

**PHY-851 QUANTUM MECHANICS I**

**Homework 3**, 30 points

September 19 - 26, 2001

Reading: *Merzbacher*, Chapter 3.

1. /5/ A particle is moving along the  $x$ -axis in the potential field  $U(x) = \alpha|x|^s$ , where  $\alpha$  and  $s$  are positive constants. Using the Bohr-Sommerfeld quantization rule, find the energy spectrum of bound states  $E_n$ .
2. /6/ Consider an atom with the nucleus of charge  $Z$  and two electrons. Using the uncertainty principle, estimate ground state energy for this atom (do not forget the Coulomb repulsion between the electrons). Compare your predictions with experimental data:  
negative hydrogen ion  $\text{H}^-$   $-1.05$ ,  
He atom  $-5.81$ ,  
positive ion  $\text{Li}^+$   $-15.12$ ,  
 $\text{Be}^{++}$   $-28.12$ ,  
 $\text{B}^{+++}$   $-45.12$ ,  
 $\text{C}^{++++}$   $-66.12$   
(all energies in Ry).
3. /5/ a. *Merzbacher*, Exercise 3.2, p. 26.  
b. *Merzbacher*, Exercise 3.18, p. 43.
4. /7/ *Merzbacher*, Problem 2, p. 49.
5. /7/ *Merzbacher*, Problem 3, p. 49.