# SAR geometry and backscatter
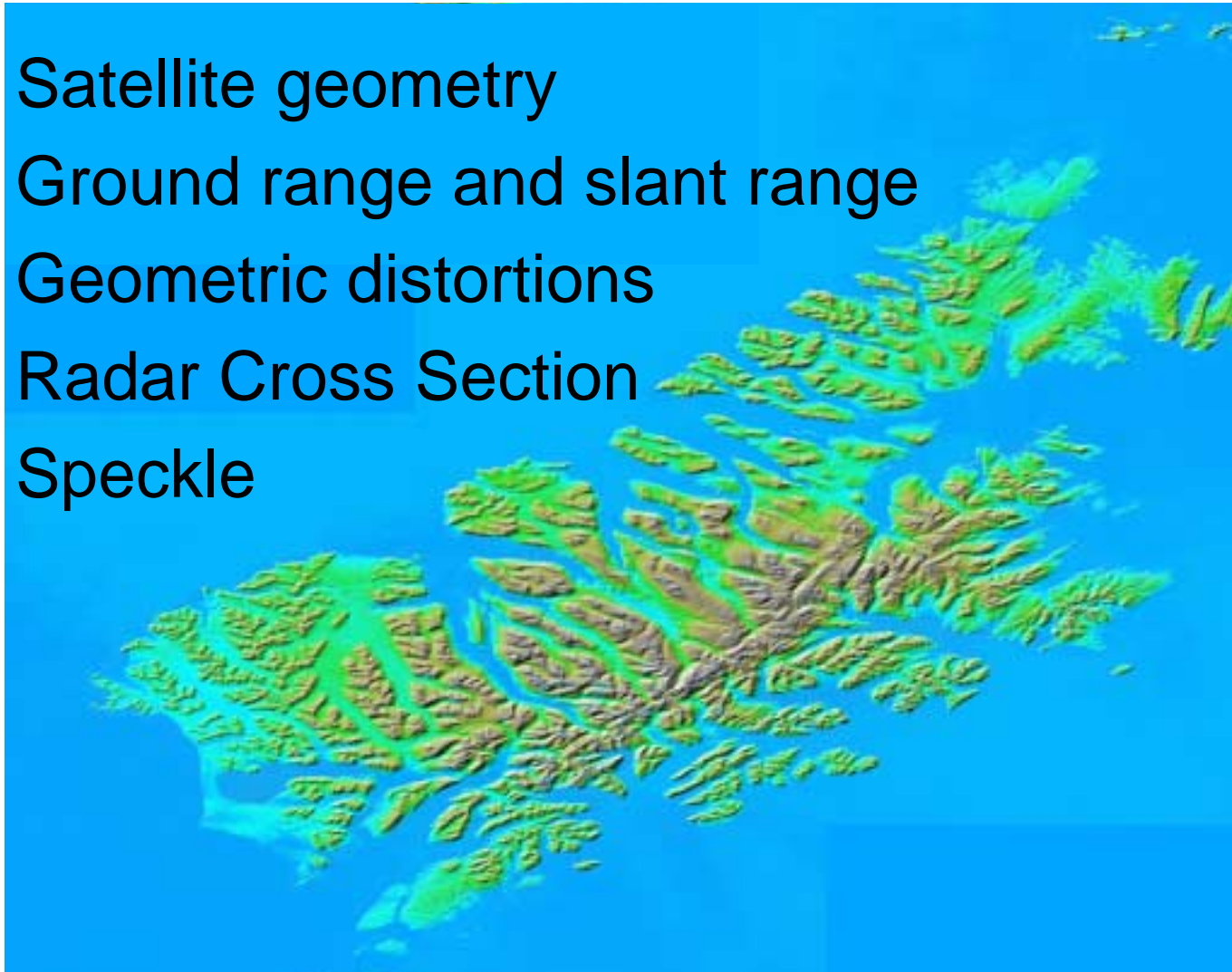
Jeremy Nicoll

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FAIRBANKS

# Outline

- Satellite geometry
- Ground range and slant range
- Geometric distortions
- Radar Cross Section
- Speckle

# What do we measure?

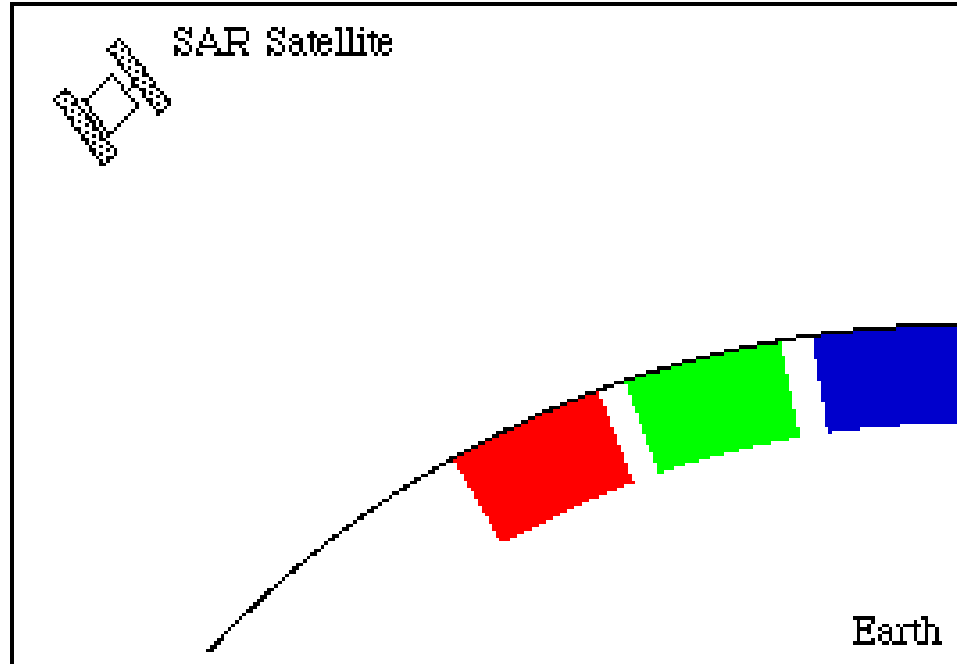- **At the satellite**
  - Radar signal strength as a function of time
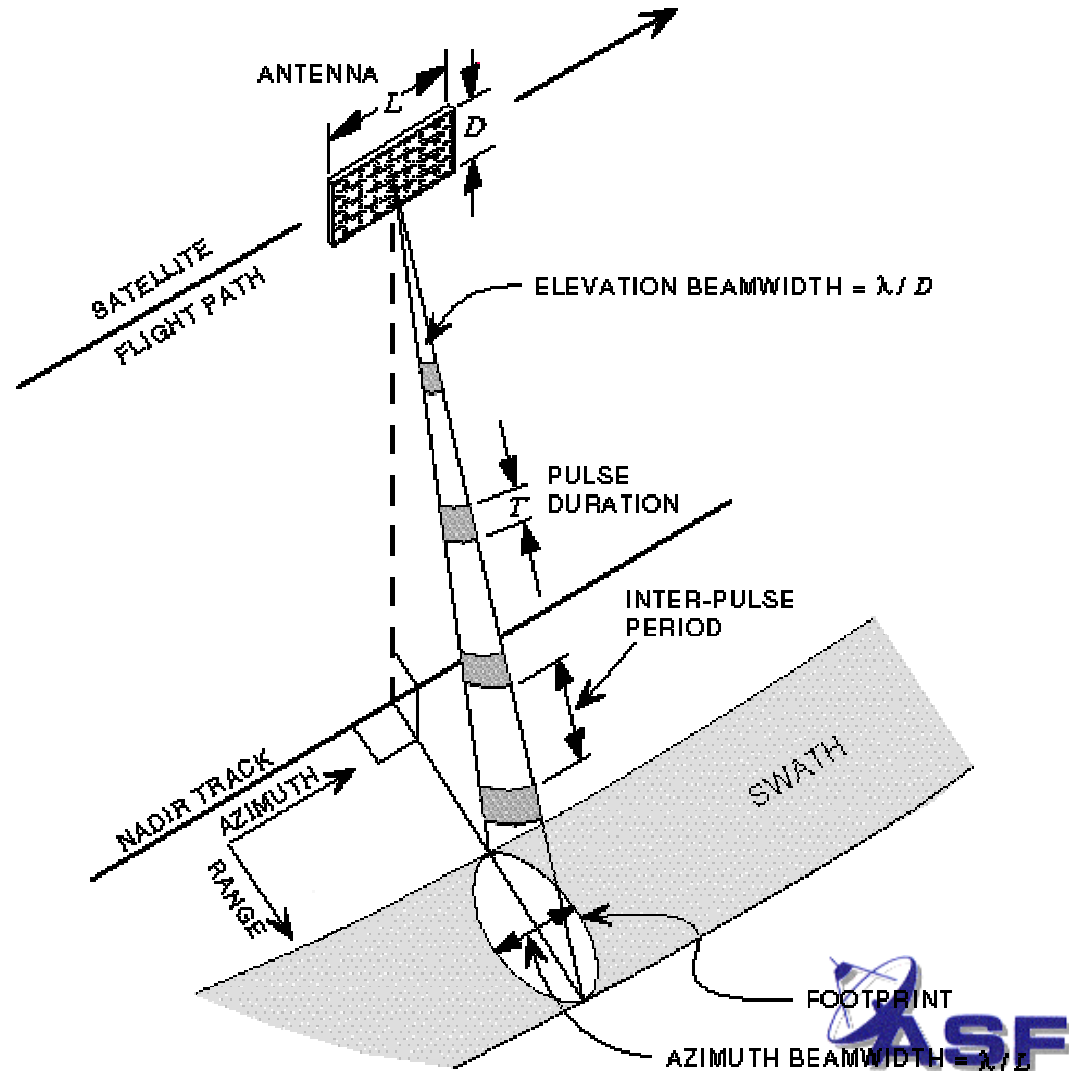- **After processing**
  - Radar Cross Section per piece of dirt
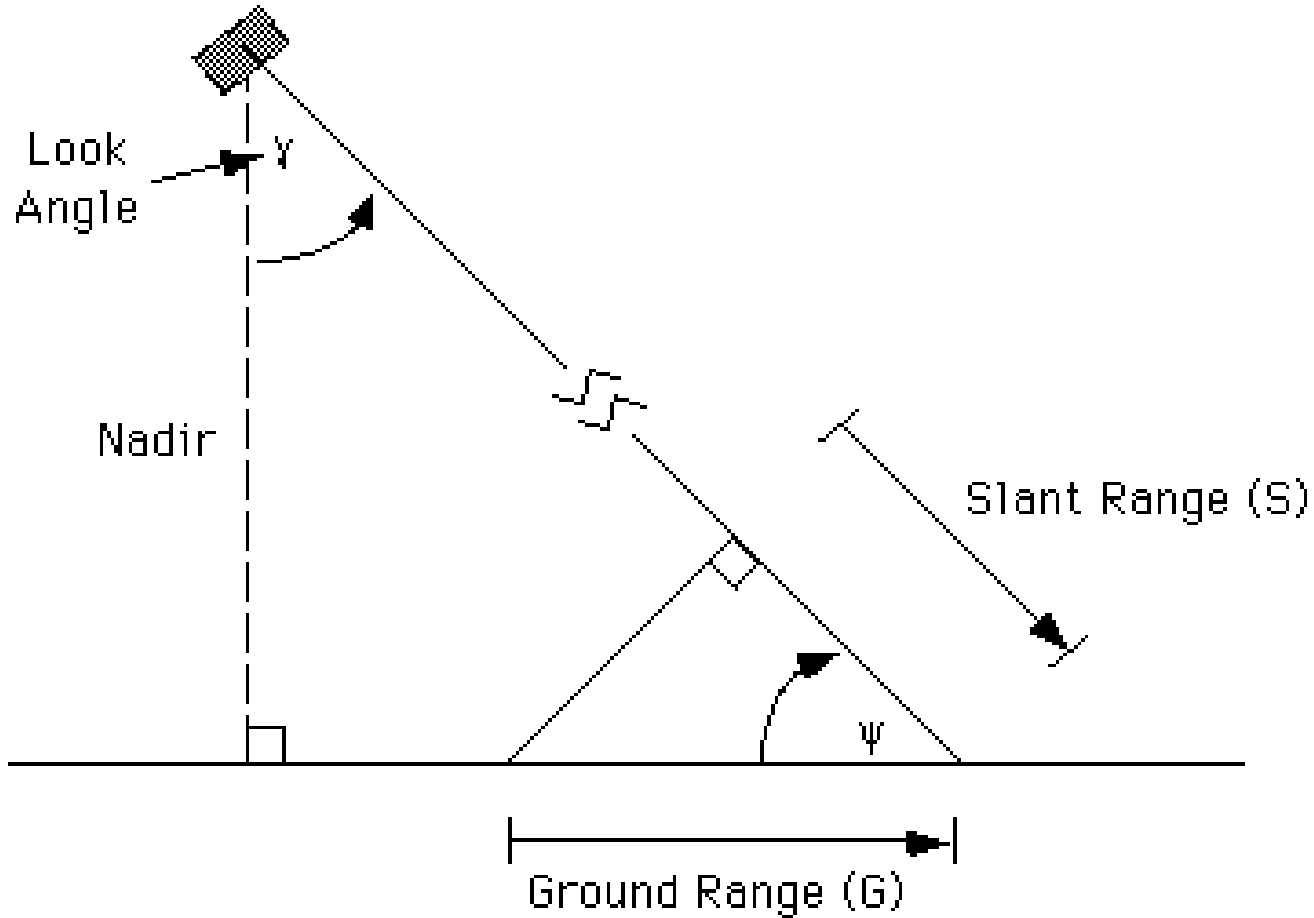
SAR geometry and backscatter

# Satellite geometry

- Azimuth
- Range
  - Slant range
  - Ground range

# Ground range and slant range



SAR geometry and backscatter
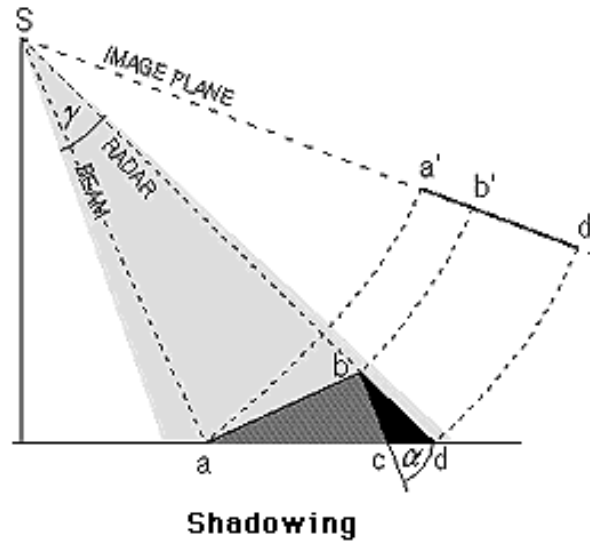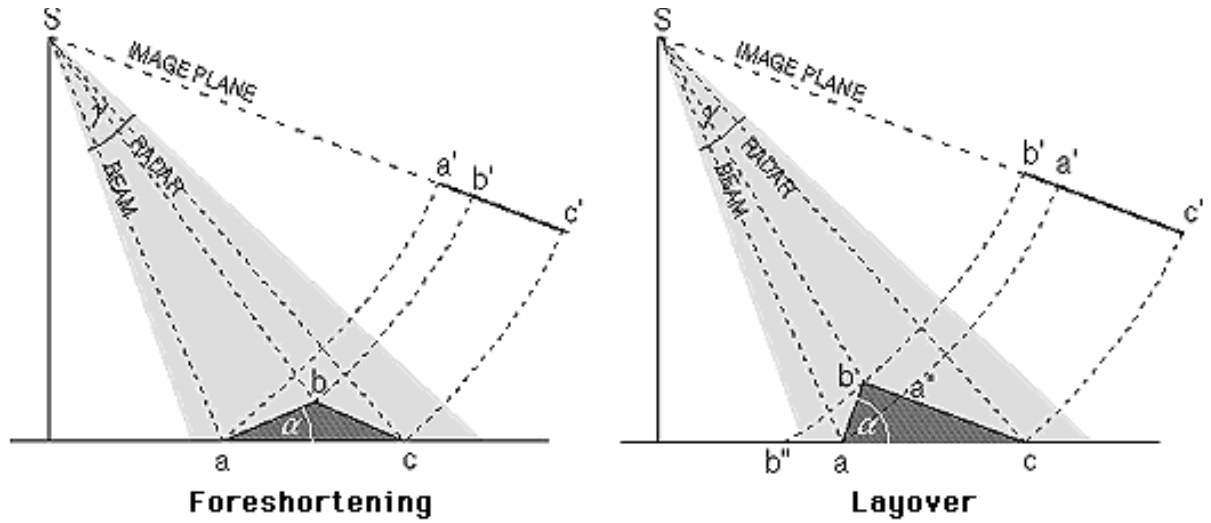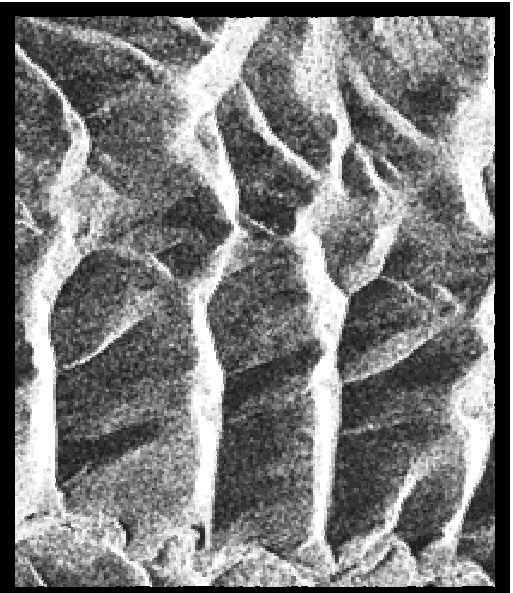
# Geometric *distortions*



Foreshortening

Layover

Shadowing

SAR geometry and backscatter

View animation

# Distortions

- Foreshortening

ERS-1

JERS-1

# **Distortions**

- Layover

http://www.ae.utexas.edu/courses/ase389/midterm/doherty/doherty.html

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# Distortions

- Shadow
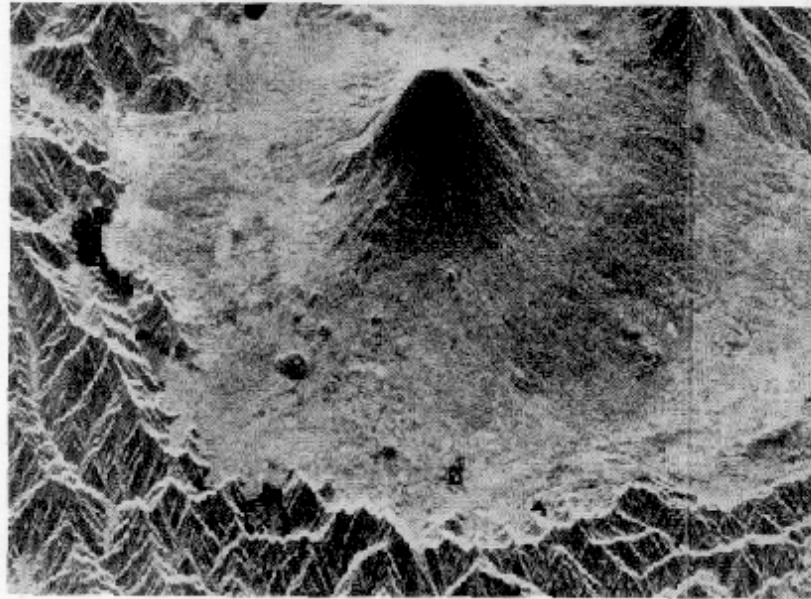
A. ERS-1 image acquired with a 67° depression angle.
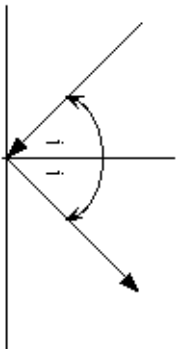
http://www-rohan.sdsu.edu/~boisver/insar/rad5.html
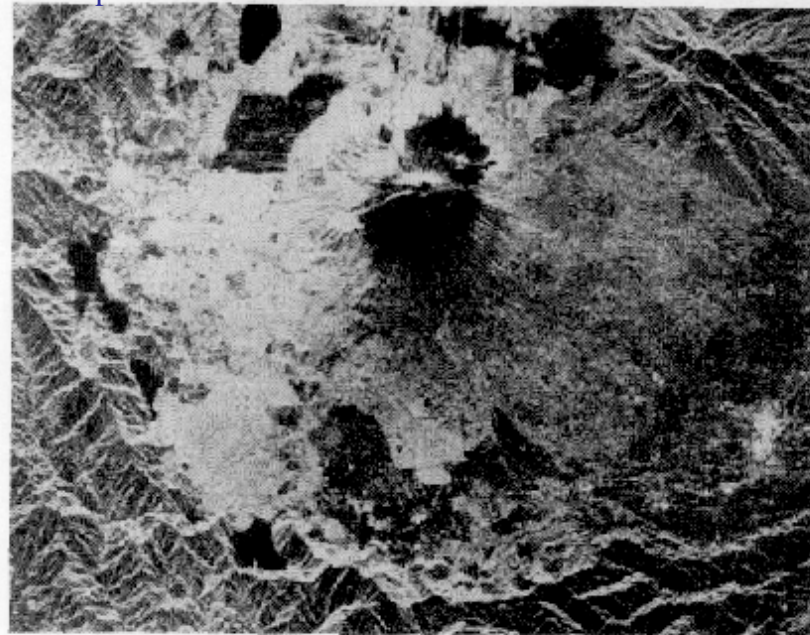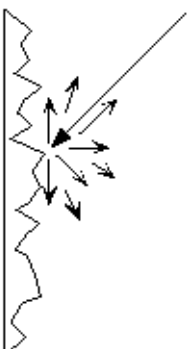
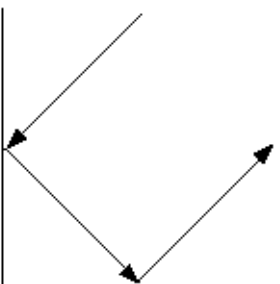B. JERS-1 image acquired with a 55° depression angle.
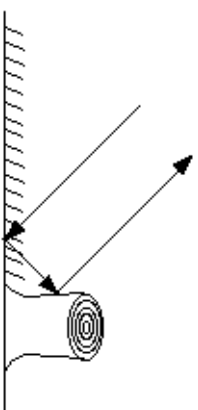
SAR geometry and backscatter

## Scattering Mechanisms

**Reflection off a smooth surface**
The angle of incidence, i, equals the angle of reflection.

**Scattering off a rough surface**
The variation in surface height is on the order of the incoming signal's wavelength.
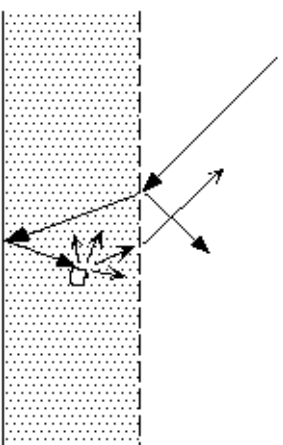
**Double Bounce**
(Corner Reflector)

**Double Bounce**
One possible natural occurence – reflecting off two smooth surfaces, grass and a freshly-cut tree's stump

**Volumetric Scattering**
Example scattering in a tree

**Volumetric Scattering**
In this example the incident radiation is both reflected and refracted/transmitted through a layer of dry snow. The refracted radiation then reflects off underlying ice, scatters off a chunk of ice in the snow, and finally refracts back toward the receiver.

# What does SAR "see"?

# Radar Cross Section

- Compare all targets to a sphere
  - Must be a "perfect sphere"
  - Cross-section is same in all directions
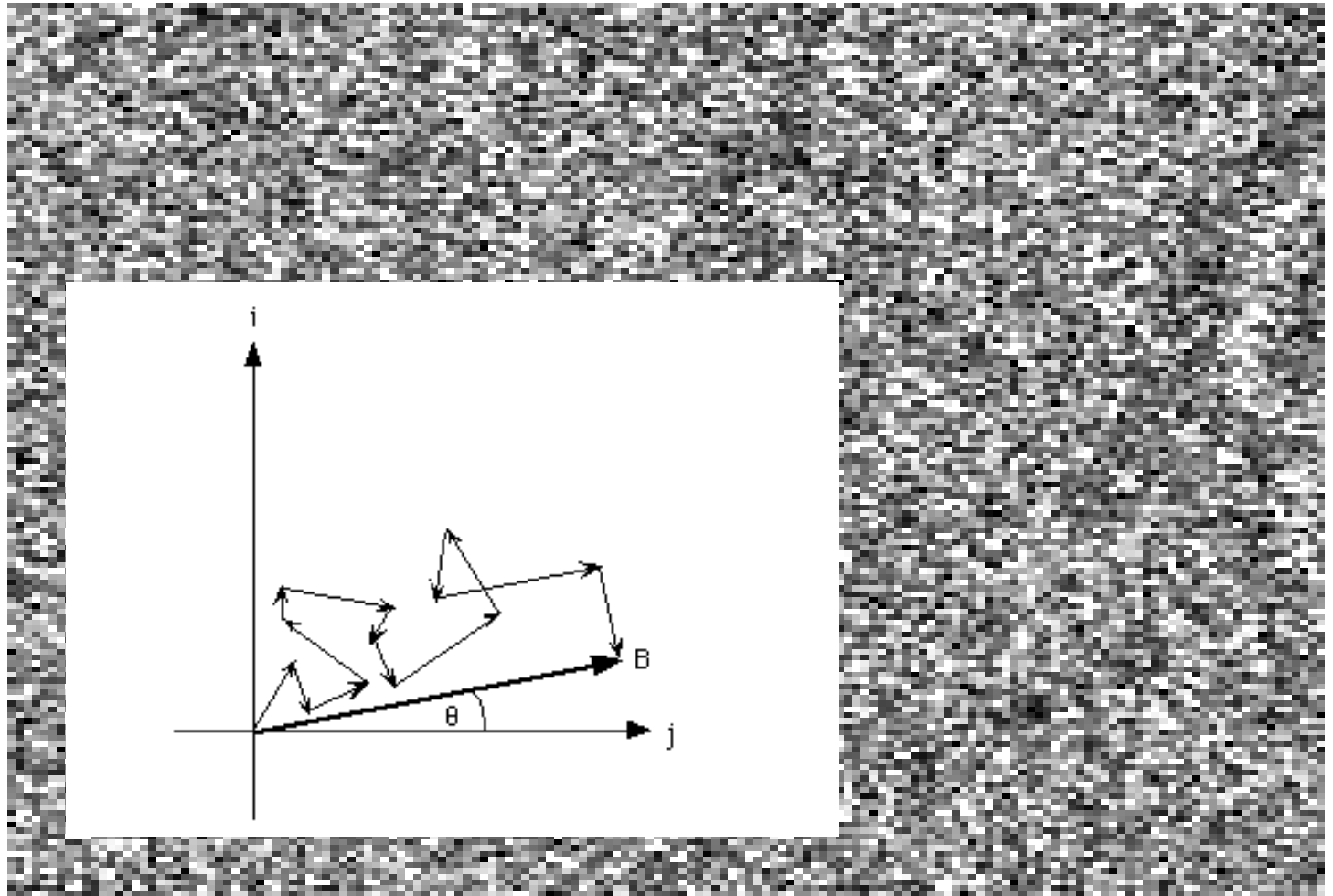  - "What size sphere would give me this return?"

http://www.gosti.com/Cal_Tgts/Cal_Tgts.html

# Speckle



- Coherent light source
  - Same wavelength
  - Same time

# **Questions?**

Additional information on layover and foreshortening:

- http://rst.gsfc.nasa.gov/Sect8/Sect8_4.html
- http://www.geoimage.com.au/pdfs/flyers/RADAR_flyer.pdf
- http://www.ersc.wisc.edu/academics/courses/IES302/handouts/302c_6.pdf