High-Intensity / Relativistic Optics

Problem set 4—Debye shielding, laser incidence, ionization

1. **Exercise:** Calculate the potential $\phi(\boldsymbol{r})$ of a system comprising an electric charge q at the origin, an immobile, homogeneous ion background and an electron distribution treated as a fluid characterized by a certain temperature T_e, which is in thermal equilibrium with the generated electro static potential $\phi(\boldsymbol{r})$. Start with a discussion of the assumption of a fixed ion background. Which conditions validate this assumption?

2. **Exercise:** Consider a laser pulse obliquely incident on an exponential plasma profile, i.e. its density distribution as a function of the distance from the target surface, x, can be desribed by $n_\mathrm{e}(x) = n_{\mathrm{e},0} \exp(x/L_\mathrm{p})$, where the target extends from $x = 0$ to larger values of x. L_p is called the plasma scale length. How does the deflection of the pulse look like? Will the laser pulse reach the critical density?

3. **Exercise:** When the laser intensity starts to get close to the so-called atomic intensity, which is the intensity associated with the atomic field strength, which is experienced by an electron on the first Bohr orbit in a hydrogen atom, the laser field becomes strong enough to distort the Coulomb field felt by the hydrogen atom's electron. Consider a modification of the Coulomb potential by a stationary, homogeneous electric field and determine the intensity I at which *over the barrier ionization* (OTBI) sets in.