The 129Xe/3He maser

- Inside bulk glass cell containing noble gas
- 150 torr of Xe, 100 torr of He buffer gas
- Temperature: 300 K
- Slight leak to 30 torr of red Ne buffer gas
- 14 MHz RF field
- 30 µs after 14 MHz
- Signal generated leak to 5 MHz hydrogen maser


129Xe atoms have nuclear spin 3/2 and electric quadrupole interaction at the cell’s walls

Solution: Orienting the cell to the “magic angle”

- If the cell has cylindrical symmetry, the frequency splitting due to quadrupole interactions
  \[ B_{Q} \approx \frac{3\omega_{Q}}{2} \]

- One can get rid of quadrupolar frequency splitting by orienting the cell to the “magic angle”

- The magic angle \( \theta = \sin^{-1}\left(\frac{1}{\sqrt{3}}\right) \approx 54.7° \)

Comparison with the 129Xe/3He maser

- Better on nuclear motion (noble gas ensembles are truly collocated, Ne and He have similar diffusion constants)
- Longer relaxation times (no magnetic field gradients due to the flux of incoming magnetization)
- No transport losses
- 27% more sensitive to LLI CPT violation

Disadvantages of the 129Xe maser:
- Frequency shifts driven by magnetization collisions & collisional contact hyperfine interaction with optically pumped Rb
- Quadrupolar interaction of 129Xe could limit stability

Tests of CPT and Lorentz Symmetry Using Noble-Gas Masers


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