Principles of a Fourier Transform
Microwave Spectrometer

- pulsed molecular expansion into chamber
- microwave excitation pulse
- pulse terminated, spontaneous coherent emission
- signal detection, signal digitized in o-scope, FT to have frequency domain spectrum
Principles

► pulsed molecular beam perpendicular to the MW pulse propagation
► amplified chirped pulse MW pulse excite mol.
► MW stops, rotational FID occurs
► emission collected by digitizer in O-scope, fast F.T.

► Jaeger group research  *Fourier Transform Spectroscopy*
Chirped pulse FTMW spectrometer

components:

i. chirped microwave pulse generation
   a linear frequency sweep 7.5 to 18.5 GHz

ii. MW excitation pulse and molecular beam
    sample interaction region

iii. detection of molecular emission
Simplified Schematic Diagram of CP-FTMW Spectrometer

1. Chirped pulse generation
2. Sample interaction region
3. FID detection
Circuit Diagram for CP-FTMW

- Rb. freq. Clock
- AWG
- MW synthesizer
- power divider
- pulse delay generator
- solid state amplifier
- antenna
- switch
- low noise amplifier
- mixer
- low pass filter O-scope
- mixer
- computer
- Fast F.T

*blue line: connected via BNC cable
white line: connected via MW cable*
Chirped Pulse Generation

- AWG a chirped pulse with linear freq sweep from 250 MHz to 1.85 GHz. The chirped pulse is mixed up with a fixed frequency from a microwave synthesizer (v).
- Mixing → a “split” chirp lower band v-2100 MHz to v-250 MHz, and upper band v+250 to v+2100 MHz.
- Then amplified to a power of 5W with a solid state amplifier.
- Chirped pulse radiated onto molecular sample by means of a broadband, high gain horn antenna.
- Molecular sample is prepared using a pulsed nozzle.
- FID is collected by a high gain horn antenna, then protected amplification (consist of power limiter, and low noise amplifier).
- Signal down converted with a mixer and signal v from MW synthesizer.
- Resulting down-converted molecular signal 250-2100 Mhz, is digitized and fast Fourier transformed on a broadband o-scope.
linear sweep pulse

- Sweep range for the pulse is linearly related to the pulse duration ($t_{\text{pulse}}$).
- CP provides a separation of the bandwidth and the pulse duration: allow to control frequency and amplitude of field delivered to sample.
- Efficient at polarizing the sample: the maximum amount of pulse energy, limited by $T_2$, can be delivered to the sample for any excitation bandwidth.
- CP is favored for large bandwidth measurements compared to transform limited pulse shapes.
Gas Handling System

- 1. Pressure gauge (high P)
- 2. Pressure gauge (low P)
- 3. Sample inlet (He)
- 4. Sample inlet (Neon)
- 5. Mixture to nozzle
- 6. To pump
- 7. Ventilation to fume hood
- 8. Sample inlet (e.g. OCS)
- 9. Sample cylinder
What can be achieved by it?

- fast, short spectrum acquisition times
  7.5-18.5 GHz in one acquisition vs. 22000 measurements with a cavity FT MW spectrometer (bandwidth ~500 kHz).
- gives accurate relative intensities
- sensitivity
References


- Picture of chamber retrieved from [http://www.pcgg.de/abstract_image/abs_hansmann.jpg](http://www.pcgg.de/abstract_image/abs_hansmann.jpg) on June 3rd 2010

- nozzle expansion