

# Fall 2016

# MATH 858W

## Time-Frequency and Wavelet Analysis: Theory and Applications

**Instructor: John Benedetto**  
**Tue/ Thur, 11:00-12:15 p.m**  
**MATH 1311**

Contact: [jjb@math.umd.edu](mailto:jjb@math.umd.edu)

### COURSE MATERIAL

1. **Time-frequency (Gabor) analysis on  $\mathbb{R}^d$  and the role of the Heisenberg group.** The short time Fourier transform (STFT), Wigner distribution, narrow band ambiguity function, and applications.
2. **Wavelet theory on  $\mathbb{R}^d$  and the role of the  $ax+b$  group.** The wide band ambiguity function and applications.
3. **Shearlets.** Theory and applications
4. **Time-frequency and wavelet uncertainty principles.** The Balian-Low phenomenon and Bourgain's theorem.
5. **Compressive sensing.** Gabor and wavelet matrix equations, sparse solutions and greedy algorithms such as orthogonal matching pursuit, Donoho's and Tao's uncertainty principles, transform coding systems for image processing, refined coding such as sigma-delta quantization, mathematical properties of Gabor matrices for CAZAC generating functions.
6. **Frames.** Time-frequency (Gabor) and wavelet frames, frame multiresolution analysis, Grassmannian frames, harmonic and group frames, and the role of the DFT.
7. **Graphs.** Time-frequency (Gabor) and wavelet theory on graphs, and the role of analysis on graphs in dimension reduction.