DESIGN AND PERFORMANCE OF A DIRECT DIGITAL CHIRPED-PULSE FOURIER TRANSFORM MICROWAVE (CP-FTMW) SPECTROMETER OPERATING IN THE 2 - 8 GHZ FREQUENCY RANGE

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We have constructed a chirped-pulse Fourier transform microwave (CP-FTMW) spectrometer operating in the 2 - 8 GHz frequency range. The chirped excitation pulse executes a linear frequency sweep covering 2 - 8 GHz in pulses with duration of 9 μs or less. This chirped pulse is created using the 8-bit D/A converter with 20 Gs/s sample rate in a high-speed arbitrary waveform generator (AWG). The output of the AWG is sent to a high-power pulsed microwave amplifier. We have used both a 300W traveling wave tube amplifier and a 4W solid state amplifier in the spectrometer. The amplified chirped pulse is broadcast onto the molecular beam sample using a WRD250 double-ridge standard gain horn with 15 dBi gain. A second WRD250 gain horn is used to collect the broadband rotational free induction decay. The molecular emission is amplified by a broadband, low-noise amplifier and converted back to a digital signal using the 8-bit A/D converter with 20 Gs/s sample rate in a digital oscilloscope. The frequency domain spectrum is obtained through fast Fourier transform of the time-domain averaged FID with 40 μs duration. The performance of the spectrometer is demonstrated by measurment of the pure rotational spectrum of iodobenzene, its ^{13}C isotopomers, and a weakly bound complex with the neon carrier gas in the molecular beam expansion. A frequency accuracy of 4 kHz for the spectrometer is demonstrated by comparison to previous measurements of the iodobenzene spectrum using several spectrometers.[a] Accurate transition intensities are obtained for both number density (^{13}C isotopomer signals) and transition moment (nuclear quadrupole hyperfine patterns). The open interaction region between the horn antennas makes it easy to incorporate a "Stark cage" for dipole moment determination.[b] Performance of the broadband dipole moment determination of iodobenzene is tested by comparison to previous work. The implementation of broadband microave-microwave double-resonance spectroscopy is also presented for the iodobenzene spectrum.

[a] Dorosh, O. *et al.*, *J. Mol. Spec.* **246** (2007), 228-232.
[b] Emilsson, T. *et al.*, *J. Chem. Phys.* **112** (2000), 1287-1294.