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RESEARCH PAPER : NATURE OF FORCES RESPONSIBLE FOR FORMATION OF POLYATOMIC MOLECULES.

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INTRODUCTION:

Atoms of inert gases, helium, neon, argon, krypton, etc. under atmospheric pressure and temperature on earth exist freely as monatomic molecules indicating high degree of saturation of binding forces within such atoms. Apart from inert gas elements, atoms of all other elements under appropriate conditions of pressure and temperature tend to form polyatomic molecules in order that such atoms may gain identical electronic configuration existing in the inert gas elements.

In the formation of either an atom or a molecule, some amount of energy must be released, forces of attraction and forces of repulsion operating among constituent nuclei and electrons must balance giving rise to minimum potential energy as well as the rest mass of the atom or molecule thus formed being less than the sum of the rest masses of the constituent nuclei and electrons.

Need for alternative approach to analysis of structures of atoms and molecules. The planetary model of atomic structure first proposed by Rutherford in order to explain the results of his experiments on the scattering of alpha particles striking thin gold foils conducted in 1911, later modified by Bohr, Somerfield and others in order to interpret discrete (optical) line spectra with fine structures produced by atoms of various elements and also to explain splitting up of (optical) atomic spectra under the action of external magnetic and electric fields as found in the experiments conducted by Zeeman, Stark, Stern and Gerlach, assigns four quantum numbers to each electron inside an atom. In this model, the orbital angular momentum of an electron is given by

$$L_l = \{l(l+1)\}^{1/2}.\{h/(2\pi)\}$$

And the corresponding magnetic dipole moment is given by

$$\mu_l = e/(2m_e).L_l ,$$

where l is azimuthally (orbital) angular quantum number, h is Planck's constant, e and m_e are electrical charge and rest mass of electron respectively.

As l can assume a value equal to zero besides integral values, an electron in the s ("sharp" in terminology of spectroscopy) – orbital for which l = 0, must have its angular momentum and associated magnetic dipole moment equal to zero, which is self-contradictory, since each electron in this model is supposed to move along orbital trajectory in order to neutralize coulomb force of attraction to the nucleus.

FORCES OPERATING WITHIN ATOMS AND MOLECULES:

In an alternative approach to the analysis of nature of coupling between nucleus and electrons in atom, outlined by Tarafder and Das[1], the idea of motion of electrons along closed orbits around the nucleus was discarded and instead, it was suggested that coulomb forces of attraction between the nucleus and the electrons are counter balanced by exchange forces resulting from exchange of some particles of non-zero rest mass among the nucleus and electrons.

In order to explain structure and bonding of polyatomic molecules consisting of atoms of same or different elements, theories of valence bond, molecular orbitals, co-ordination of bonds, suggesting transfer or sharing of electrons among constituent nuclei have been

introduced. In the light of theory of exchange forces proposed by Tarafder and Das[1], it can be stated that same type of mechanism is responsible for formation of individual atoms and molecules. Thus, while in an individual single atom, coulomb and exchange forces operate among the nucleus and the electrons, in molecules consisting of two or more atoms of same or different elements, exchange forces and coulomb forces operate among the nuclei and electrons tending to counterbalance one another resulting in minimum potential energy.

CONCLUDING REMARKS:

Data obtained from experiments conducted on two isotopes of hydrogen, protium ($_1H^1$) and deuterium ($_1H^2$ or, $_1D^2$), each containing one electron in its atom, show that the values of bond dissociation energy are 435.88 kJ.mol^{-1} and 443.35 kJ.mol^{-1} respectively. The nucleus of protium is a single proton and that of deuterium, also known as deuteron, consists of a proton and a neutron. This difference indicates the possibility that in addition to the three features of spin dependence resulting in tensor or non-central character, saturation and short range action, as mentioned by Tarafder and Das[1], exchange forces operating among nucleus and electrons in an atom, may also depend to some extent on the presence of neutrons in the nucleus.

It can be suggested from the above discourse that spectrometers of higher resolving power may be employed for detection of fine or minute difference in the spectra produced by different isotopes of the same elements, from which dependence of exchange forces on mass number of elements can be investigated more effectively.

REFERENCE:

1) Dr. G. Tarafder, J. K. Das, *IJRPET, 2, 11 (Nov. 2016).*