# Mathematics of super-resolution biomedical imaging

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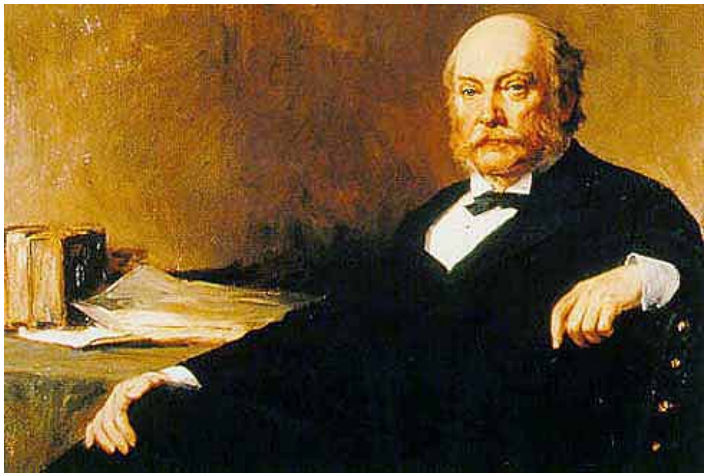
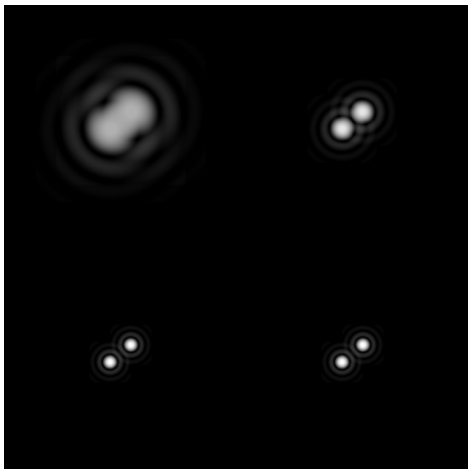
# Mathematics for biomedical imaging

- Mathematical and numerical frameworks for biomedical imaging applications.
- Biomedical imaging:
  - Image electrical, optical, and mechanical tissue properties using electromagnetic and elastic waves at single or multiple frequencies.
  - Enhance the resolution, the stability, and the specificity.

# Mathematics for biomedical imaging

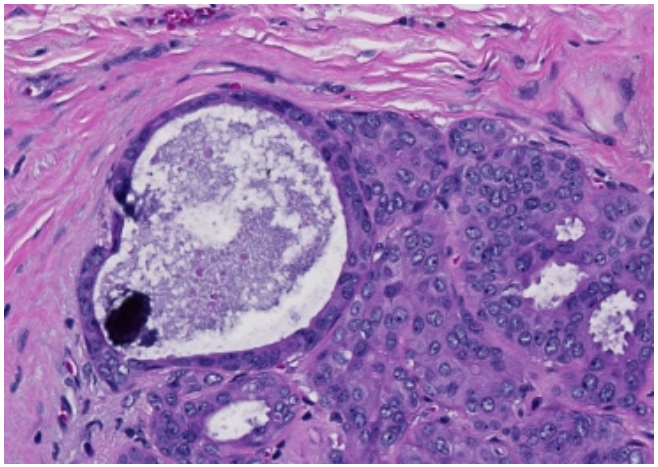
- Key concepts:
  - Resolution: smallest detail that can be resolved.
  - Robustness: stability of the image formation with respect to model uncertainty and electronic noise.
  - Specificity: physical nature (benign or malignant for tumors).





# Mathematics for biomedical imaging

- Direct and inverse problems for wave propagation in complex media.
- Waves: Visualization of contrast information on the electrical, optical, mechanical properties of tissues.
- Tissue contrasts:
  - Highly sensitive to physiological and pathological tissue status.
  - Depend on the cell organization and composition.
  - Overall parameters, averaged in space over many cells.
- Recognize the microscopic cell organization and composition from measurements at the macroscopic level.



# Super-resolution techniques

- Scale separation techniques: take advantage of the smallness of the imaged anomalies.
- Hybrid imaging: one single imaging system based on the combined use of different imaging modalities.
- Dynamical imaging: Separation techniques based on dynamical models; SVD of the associated Casorati matrices.
- Spectroscopic imaging: specific dependence with respect to the frequency of the tissue properties.
- Dictionary matching based approach (machine learning approach).