# TWIN BEAM GENERATION IN HOT SODIUM VAPORS

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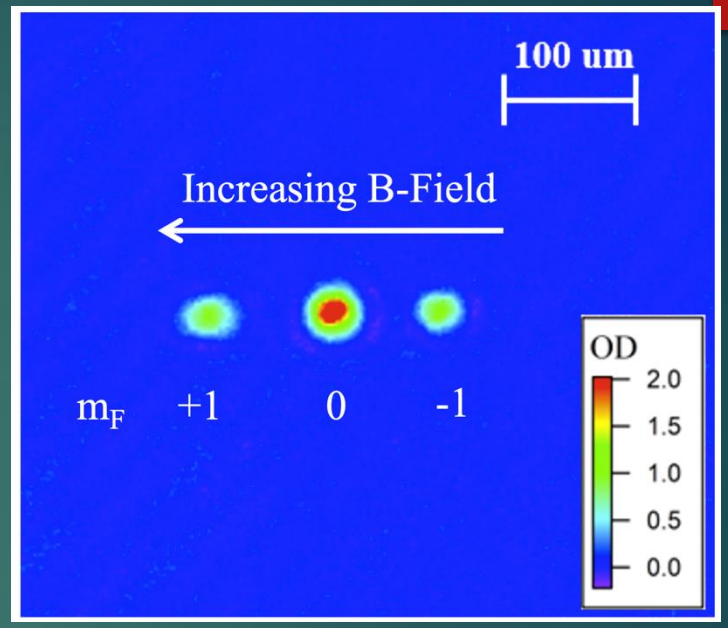
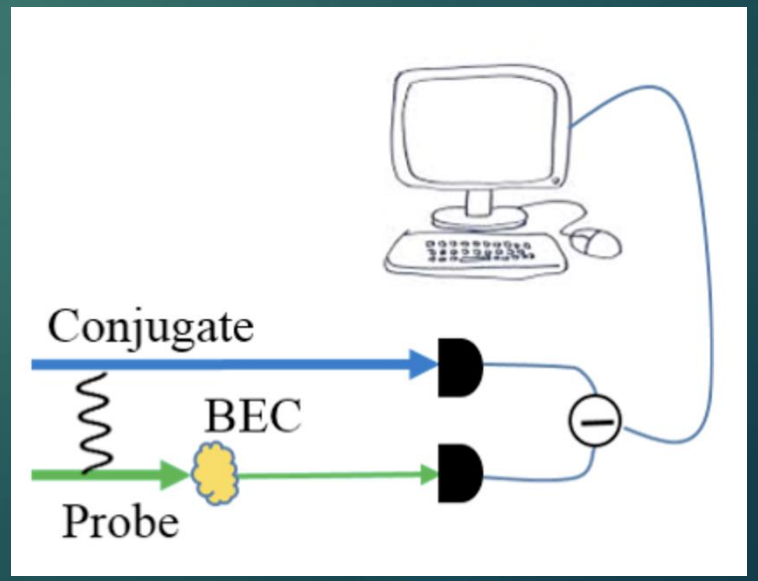
# Why Twin Beams?

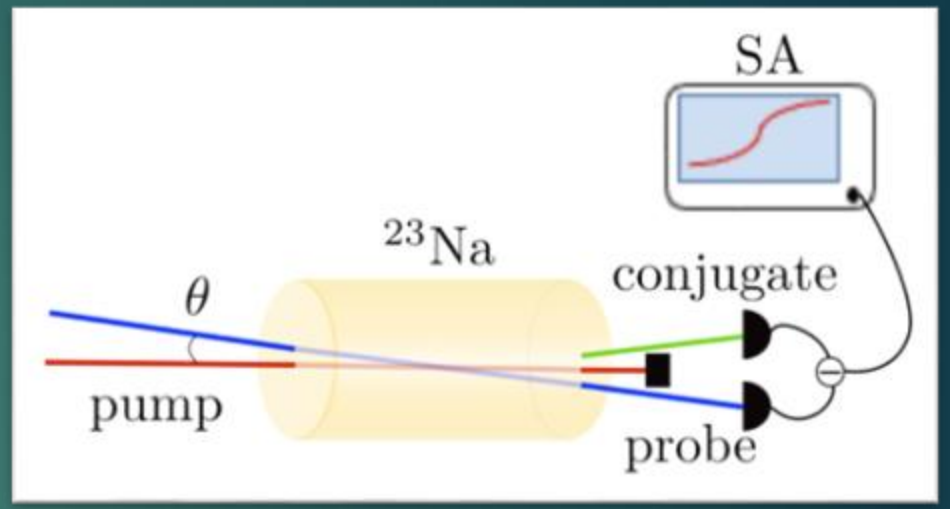
- BEC experiments need precise spin readout
- Can we improve absorption imaging of ultra cold atoms?
- Better than shot noise limit?
- Four Wave Mixing (FWM) generates quantum-correlated light

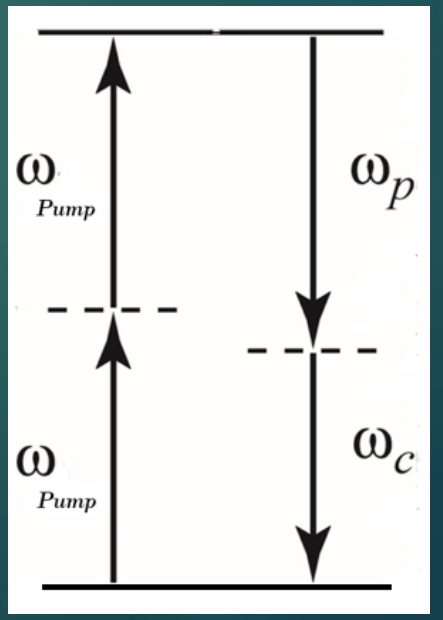


# Four-Wave Mixing in Sodium Vapor

- Nonlinear FWM in sodium generates entangled beams
- 2 pump photons in, probe and conjugate out
- Sodium has a simple energy level structure



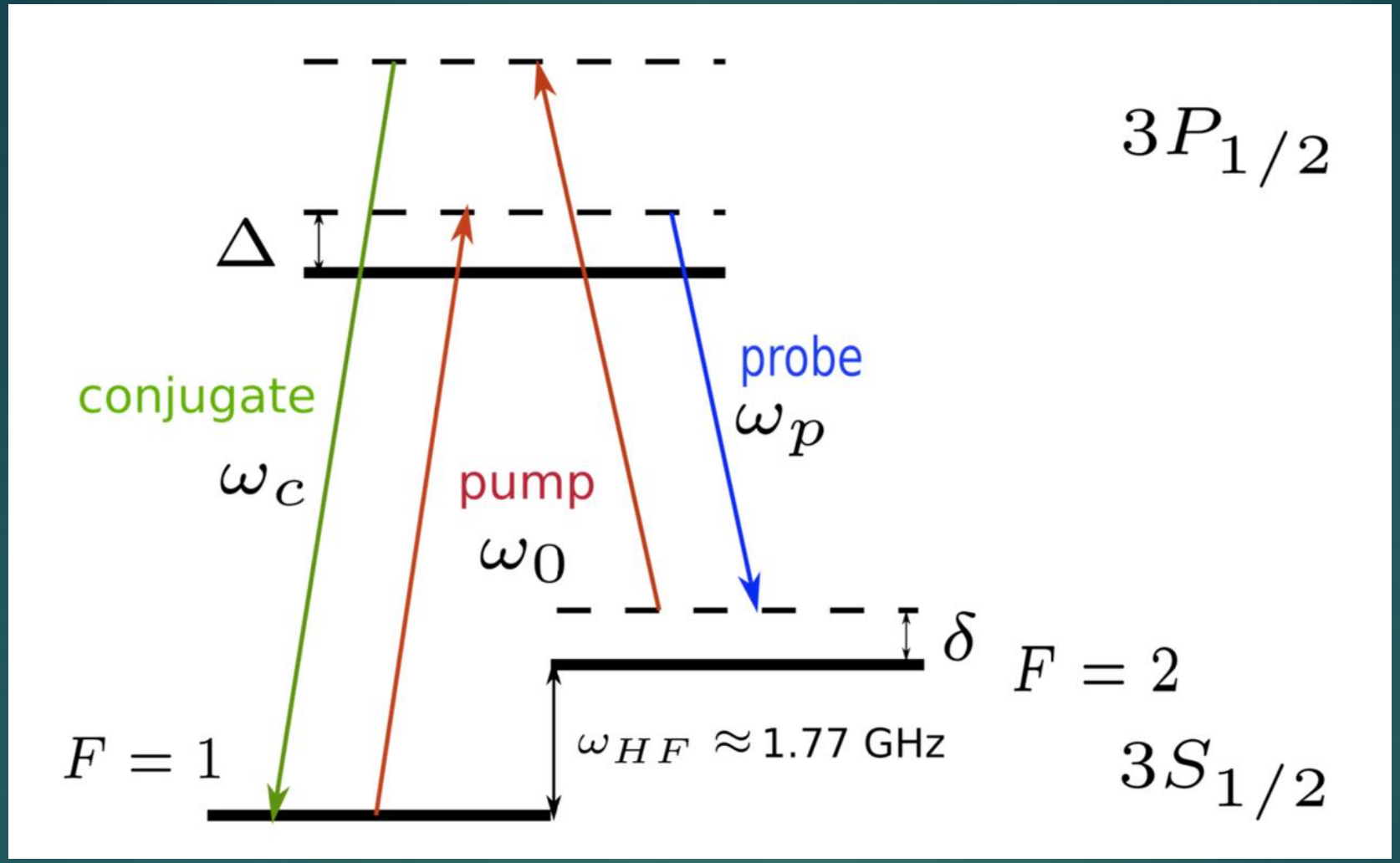
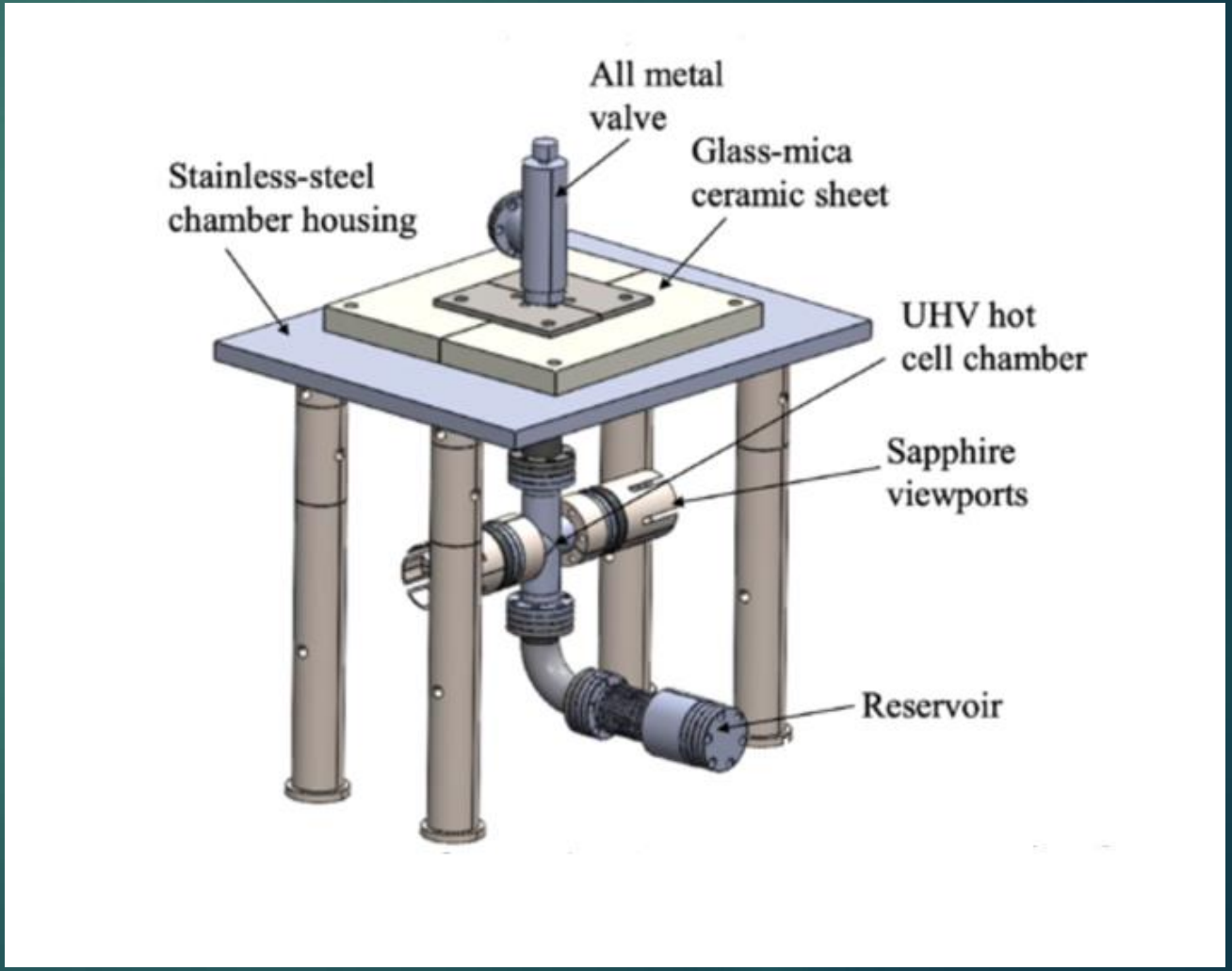



Figure: Energy level diagram illustrating the four-wave mixing (FWM) process.

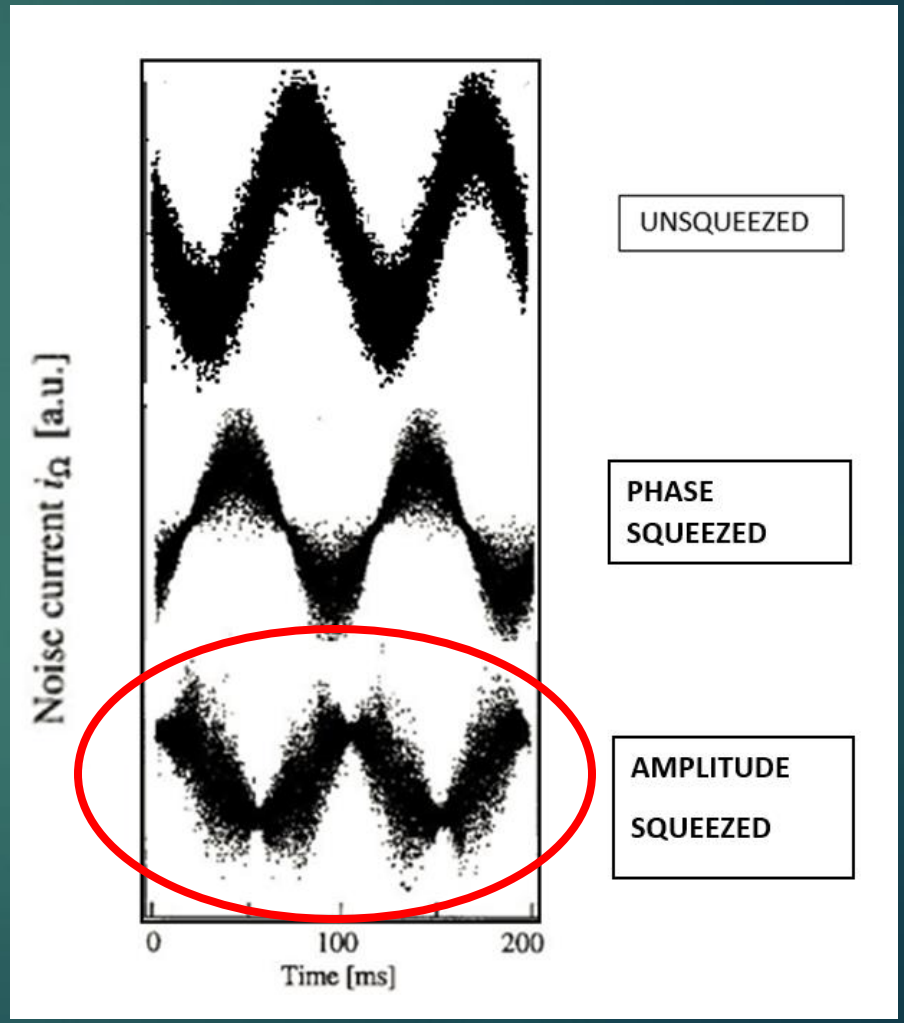
# Experimental Apparatus

- Custom built cell
- Stainless steel body with sapphire windows
- Vacuum-sealed sodium reservoir prevents contamination



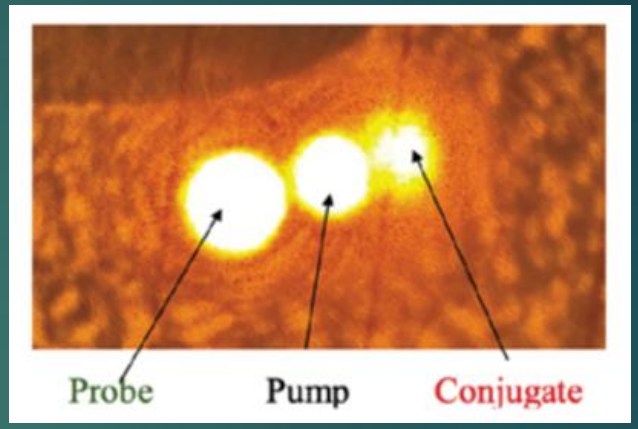
# Goals

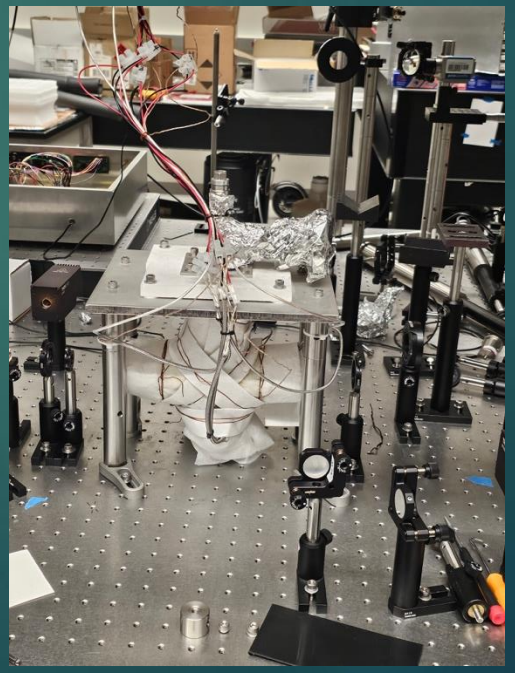
- Generate correlated twin beams at 589 nm
- Enable squeezed light probing for ultracold spin systems
- Big picture: better quantum sensing for cold atom physics



# Next Steps

- Observe twin beams
- Optimize temperature, angle, and beam size to maximize squeezing
- Measure squeezing using custom detector



# QUESTIONS?

# Resources


- Zhang, Q. (2021). *Nonlinear processes in hot sodium vapors and sodium spinor Bose-Einstein condensates for entanglement generation* (Doctoral dissertation). University of Oklahoma.

- Thiel, C. W. (2000). *Four-wave mixing and its applications* [Technical report]. Montana State University. https://www.researchgate.net/publication/241258853

- Ooi, H. G. (2020, November 20). *Generating twin-beams of light at 589 nm via four-wave mixing in sodium vapor* [General exam paper]. University of Oklahoma, Homer L. Dodge Department of Physics and Astronomy.