Working Group I:
Report of the Atomic and Plasma Physics Subgroup

Linda Young
Argonne National Laboratory

8 Apr 1999

List of Attendees:

Ali Belkacem	abelkacem@lbl.gov
Zenghu Chang	liao@flip.eecs.umich.edu
Bob Dunford	dunford@anlphy.phy.anl.gov
Dave Ederer	dlederer@mailhost.tcs.tulane.edu
Armon McPherson	armon@aps.anl.gov
Steve Southworth	southworth@anl.gov
Linda Young	young@anl.gov

1. We considered the subjects contained in the proposed table of contents within the context of the proposed X-ray FEL:

   1 Angstrom, 100 fs pulse duration, 10^{10} photons/pulse, 10^{16} W/cm^2, 100 Hz.

   - Non-perturbative & nonlinear processes
   - Studies of multiphoton ionization
   - Hot electron relaxation
   - Time-resolved Fluorescence Spectroscopy of Atomic Systems
   - Shake and cascade phenomena

2. Laser pump/x-ray probe experiments which would benefit from the proposed FEL were discussed. We discussed high-field laser-induced modifications of x-ray photoionization and Auger processes which could be more easily done with the proposed FEL due to the better match between pulse length and repetition rate with existing laser technology. Z. Chang of U. Michigan showed some recent data from their laboratory on this process taken with a high harmonic source and fundamental derived from the same source. This observed cross correlation signal was a useful diagnostic for pulse duration of the short wavelength radiation. D. Ederer, S. Southworth and L. Young volunteered to put numbers in for a possible experiment of this sort.

3. We noted that experiments investigating energy disposal pathways in individual atoms and molecules (clusters) could be useful input for the understanding of damage mechanisms in complex materials. Such experiments could be performed as some of the first experiments on such a source and would benefit from the high intensity and low repetition rate of the source.

4. We moved on to explore the possibility of non-linear or non-perturbative interactions in the x-ray range. Here we sketched out some possible experiments which would require calculations/homework by various members of the group (and/or outside interested parties).

   - Two photon absorption in the x-ray range, e.g. 1s-2p-3d in a system of suitable Z to make 1s - 3d resonant.

   - Modifications of the x-ray scattering process at high x-ray intensities.

   - Modifications of x-ray absorption by high photon density.

- What happens if a second photon is absorbed by the atom during the process of ejection of the first photon, or during the lifetime of the K-hole state? How is the outgoing electron affected?

5. We noted that there were no plasma physicists present, but also that the fast time scale and short wavelength of the proposed FEL could be a useful probe for plasmas, since optical photons do not penetrate plasmas.

6. We decided to meet again at the X99 meeting in Chicago in August and with the pump-probe group in Michigan in December. We noted the overlap in interest with the Chemical Sciences and Fundamental Physics Groups as well.

7. We will be consulting theorists on the basic question: How is our understanding of photon/atom interactions altered, if at all, for atoms exposed to the intense, short wavelength radiation from this source?