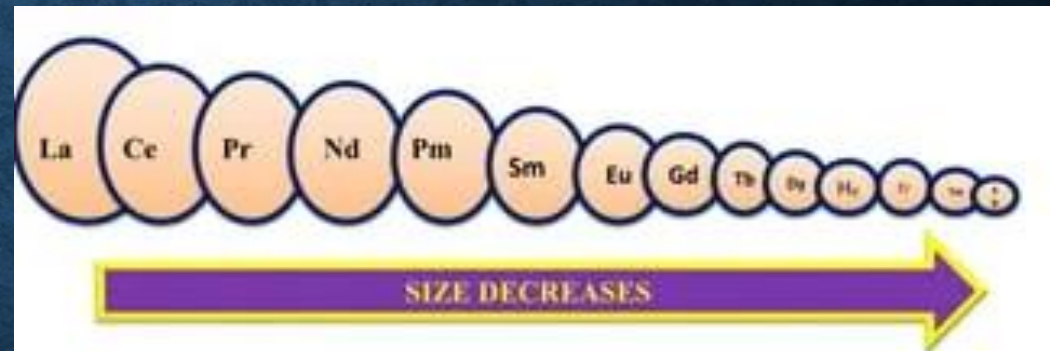
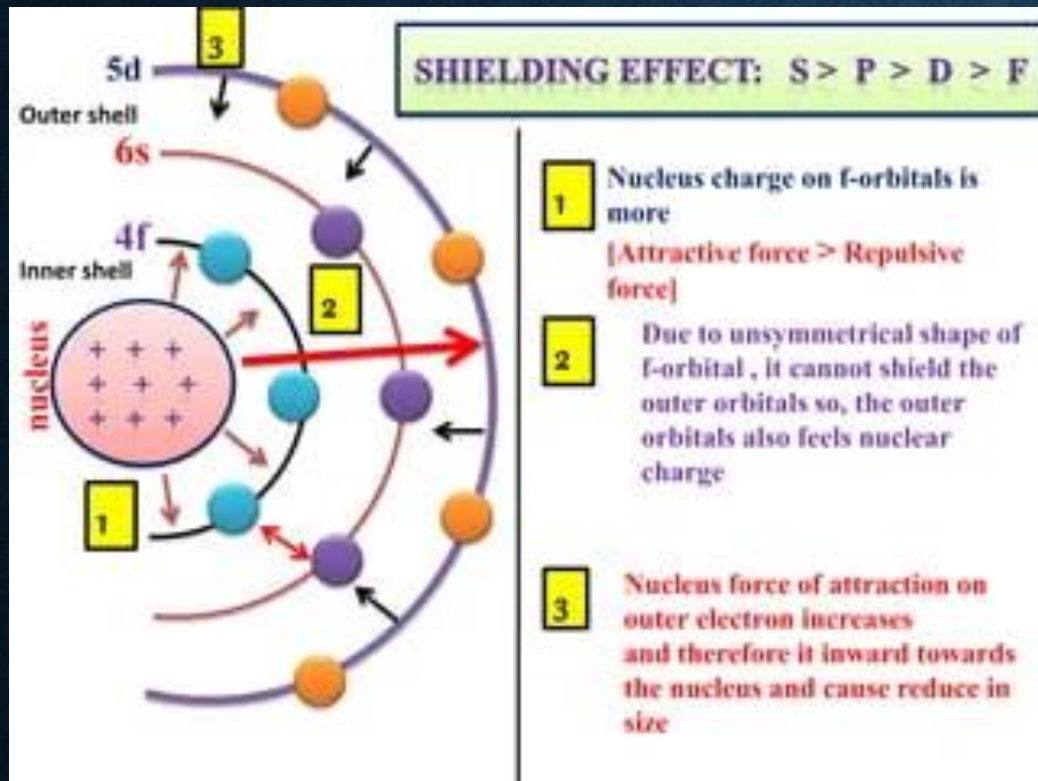


**LANTHANIDES** ARE THE RARE EARTH ELEMENTS OF THE MODERN PERIODIC TABLE, I.E., THE ELEMENTS WITH ATOMIC NUMBERS FROM 58 TO 71, FOLLOWING THE ELEMENT LANTHANUM. THEY ARE CALLED RARE EARTH METALS SINCE THE OCCURRENCE OF THESE ELEMENTS IS VERY SMALL ( $3 \times 10^{-4}$  % OF THE EARTH'S CRUST). THEY ARE AVAILABLE IN 'MONAZITE' SAND' AS LANTHANIDE ORTHOPHOSPHATES. THE TERM 'LANTHANIDE' WAS FIRST INTRODUCED BY THE NORWEGIAN MINERALOGIST VICTOR GOLDSCHMIDT IN THE YEAR 1925. THE LANTHANIDE FAMILY CONSISTS OF FIFTEEN METALLIC ELEMENTS (FROM LANTHANUM TO LUTETIUM). THE VALENCE ELECTRONS OF THESE ELEMENTS LIE IN THE 4F ORBITAL, I.E. WHY THEY ARE CALLED F-BLOCK ELEMENTS. LANTHANUM, HOWEVER, IS A D-BLOCK ELEMENT WITH AN ELECTRONIC CONFIGURATION OF  $[Xe]5d^16s^2$ .

## LANTHANIDE CONTRACTION, also called LANTHANOID CONTRACTION,

DEFINITION- THE STEADY DECREASE IN THE SIZE OF THE ATOMS AND IONS OF THE RARE-EARTH ELEMENTS WITH INCREASING ATOMIC NUMBER FROM LANTHANUM (ATOMIC NUMBER 57) THROUGH LUTETIUM (ATOMIC NUMBER 71).

REASON— FOR EACH CONSECUTIVE ATOM THE NUCLEAR CHARGE IS MORE POSITIVE BY ONE UNIT, ACCOMPANIED BY A CORRESPONDING INCREASE IN THE NUMBER OF ELECTRONS PRESENT IN THE 4F ORBITALS SURROUNDING THE NUCLEUS. THE 4F ELECTRONS VERY IMPERFECTLY SHIELD EACH OTHER FROM THE INCREASED POSITIVE CHARGE OF THE NUCLEUS, SO THAT THE EFFECTIVE NUCLEAR CHARGE ATTRACTING EACH ELECTRON STEADILY INCREASES THROUGH THE LANTHANIDE ELEMENTS, RESULTING IN SUCCESSIVE REDUCTIONS OF THE ATOMIC AND IONIC RADII. THE LANTHANUM ION,  $\text{La}^{3+}$ , HAS A RADIUS OF 1.061 ANGSTROMS, WHEREAS THE HEAVIER LUTETIUM ION,  $\text{Lu}^{3+}$ , HAS A RADIUS OF 0.850 ANGSTROM.



Shielding effect → The inner-shell electrons shield the outer-shell electrons so they are not effected by nuclear charge

**POOR SHIELDING** → Positively charge nucleus has greater attraction to electrons → decreasing the atomic radius as the  $Z$  ↑

◇ There will be **repulsive force** between inner and outer electrons which leads to restrict the penetration of the outer shell towards the nucleus and thus shield the nucleus charge for outer shell electrons

## CONSEQUENCES OF LANTHANIDE CONTRACTION

The following points will clearly depict the effect of LANTHANIDE CONTRACTION:

1. ATOMIC SIZE
2. DIFFICULTY IN THE SEPARATION OF LANTHANIDES
3. EFFECT ON THE BASIC STRENGTH OF HYDROXIDES
4. COMPLEX FORMATION
5. THE IONIZATION ENERGY OF D-BLOCK ELEMENTS

1. **ATOMIC SIZE:** THE SIZE OF THE ATOM OF THE THIRD TRANSITION SERIES IS NEARLY THE SAME AS THAT OF THE ATOM OF THE SECOND TRANSITION SERIES. FOR EXAMPLE, THE RADIUS OF ZR = RADIUS OF HF AND RADIUS OF NB = RADIUS OF TA, ETC.

2. **DIFFICULTY IN THE SEPARATION OF LANTHANIDES:** AS THERE IS ONLY A SMALL CHANGE IN THE IONIC RADII OF LANTHANIDES, THEIR CHEMICAL PROPERTIES ARE SIMILAR. THIS MAKES THE SEPARATION OF ELEMENTS IN THE PURE STATE DIFFICULT.

3. **EFFECT ON THE BASIC STRENGTH OF HYDROXIDES:** AS THE SIZE OF LANTHANIDES DECREASES FROM LA TO LU, THE COVALENT CHARACTER OF THE HYDROXIDES INCREASES, AND HENCE THEIR BASIC STRENGTH DECREASES. THUS, LA (OH)<sub>3</sub> IS MORE BASIC, AND LU(OH)<sub>3</sub> IS THE LEAST BASIC.

4. **COMPLEX FORMATION:** BECAUSE OF THE SMALLER SIZE BUT HIGHER NUCLEAR CHARGE, THE TENDENCY TO FORM COORDINATE COMPLEXES INCREASES FROM  $La^{3+}$  TO  $Lu^{3+}$ .

5. **ELECTRONEGATIVITY:** IT INCREASES FROM  $La$  TO  $Lu$ .

6. **IONIZATION ENERGY:** THE ATTRACTION OF ELECTRONS BY THE NUCLEAR CHARGE IS MUCH HIGHER, AND HENCE IONIZATION ENERGY OF 5d ELEMENTS IS MUCH LARGER THAN 4d AND 3d. IN THE 5D SERIES, ALL ELEMENTS EXCEPT  $Pt$  AND  $Au$  HAVE FILLED THE S-SHELL.

# THANKS

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