Accepted Manuscript

Temperature is not an observable in superstatistics

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PII: S0378-4371(18)30425-4
DOI: https://doi.org/10.1016/j.physa.2018.04.007
Reference: PHYSA 19439

To appear in: *Physica A*

Received date : 10 October 2017
Revised date : 5 February 2018

Please cite this article as: S. Davis, G. Gutiérrez, Temperature is not an observable in superstatistics, *Physica A* (2018), https://doi.org/10.1016/j.physa.2018.04.007

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***Highlights (for review)**

* Superstatistical temperature distributions cannot be recovered in general by any microscopically observable estimator.
* Energy and temperature are not in the same footing as thermodynamical quantities when superstatistics is considered.
* Superstatistics is best understood as Bayesian thermodynamics with a unique but uncertain temperature.

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