Rydberg Radar: A quantum architecture covering the radio window for multi-science SoOP remote sensing with focus on land surface hydrology

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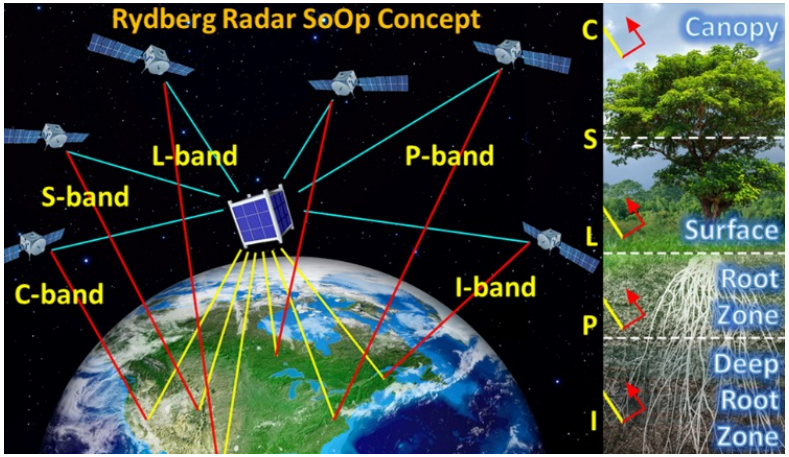
Objective

- Develop a Quantum Rydberg Radar architecture that has a high sensitivity, as well as dynamic and rapid tuning capability to detect signals in various bands in the 10 kHz-1 THz regime – providing vast improvements over classical and state-of-art radars
- Develop a revolutionary architecture that requires no radar antenna, deployable structures, or RF front-end electronics (such as mixers, waveguides, etc.) – providing a unique capability over classical and state-of-art radars
  - Enable measurement of dynamics and transients in land surface hydrology (LSH) science for vertical soil moisture profiles from canopy to deep-root-zone using multi-bands
  - Enable reception of multi-band (I-C bands) signal-of-opportunity (SoOp) from communication and navigation satellites using a single tunable instrument



Mission concept of Rydberg Radar in view of multiple SoOp navigation and communication satellites

Approach

- Develop an experiment to demonstrate Rydberg detection of SoOp from satellites using laboratory instrumentation
- Develop RF models of the Rydberg detector cell as a function of laser and detector system function and properties, vapor cell, gas, and thermal properties, LO signal properties, SRR and digital tuning properties
- Develop integrated Rydberg radar system model
- Develop an experiment to demonstrate Rydberg-based SoOp radar reflectometry

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Key Milestones

• Design experiment to demonstrate SoOp detection	08/22
• Complete component-level design and procurement	01/23
• Develop RF models of Rydberg detector	03/23
• Demonstrate Rydberg detection of SoOp	03/23
• Complete integrated Rydberg radar system model	07/23
• Validate experiment design in the lab	10/23
• Demonstrate Rydberg SoOp radar reflectometry	12/23
• Develop multi-band outdoor Rydberg system	05/24
• Conduct tower experiment	07/24

$TRL_{in} = 2$ **$TRL_{current} = 3$**