

Bohr's Atomic Model – Quantum Mechanics Tarmit Atangin

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Thuhma

Rin aiin hna ka ngah ta a. Ziah zel a har dawn viau mai. Tun tumah hian quatum mechanics lo lan chhuahna tak tak – old quantum mechanics an tih mai – Bohr's atomic model dik famkimlohna chu ka lo thlur dawn a. Mathematics hi a pawimawh a, chuvangin equation hriat chian ngai ka tih chu ka lo ziak thla zel dawn a ni.

Bohr's atomic model sawi hmasa phawt ang

Bohr's atomic model, 1913 daih tawha hmuh chhuah, quantum mechanics bul pawimawh lo tantu kha kan zir tawh turah ka ngai a. Khatah khan point 3 lian deuh deuh a awm a:

- 1) Electron hian nucleus a hel a.
- 2) Electron hian nucleus hi planet-in Ni a hel ang hian kal kualna, orbit a nei a. Chu a helkualna chu nucleus atanga inhlal dan indawtin a awm a.
- 3) A hel kualna, orbit pakhat atanga a helkuanlna hmun dangah a insawn khan energy a hlauh emaw a neih belh thei tih a ni.

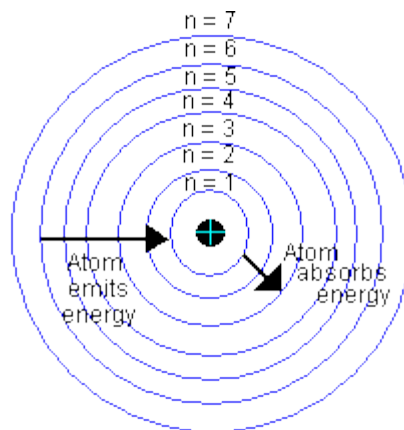


Figure 1: Bohr's atomic model

Figure 1-a inziak ang hian electron-te chuan nuclues helna an nei a. Chu'ng a helna-te chu 'n' hlutna khian a entir a. Entirnan: 'n' hlutn khi 1 a nih chuan a helna hmasa ber (first orbit) a ni anga, chutiang zelin 'n' hlutna 2 a nih chuan a helna hmasa ber dawttu (second orbit) a ni mai dawn a ni. Point number 2 leh 3-na khi thuhmun angah pawh a ngaih theih a. Electron hi an helna pakhatah (orbit) an awm chuan chakna (energy) an neih zat a pangngai reng tur a ni a. Mahse helna dangah an pakai chuan energy an hlauh emaw an neih belh dawn a ni. A lemziaka a lan dan ang khian nuclues lam hawi zawnga a insawn chuan chakna (energy) a pe chhuak ang a, amaherawhchu nuclues hlat lamah a insawn a nih chuan energy a neih belh thung dawn a ni.

Bohr's atomic orbital-ah electron chu han dah chhin dawn teh ang...

A chungka ka sawi ang khian Pu Bohr – a khan electron kha a helkualna (orbit) pakhatath awm chuan chakna thahruia a neih emaw a pekchhuah emaw loh chuan a awm chhunzawm char char thin a ti a ni a. Tunah hian electron chu a helna orbit inkarah khian a awm thei em tih kan enchhin dawn a ni. Bohr's model-ah khan electron orbit radius kha a hnuai ami ang hian kan nei tih kan hria a:

$$r_n = \frac{4\pi\epsilon_0\hbar^2}{me^2} n^2 \quad (1)$$

m leh e hi elctron rih zawng leh an charge kha a ni a. Hemi orbit chungah chiah khian a hnuai ami khu a awm veleh a:

$$r_{n+1} = \frac{4\pi\epsilon_0\hbar^2}{me^2} (n + 1)^2 \quad (2)$$

Equation (2) atangin (1) khi ka paih chuan an orbit hlat zawng ka hmu thei anga:

$$\Delta r = \frac{4\pi\epsilon_0\hbar^2}{me^2} 2n + 1 \sim \frac{4\pi\epsilon_0\hbar^2}{me^2} 2n \quad (3)$$

Khilailah khian $2n + 1$ hian $2n$ a tluk ka tih theih chhan chu elctron orbit hi nulues atangin a hla a, a radius a lian tihna a nih chu. A nih chuan 1 hi kan dah tha thei (approximate) tihna a ni.

Uncertainty principle-ah let leh lawk teh ang

Uncertainty principle hi quantum mechanics lo hring chhuaktu leh kan thupui khel mek lo pe chhuaktu a ni a, a hmaih theih loh a ni. Uncertainty principle kha momentum leh space ang zawngin heti hian kan ziak thei a:

$$\Delta p \Delta r \geq \hbar \quad (4)$$

Electron awmna kha nuclues atangin hla viau ta se, nuclues atanga potential enrgy khan engmah a va tithei tawh lova, chuvangin electron enrgy kha kinetic hlawm nei angah kan ngai thei anga, hetiangin:

$$E = \frac{p^2}{2m} \quad (5)$$

Emaw heti ang pawh hian kan ziak leh thei a:

$$\Delta E = \frac{2p\Delta p}{2m} = \frac{p}{m} \Delta p \quad (6)$$

$$\text{Or } \Delta p = \frac{m}{p} \Delta E \quad (7)$$

Mahse $\frac{p}{m}$ hian tlukpui a nei a, chu chu nulues a hel kualna chak zawng velocity, v kha a ni a. Bohr's angular momentum postulate hmang khan heti kan nei thei a:

$$mvr = n\hbar \quad (8)$$

$$\text{Or } v = \frac{n\hbar}{mr} \quad (9)$$

A nih chuan, equation (3), (4), (7) leh (9) hmang hian hei hi kan nei thei a:

$$\Delta E = \left(\frac{me^4}{32\pi^2\epsilon_0^2\hbar^2} \right) \frac{1}{n^2} \quad (10)$$

Bohr's radius chung a electron dah tum thupiah lut leh tawh ang

Equation (10) khi chik takin a lo chhuah dan kan en chuan electron-in orbit inkarah energy a neih theih zat, uncertainty in energy a lo ni a. Bracket chung hluhna khi han chhut ta ila heti ang hian a lo chhuak dawn a ni:

$$\Delta E = (13.6) \frac{1}{n^2} eV \quad (11)$$

A nih leh orbit-ah electron a awm khan eng zat nge energy a neih kha? Heti ang hian a ni tiraw?

$$E_n = (13.6) \frac{1}{n^2} eV \quad (12)$$

Equation (11) hian uncertainty in energy kha a hril a, equation (12) erawh hi chuan khawi orbit-ah pawh awm se a energy zat kha a pe bawh a ni. Chuti ang a nih chuan equation (11) hi (12) atangin paih ta ila, heti ang hi kan hmu ang:

$$E_n - \Delta E = 0 \quad (13)$$

Uncertainty in energy khi a tam khawp mai a, electron energy-in orbit-a energy a neih zat nen kan khaikhin chuan a inang reng a ni. Equation (13) a a lan dan ang hian an danglamna chu zero a ni a. Hemi awmzia chu electron-te kha orbit-ah an awm reng thei loh tih a ni. Tin, orbit inkarah pawh an awm thei chuang lo tihna a ni tel bawh.

Quantum mechanics chuan a zu zawng chhuak ta a!

Equation (13) ka hrilhfiah dan khi kan hrethiam em aw... Uncertainty energy leh energy pangngai intluk tih awmzia chu quantum mechanics tarmit atang chuan electron-te hian awmna bik an nei lo a, an che reng a. Partilce angin a ngaih theih tawh lo a, electron chu hmun tinah a awm zawk a lo ni. Man tum pawh ni ila awmna ber pawh a neih loh avangin kan man thei dawn lo a. Pawl hniam zawka eletrcity leh magnetism vela '*field*' kan zir ang khan electron chu field angin kan lo represent a lo ngai tawh a ni. Chu field chu '*space*' (hmunruak) ah hian a inzam chhuak a ni.

Chuan hydrogen atom lo ngaihtuah ta ila, a chung a electron chu field angin kan sawi angai ta a, chu orbital kan tih alo ngai tawh ang. Helai orbital ka tih tih Pu Bohr-a orbit nen ngaihpawlh miah loh tur a ni a. Electron chuan orbit a nei lo a, radius pawh a nei chuang lo a, chumi awmzia chu electron chu particle anga kan ngaihna kha dah that rih a ngai tihna a lo ni. A hmaa kan zir tawh thin ang khan orbital chuan pianhmang hrang hrang a nei a, s orbit chu a mum a, chutiang zelin p orbit pianhmang chu a laiah rekin a sawl kha a ni a.

A nih chuan mathematics takin electron chu *wave function* hmangin kan ziak ta thin tawh zawk a. Wave function chuan electron field chu a represent a. Space (hmun) leh time (hun) ah a innghat tlat a. Space a danglamin a danglam thei a chutiang zelin field chu (electron sawi aiah hmang tawh ang) hun a danglamin a lo danglam ta thin a ni.

Wave function chuan nihdan a nei ve a

Mathematics lamah khan function tam tak kan nei a. Nihdan inang lo tak tak an ni hlawm a. A then chu continous (inzawm) an ni a, a then chu a laklawhah a chat a. Chuti ang zelin

danglamna an nei teuh a. He electron field sawi nan-a kan hman electron nihphung zawng zawng kengtu wave function, $\Psi(x, t)$ hian nihphung a nei a.

A hmasa berah chuan wave function hi lian tak, infinite a ni thei lo a. Chumi awmzia chu mihring kan chhiar theih zat tam zawng a hen a ngai tihna a ni a. A chhan chu electron kan hmuh theihna, probability density khan infity a tluk ve mai dawn a, chu chu thil ni thei miah lo a ni. A pahnihnaah chuan wave function chu a continuous, inzawm a ngai a. A lai laklawhah emaw a bung thei lo a ni. Chumi awmzi chu step function kan tih ang te kha a ni thei lo tihna a nih chu. A dawt leha chuan $\Psi(x, t)$ hian value, hluatna pakhat chauh a nei tur a ni. A nih chuan graph kual nguai, x – axis atanga chhiar a y – value pakhat aia tam nei thei zawng zawng kha a rem lo tihna a ni. A dang pahnih pawh a la awm a, artifice lo chhuak leh turah kan thai lang tawh mai dawn nia.

Ti-tawp tawh ang

Atomic model lo chhuah chhoh dan kha kan la hre theuh ang a. 1902 khan cubic model an lo sawichhuak, propose a. Plum-pudding model chu 1904-ah an propose veleh a. Hemi kum vek hian Saturnian model tih chu an sawi chhuak leh ta a. Kum 7 vel zet a vei hnuah Rutherford model, rintlak tak mahse classical mechanics lam tarmnit atanga lo piang chhuak chu a lo lang veleh a. A rintlak hle a mahse quantum mechanics tarmnit atngin Pu Bohr-a khan a thllir veleh a, *Bohr's model* chu 1913-ah a lo piang chhuak ta a ni. A rintlak hle a amaherawhchu Pu de-Broglie leh Pu Heisenberg-a te an lo lan hnu khan a dik hlel a ni tih hriat chhuah a ni ta a. A chung ami khi a dikloh zia proof dan leh sawifiahna chu a ni. Lo chhuak leh turah chuan khi wave function khi kan chawh chhuak dawn a ni. Wave function kan tih khan electron kan sawina a ni tih kha hrereng ila. Electron chu kan hrechiang deuh deuh dawn tihna a nih chu.