DD 4 Ionization of Excited Hydrogen Atoms Below the Classical Threshold by a Microwave Field.* P.M.Koch[1], R.Bluemel[2], U.Smilansky[3], K.A.H.van Leeuwen[1], D.Richards[4]. [1]SUNY at Stony Brook, [2]TU & MPQ Munich [3]Weiz. Inst. Israel, [4]Open Univ. GB.-- We present and discuss[1] experimentally observed non-monotonic structures in the ionization signal near the onset of microwave ionization of (3-D) hydrogen atoms. We show that classical dynamics, which reproduces most other features of the ionization behavior, is unable to explain the non-monotonic structures. We present for the first time a detailed 1-D quantum calculation which reproduces these structures, and which establishes beyond doubt their quantum mechanical origin. Finally, we show that the phenomenon can be explained as due to the ocurrence of avoided crossings of the relevant Floquet eigenvalues.

* Supported by NSF grant PHY85-21014

[1] R. Bluemel et al., submitted to Phys. Rev. Lett.

DD 5 Two Frequency Microwave Quenching of Excited H Atoms.* L.Moorman, P.M.Koch, K.A.H.van Leeuwen, B.E.Sauer, E.J.Galvez, A.Mortazawi-M. SUNY at Stony Brook, G.v.Oppen, TU Berlin, FRG.-- Experiments on microwave quenching with frequency ν_1 of laser-excited H atoms have been done in the presence of a second microwave field of frequency ν_2. For limited studies of some n values between 43 and 77 we swept the strength of ν_1 (or ν_2) with fixed amplitude of ν_2 (or ν_1) and recorded the quenching curves. The presence of a second microwave field always makes the system less stable than for a single microwave field. For fixed amplitude of one frequency, for some n values, we observed definite subthreshold structures as the amplitude of the other frequency was varied. These structures vary systematically with variations in the field strength(s). For either frequency alone we see stability associated with classical resonances where the scaled frequency n^3w is near the ratio of certain small integers, confirming the results previously published for 9.92 GHz.[1]

*Supported by NSF grant PHY85-21014.

[1]K.A.H.van Leeuwen et al., Phys.Rev.Lett. 55,2231(1985)

DD 6 Microwave Quenching of Excited H Atoms in the Presence of Infrared Laser Light.* E.J.Galvez, P.M.Koch, L.Moorman, B.Sauer, SUNY at Stony Brook.--We compared separately at 7.58 and 11.89 GHz the microwave quenching of H(n) atoms both with and without CO_2 laser radiation (~few W/cm²), that was used to prepare the excited atoms, being allowed to go through the cavity. With no laser radiation in the cavity, the n=46 quench curve has a flat upper asymptote and drops smoothly (above the ionization threshold-I.T.) to a flat lower asymptote. If laser radiation is present in the cavity, but the n=46 atoms are produced before the cavity, we obtain the same curve. If, however the atoms are prepared inside the cavity with the laser radiation present, we see oscillatory structures in the upper asymptote that begin at or below 2% of the ionization threshold power and which extend all the way to the I.T.. This indicates that the subthreshold structure is caused by laser excitation within the microwave field region.

* Supported by NSF Grant PHY85-21014.

DD 7

Multiphoton Ionization Spectroscopy of F and F_2. G. C. HERRING, LEONARD E. JUSINSKI, MARK J. DYER, and WILLIAM K. BISCHEL, Chemical Physics Laboratory, SRI International*--Using a time-of-flight (TOF) mass spectrometer, resonantly-enhanced multiphoton ionization (REMPI) spectra of F and F_2 have been obtained at 285 nm. We have found that the 3+1 REMPI of F_2 produces only F^+ and no F_2^+ within the sensitivity of our detector. This suprising result implies that ionization of F_2 is immediately followed by photodissociation of F_2^+ with a cross section estimated to be $\geq 10^{-19}$ cm². This fact limits any technique that uses photoionization and mass spectrometry to separate the REMPI spectra of F and F_2. However, F_2 dissociation occurs perpendicular to the electric field direction, while F_2^+ dissociation occurs parallel to the field direction. Dissociation along the TOF axis will yield a double peak, while dissociation perpendicular to the TOF axis will yield a single peak. We have used the single and double-peaked structure of the F^+ signal to simultaneously obtain and to distinguish between the F and F_2 spectra. We have also measured the F_2 and F_2^+ dissociation energies, finding good agreement with previous measurements.

*Supported by AFOSR Under Contract No. F4620-85-K-0005.

DD 8 A Relativistic Approach to Photon Ionization Theory. D.-S. GUO, U. of Oregon.--* The work of Keldysh[1] and Reiss[2] has been revised by using the exact relativistic Volkov solution for the final electron state in order to derive the photon ionization rate. In the limiting case of weak photon field strength, when the radiation frequency is not very low, the result reduces to the ordinary formula for one-photon ionization. When the electromagnetic field is not very weak and approaches a constant value (the radiation frequency vanishes), the formula describes photon-exchange ionization or electron tunneling.

*Supported in part by NSF and AFOSR.

[1]L. V. Keldysh, Sov.Phys.-JETP 20, 1307 (1965).

[2]H. R. Reiss, Phys. Rev. A 22, 1786 (1980).

DD 9 Atomic Response to Strong Laser Pulses. D.A. WASSON and S.E. KOONIN, CALTECH.* --We present a classical model for studying the response of an atom to a strong time varying electric field. The model approximates the atomic electron distribution as one in classical phase space, which is then evolved in time using the classical equations of motion. A series of calculations using the Thomas-Fermi atom to generate the initial distribution and external fields with strength from 0.5-10 V/Å have been completed. We report results concerning the energy and angular distributions of the ionized electrons, as well as the excitation and ionization rates of the atom.

* Supported in part by NSF grants PHY85-05682 and PHY86-04197.

DD 10 Multiphoton Ionization of Ba From 270 to 700 nm Y. Zhu, R. Jones, W. Sandner, and T. F. Gallagher, Univ. of Virginia. --We have observed the multiphoton ionization spectra of Ba^+ and Ba^{++} between 270 and 700 nm. The pulsed laser intensity was about 10^9 to 10^{10} W/cm²; the pulse duration was 5 ns and linewidth was ≤ 1 cm^{-1}. Previously unreported Ba $5p_{3/2}np_j$ J = 2 autoionizing series were observed. From 270 to 400 nm, very few Ba^{++} resonances were observed. In contrast, the spectra between 400 and 590 nm exhibit many Ba^{++} resonances, the linewidths of which vary from 50 cm^{-1} to about 1 cm^{-1}. The intensity ratio of Ba^{++} to Ba^+ signals as high as 5 was observed for some Ba^{++} resonance lines originating from low lying Ba^+ ion states and broadened due to the AC Stark effect. The measurements indicate that sequential ionization is dominant. But some broad Ba^{++} lines cannot yet be assigned to intermediate Ba^+ transitions. This suggests that the production of those Ba^{++} may proceed through Ba autoionizing states.