

Thermodynamics of Lorentzian Taub-NUT Spacetimes

Alvaro B. Bordo,^{1,2} Finnian Gray,^{1,2} David Kubizňák,^{1,2,*} and Robert B. Mann^{1,2}

¹*Perimeter Institute, 31 Caroline Street North, Waterloo, ON, N2L 2Y5, Canada*

²*Department of Physics and Astronomy,*

University of Waterloo, Waterloo, Ontario, Canada, N2L 3G1

Abstract

The thermodynamics of the Taub-NUT solution has been predominantly studied in the Euclidean sector, upon imposing the condition for the absence of Misner strings. Such thermodynamics is quite exceptional: the periodicity of the Euclidean time is restricted and thence the NUT charge cannot be independently varied, the entropy is not equal to 1/4 of the area, and the thermodynamic volume can be negative. We shall revisit this paradigm and study the thermodynamics of the Lorentzian Taub-NUT solution, maintaining (as recently shown relatively harmless) Misner strings. We argue that in order to formulate a full cohomogeneity first law where the NUT parameter can be independently varied, it is natural to introduce a new charge together with its conjugate quantity. We consider two scenarios: one in which the entropy is given by the Lorentzian version of the Noether charge, the other in which the entropy is given by the standard Bekenstein–Hawking area law. In both cases consistent thermodynamics with positive thermodynamic volume can be formulated. Inclusion of charge will also be briefly discussed. Based on [1] and [2].

[1] D. Kubizňák, and R. B. Mann, *Thermodynamics of Lorentzian Taub-NUT spacetimes*, in preparation (2019).

[2] Alvaro B. Bordo, F. Gray, D. Kubizňák, *Thermodynamics and Phase Transitions of NUTty Dyons*, in preparation (2019).

* dkubiznak@perimeterinstitute.ca