Referee Report on "Kepler Harmonies and Conformal Symmetries"

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I. MANUSCRIPT UNDER REVIEW

- Title: Kepler Harmonies and Conformal Symmetries
- Authors: G. W. Gibbons et al.
- Journal: Physics Letters B

II. SUMMARY

The manuscript investigates Keplerian scaling relations by embedding the classical Kepler problem into a higher-dimensional Bargmann-type geometric framework. By restricting the dynamics to null geodesics in an extended spacetime, the authors construct conformal Killing vectors and derive formally conserved quantities. Classical results such as the virial theorem and Kepler's third law are then reinterpreted within this geometrical setting.

III. GENERAL ASSESSMENT

The manuscript is mathematically competent and clearly written. However, it does not satisfy the criteria of a fundamental theoretical physics contribution.

All nontrivial results rely on an *ad hoc* extension of the physical system rather than emerging from the intrinsic variational structure of the Kepler problem. Consequently, the claimed symmetries and conserved quantities do not belong to the original physical theory and cannot be regarded as genuine physical observables.

The work constitutes a formal geometric reformulation rather than a physical derivation or explanation.

IV. MAJOR CONCEPTUAL ISSUES

A. Artificial dimensional extension

The Kepler scaling

$$t \to \lambda^3 t, \qquad x \to \lambda^2 x \tag{1}$$

is explicitly acknowledged by the authors not to be a symmetry of the classical Kepler Lagrangian.

To recover this scaling as a symmetry, the manuscript embeds the system into a five-dimensional Bargmann spacetime and imposes the null-geodesic constraint

$$L = 0. \tag{2}$$

This procedure changes the dynamical system itself. The resulting symmetry is a property of the constructed auxiliary space, not of the Kepler problem.

A symmetry obtained only after altering dimensionality and dynamical domain cannot be interpreted as an emergent or hidden symmetry of the original physical system.

B. Nonphysical conserved quantities

The manuscript introduces a new conserved quantity associated with the conformal symmetry of the extended space.

However:

- the quantity depends on non-projectable variables,
- it does not reside in the physical three-dimensional phase space,
- it explicitly fails to project onto observable Keplerian dynamics.

The authors acknowledge that the quantity "does not project down" to the physical space. A conserved quantity that is not definable in the observable phase space is not a physical observable.

C. Misapplication of Noether's theorem

The application of Noether's theorem is valid only within the artificially constrained null-geodesic sector of the extended space.

The appearance of conservation laws is therefore a consequence of imposed constraints rather than of genuine variational symmetries. Noether's theorem is not revealing new physics but merely reflecting the imposed geometric structure.

D. Absence of variational closure

The manuscript does not derive its framework from a closed variational principle. The dimensional extension, metric structure, and constraints are introduced *a priori* and are not dynamically determined.

No physical scale, observable, or invariant is generated intrinsically. All results are encoded in the initial geometric ansatz.

E. Circular reinterpretation of known results

Applications to the virial theorem and Kepler's third law rely on classical Newtonian assumptions already equivalent to the original Kepler dynamics.

No new predictions, constraints, or discriminating observables are obtained. The derivations are therefore circular and do not extend physical understanding.

V. LACK OF FALSIFIABILITY AND PREDICTIVE POWER

The manuscript provides:

- no new quantitative predictions,
- no experimentally distinguishable consequences,
- no constraints capable of falsifying competing frameworks.

As such, the construction remains mathematically elegant but physically sterile.

VI. CONCLUSION AND RECOMMENDATION

The manuscript does not present a genuine physical symmetry, does not introduce new observables, and does not derive its structure from a closed variational principle. Its results are entirely dependent on an auxiliary geometric embedding.

For these reasons, the work does not meet the standards required for publication as a contribution to fundamental theoretical physics.

Recommendation:
Reject

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