# QUANTUM CASCADE LASERS: FROM SYSTEMS FOR CHEMICAL SENSING TO NONLINEAR OPTICS IN THz

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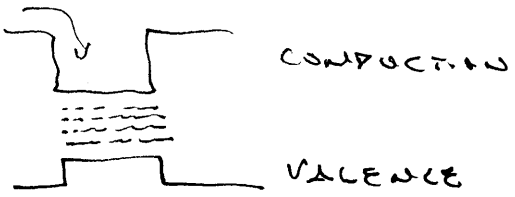
2:00 DETAILED INTRO TO QUANTUM CASCADE LASER




0515 ADVANTAGES OF QCL INFRA-RED/THz SUITED TO CHEMICAL ANALYSIS

0640 OPTICAL PHONON SCATTERING 30..45 meV (30..45 μm)

0915 TYPICAL QCL DESIGN, BRAGG REFLECTORS

1105 OUTLINE TO APPLICATIONS
3.5–12 μM 2KA/cm² CURRENT DENSITY

1340 MID-IR SPECTROMETER ON A CHIP

1520 TECHNICAL APPROACH – MULTI SOURCE EXCITATION WITH OVERLAPPING WAVELENGTH EMISSIONS

1700 BROAD GAIN QCL DESIGN

1840 LASER ARRAY FABRICATION

1950 PERFORMANCE 32 λ FROM 8.0 – 9.4 μM

2030 SPECTROSCOPY ABILITY FROM 2mm² CHIP

2213 CHEMICAL SENSING IN NEAR FIELD W/ ANTENNA SERVING AS A RESONANT FIELD ENHANCEMENT 70X's ON A "FEED POINT" GAP OF 100 nM (λ/70)

2616 OUTLINE FOR DESIGN IN 1–5THz RANGE
SCREENING, SPECTROSCOPY, LOCAL OSCILLATORS FOR SUPERHET DETECTORS

2804 THz QLC PERFORMANCE – MUST BE REFRIGERATED

2940 ROOM TEMP THz REPORTS $T_{MAX} \approx 180°K$

3050 LIFETIME ↓ TEMP ↑

3120 LO PHONON SCATTERING OF THERMAL ELECTRONS
MATERIAL SCIENCE IN QUANTUM DOTS/WIRES FOR
ELECTRON CONFINEMENT

3400 FREQ. MIXING SYSTEMS

3510 CHALLENGES LARGE POWER, LARGE STRUCTURES
CURRENTLY USED BUT QCLs ARE 2 ORDERS SMALLER

3650 QUANTUM WELLS 4 ORDERS GAIN BUT LARGE ABSORPTION

3740 POPULATION INVERSION

3820 SECTION DESIGN

4000 WAVEGUIDE DESIGN

4045 DEVICE PERFORMANCE 4-5THz .3-7μW OUTPUT
EFF ~ $5\mu W/W^2$ CAN BE INCREASED BY FACTOR OF 10

4180 ANALYSIS

4340 DEVICE IMPROVEMENT

4450 SUMMARY
100mW SOURCES OF THz EMISSION CW CAN BE BUILT

4700 ACKNOWLEDGE
BREATH ANALYSIS