Chapter 3. Mathematics of the Solid Mass Atom- The Atomic Field

1. Postulate 3.1 – The Potential Energy of Two Atoms, the Atomic Field of One Atom

In chapter 1 it was proved that $E \neq m\mathbf{c_0^2}$ and consequently that the governing equation for the binding energy, B.E., of the quantum mechanical atom is false i.e. $B.E. \equiv \Delta E \neq \Delta m\mathbf{c_0^2}$. This necessitates the design of a new atom. The new atom is developed within the context of Newton's Laws and the Newtonian Transform. The gravitational potential Φ_G between two atoms of the same mass, assuming a radially symmetric density, is $\Phi_G = -m^2G/r$, where r is the center-to-center distance between two atoms and $G=(6.67)10^{-8}$ ergcm/gm^2 is the gravitational constant. In the remainder of this text, m stands for the gravitational mass as operationally defined in Chapter 2, Section 8. For transition metal atoms of mass $\sim 10^2$ AMU, $|\Phi_G|$ is too small by a factor of 10^{-32} to account for the $\approx$1ev chemical potential energy of two atoms chemically bonded together with $r=2r_0$, where r_0, the average radius of the atom is, $r_0 \approx 1\mathring{A}$. If one assumes the chemical potential for the above two atoms to be of form $\Phi = -m^2H/r$ with $\Phi(2r_0) = -m^2H/2r_0 = 1ev \approx 10^{-12}$ergs then $H \approx 10^{24}$erg.cm/gm^2 and therefore $|\Phi| >> |\Phi_G|$. Consequently $\Phi = -m^2H/r$ is not the correct potential for $r >> 2r_0 \approx 2\mathring{A}$.

Within the context of Newton's Laws, position, velocity and acceleration are measured from an inertial frame. For convenience the inertial frame chosen is one at rest with respect to the center of mass of the system under study. See figure 3.1.

Postulate 3.1

Atoms are continuous mass, space filling, neutral spheres of radius $\bar{h}_0 \approx 10^{-8}$cm where $\bar{h}_0$ is the average radius. In the following it is assumed that for the purpose of calculating potential energy and field strength at standard temperature and pressure, temperature and time effects on the mass density are negligible and that the density is spherically symmetric $\rho = \rho(h)$, $h = s + \chi(s,t)$, $\chi(s,0) = 0$, $0 \leq s \leq h \leq h_0$. h_0 is the radius of the atom with $h_0 = \bar{h}_0 + \chi(\bar{h}_0, t)$ and $\chi(\bar{h}_0, 0) = 0$. All quantities are measured from inertial frame S at rest with respect to the center of mass of the system under study. Using figure 3.1, the atomic field of one atom is postulated to be:

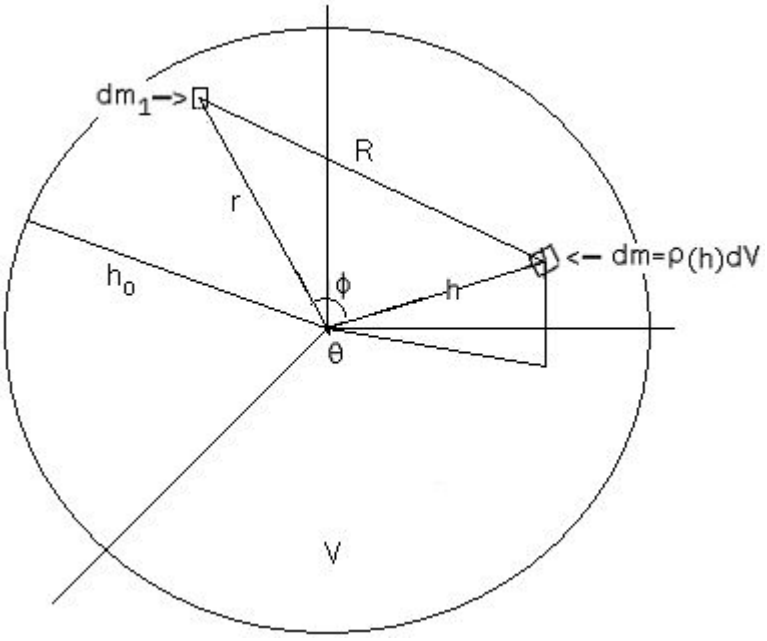
3.1 $$d\Psi(r,t) = -\rho(h)[He^{-(R/h_0)^n} + G]\frac{dV}{R}, \quad n = n(\rho(h_0)), \text{ n a positive real number}$$

$$\Psi(r,t) = -\int_V \rho(h)[He^{-(R/h_0)^n} + G]\frac{dV}{R},$$

$$R^2 = h^2 + r^2 - 2rh\cos\phi \text{ and } dV = h^2\sin\phi\, dh\, d\theta\, d\phi$$

H is a constant with units $\frac{erg\,cm}{gm^2}$ whose value is determined in chapter 3, section 8. r is independent of time.

FIGURE 3.1



For $\frac{R}{h_o} \leq 1$, as n—>∞:

3.2 $$\Psi(r,t) = -[H+G]\int_V \rho(h)\frac{dV}{R} \doteq -H\int_V \rho(h)\frac{dV}{R}\,,\quad h \leq h_o$$

For $1<\frac{R}{h_o}$, in order to derive the coefficient of expansion of the atomic elements in solid form and the specific heats of the atomic elements, (See chapter 5, section 1)

3.3 $$\Psi(r,t)=\Psi(h_o^+)+\frac{\partial\Psi}{\partial r}(h_o^+)\cdot(r-h_o^+)+\ldots :\ h_o<r \lesssim \bar{h}_o+10^{-2}\bar{h}_o$$

$$\Psi(r) \doteq -mG/r : \bar{h}_o+10^{-2}\bar{h}_o \lesssim r$$

The total mass of the atom m is: $m = 4\pi\int_0^{h_o} h^2\rho(h)dh$ and with $\rho(h)=a_p(\frac{h}{h_o})^p$,

$a_p=\frac{(p+3)m}{4\pi h_o^3}>0$. To insure stability it is required that $\frac{\partial\rho}{\partial h}=p a_p\left(\frac{h}{h_o}\right)^{p-1} \leq 0$, and consequently $p \leq 0$. m is finite and therefore $-3<p\leq 0$. For future reference:

3.4 $$\rho(h)=\frac{(p+3)m}{4\pi h_o^3}\left(\frac{h}{h_o}\right)^p$$

With regard to 3.1, (See figure 3.1) it is assumed that a change in position of mass element dm from $\underset{\sim}{h}$ at time t to $\underset{\sim}{h}+d\underset{\sim}{h}$ at time t+dt holding the position of dm_1 constant, results in an instantaneous change in the field strength from $-\rho[He^{-(R/h_0)^n}+G]\frac{dV}{R}$ at time t, to $-\rho[He^{-([R+dR]/h_0)^n}+G]\frac{dV}{(R+dR)}$ at time t+dt, where $\underset{\sim}{R}+\underset{\sim}{h}=\underset{\sim}{R}+d\underset{\sim}{R}+\underset{\sim}{h}+d\underset{\sim}{h}$ and $d\underset{\sim}{R}=-d\underset{\sim}{h}$. Note that $\rho(h)dV(h)=\rho(h+dh)dV(h+dh)$. If experimentally the change in field strength is not instantaneous, then Ψ will depend on $\underset{\sim}{v}$ where $\underset{\sim}{v}$ is the velocity at which a change in potential due to a change in position of dm is propagated through the mass between dm and dm_1. Assuming $\underset{\sim}{v}$ is a function of mass density ρ and assuming ρ to be spherically symmetric, then $\underset{\sim}{v}$ depends on h. Given that τ -t is the time interval that it takes a change in position of dm at $\underset{\sim}{h}$, to be detected at $\underset{\sim}{r}$; To actually compute τ is mathematically very similar to the geophysical problem of computing the first arrival time τ of an earthquake wave at $\underset{\sim}{r}$, given a point earthquake at $\underset{\sim}{h}$ at time t.

2. Evaluation of the Atomic Field

From figure 3.1, $R^2=h^2+r^2-2rh\cos\phi$ and $dV=h^2\sin\phi\,dh\,d\theta\,d\phi$. From 3.2:

3.5 $$\Psi(r,t)=-H\int_0^{\pi}\int_0^{2\pi}\int_0^{h_0}\rho(h)\frac{h^2\sin\phi\,dh\,d\theta\,d\phi}{(h^2+r^2-2hr\cos\phi)^{\frac{1}{2}}},\quad r<h_0$$

Let $U(\phi)\equiv h^2+r^2-2rh\cos\phi$ and $dU=2hr\sin\phi\,d\phi$. Substituting into 3.5 yields:

3.6 $$\Psi(r,t)=-\frac{H}{2r}\int_{U(o)}^{U(\pi)}\int_0^{2\pi}\int_0^{h_0}h\rho(h)\frac{dh\,d\theta\,dU(\phi)}{U(\phi)^{1/2}}=-2\pi\frac{H}{r}\int_0^{h_0}h\rho(h)\left[(h+r)-|h-r|\right]dh$$

With $r < h_0$, 3.6 divides into two integrals according to $h\leq r$ or $r\leq h$.

3.7 $$\Psi(r,t)=-4\pi\frac{H}{r}\left\{\int_0^{r}h^2\rho(h)dh+\int_r^{h_0}rh\rho(h)dh\right\}$$

Using 3.4, 3.7 becomes:

3.8 $$\Psi(r)=-\frac{mH}{r_o}\frac{1}{(p+2)}\left[(p+3)-\left(\frac{r}{r_o}\right)^{p+2}\right],\ r\le r_o$$

$$\Psi(h)=-\frac{mH}{h_o}\frac{1}{(p+2)}\left[(p+3)-\left(\frac{h}{h_o}\right)^{p+2}\right],\ h\le h_o$$

For $p=-2$, 3.8 becomes:

3.9 $$\Psi(r)=-\frac{mH}{r_o}\left[1-\ln\left(\frac{r}{r_o}\right)\right],\ r\le r_o,\ p=-2$$

$$\Psi(h)=-\frac{mH}{h_o}\left[1-\ln\left(\frac{h}{h_o}\right)\right],\ h\le h_o$$

The first equation in 3.8 and 3.9 is for the special case $h_o=r_o=$const. The case $r\ge h_o$ is evaluated in chapter 5, section 1.

3. Postulate 3.2- Elastic collisions:

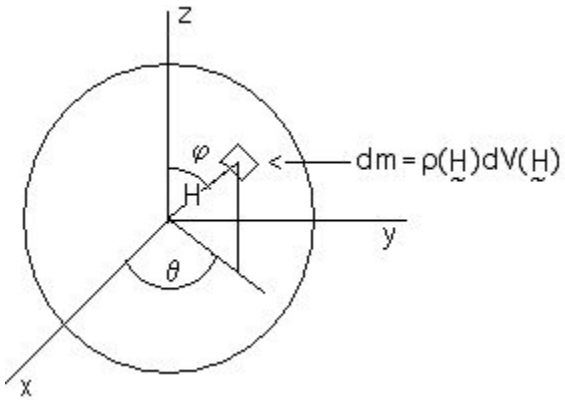
With in the context of 3.1 with however $\rho=\rho(r)$ and r_o=const., let $f_S(r+dr)$ represent the magnitude of the static force in the $-\hat{r}$ direction pressing on area $dA=(r+dr)^2\sin\varphi d\theta d\varphi$,at r+dr, due to atomic field forces and let $f_S(r)$ represent the magnitude of the static force in the $-\hat{r}$ direction pressing on area $dA=(r)^2\sin\varphi d\theta d\varphi$,at r, due to atomic field forces with $f_S(r+dr)-f_S(r)=df_S(r)=-\rho(r)dAdr\frac{d\Psi}{dr}$.
For the present the atomic mass is considered motionless with respect to its center of mass and $f_S(r)$ stands for the static force pressing on area dA.
The static pressure difference dP_{Ψ_S} due to atomic field forces is given by
$dP_{\Psi_S}=\frac{df_S(r)}{dA}=-\rho(r)dr\frac{d\Psi}{dr}$. Integrating dP_{Ψ_S}:

3.10 $$P_{\Psi_S}(r)=P_{\Psi_S}(r_0)+\int_r^{r_0}\rho\frac{d\Psi}{dS}dS$$

$P_{\Psi_S}(r)$ is the static pressure in the $-\hat{r}$ direction due to field forces on a spherical surface of radius r within the atom. The dynamic pressure P_Ψ will be derived below.

Consider an oscillating element of mass $dm=\rho(\underset{\sim}{H})\,dV(\underset{\sim}{H})$ within the atom. See figure 3.2.
The function $\underset{\sim}{H}=(H_x,H_y,H_z)=H_o\hat{r}+\underset{\sim}{\xi}(H_o,\theta,\phi,t)$ represents the position of dm in spherical coordinates where $H=|\underset{\sim}{H}|$. See 3.11

FIGURE 3.2



3.11 $$\underset{\sim}{H} = H_o\hat{r} + \underset{\sim}{\xi}(H_o,\theta,\phi,t), \quad \underset{\sim}{H}_o = H_o\hat{r}$$

$$H_x = H_o\hat{r}\cdot\hat{x} + \xi_x(H_o,\theta,\phi,t) \text{ with } \xi_x(H_o,\theta,\phi,0)=0$$

$$H_y = H_o\hat{r}\cdot\hat{y} + \xi_y(H_o,\theta,\phi,t) \text{ with } \xi_y(H_o,\theta,\phi,0)=0$$

$$H_z = H_o\hat{r}\cdot\hat{z} + \xi_z(H_o,\theta,\phi,t) \text{ with } \xi_z(H_o,\theta,\phi,0)=0$$

In all cases, $\frac{d\underset{\sim}{H}_o}{dt} = \frac{d\theta}{dt} = \frac{d\phi}{dt} \equiv 0$.

The velocity of dm is:

3.12 $$\underset{\sim}{W} = W_x\hat{x} + W_y\hat{y} + W_z\hat{z} = \frac{\partial H}{\partial t}_x\hat{x} + \frac{\partial H}{\partial t}_y\hat{y} + \frac{\partial H}{\partial t}_z\hat{z}$$ and the acceleration of dm is:

$$\underset{\sim}{a} = \frac{\partial \underset{\sim}{W}}{\partial t} = \frac{\partial^2 H_x}{\partial t^2}\hat{x} + \frac{\partial^2 H_y}{\partial t^2}\hat{y} + \frac{\partial^2 H_z}{\partial t^2}\hat{z}$$

with:

3.13 $$\frac{\partial H}{\partial t}_x = \frac{\partial \xi}{\partial t}_x(H_o,\theta,\phi,t) \text{ and } \frac{\partial^2 H}{\partial t^2}_x = \frac{\partial^2 \xi}{\partial t^2}_x(H_o,\theta,\phi,t)$$

$$\frac{\partial H}{\partial t}_y = \frac{\partial \xi}{\partial t}_y(H_o,\theta,\phi,t) \text{ and } \frac{\partial^2 H}{\partial t^2}_y = \frac{\partial^2 \xi}{\partial t^2}_y(H_o,\theta,\phi,t)$$

$$\frac{\partial H}{\partial t}_z = \frac{\partial \xi}{\partial t}_z(H_o,\theta,\phi,t) \text{ and } \frac{\partial^2 H}{\partial t^2}_z = \frac{\partial^2 \xi}{\partial t^2}_z(H_o,\theta,\phi,t)$$

The following postulate is fundamental to the rest of this text.

Postulate 3.2 The component of $\underset{\sim}{W}$ in the $-\hat{r}$ direction is caused by the atomic field force $d\underset{\sim}{f}_{\Psi}=-\rho(\underset{\sim}{H})dV(\underset{\sim}{H})\nabla\Psi$. Components of $\underset{\sim}{W}(\underset{\sim}{H})$ in the $+\hat{r}$, $\pm\hat{r}X\hat{\varphi}$, $\pm\hat{\varphi}$, direction are hypothesized to result from internal elastic collisions, of dm with the mass on either side of dm, respectively, in the $-\hat{r}$, $\mp\hat{r}X\hat{\varphi}$, $\mp\hat{\varphi}$, directions. During internal elastic collisions, dm remains constant, where $dm=\rho(\underset{\sim}{H})\,dV(\underset{\sim}{H})=\rho(\underset{\sim}{H}+d\underset{\sim}{H})\,dV(\underset{\sim}{H}+d\underset{\sim}{H})$.

Assuming that the sum of the pressure due to vibrating $dm_i=\rho(\underset{\sim}{H}_i)\,dV(\underset{\sim}{H}_i)$ where $|\underset{\sim}{\bar{H}}_i|=|\underset{\sim}{\bar{H}}_j|$, with $dm=4\pi|\underset{\sim}{\bar{H}}_i|^2\rho(|\underset{\sim}{\bar{H}}_i|)[d|\underset{\sim}{\bar{H}}_i|]$, results in a spherically symmetric pressure about the center of mass of the atom; Let $P_\Psi(h)$, pressing in the $-\hat{h}$ direction, represent the pressure at h within an atom due to field forces and $P_\Psi(h_o)$ represents the pressure at the surface of the atom due to field forces. Also let $P_C(h)$ represent the pressure at h within an atom due to contact forces and let $P_C(h_o)$ represent the externally applied pressure at the surface of the atom where as before $h=r+\chi(r,t)$, $\chi(r,0)=0$, $0\le r\le h_o$ and $h_o=\bar{h}_o+\chi(\bar{h}_o,t)$, $\chi(\bar{h}_o,0)=0$. Let h equal, $h=<|\underset{\sim}{H}|>=<H>=<|\underset{\sim}{r}+\underset{\sim}{\xi}(\underset{\sim}{r},t)|>$. The brackets <> represent a space average around the spherical surface with radius $r=|\underset{\sim}{r}|$ at time t. Time independent r is measured from the center of mass of the atom. Note that h as here written is independent of θ and ϕ. P_Ψ and P_C are computed using the space averaged h instead of the actual position $\underset{\sim}{H}$.

Returning to 3.10 and $P_{\Psi_s}(r)$: An underlying assumption in deriving $P_{\Psi_s}(r)$, is that the atomic mass is motion less with respect to the atomic center of mass. Postulate 3.2 states the assumption that atomic field forces hold the atom together and internally generated contact pressure forces due to vibrational motion keep the atom from internal collapse. i.e. the atomic mass is not motion less with respect to the atomic center of mass.

Under the influence of the atomic field force $-dm\frac{d\Psi}{dr}$, figure 3.3, dm acquires a speed $V_r(r)$ in the $-\hat{r}$ direction and a kinetic energy $\frac{1}{2}dmV_r^2(r)$. If after reflection from the mass below it and above it, the velocity remains in the $\pm\hat{r}$ direction then, rewriting 3.10:

$$3.10\quad P_{\Psi_s}(r)=P_{\Psi_s}(r_o)+\int_r^{r_o}\rho\frac{d\Psi}{dS}dS.$$

Assuming Postulate 3.2, the velocity does not remain in the $\pm\hat{r}$ direction and the kinetic energy of dm, $\frac{1}{2}dmV^2(r)_{r,r<m>s}$, is shared with the surrounding mass resulting in $V^2(h)_{r,r<m>s}=U^2_{r<m>s}(h)=3U^2_{r,r<m>s}(h)$ where $(\frac{dh}{dt})^2=U^2_{r,r<m>s}(h)$ and $3(\frac{dh}{dt})^2=U^2_{r<m>s}(h)$.

$U^2_{r<m>s}(h)$ is the r<m>s speed squared if the kinetic energy is shared and $U^2_{r,r<m>s}(h)$ is the rms speed squared of the r component of the velocity if the kinetic energy is shared. 3.10 becomes:

3.14 $$P_\Psi(h)=P_\Psi(h_o)+\frac{1}{3}\int_h^{h_o}\rho(w)\frac{d\Psi}{dw}dw$$

4. Postulate 3.3 - Energy Equilibrium Condition

An atom in energy equilibrium with itself has constant total internal energy, KE+PE= internal kinetic energy+ internal potential energy=const. , and has no net flow of energy from one part of the atom to another.
There are two ways in which energy flow is possible in a solid mass atom, convection and conduction. To prevent convective energy flow it is required that $\frac{d\rho}{dh}=\frac{d\rho(h)}{dh}\le 0$, $0\le h\le h_o$.
The condition under which there is no energy flow by conduction is postulated below. Let $\Delta E(h)$ represent the total energy of a spherical shell of radius h and thickness Δh and let $\Delta E(h_1)$ represent the total energy of a spherical shell of radius h_1 and thickness Δh_1 where $\Delta E(h)\doteq 4\pi h^2\rho(h)[\frac{1}{2}U^2_{rms}(h)+\Psi(h)]\Delta h$ and $\Delta E(h_1)\doteq 4\pi h_1^2\rho(h_1)[\frac{1}{2}U^2_{rms}(h_1)+\Psi(h_1)]\Delta h_1$ with $\Delta h<<h$ and $\Delta h_1<< h_1$. See figure 3.4
For convenience, the notation r<m>s has been replaced by rms. rms means r<m>s
The mass contained within the spherical shell of radius h and thickness Δh is given by $\Delta m(h)\doteq 4\pi h^2\rho(h)\Delta h$ and the mass contained within the spherical shell of radius h_1 and thickness Δh_1 is given by $\Delta m(h_1)\doteq 4\pi h_1^2\rho(h_1)\Delta h_1$. It is postulated:

Postulate 3.3. If $\lim_{\Delta h\to 0}\frac{\Delta E(h)}{\Delta m(h)}=\lim_{\Delta h_1\to 0}\frac{\Delta E(h_1)}{\Delta m(h_1)}$, then
$\frac{dE(h)}{dm(h)}=\frac{dE(h_1)}{dm(h_1)}=[\frac{1}{2}U^2_{rms}(h)+\Psi(h)]=[\frac{1}{2}U^2_{rms}(h_1)+\Psi(h_1)]=C_1$ and there will be no net energy flow in the solid mass atom due to conduction and further, if $\frac{d\rho(h)}{dh}\le 0$ for $0\le h\le h_o$, there will be no net energy flow in the solid mass atom due to convection and therefore the atom will be in energy equilibrium with itself.
Conversely, if the atom is in energy equilibrium with itself then $[\frac{1}{2}U^2_{rms}(h)+\Psi(h)]=C_1$ and $\frac{d\rho(h)}{dh}\le 0$ for $0\le h\le h_o$.

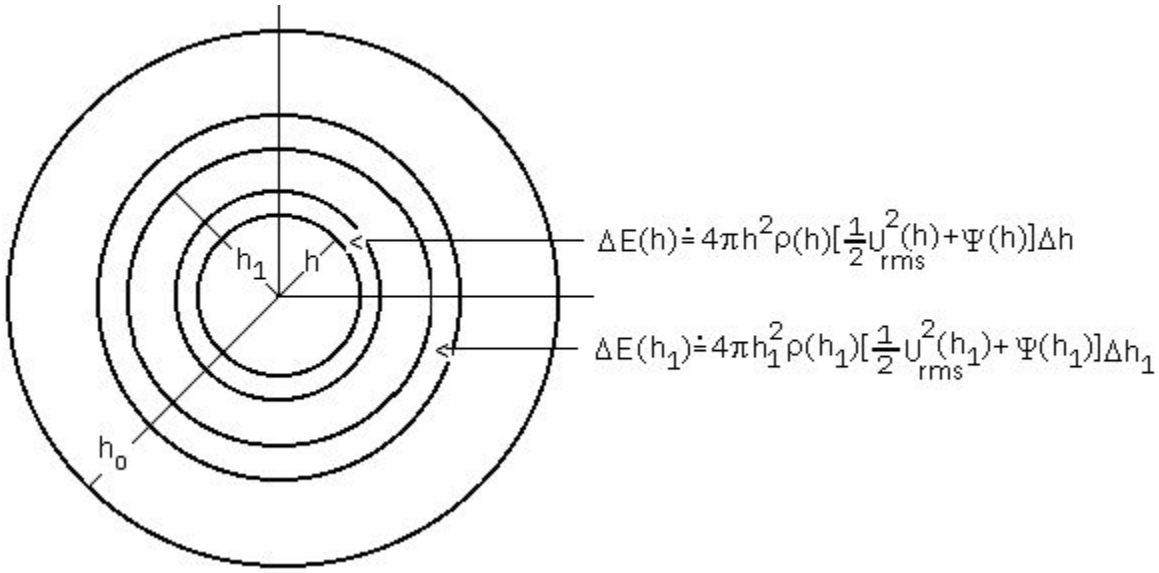
For future reference:

3.15 $[\frac{1}{2}U^2_{rms}(h)+\Psi(h)]=[\frac{1}{2}U^2_{rms}(h_0)+\Psi(h_0)]=C_1$

From 3.15, the total internal energy of the atom TIE remains constant where:

3.16 $TIE=\int_{V(h_0)}\{\frac{1}{2}\rho(h)U^2_{rms}(h)+\rho(h)\Psi(h)\}dV=C_1\int_{V(h_0)}\rho(h)dV=mC_1$ =constant, m is the mass of the atom and $V(h_0)$ is its volume.

FIGURE 3.4



From 3.16 the total internal energy is $TIE=T+V=mC_1$ and:

3.17 $T+V=mC_1$

3.18 $T=2\pi\int_0^{h_0}h^2\rho(h)U^2_{rms}(h)dh,\quad V=4\pi\int_0^{h_0}h^2\rho(h)\Psi(h)dh$

With $[\frac{1}{2}U^2_{rms}(h)+\Psi(h)]=[\frac{1}{2}U^2_{rms}(h_0)+\Psi(h_0)]=C_1$:

(i) If, $-\infty<C_1<0$, then the radius of the atom, $h_0=\bar{h}_0+\chi(\bar{h}_0,t)$ with $\chi(\bar{h}_0,0)=0$, has a least upper bound R, $R<\infty$, where R =const. and $\Psi(R)=C_1$.

To show this:

$\lim_{\bar{h}_0 \to \infty} [\frac{1}{2} U^2_{rms}(\bar{h}_0) + \Psi(\bar{h}_0)] = \lim_{\bar{h}_0 \to \infty} \frac{1}{2} U^2_{rms}(\bar{h}_0) \neq C_1 < 0$. Consequently there exists a R $<\infty$, with $\Psi(R)=C_1$ such that:

1. $\frac{1}{2} U^2_{rms}(R) + \Psi(R) = \frac{1}{2} U^2_{rms}(R) + C_1 = C_1$ hence $\frac{1}{2} U^2_{rms}(R)=0$
2. $[\frac{1}{2} U^2_{rms}(h) + \Psi(h)] > C_1$ for r>R
3. $[\frac{1}{2} U^2_{rms}(h) + \Psi(h)] = C_1$ for $h \leq h_o \leq R$

(ii) $h_o \neq 0$.
To show this:
For a point mass atom $\Psi(0) = -\infty$ and $U^2_{rms}(0)=0$ and $\frac{1}{2} U^2_{rms}(0) + \Psi(0) = -\infty$ which violates the supposition that $-\infty < C_1$. Therefore $h_o \neq 0$ as to be shown.

(iii) $C_1 \geq 0$, the atom is unstable, $\frac{1}{2} \delta m U^2_{rms}(h) \geq -\delta m \Psi(h)$. The kinetic energy of every point like mass δm in the atom is greater than the absolute value of its potential energy and consequently δm escapes to infinity. This process is true for every δm and consequently the entire atom escapes about its center of mass to infinity.

Internal elastic collisions at the nuclear level is a fundamentally new assumption. In this text, all atoms and sub atomic particles are hypothesized to be charge neutral. The root cause of all experiments involving charge effects is hypothesized to be the result of collisions of neutral mass atoms with one another or to the collision of a neutral mass atom with a neutral mass subatomic particle.
It is generally assumed that charged particles are kept from collapse by like charge repulsion. As hypothesized above, all "charged particles" are in reality charge neutral and as calculated below, the force generated by neutral mass internal elastic collisions keeps all so called "charged particles" from collapse. As discussed in the following chapters:
1. The electromagnetic field is due to solid mass photons created by and emitted by neutral mass atoms during collision. See chapter 6.
2. The change in internal energy of a particle ΔE_p is $\Delta E_p = \Delta E_{mr} + \Delta E_{rm}$ where ΔE_{mr} is the energy necessary to increase the mean radius of the particle by Δr_o and ΔE_{rm} is the energy to increase the amplitude of the radial motion of the surface of the particle by Δa. So called "Negative charged particles" are created from neutral particles by adding energy to neutral particles so that $\Delta E_p > 0$. The particles are called "Negative" w.r.t. particles in the initial state although the particles remain charge neutral and the initial and final states differ only in internal energy.
So called "Positive charged particles" are created from neutral particles by subtracting energy from neutral particles so that $\Delta E_p < 0$. The particles are called "Positive" w.r.t. particles in the initial state although the particles remain charge neutral and the initial and final states differ only in internal energy.

The energized, de-energized particles remain charge neutral and the experimental effects created by the energized, de-energized particles are explained on a case by case basis. E.g.

2A. Triboelectric repulsive forces between two energized objects (e.g. a gold leaf electroscope), is due to heating of the neutral material between the two energized objects. Triboelectric attractive forces between two energized objects is due to cooling of the neutral material between the two energized objects. See chapter 7.

2B. An electric current is the passage of ΔE_p from atom to atom by direct contact. This and the forces created by current carrying wires on one another is discussed in chapter 7

5. Contact Pressure $P_C(h)$ and Field Generated Pressure $P_\Psi(h)$.

Using $h=r+\chi(r,t)$, $\chi(r,0)=0$, $0\le r\le h_o$ and $h_o=\bar{h}_o+\chi(\bar{h}_o,t)$, $\chi(\bar{h}_o,0)=0$: Δh is, $\Delta h=\Delta r+\chi(r+\Delta r,t)-\chi(r,t)$. Let ΔF be the difference in scalar force across an annular region of radius h and thickness Δh where $\Delta F\doteq 4\pi h^2\rho(h)\Delta h\cdot\frac{dh}{dt}\doteq 4\pi h^2\rho(h)\Delta h\cdot\dot{U}_{r,rms}\doteq 4\pi h^2\Delta P_C$ with $\Delta P_C=P_C(h+\Delta h)-P_C(h)$. Solving for $\frac{\Delta P_C}{\Delta h}$: $\frac{\Delta P_C}{\Delta h}\doteq\rho(h)\cdot\dot{U}_{r,rms}=\sqrt{\frac{3}{3}}\rho(h)\cdot\dot{U}_{rms}=\sqrt{\frac{3}{3}}\rho(h)\cdot\frac{dU_{rms}}{dh}(\frac{dh}{dt})=\sqrt{\frac{3}{3}}\rho(h)\cdot\frac{dU_{rms}}{dh}\cdot(U_{r,rms})=\frac{1}{3}\rho(h)\cdot U_{rms}\cdot(\frac{dU_{rms}}{dh})$ and $\frac{dP_C}{dh}=\frac{1}{3}\rho(h)\cdot U_{rms}\cdot(\frac{dU_{rms}}{dh})$.

From 3.15 and 3.14: $\frac{dP_C}{dh}=\frac{1}{3}\rho(h)U_{rms}\cdot(\frac{dU_{rms}}{dh})=-\frac{1}{3}\rho(h)\frac{d\Psi}{dh}=\frac{dP_\Psi}{dh}$.

Collating results for future use:

3.19 $$P_\Psi(h)=P_\Psi(h_o)+\frac{1}{3}\int_h^{h_o}\rho(w)\frac{d\Psi}{dw}dw \qquad P_C(h)=P_C(h_o)-\frac{1}{3}\int_h^{h_o}\rho(w)U_{rms}[w]\frac{dU_{rms}}{dw}dw$$

$$P_\Psi(h)=P_C(h) \text{ and } \frac{dP_\Psi}{dh}=\frac{dP_C}{dh}$$

$$\frac{dP_\Psi}{dh}=-\frac{1}{3}\rho(h)\frac{d\Psi}{dh} \qquad \frac{dP_C}{dh}=\frac{1}{3}\rho(h)\cdot U_{rms}\cdot(\frac{dU_{rms}}{dh}).$$

Using $\frac{dP_\Psi}{dh}=\frac{dP_C}{dh}$ yields: $\frac{1}{3}\rho(h)\cdot U_{rms}\cdot(\frac{dU_{rms}}{dh})+\frac{1}{3}\rho(h)\frac{d\Psi}{dh}=0$ and integrating yields once again, 3.15, $[\frac{1}{2}U_{rms}^2(h)+\Psi(h)]=[\frac{1}{2}U_{rms}^2(h_o)+\Psi(h_o)]=C_1$.

Note that in general $P_\Psi(h)\neq P_C(h)$.

$P_\Psi(h)=P_C(h)$ for $t=\tau$, iff $P_C(h_o)=P_\Psi(h_o)$ for $t=\tau$.

If $P_C(h_o)\neq P_\Psi(h_o)$ for all $t>0$, then either $P_C(h_o)>P_\Psi(h_o)$ or $P_C(h_o)<P_\Psi(h_o)$. If $P_C(h_o)>P_\Psi(h_o)$ for all $t>0$, then the atomic surface expands to infinity and therefore $C_1>0$

contrary to the assumption that $C_1 < 0$. If $P_c(h_o) < P_\Psi(h_o)$ for all t>0, then the atom collapses to a point with $C_1 = -\infty$ which violates the supposition that $-\infty < C_1$. Consequently, $\sim(P_c(h_o) \neq P_\Psi(h_o))$ for all t>0.

6. The Virial Theorem and time dependent T and V

Returning to the asymmetric description of the atom with $\underset{\sim}{H} = \underset{\sim}{r} + \underset{\sim}{\xi}(\underset{\sim}{r},t)$ and $\underset{\sim}{\xi}(\underset{\sim}{r},0)=0$. See fig.3.2 and postulate 3.2. Let $\rho(\underset{\sim}{H})$ be the mass density of the atom, where $\underset{\sim}{H}$ is measured from the center of mass of the atom. Using 3.18:

3.20 $$T = \frac{1}{2}\int_V \rho(\underset{\sim}{H})U^2(\underset{\sim}{H})dV, \quad V = \int_V \rho(\underset{\sim}{H})\Psi(\underset{\sim}{H})dV$$

With $dm = \rho(\underset{\sim}{H})dV(\underset{\sim}{H})$ and $\frac{dm}{dt}=0$. Note that although dV is time dependent, dm is not. Define G as:

3.21 $$G = \int \underset{\sim}{H}\rho(\underset{\sim}{H})\underset{\sim}{U}(\underset{\sim}{H})dV = \int_V \underset{\sim}{H}\cdot\underset{\sim}{U}(\underset{\sim}{H})dm$$ (See reference 3.1).

$$\frac{dG}{dt} = \int_V [U(\underset{\sim}{H})^2 + \underset{\sim}{H}\cdot\dot{\underset{\sim}{U}}(\underset{\sim}{H})]dm$$

In every volume element δV containing mass δm; $\underset{\sim}{H}\cdot\underset{\sim}{U}(\underset{\sim}{H})\delta m$ with $\underset{\sim}{H}$ in δV can be broken up into pairs $\underset{\sim}{H}_i\cdot\underset{\sim}{U}(\underset{\sim}{H}_i)\delta m_i + \underset{\sim}{H}_j\cdot\underset{\sim}{U}(\underset{\sim}{H}_j)\delta m_j = 0$. Any net velocity of δm, is quickly broken up into internal vibrational energy. See postulate 3.2. Consequently $G = \int_V \underset{\sim}{H}\cdot\underset{\sim}{U}(\underset{\sim}{H})dm \equiv 0$ and $\frac{dG}{dt} \equiv 0$. By the same argument as above, $\int_V \underset{\sim}{H}\cdot\dot{\underset{\sim}{U}}(\underset{\sim}{H})dm \equiv 0$ and using 3.21,

3.22 $$\frac{dG}{dt} = \int_V U(\underset{\sim}{H})^2 dm \equiv 0.$$

On physical grounds, $\int_V \underset{\sim}{U}(\underset{\sim}{H})^2 dm>0$ and consequently $\frac{dG}{dt} \not\equiv 0$. The inconsistent result $\frac{dG}{dt} \equiv 0$, $\frac{dG}{dt} \not\equiv 0$ is dependent on the existence of two forces acting on δm, a field force and a contact force and in general if only a field force exists, the inconsistent result does not exist.

On physical grounds $\frac{dG}{dt}>0$ represents physical realty and therefore $\frac{dG}{dt} \equiv 0$ does not represent physical reality. The physical reality of $\frac{dG}{dt} \equiv 0$ is necessary for the derivation of the Virial Theorem 2T+V=0, and consequently the Virial theorem does not represent physical reality for the continuous mass atom.

In the case of a contracting star, for every δm in δV, δm has a net $\underset{\sim}{U}(\underset{\sim}{H})$ directed toward the center of mass of the star. Therefore, $\underset{\sim}{H}_i \cdot \underset{\sim}{U}(\underset{\sim}{H})_i \delta m_i + \underset{\sim}{H}_j \cdot \underset{\sim}{U}(\underset{\sim}{H})_j \delta m_j \neq 0$, and consequently $G \not\equiv 0$; one cannot conclude that $\frac{dG}{dt} \equiv 0$ and the Virial theorem holds true.

7. Classical Binding Energy

Returning to the spherically symmetric atom, use $V = 4\pi \int_0^{h_0} S^2 \rho(S) \Psi(S) dS$ to define V^- and V^+:

3.23 $$V^- = 4\pi \int_0^{h_0} S^2 \rho(S) \bar{\Psi}(S) dS, \quad V^+ = 4\pi \int_0^{h_0} S^2 \rho(S) \overset{+}{\Psi}(S) dS, \quad V = V^- + V^+$$

where from 3.7, 3.8:

$$\Psi(h) = -4\pi \frac{H}{h} \left\{ \int_0^h S^2 \rho(S) dS + \int_h^{h_0} hS\rho(S) dS \right\} = \bar{\Psi}(h) + \overset{+}{\Psi}(h) = -\frac{mH}{h_0} \frac{1}{(p+2)} \left[(p+3) - \left(\frac{h}{h_0}\right)^{p+2} \right]$$

where $\bar{\Psi}(h)$ and $\overset{+}{\Psi}(h)$ are:

3.24 $$\bar{\Psi}(h) = -4\pi \frac{H}{h} \int_0^h S^2 \rho(S) dS = -\frac{mH}{h_0} \left(\frac{h}{h_0}\right)^{p+2}$$

$$\overset{+}{\Psi}(h) = -4\pi \frac{H}{h} \int_h^{h_0} hS\rho(S) dS = -\frac{mH}{h_0} \left[\frac{(p+3)}{(p+2)} \left[1 - \left(\frac{h}{h_0}\right)^{p+2} \right] \right], \quad p \neq -2$$

The classical binding energy of the atom, an idealized concept, is defined as the negative of the energy necessary to pull an atom completely apart to point like masses each of which is infinitely separated from every other point like mass, in the limit as the mass of each point like mass $\longrightarrow 0$. In order to pull an atom apart, energy must be added to the atom.

The experimentally determined mass difference Δm, cannot be used in conjunction with the derived binding energy formula $BE=-(\Delta m)c_0^2$ as a guide to determine the BE of the atom as $E=mc_0^2$ was proven false in chapter 1.

The classical expression for the binding energy is,

3.25 $$BE_{CL}=V^-=4\pi\int_0^{h_0} S^2\rho(S)\Psi^-(S)dS\,.$$

V^- represents the total energy expended in "Pulling" each mass element $4\pi h^2\rho(h)dh$ from h to infinity, starting with the surface mass at $h=h_0$ and ending with the interior mass at h=0.

One can also pull an atom completely apart by pulling each mass element $4\pi h^2\rho(h)dh$ from h to infinity, starting with the interior mass at h=0 and ending with the surface mass at $h=h_0$. When measured this way,

$BE_{CL}=V^+=4\pi\int_0^{h_0} S^2\rho(S)\Psi^+(S)dS$. By direct computation using 3.23, (see chap. 10, sec. 2)

3.26 $$BE_{CL}=V^+=V^-=\tfrac{1}{2}V=-\frac{m^2H}{h_0}\frac{(p+3)}{(2p+5)}\,,\quad -2.5<p\le 0$$
$$=-\infty,\quad -2.5^+=p$$
$$=-\infty,\quad -3<p\le -2.5^-$$

The atom from which 3.26 is derived does not represent physical reality as no force exists to keep the atom from collapse and consequently 3.26 does not represent physical reality. The force that prevents the solid mass atom from collapse is generated by internal vibrational motion resulting in the pressure $P_c(h)$ of 3.19.

Within the context of the solid mass atom, adding $|mC_1|$ to the atom by direct neutral particle collision results in an atom with Total Internal Energy=TIE=0 and consequently TIE=BE=Binding Energy of the solid mass atom. Adding $|mC_1|$ to the solid mass atom, results in an atom that expands to infinity with 0 kinetic energy and 0 potential energy at infinity.

3.27 $BE=TIE=T+V=mC_1=(\frac{1}{2})4\pi\int_0^{h_0} h^2\rho(h)U_{rms}^2(h)dh+4\pi\int_0^{h_0} h^2\rho(h)\Psi(h)dh \quad <0$

In traditional classical mechanics courses where total internal vibrational kinetic energy is not taken into account, the total internal energy TIE_{CL} of a classical continuous mass sphere is:

$$TIE_{CL}=PE=4\pi\int_0^{r_0} r^2\rho(r)\Psi(r)dr \neq 4\pi\int_0^{r_0} r^2\rho(r)\Psi^-(r)dr=BE_{CL}.$$

That is classically, $TIE_{CL}\neq BE_{CL}$. However for the solid mass atom TIE=BE. Numerical values of BE are computed in chapter 3, section 8.

8. Evaluation of H and the Binding Energy of the Elements

Assuming that $\frac{1}{2}U_{rms}^2(h_0) << |\Psi(h_0)|$ and using 3.8 and 3.15:

3.28 $$-\frac{m^2H}{h_0}=m\Psi(h_0)\doteq mC_1=B.E.$$

In chapter 9, sec.1, H is evaluated at $H\approx 10^{30}\frac{erg\,cm}{gm^2}$ and is set here for specificity at $H=1.0\cdot 10^{30}\frac{erg\,cm}{gm^2}$. Using 3.28 evaluate C_1 and B.E. using $h_0=0.50\cdot 10^{-8}$cm. This yields:

3.29 $B.E.\doteq -3.5\cdot 10^2$ev and $C_1=-3.34\cdot 10^{14}\frac{erg}{gm}$

Using 3.28 and 3.29 the value of the binding energy of selected atoms is listed below.

TABLE 3.1

Atom	BE(ev)	T^oK
H	$-3.5\cdot 10^2$	$2.7\cdot 10^6$
Ne	$-1.4\cdot 10^5$	$1.1\cdot 10^9$
Al	$-1.0\cdot 10^5$	$7.8\cdot 10^8$
Fe	$-5.1\cdot 10^5$	$4.0\cdot 10^9$
Ag	$-1.6\cdot 10^6$	$1.2\cdot 10^{10}$
Pb	$-5.0\cdot 10^6$	$3.9\cdot 10^{10}$
U	$-7.4\cdot 10^6$	$5.8\cdot 10^{10}$

9. Evaluation of U_{rms}

Using 3.15, 3.28 and 3.8: $U^2_{rms}(h)=2[C_1-\Psi(h)]\doteq 2\frac{mH}{h_0}\frac{1}{(p+2)}\left[1-(\frac{h}{h_0})^{p+2}\right]\geq 0$:

3.30 $U^2_{rms}(h_0) << 2|\Psi(h_0)|$, Beginning Assumption

$$U^2_{rms}(h)=2\frac{mH}{h_0}\frac{1}{(p+2)}\left[1-(\frac{h}{h_0})^{p+2}\right]\geq 0:$$

$$U^2_{rms}(h)=-2\frac{mH}{h_0}\ln(\frac{h}{h_0}),\ p=-2$$

$$U^2_{rms}(0)=\infty,\ -3<p\leq -2,$$

$U_{rms}(0)$ has been computed for p=0, −1, −1.5 and is listed in table 3.2. $U_{rms}(0)=\infty$ for $3< p\leq -2$.

TABLE 3.2

Atom	$U_{rms}(0)$, p=0	$U_{rms}(0)$, p=−1	$U_{rms}(0)$, p=−1.5	$U_{rms}(0)$, p=−1.9
H	$1.8\cdot10^7$	$2.6\cdot10^7$	$3.7\cdot10^7$	$8.2\cdot10^7$
Ne	$8.2\cdot10^7$	$1.1\cdot10^8$	$1.6\cdot10^8$	$3.6\cdot10^8$
Al	$5.9\cdot10^7$	$8.4\cdot10^7$	$1.2\cdot10^8$	$2.2\cdot10^8$
Fe	$9.3\cdot10^7$	$1.3\cdot10^8$	$1.9\cdot10^8$	$4.2\cdot10^8$
Ag	$1.2\cdot10^8$	$1.7\cdot10^8$	$2.4\cdot10^8$	$5.3\cdot10^8$
Pb	$1.5\cdot10^8$	$2.1\cdot10^8$	$3.0\cdot10^8$	$6.7\cdot10^8$
U	$9.6\cdot10^8$	$1.3\cdot10^8$	$2.6\cdot10^8$	$2.6\cdot10^8$

Rms speed in $\frac{cm}{sec}$

10. Explosive Property of the Solid Mass Atom

A totally unexpected explosion property of the solid mass atom was discovered by the author in March of 1987. This property makes it possible to understand how to induce an atom to explode and led to an understanding of the physical changes undergone by a solid mass atom during radioactive decay, in atomic reactor power generation, and in atomic and thermonuclear explosions.

From 3.15 and 3.17, in a stable atom, $[\frac{1}{2}U^2_{rms}(h)+\Psi(h)]=[\frac{1}{2}U^2_{rms}(h_0)+\Psi(h_0)]=C_1<0$, and $T+V=mC_1<0$. If energy $|mC_1|$ is added to the atom then the atom will explode with total energy zero. If on the other hand energy $|mC_1|+\varepsilon$ with $\varepsilon>0$ is added to the atom, then the atom will explode with total energy ε available to do work on the external world.

The physical and mathematical details as to how to add energy ε to the atom and the physical and mathematical details of the explosion property as applied to the hydrogen bomb, are given in chapter 10.

Reference

3.1 H. Goldstein, Classical Mechanics, p69, (Addison-Wesley, 7th printing, 1965)