New phenomena in high pressure chemistry

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At high pressures, a number of unusual phenomena appear. Unusual compositions, for example, Na_3Cl and $NaCl_7$, become thermodynamically stable. Many of these compounds have unusual physical and chemical properties, for example, high-temperature superconductivity (from T_c to 253 K in $(La,Y)H_{10}$), and some may exist in planetary interiors (for example, new Mg and Si oxides and silicates magnesium. In many systems, electrides appear (for example, [1]), i.e. substances in which electrons localized in the voids of the structure play the role of anions. Molecular states disappear—under pressure, molecules either dissociate or polymerize. Unusual oxidation states become stable, especially high ones—for example, Cs^{5+} in CsF_5. Many of these phenomena can be explained by expanding the concepts of electronegativity and chemical hardness of atoms to high pressures [2]—for this, Mulliken's definition of electronegativity was changed and a new scale was created, tabulated for all elements from H ($Z = 1$) to Cm ($Z = 96$) at pressures up to 500 GPa. The physical meaning of our electronegativity is the chemical potential of an electron in an atom relative to an electron gas at the same pressure, taken with a minus sign. A recent hypothesis [3] about the origin of water on Earth will also be presented, based on the stability of $Mg_2SiO_5H_2$, a recently predicted [3] substance likely to have been present in the interior of the early Earth.

[1] Huang H M, Zhu Q, Blatov V A, Oganov A R, Wei H, Jiang P and Li Y L 2023 *Nano Lett.* **23** 5012–5018

[2] Dong X, Oganov A R, Cui H, Zhou X F and Wang H T 2022 *Proc. Natl. Acad. Sci. U. S. A.* **119** e2117416119

[3] Li H F, Oganov A R, Cui H, Zhou X F, Dong X and Wang H T 2022 *Phys. Rev. Lett.* **128** 035703