Anomalous thermodynamics of entropic phase transitions

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Poorly known thermodynamic objects—unified anomalous thermodynamics regions (ATR)—are under discussion as combination of *entropic phase transition* itself and conjugated region of regular (gapless) but anomalous thermodynamics [I.Iosilevskiy]. It is the forced delocalization of some kind of bound complexes that is the unique driver of main physical transformations in both parts of ATR (e.g., "pressure ionization", "pressure dissociation", etc). It is the multilayered structure of thermodynamic surfaces $T(P,V)$, $S(P,V)$, $U(P,V)$ (temperature, entropy, energy)—that is the unique "geometric" feature of main transformations in both parts of ATR. The main sequences of multilayered structure of $T(P,V)$, $S(P,V)$, $U(P,V)$ surfaces are anomalous (returnable) crossing of the ATR zone by trajectories of shock and isentropic compression and expansion. The main sequence of this returnable type of crossing for ATR zone is anomalous Z-shaped ("zigzag") form for P–V trajectories of shock and isentropic compression and expansion. This Z-shaped form of the P–V trajectories for compression and expansion leads in turn to violation for the global concavity property for isentropes, i.e. violation of global form for the Bethe–Weyl conditions. This violation in turn means hydrodynamic instability (i) for the simple (single-wave) form of the shock and isentropic compression, and (ii) simple single-wave form of isentropic expansion. Thermodynamic modeling via SAHA code and hydrodynamic modeling were applied to the anomalies in crossing of ATR in dense hydrogen and nitrogen plasmas, e.g., "shock cooling" [W.Nellis] during compression and "shock rarefaction wave" [Ya.Zeldovich] during adiabatic expansion.