# Cosmic Dawn Zero-mode Signal Detection and Experiments (Outline)

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1. **Introduction to zero-mode experiments (LJG)**
   1. Focus on Cosmic Dawn
      1. character of the signal (global or all-sky, narrow, broad, inflection, turning points, strong, faint, dipole)
   2. Experiments
      1. names, locations, citations
      2. very concise / statement of what above citations focus on
2. **Architectures for zero-mode signal detection (RS)**
   1. Single EM sensor
   2. Outriggers to Fourier synthesis telescopes
   3. Interferometer methods
   4. Moon block
3. **Signal path primer (RS)**
   1. antenna geometries
      1. basics
         1. dimensions
         2. feed points
         3. ground screens
         4. gain patterns
      2. broadband dipoles
         1. rule of thumb - octave limitation
      3. other forms (as in SARAS)
   2. switched receiver
      1. switching to defeat 1/f noise
      2. basics
         1. gain
         2. isolation
         3. linearity
         4. bandpass and out of band effects
         5. additive noise at output
         6. radiated noise at input
         7. impedance match
         8. temperature sensitivity
      3. signal transport and supply of power
         1. digitization away from antennas
         2. buried coax and fiber cables
         3. potential cable interactions with antennas
         4. shielding by ground screens and soil conductivity
   3. analog-digital converters
      1. ????
   4. spectrometers and correlators
      1. ????
4. **Common design drivers (RS)**
   1. frequency structure
   2. gain pattern
      1. low gain is OK; the sky is bright
      2. shape
      3. variation with frequency
   3. ground screens. ???
      1. basic and shaped
      2. effects of ground permittivity and conductivity
   4. impedance mismatches
      1. at antenna terminals
      2. along the receiver signal path – multipath propagation to the detector
      3. Isolation
      4. filters
      5. differentials among signal paths
   5. long and short paths
   6. 1/f “noise”
   7. noise characteristics
5. **Calibration approaches (LJG)**
   1. Bandpass calibration
   2. Calibration of additives
   3. some sub-units can be cal’d in the lab, others only in the field.
   4. Ideal goal: flat spectral baseline to 1:106
   5. Compromise to admit spectral baselines that are at least partially orthogonal to 21-cm signals
   6. Switching
      1. Dicke switching
      2. ways in which to separate what is up and downstream from frontend switch
      3. inbuilt noise and calibration sources
   7. correlation spectrometers – phase switching
   8. when all else fails, fit a model to the spectral baseline
      1. physically motivated
      2. empirical
      3. dangers
6. **Experimental Challenges (RS)**
   1. Foregrounds
      1. origins and characteristics
      2. discrimination btw. 21cm and foreground signals
   2. RFI
   3. Antenna
      1. Reflection efficiency
      2. Radiation efficiency
      3. interaction with ground
      4. accurate calibration
         1. gain pattern
         2. sensitivity
   4. receiver
      1. self-noise (noise parameters)
      2. reflections
      3. isolation
      4. linearity
      5. temperature stability
   5. performance trade-offs, pros/cons
      1. electrically small antennas
      2. antenna geometry and simulation
      3. *etc.*
7. **LEDA, SARAS, and EDGES (LJG)**
   1. discussion of design considerations emphasized in each project
   2. status
8. **First detection? EDGES. (LJG)**
9. **Outlook (LJG)**
   1. Testing the claim
   2. Is there more to do after the first detection with reasonable S/N?