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Novel phases of simple substances at megabar pressures

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Under megabar pressures solids can be strongly compressed: volume of solid hydrogen decreases in ∼20 times, even diamond is 1.5 fold compressed at achievable pressures of >300 GPa. This dramatically changes interatomic distances in materials eventually leading to metallization in a number of presenting substances. Metals under compression supposedly remain in metallic state. But at high densities the core electrons come in to play and the electronic structure significantly departs from the simple metal as it was demonstrated for lithium. We present an ultimate case: sodium - simple metal - becomes transparent at pressures of ≈200 GPa transforming into ionic-electride-like state. We will present also our recent studies on nitrogen and nitrogen-rich materials: ammonia, azides and others, and progress on studies at pressures ∼400 GPa.