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Reply

Reply to Jay Lawrence. Comments on Piero Quarati *et al.* Negentropy in Many-Body Quantum Systems. *Entropy* 2016, *18*, 63

Piero Quarati [1,2,*], Marcello Lissia [1] and Antonio M. Scarfone [3,4]

1. Istituto Nazionale di Fisica Nucleare (INFN)-Sezione di Cagliari, Monserrato 09042, Italy; marcello.lissia@ca.infn.it
2. Dipartimento di Scienza Applicata e Tecnologia (SCUDO)-Politecnico di Torino, Torino 10129, Italy
3. Istituto dei Sistemi Complessi (ISC-CNR) c/o Politecnico di Torino, Torino 10129, Italy; antoniomaria.scarfone@cnr.it
4. Istituto Nazionale di Fisica Nucleare (INFN)-Sezione di Torino, Torino 10125, Italy

* Correspondence: pierino.quarati@ca.infn.it; Tel.: +39-011-090-7339

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The Comments are explicitly related to contents of two published papers: actual [1] and [2]. A third paper [3], where the measured screening potential liquid-solid difference is explained using the correlation entropy S^-, should also be considered.

The mechanism described in the published paper [1] that increases the kinetic energy of light nuclei undergoing nuclear fusion, usually low energy deuterons accelerated against a host environment with implanted deuterons, does not substitute the electronic screening mechanism (as the standard Salpeter screening, the adiabatic or other proposed stationary or dynamic versions). It must be taken in addition to the electron screening potential energy after the stopping power corrections as, for instance, in the case of d-d fusion in deuterated metals or other similar fusion reactions.

The contributions of the positive and negative parts of entropy of the environment, given in [1], *concern the entropy per single ion* (S^+ and S^- are in k_B units per ion). The negative part (negentropy), is related to many-body correlations. To explain experimental results we require that the number of ions involved in the mechanism contributing to the enhancement of the fusion rates is of the order of few thousands depending on the fusion reaction and on the host environment. This amount of ions, *compared to the Avogadro number, is almost negligible*. The ions contributing are those belonging to the cage (Ref. [57] of [1], p. 655; see also Verlet and Weis [4]) of the fusing ions during their mean free path between two elastic collisions. Consequently, total S^+ and S^- of the complete host environment are not modified, the mechanical and thermodynamic bulk properties of the host environment are not changed at all. The environment does not relax or make transitions to a different thermodynamic state, remains stable with its entropy sum of positive and negative contributions. The parameters characteristic of the environment can fluctuate around their mean values.

The choice to write the entropy as the sum of two contributions (available for work, unavailable) already indicated by Clausius (valoric interpretation of entropy [5]) and used, for instance, by Klimontovich [6,7] and by Chang (Refs. [16,17] of [1]), in many works when the system is away from the $q = 1$ global equilibrium state, permits to take track of the rôle of the two parts. Entropy can be thought in terms of distance from equilibrium and of relative phase space occupation instead of measure of disorder.

In the lack of direct measurements of distribution functions, Wallace (Refs. [54–56] of [1]) made a correlation expansion under the approximation of many-body correlations in terms of two-body correlation (see also par. 21, 22 and 23 of Wallace book (Ref. [56] of [1]) and [8] for a discussion on approximation and limits of the melting entropy model with results on normal-metal melting-entropy

(Mg, Cu, Ag, Au, Zn, Cd, Hg, Al, In, Pb) not in good agreement with measurements (see Table 22.1 P. 232 of (Ref. [56] of [1]) and compare with Table 8 P. 659 of (Ref. [57] of [1])). Therefore, it seems to us valuable to explain the considered metal melting processes by means of a different melting entropy treatment and a different point of view. We are interested in reproducing the experimental melting entropies (collected and reported in (Ref. [57] of [1]) and in separating by means of the entropic parameter q normal and anomalous metals. The values $q = 1.8$ (anomalous metals) and $q = 1.9$ (normal) are required to fit the experimental measurements. This is a fit, of course, but the analytical meaning of q can easily be derived making equal Equations (22) and (24) in [2]. The parameter q can be given in terms of correlation entropy.

Therefore, *the proposed mechanism based on the rôle of the negative entropy per ion of the neighbors (cage) of the fusing ions does not produce a change or relaxation of the state of the host environment and can give an explanation of not yet explained experimental observations.*

Conflicts of Interest: The authors declare no conflict of interest.

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