Compressed Sensing MRI

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Presentation by Alok Deshpande
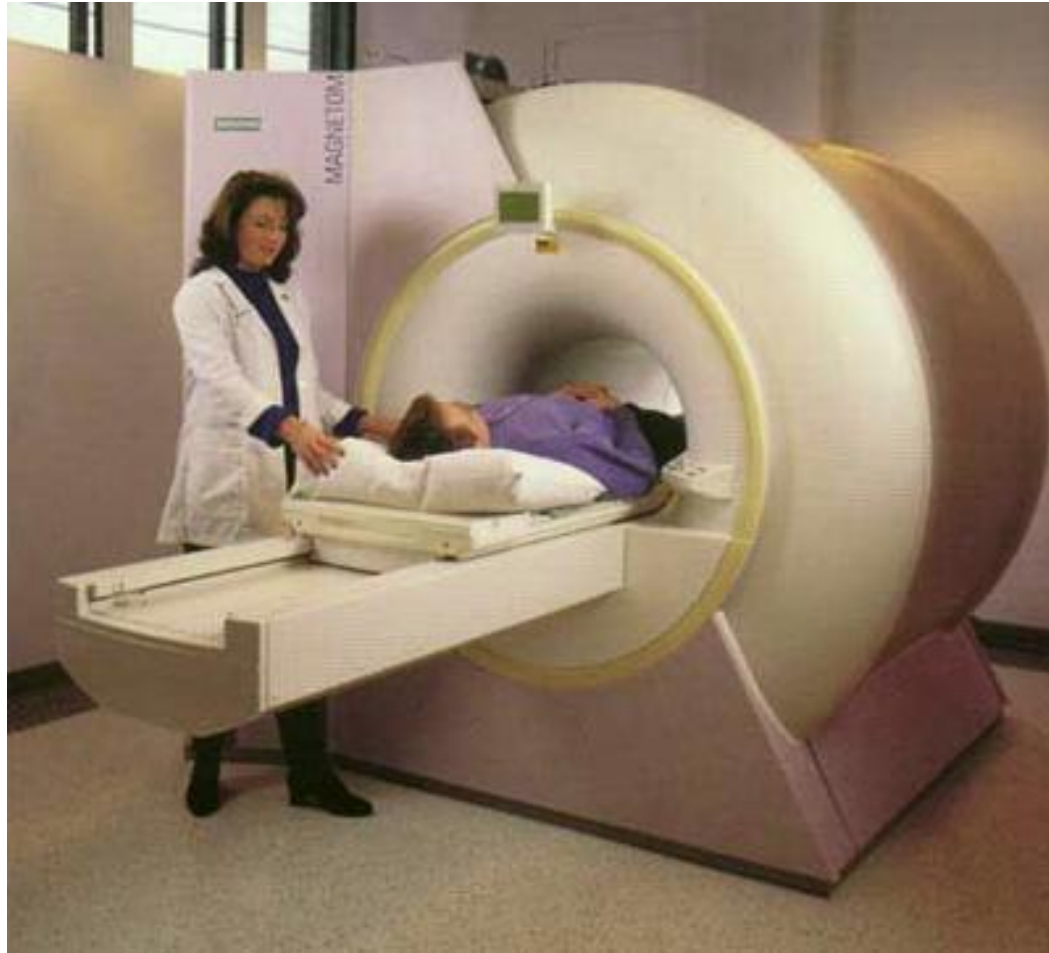For CS 838 final project

Talk Outline

- Why this topic? (Introduction)

- Principles of MRI

- How does sparsity arise in 3D data?

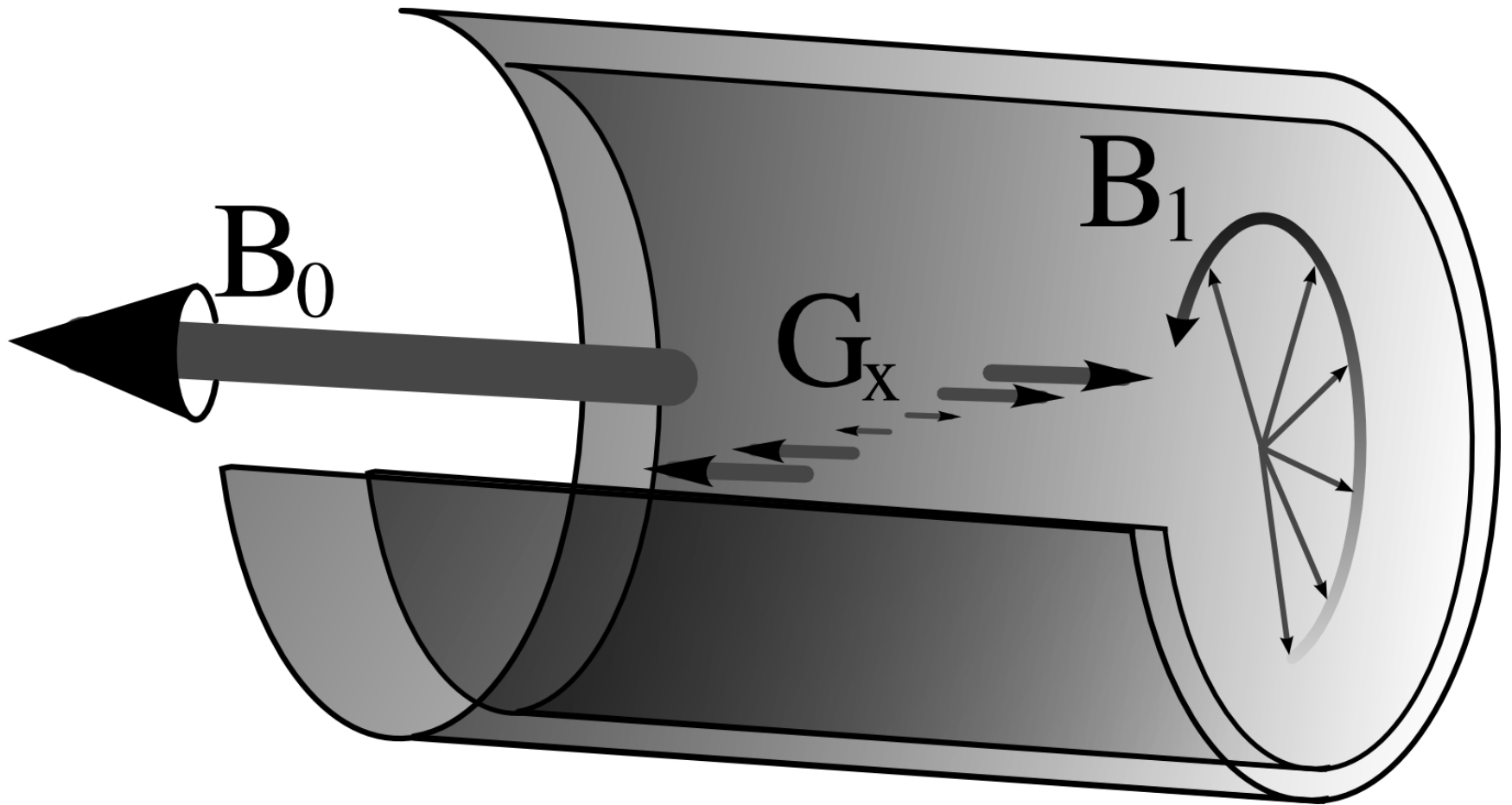- Natural fit between CS and MRI

- Applications

Why this topic?
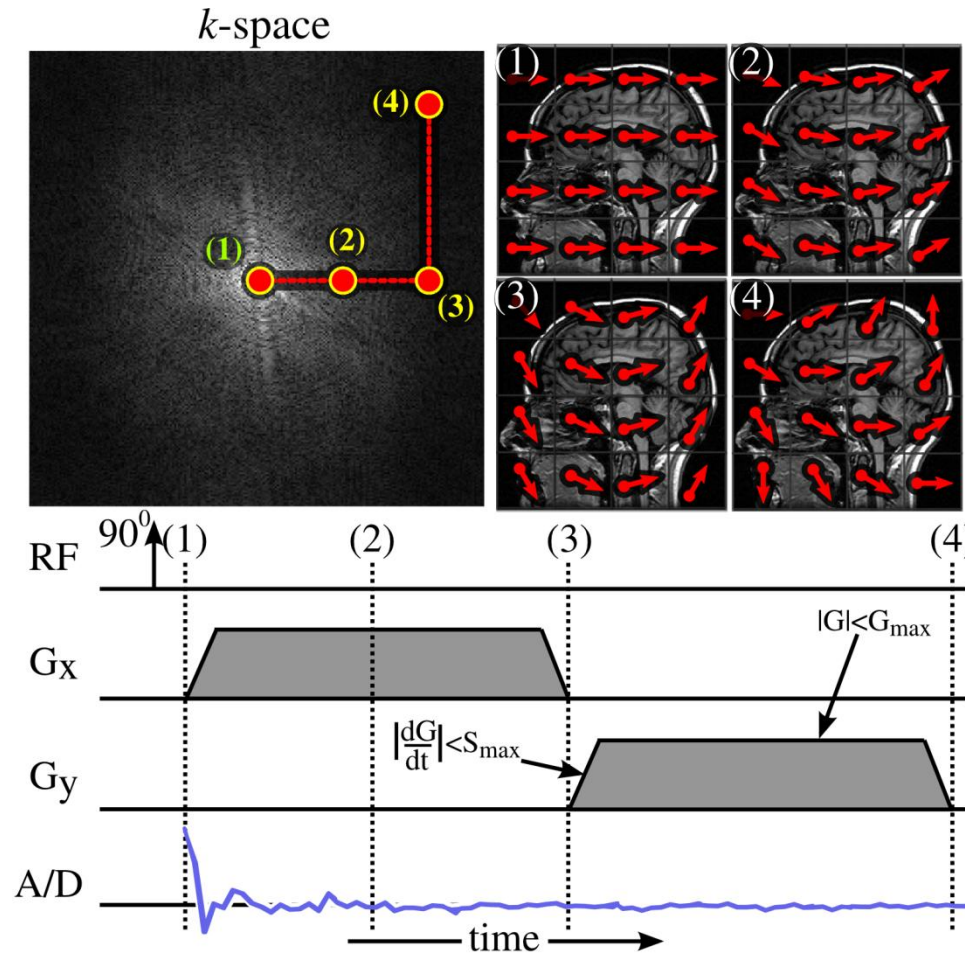
- My current work
- MRI well suited to CS!
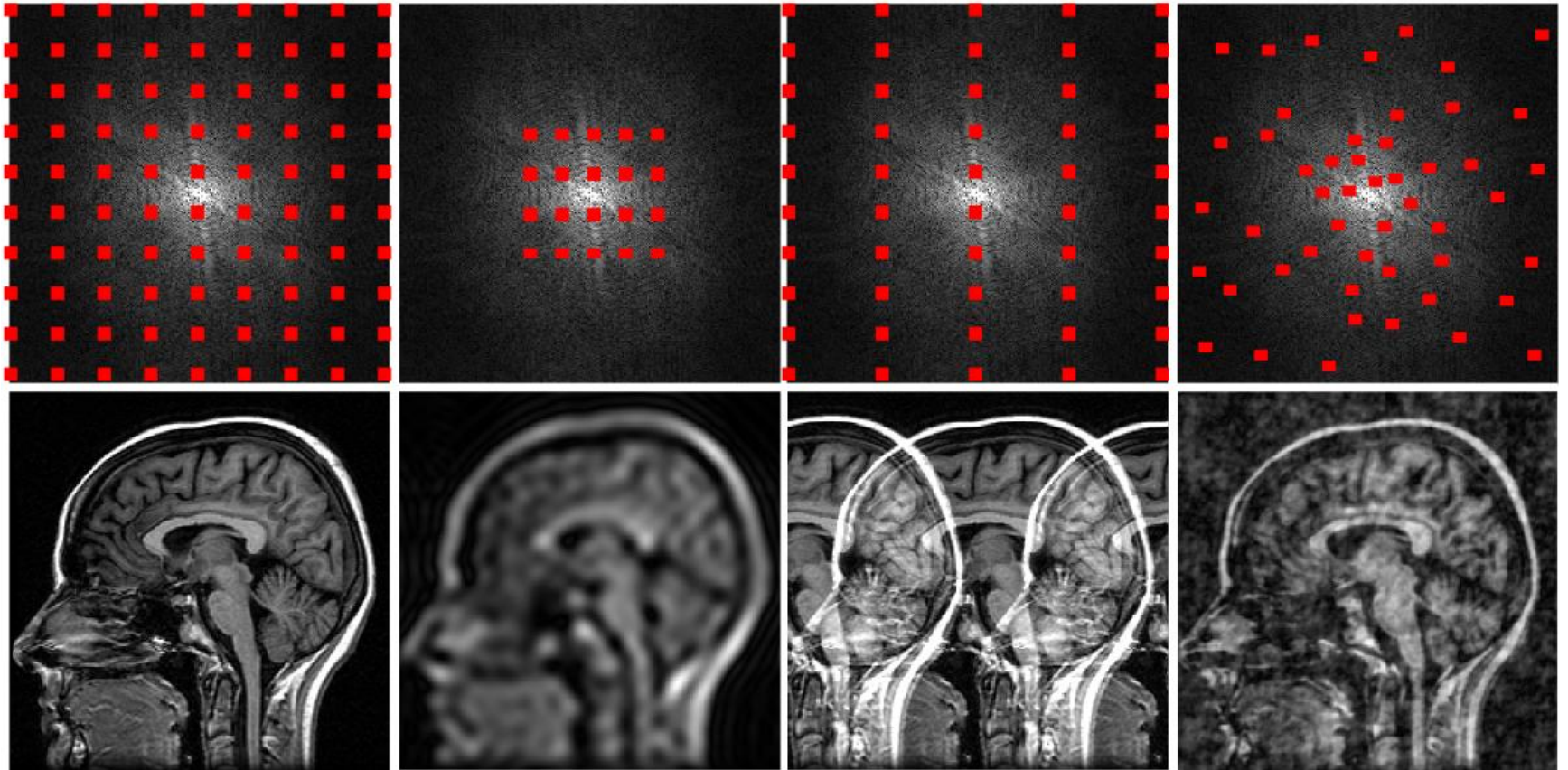
Principles of MRI

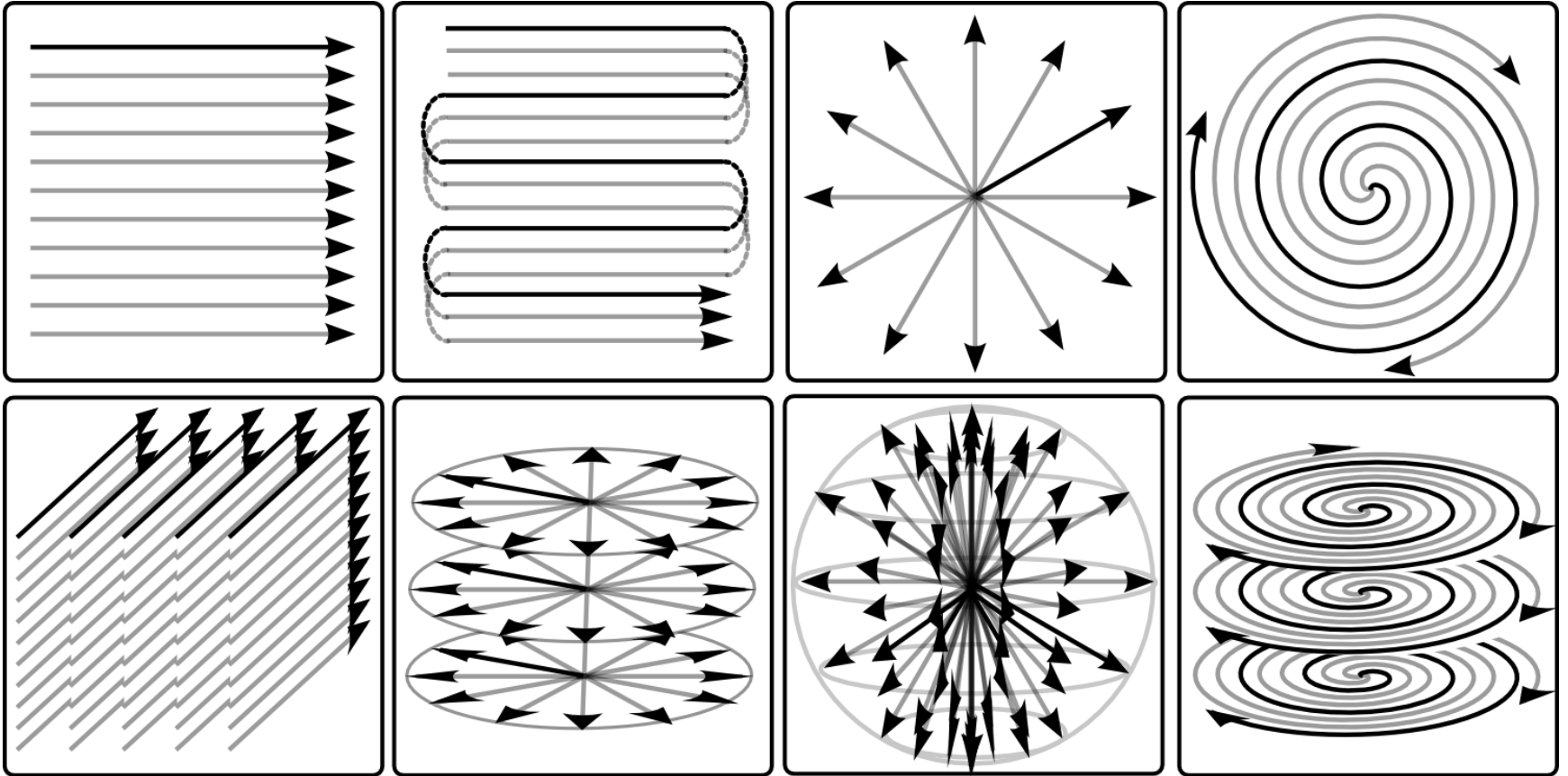# Principles of MRI

Principles of MRI

Why limited samples per acquisition?

- To avoid inadequate image resolution, excessive image artifacts

- Gradient system performance and physiological constraints
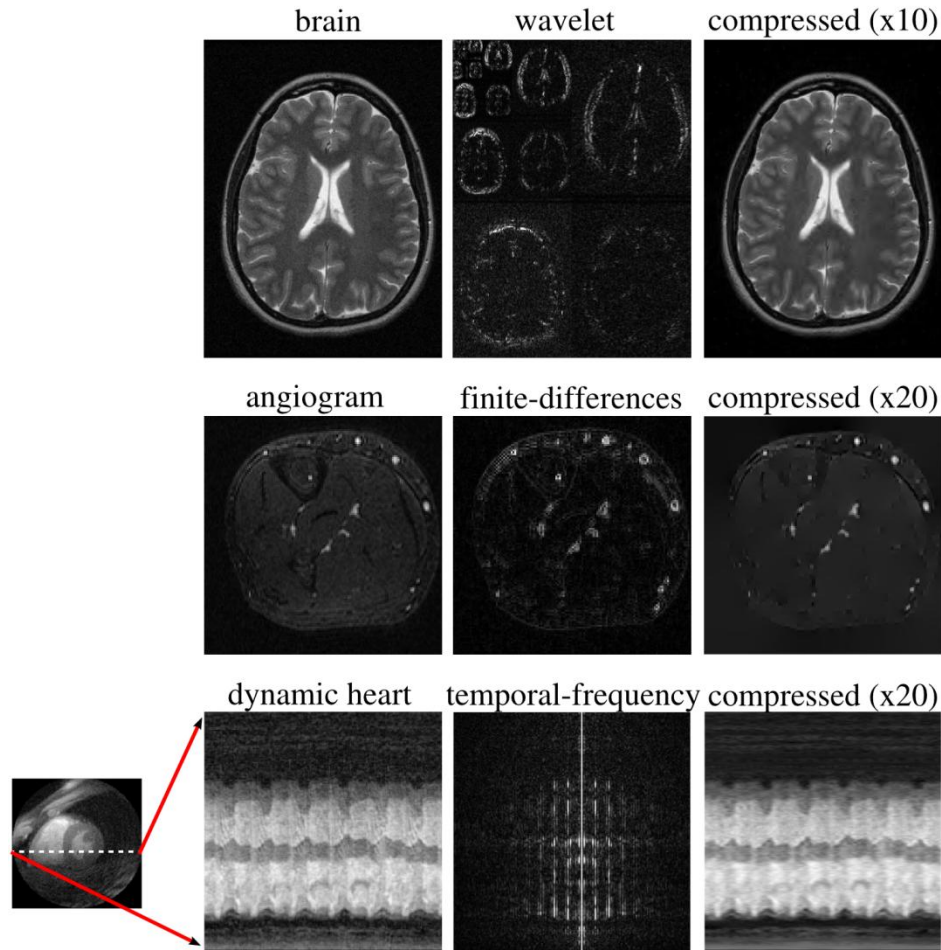
- Violation of Nyquist criterion – artifacts!

Principles of MRI
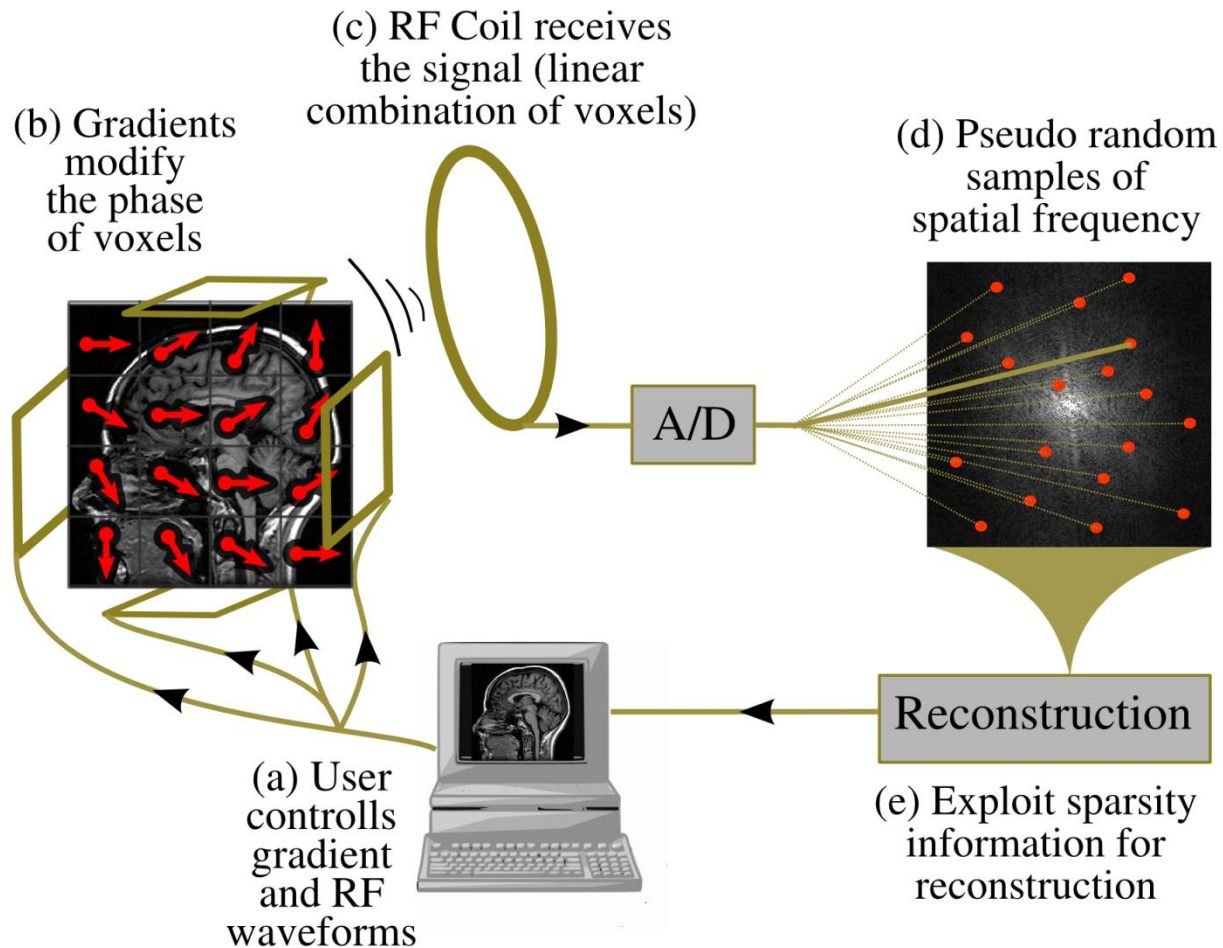
Principles of MRI

How does sparsity arise in 3D data?

Natural fit between CS and MRI

- A successful application of CS requires:
- **CS1 Transform Sparsity**: The desired image must have a sparse representation in a known transform domain (i.e., it must be compressible by transform coding),
- **CS2 Incoherence of Undersampling Artifacts**: The aliasing artifacts in a linear reconstruction caused by k-space undersampling must be incoherent (noise-like) in the sparsifying transform domain.
- **CS3 Nonlinear Reconstruction**: The image must be reconstructed by a non-linear method which enforces both sparsity of the image representation and consistency of the reconstruction with the acquired samples.

Natural fit between CS and MRI

(b) Gradients modify the phase of voxels

(c) RF Coil receives the signal (linear combination of voxels)

(d) Pseudo random samples of spatial frequency

A/D

(a) User controlls gradient and RF waveforms

Reconstruction

(e) Exploit sparsity information for reconstruction

Measuring Incoherence

- Derived from point spread function

- Goal of irregular sampling: to spread leakage quasi uniformly across the image, so that the maximal leakage is small
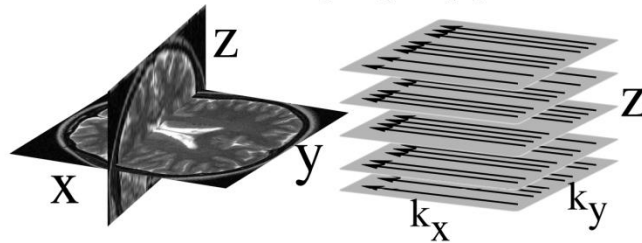
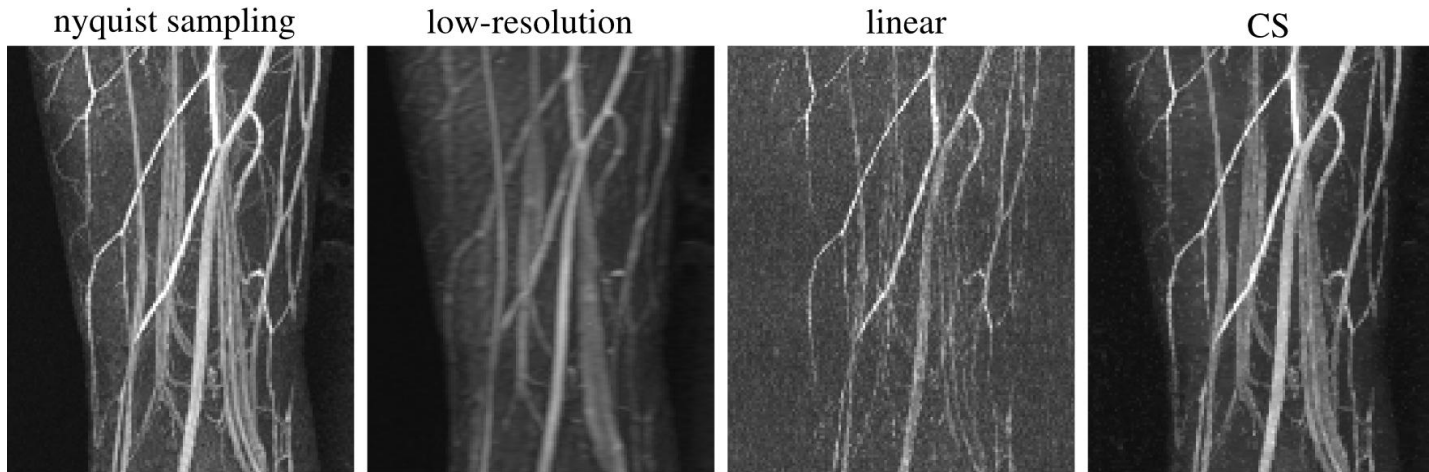# Example Sampling Trajectories and Corresponding PSFs
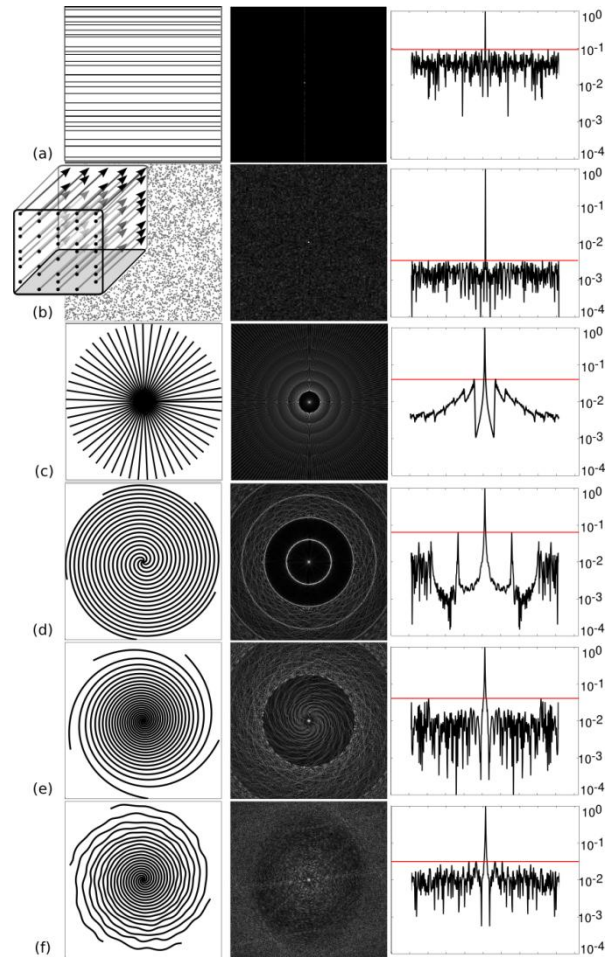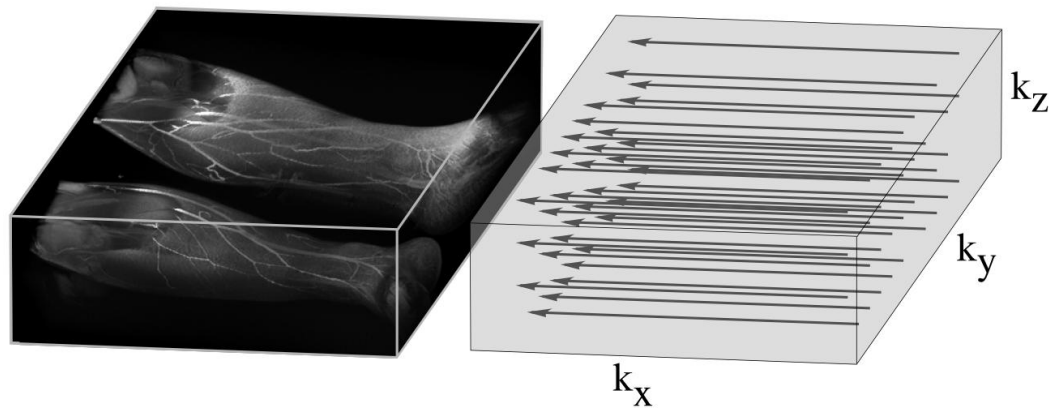
Applications: Brain Imaging

Nyquist sampling   low-res. sampling   linear   CS wavelet + TV
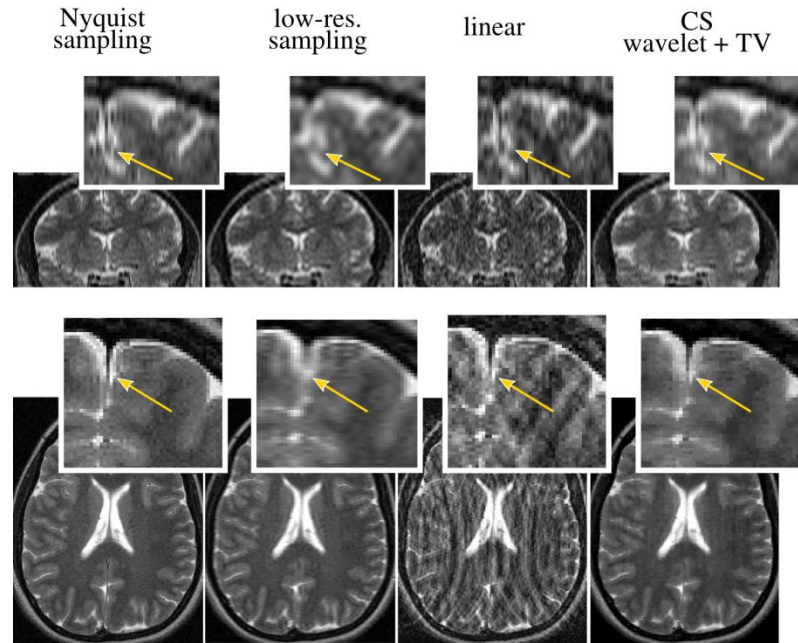
multi-slice 2D Cartesian sampling configuration:

Applications: Angiography

nyquist sampling   low-resolution   linear   CS

3D Cartesian sampling configuration:

Questions?