Klimontovich's S-theorem for Nonadditive Open Systems and Constraints

G. Barış Bağcı[*]

Department of Physics,University of North Texas, P.O. Box 311427, Denton, TX 76203-1427,USA

and

Department of Physics, Faculty of Science, Ege University, 35100 Izmir, Turkey

[*] Electronic Address: `gbb0002@unt.edu`

Klimontovich's S theorem [1, 2] serves as a measure of order relative to a reference state for open systems, thereby providing the correct ordering of entropy values with respect to their distance from equilibrium state. Therefore, this theorem has been used as a measure of complexity for the logistic map [3], heart rate variability [4, 5] and the analysis of electroencephalograms of epilepsy patients [6]. The S-theorem can also be considered as a generalization of Gibbs' theorem if one of the distributions is associated with the equilibrium state.

Here, a nonadditive generalization of the S theorem is presented by the employment of Tsallis entropy [7]. This generalized form is then illustrated by applying it to the modified Van der Pol oscillator [8]. Interestingly, this generalization procedure favors the use of ordinary probability distribution instead of escort distribution [9].

[1] Yu. L. Klimontovich, Physica A 142, 390 (1987).

[2] Yu. L. Klimontovich, Chaos, Solitons and Fractals 5, 1985 (1994).

[3] P. Saparin, A. Witt, J. Kurths, and V. Anischenko, Chaos, Solitons and Fractals 4, 1907 (1994).

[4] J. Kurths et al., Chaos 5, 88 (1995).

[5] A. Voss et al., Cardiovasc. Res. 31, 419 (1996).

[6] K. Kopitzki, P. C. Warnke, and J. Timmer, Phys. Rev. E 58, 4859 (1998).

[7] C. Tsallis, J Stat Phys 52, 479 (1988).

[8] H. Engel-Herbert and W. Ebeling, Physica A 104, 378 (1980).

[9] C. Tsallis, R. S. Mendes, and A. R. Plastino, Physica A 261, 534 (1998).