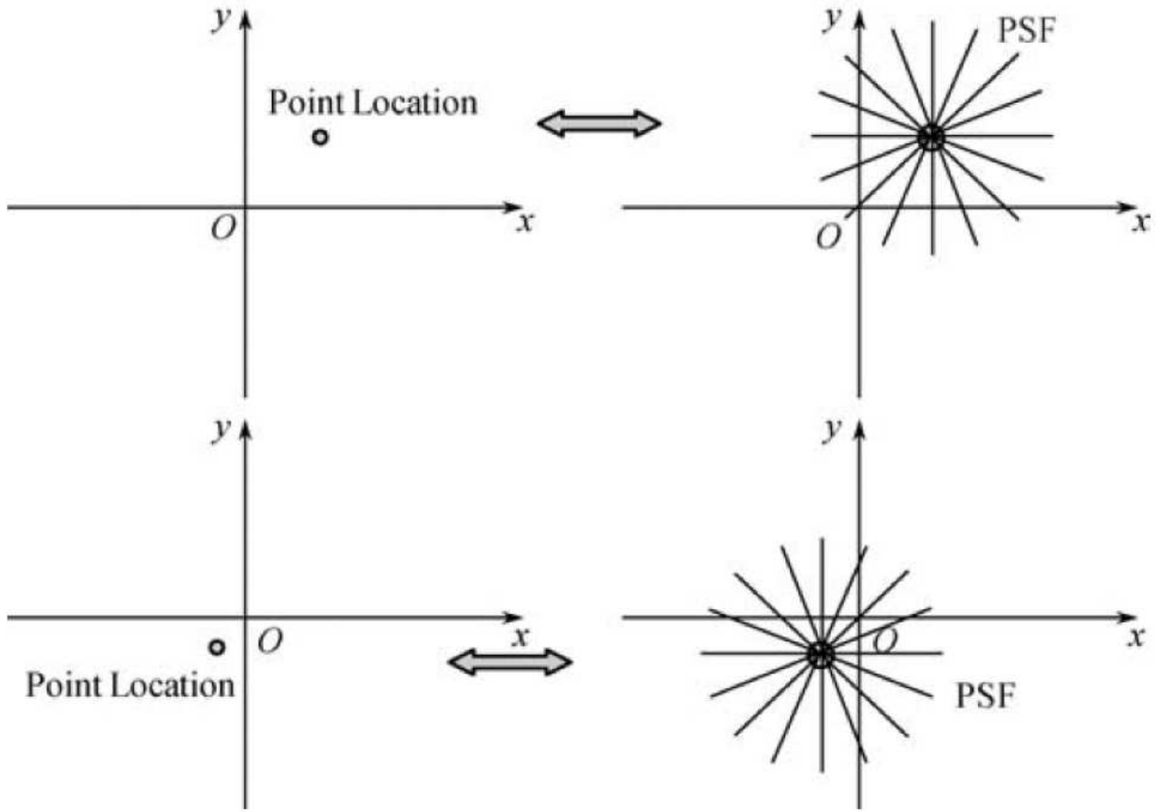

Figure 7: Relationship between point object and its PSF (Zeng, 2009)

Point Spread Function: Fan Beam

- Draw a line through the reconstructed point and the source position.
- Repeat this for every source position.
- For a complete circle, the pattern is also shift-invariant.
- It can be shown that the full circle PSF is equivalent to the parallel beam PSF!

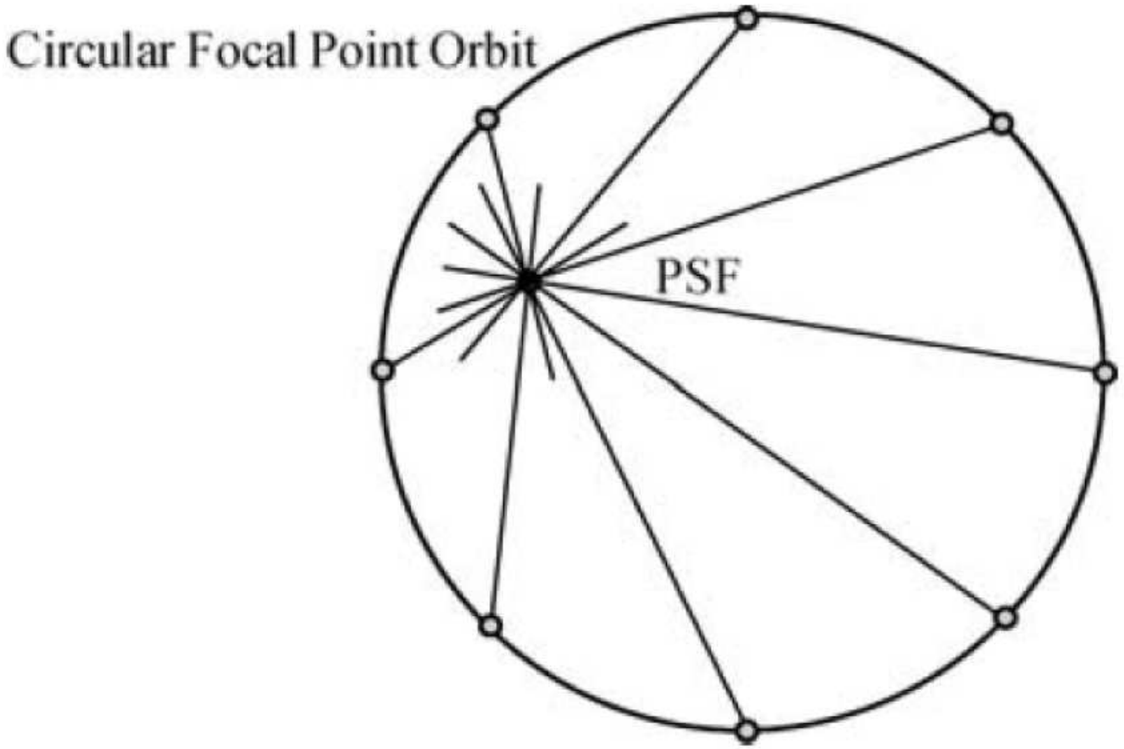

Figure 8: PSF in fan beam geometry (Zeng, 2009)

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Take Home Messages

- Since parallel beam scanners are slow, the next logical step are designs using fan beam geometry.
- We have learned what a sinogram is.
- The PSF is a useful tool to analyze the reconstruction output and relate it to the input.
- Our observation on the similarity of both parallel beam and fan beam PSF motivates the reconstruction algorithm in the following unit.

Further Readings

Helpful reads for the current unit:

Gengsheng Lawrence Zeng. *Medical Image Reconstruction – A Conceptual Tutorial*. Springer-Verlag Berlin Heidelberg, 2010. DOI: 10.1007/978-3-642-05368-9

Ronald N. Bracewell. *The Fourier Transform and Its Applications*. 3rd ed. Electrical Engineering Series. Boston: McGraw-Hill, 2000