Welcome all! Myself Doctor Jyoti V Sawant, Associate Professor,

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session, I will be discussing about Module 13 of "Periodicity of

elements" entitled Allred and Rochow scale of

electronegativity. Outline of the today's module:

Electronegativity.
Allred and Rochow electronegativity.
At the end of this session students will be able, to define the

Electronegativity. Described the Allred and Rochow electronegativity.

Compare Allred and Rochow electronegativity values

with Pauling's electronegativity values. To predict the

nature of bond between the combining atoms. Allred and Rochow

electronegativity. What is electronegativity?

Electronegativity, symbolized by the letter "χ"chi. Electronegativity is

a property of an atom in the molecule. Different scientists

tried to explain electronegativity in different ways.

Pauling explain the Electronegativity as the power of an atom in a molecule to

attract electrons to itself.

Consider a molecule of hydrogen, in which a pair of electrons are shared between the two hydrogen

atoms. As in the atom, proton in the nucleus, attract the

electron around the nucleus, shared electron in the valence shell in the molecule

are attracted by the nucleus of atoms. Hence electronegativity can be also

explained, as a measure of an atom's ability to attract the

bonding or shared electrons, of a covalent bond to itself.

So we can write.Electronegativity is directly

proportional to the attractive force, F. Electronegativity

can not be directly measured. So different methods have been put

forward by different scientists to explain the

electronegativity. In 1931, Pauling, determine the

electronegativity between the two combining atoms by

considering the binding energy of the two combining atoms.

Further, in 1934 Mulliken explained the electronegativity based on the

ionisation energy and electron affinity. Allred and Rochow, in

1958 defined electronegativity as attractive force between the

nucleus and valence shell electrons at a distance equal to

the covalent radii. Let us consider the molecule formed by a covalent bond

between the atom 1 and atom 2. Protons in the atom1, attract a shared

pair of electrons in a molecule towards itself. An attractive force

depends upon the number of protons present in the nucleus,

so we can write attractive force F is directly proportional to the

number of protons and that is equal to the number of electrons.

So we can say.

Electronegativity depends on atomic number ‘Z’ and the distance between the shared electrons and positively charged nucleus; and is given as r, that is the covalent radius of an atom. However, the shared electron in the valence shell of molecule are attracted by protons in the nucleus and at the same time repelled by the other electrons in the atoms. Repulsive forces ‘S’ shown over here is between the shared electrons and electrons in an atom. This cumulative effect of attractive and repulsive forces on the shared electrons is called as effective nuclear charge and is given as Z effective.

Therefore, the extent of attractive nuclear force on the shared electron is proportional to the effective nuclear charge or net nuclear charge. An effective nuclear charge is given as Z effective

equal to Z actual minus S.

Where as effective nuclear charge can be defined as a reduced nuclear charge felt by the shared electron due to repulsive forces. Here we can write now, force F is directly proportional to Z effective.

Let us consider equation 1.

Allred and Rochow identified the electronegativity of an atom with the electrostatic field.This attractive force ‘F’ is electrostatic in nature and is given by Coulomb's Law formula. Force is directly proportional to e^2/r^2.

Let this be considered as an equation 2.

Combining equations 1 and 2, Allred and Rochow identified the electronegativity of an atom with electrostatic

field. Thus attractive force F is electrostatic in nature and

is given by Coulomb's Law. This force F can be written as directly

proportional to e^2/r^2, where e is a charge

on the electrons and r is a covalent radii Combining equation

1 and 2, force 'F' is directly proportional to e^2 and Z effective and inversely proportional to r^2. Accordingly, one measure the

electronegativity by measuring this electrostatic force of attraction between the nucleus and a shared electrons from the bonded atoms.
So we can write electronegativity ;χ' is directly proportional to the attractive force F.
Thus, electronegativity 'χ' can be written as e^2 Z effective / r^2 ,

Where 'e' is a charge on the electron. And $e(Z_{eff})$ is the

charge which is effective at the electron due to the nucleus and

its surrounding electrons. Thus Allred and Rochow converted this

attractive force F values into electronegativity

values by choosing the numericals to give the values comparable to

the Pauling's electronegativities by using formula that is

empirical relationship. Chi Allred and Rochow (χ_{AR}) is equal to $0.359(Z_{eff})/r^2_{cov}$, plus 0.744.
The value of Z effective in this formula can be determined by Slater's rules.
Allred and Rachow obtained this numericals by adding certain parameters so that it would more closely

corresponding to the Pauling's electronegativity scale.
Let us consider one example to solve Allred and Rochow

Electronegativity (χ_{AR}) considering covalent radius of carbon as 0.77

Angstrom. Allred and Rochow electronegativity is given as

$$\chi_{AR} = \left(\frac{0.359\, Z_{effective}}{r_{cov}^2}\right) + 0.744$$

In this example covalent radii is given as 0.77 Angstrom,
we have to calculate $Z_{effective}$ as:
Z effective is given as Zactual minus S (Zeff = Zact-S)
since the atomic number of carbon is 6. So we have that Zactual is equal to 6

and based on this, we can calculate the screening

constant and is equal to (0.35 * 4 + 0.85*2).
So we have Zeffective calculated based on this formula as 2.90.
Substituting this value in the Allred and Rochow electronegativity χ_{AR}

we get Allred -Rochow electronegativity 2.50.

Similarly, Allred and Rochow electronegativity for hydrogen

and the 2nd row elements have been calculated and tabulated in the

table. The electonegative values so obtained are in good

agreement with those obtained by Pauling in 1931.
Let us see the significance of the Allred-Rochow electronegativity.
It is possible to make a reasonable guess at the electronegativity values for the element.
One can predict the nature of bonds formed.

Based on this, if the atoms having a similar electronegativity values will form a nonpolar bond, that is a

covalent bond, whereas the atom with large electronegativity

difference, i.e Allred -Rochow electronegativity, will

form a polar bond; that is an ionic bond.

These are some of the references for further reading. Thank you.