

# Anomalous thermodynamics and entropic phase transitions in warm dense matter

Iosilevskiy I.L.<sup>1,®</sup>, Gryaznov V.K.<sup>2</sup> and Shutov A.V.<sup>2</sup>

<sup>1</sup> Joint Institute for High Temperatures of the Russian Academy of Sciences, Izhorskaya 13 Bldg 2, Moscow, 125412, Russia

<sup>2</sup> Federal Research Center of Problems of Chemical Physics and Medicinal Chemistry of the Russian Academy of Sciences, Academician Semenov Avenue 1, Chernogolovka, 142432,

® ilios@ihed.ras.ru

Poorly recognized thermodynamic objects – Anomalous Thermodynamics Regions (ATR) are under discussion as combination of *entropic phase transition* and conjugated region with regular (gapless) but *anomalous* thermodynamics [1]. It is the *forced delocalization* of some kinds of bound complexes (e.g. *pressure ionization*, *pressure dissociation* etc) that is the *main driver* of all physical transformations in both parts of ATR. And it is *multilayered structure* of thermodynamic surfaces  $T(P, V)$ ,  $S(P, V)$ ,  $U(P, V)$  (temperature, entropy, energy)—that is the unique “*geometric*” feature of these thermodynamic transformations in both parts of ATR. The main sequence of this multilayered structure of the surfaces  $T(P, V), S(P, V), U(P, V)$  is anomalous (“*returnable*”) type of crossing of the ATR-zone by dynamic trajectories of shock and isentropic compression and expansion. The main sequence in turn of such type of crossing is anomalous *Z-shaped* (“*zigzag*”) form for dynamic *PV*-trajectories mentioned above. That leads in turn to *violation* within ATR for *global concavity* property for isentropes and hence to possibility of *hydrodynamic instability* of the simple (*single-wave*) form of the shock and isentropic compression and expansion. Three examples of discussed ATR: - Two entropic Liquid-Liquid phase transitions in high *T-P* nitrogen and hydrogen, and ATR for Quark-Hadron phase transition in ultra-dense nuclear matter.

[1] Iosilevskiy I 2015 Entropic phase transitions and accompanying anomalous thermodynamics of matter *Journal of Physics: Conference Series* vol 653 (IOP Publishing) p 012077