Quantum-based technologies: Overview and application to aviation security

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https://quantumconsortium.org

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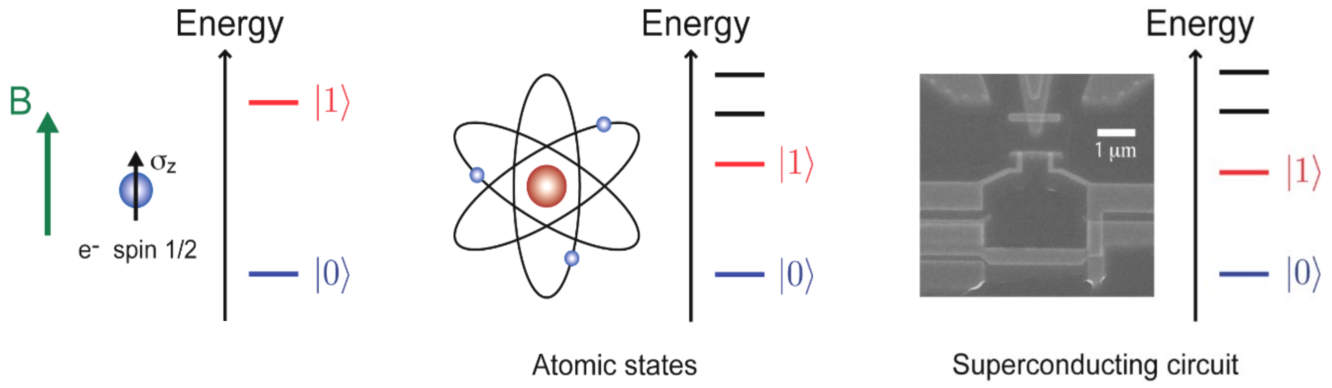
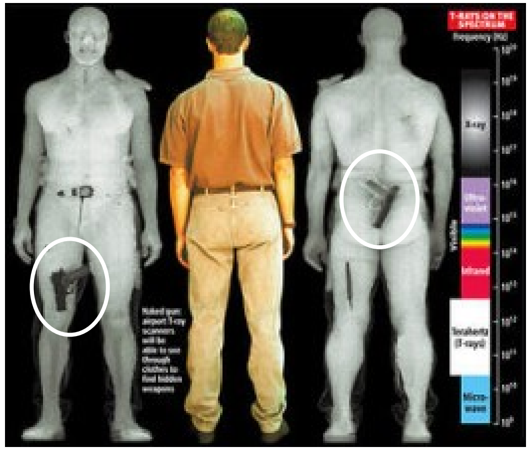
So what? Who cares?



- Quantum mechanics = novel characteristics
  - ✓ Quantized energy levels
  - ✓ Superposition
  - ✓ Entanglement
- Applications
  - ✓ Computing– lots of interest; still very early stage
  - ✓ Communications and cybersecurity
  - ✓ Sensing and metrology– early examples here today
- Quantum states are extremely sensitive to the environment – hence they make excellent sensors
- Quantum properties are fundamental – calibration not required
- Advances in classical quantum-enabling technologies (cryo, lasers, etc.) may also benefit nonquantum applications (e.g. aviation/homeland security)
- DHS missions that quantum may help to address:
  - Standoff detection at border crossings
  - Buried infrastructure detection (e.g. tunnels)
  - Airport screening

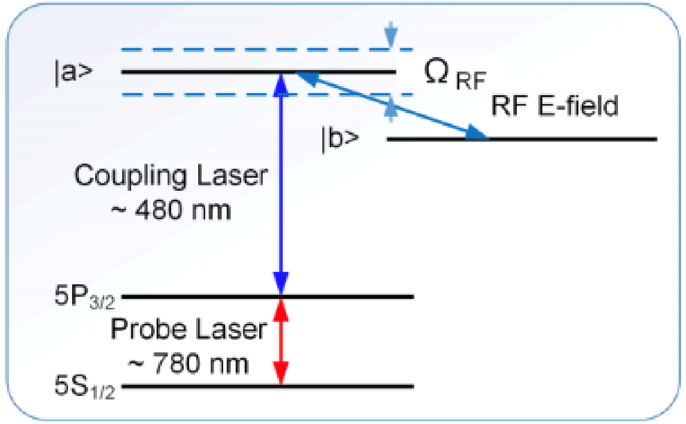
Quantum sensor for THz detection

- **Problem:** THz sources are weak (<0.1 W) and conventional THz sensors are noisy or need to be cryogenically cooled.
- **Solution**: A low-noise, room-temperature THz detector for:
    - Standoff non-destructive imaging
    - Chem/bio aerosol detection
    - High bandwidth comms



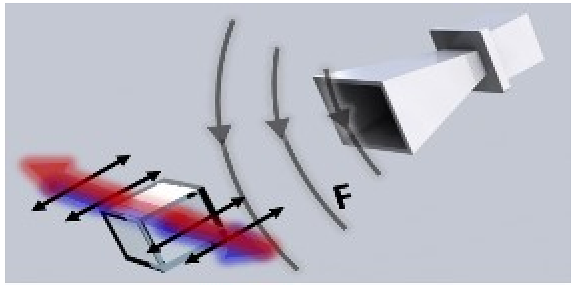
Sub-THz imaging requires active scanning and must be close to source.

- **How does a Rydberg atom quantum detector work?**
    - A quantum detector uses **a vapor of Rydberg atoms** to convert **MHz-THz** signals to optical signals with **high sensitivity**. Each atom acts like an independent interferometer, translating an incident RF field to an optical signal.



Underlying physics. Atoms may be prepared into THz-sensitive Rydberg states with the appropriate combination of electromagnetic fields/lasers.

TRL = 2 – 3



Quantum detector. A vapor cell of alkali atoms prepared in quantum Rydberg states acts as a low-noise, sensitive detector element from MHz – THz.

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