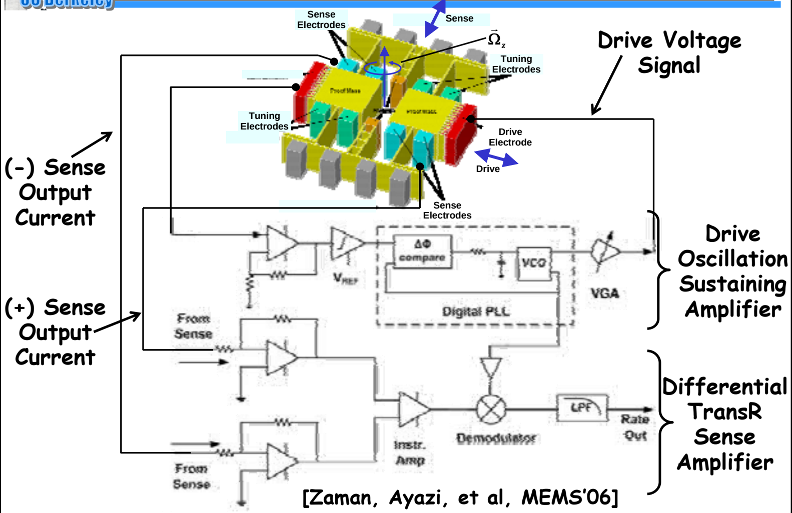
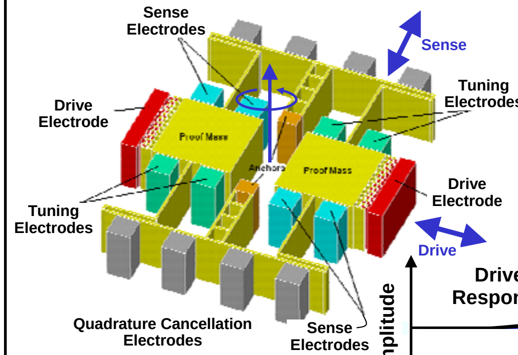
MEMS-Based Tuning Fork Gyroscope

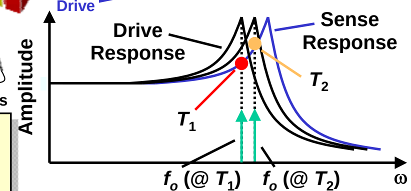


MEMS-Based Tuning Fork Gyroscope

- Drive and sense axes must be stable or at least track one another to avoid output drift



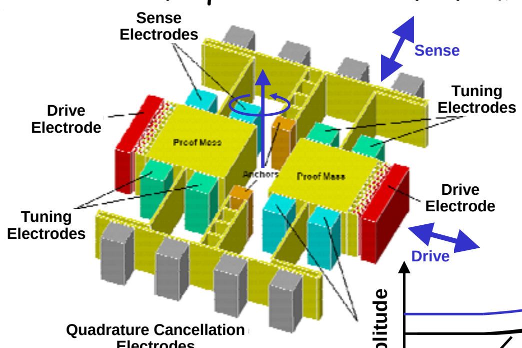
Problem: if drive frequency changes relative to sense frequency, output changes ⇨ bias drift



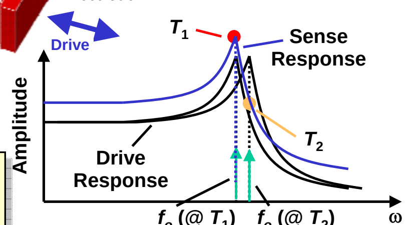
Need: small or matched drive and sense axis temperature coefficients to suppress drift

Mode Matching for Higher Resolution

- For higher resolution, can try to match drive and sense axis resonance frequencies and benefit from Q amplification



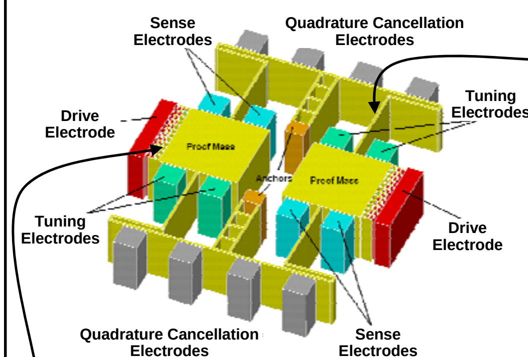
Problem: mismatch between drive and sense frequencies ⇨ even larger drift!

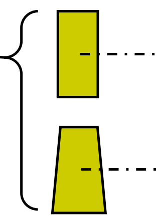


Need: small or matched drive and sense axis temperature coefficients to make this work

Issue: Zero Rate Bias Error

- Imbalances in the system can lead to zero rate bias error



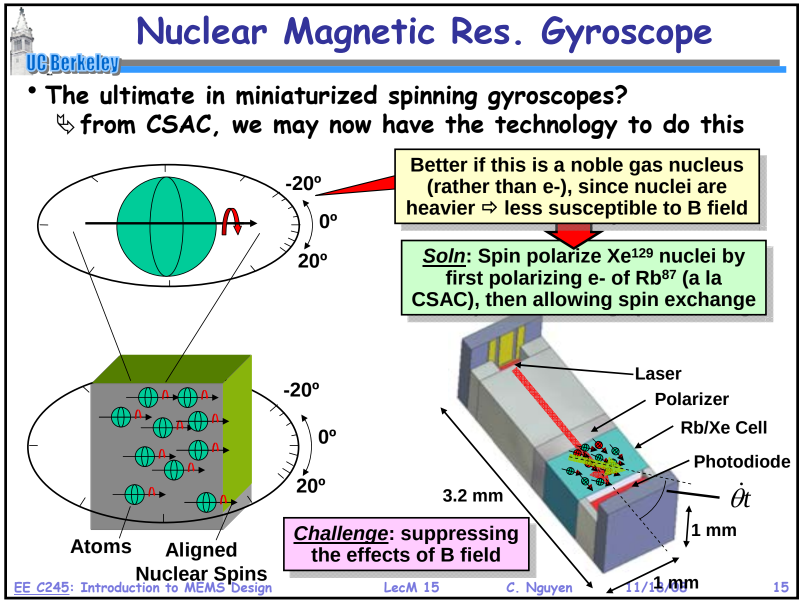


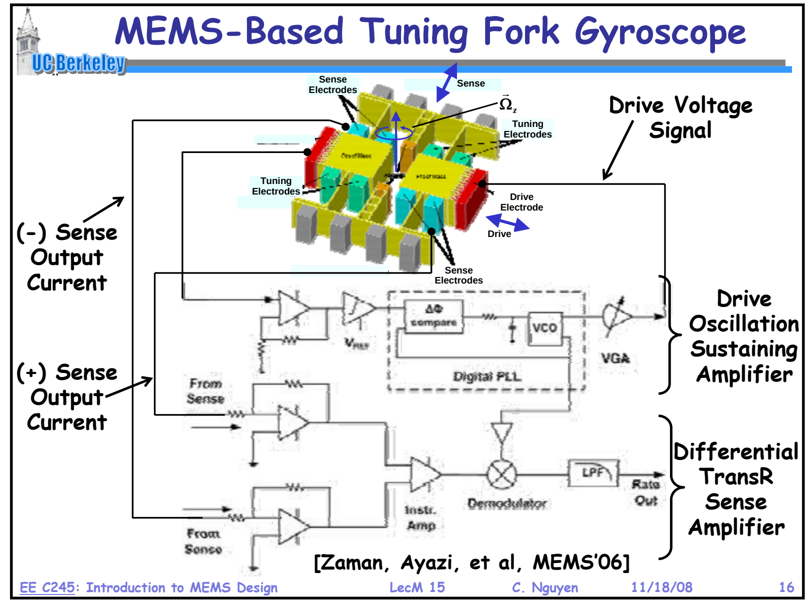
Mass imbalance ⇨ off-axis motion of the proof mass

Quadrature output signal that can be confused with the Coriolis acceleration

Drive imbalance ⇨ off-axis motion of the proof mass

Output signal in phase with the Coriolis acceleration


Nuclear Magnetic Res. Gyroscope
UC Berkeley
• The ultimate in miniaturized spinning gyroscopes?
↳ from CSAC, we may now have the technology to do this
-20°
0°
20°
Better if this is a noble gas nucleus (rather than e-), since nuclei are heavier ⇨ less susceptible to B field
Soln: Spin polarize Xe129 nuclei by first polarizing e- of Rb87 (a la CSAC), then allowing spin exchange
-20°
0°
20°
Laser
Polarizer
Rb/Xe Cell
Photodiode
3.2 mm
1 mm
1 mm
Atoms
Aligned Nuclear Spins
Challenge: suppressing the effects of B field
EE C245: Introduction to MEMS Design
LecM 15
C. Nguyen
11/18/08
15


MEMS-Based Tuning Fork Gyroscope
UC Berkeley
Sense Electrodes
Sense
Tuning Electrodes
Tuning Electrodes
Drive Electrode
Drive
Sense Electrodes
Drive Voltage Signal
(-) Sense Output Current
(+) Sense Output Current
Drive Oscillation Sustaining Amplifier
Differential TransR Sense Amplifier
ΔΦ compare
VCO
Digital PLL
VGA
From Sense
Instr. Amp
Demodulator
LPF
Rate Out
From Sense
[Zaman, Ayazi, et al, MEMS'06]
EE C245: Introduction to MEMS Design
LecM 15
C. Nguyen
11/18/08
16