

## Peer-Review

Li, Jerry. 2026. "On the Conditions under Which Instantaneous Mass-Transfer Mappings Reproduce Conservative Limits." *Journal of High School Science* 10 (1): 315–34. <https://doi.org/10.64336/001c.159153>.

1. I am having trouble understanding your contribution. Analytic binary evolution codes like BSE, COSMIC, and the binary module in MESA evolve orbital parameters using formulas derived from conservation laws. For conservative mass transfer they enforce total mass conservation and angular momentum conservation. There is no approximation here regarding orbital dynamics — the equation comes directly from the theoretical model. Therefore, the issue discussed in your manuscript does not arise.

2. Hydrodynamic simulations such as SPH codes and grid-based stellar interaction codes simulate the actual gas flow between stars. The transfer stream carries angular momentum naturally, so conservation arises automatically from the equations of motion. Again, the issue mentioned in your manuscript does not arise.

3. The only models where mass is manually moved instantaneously between bodies are hybrid N-body or toy dynamical models. Even in these models; many cluster codes do not teleport mass between stars the way the paper describes. Instead they usually adjust orbital elements directly, or apply analytic binary evolution prescriptions. So the exact operator analyzed in the manuscript may not be used in any major codes.

4. Therefore, your manuscript mainly seems to serve as a numerical cautionary example. You do not show that any existing astrophysical code actually uses that scheme. If you were to inspect the implementation of NBODY6, COSMIC, BSE, etc. and reproduce the drift inside one of those codes; and show that their mass-transfer updates correspond to the analyzed mapping; then the result could become "Widely used astrophysical simulation codes introduce systematic angular momentum errors during instantaneous mass transfer." or something to that effect. That would be a significant methodological finding. Can you show this?

5. You state that as  $\Delta t$  approaches zero, unclosed instantaneous mapping is not equal to continuous transfer - an operator splitting issue. The argument depends on holding the mapping fixed while shrinking  $\Delta t$ . However, that mapping includes a strong assumption (among others) that the transferred mass instantly acquires the accretor's velocity. If the transferred mass were assigned the donor's velocity, or an intermediate stream velocity, or the correct specific angular momentum of the transfer stream then the angular momentum change per step would be different and may approach  $\Delta t \rightarrow 0$ . Hence, the non-convergence the paper highlights is not a universal property of instantaneous transfer, but a property of one specific mapping. Please make this clear in the manuscript. This is because your paper reads as if the failure of convergence is a general principle of instantaneous mass-transfer schemes.

6. Your 4–22% orbital drift looks large because of the way you have set up the experiment. You transfer a large total mass fraction (15%), error accumulates over 500 events and you have chosen mass ratios that maximize angular momentum difference. Is this actually what happens in binary star systems? How does the drift scale with total transferred mass? What happens if only 1–2% mass transfer occurs? Does the drift persist for more realistic transfer rates? If the drift shrinks dramatically under more realistic conditions, the practical significance may be smaller than the exaggerated numbers.

7. The strongest practical use I see for this is when binaries are embedded in multi-body dynamical simulations, where analytic orbital evolution formulas cannot be applied. If you framed the work as "a method for maintaining angular-momentum consistency during mass transfer in dynamical N-body simulations", then the contribution would be clearer and more compelling. Obviously, if the method is intended for use in multi-body dynamical simulations, then demonstrating its behavior in 3–5 body systems would be an important and likely necessary validation step.

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Please verify that all links to the references point to the correct source.

The authors must disclose and acknowledge any assistance received in the preparation of this manuscript, including but not limited to editorial, technical, analytical, or writing support. All such contributions must be clearly stated in the Acknowledgments section. Include enough recent references along with foundational ones. Ensure references directly support your claims. Avoid “padding.” Use credible sources (peer-reviewed journals, reputable books, official reports).

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## Response to Reviewers

### *On the Conditions Under Which Instantaneous Mass-Transfer Mappings Reproduce Conservative Limits*

Jerry (Yuze) Li

We thank the editor and both reviewers for their careful reading and constructive feedback. The revised manuscript incorporates substantial new content in addition to the reframing and clarifications requested by the reviewers. Below we address each comment verbatim and describe the corresponding changes in detail.

#### **Summary of Major Additions**

We have made the following major additions to the revised manuscript:

- 1. New Analytical Derivation (Section 3.4):** We derive a closed-form result for the cumulative angular momentum drift of the unclosed mapping:  $L_f/L_0 = (1-f)(1+fq_0)$ , where  $f$  is the fractional mass transferred and  $q_0$  is the initial mass ratio. This formula reveals that the unclosed mapping leaves the orbital separation exactly unchanged ( $a_f/a_0 = 1$ ). We prove this cancellation is exact, not approximate, and provide a physical explanation: the mapping performs no mechanical work on the orbit.
- 2. Three-Body Proof-of-Concept Validation (Section 4.5, Figure 5, Table 4):** We test the closure condition in hierarchical three-body systems with both a weak perturber ( $m_3 = 0.3 M_\odot$  at 8.0 AU) and a stronger perturber ( $m_3 = 0.8 M_\odot$  at 5.0 AU). The closure suppresses spurious transfer-induced angular-momentum jumps in the inner binary from  $\sim 2 \times 10^{-4}$  per event to  $\sim 10^{-16}$ , demonstrating effectiveness even under external perturbations.
- 3. Scaling Analysis (Section 5.5, Table 5):** We conduct additional simulations at mass-transfer fractions of 1%, 2%, 5%, 10%, and 15% for all three mass ratios. All numerical deviations match the analytical prediction  $|1 - (a_f/a_0)_{\text{cons}}|/(a_f/a_0)_{\text{cons}}$  to within simulation precision.
- 4. New Discussion Subsection (Section 5.3):** We explain physically why the unclosed orbit is frozen at  $a_f/a_0 = 1$ : the mapping performs no mechanical work, and the angular momentum drift exactly cancels the reduced-mass change.
- 5. Applicability Section (Section 5.6):** We explicitly clarify that analytic binary evolution codes (BSE, COSMIC, MESA) do not employ the position-velocity mapping we analyze, and that the closure is most relevant to dynamical N-body simulations.
- 6. Reference Corrections:** References 3, 5, and 12 have been corrected as detailed below. These additions elevate the paper from a numerical observation to an analytical characterization with closed-form predictions. All numerical deviations (4.45–22.10%) now follow quantitatively from a single analytical result, verified to four significant figures against simulations.

#### **Reviewer 1**

##### **Comment 1**

**Reviewer Comment:** I am having trouble understanding your contribution. Analytic binary evolution codes like BSE, COSMIC, and the binary module in MESA evolve orbital parameters using formulas derived from conservation laws. For conservative mass transfer they enforce total mass conservation and angular momentum conservation. There is no approximation here regarding orbital dynamics — the equation comes directly from the theoretical model. Therefore, the issue discussed in your manuscript does not arise.

**Response:** The reviewer is correct. Analytic binary evolution codes such as BSE, COSMIC, and MESA evolve orbital elements directly using conservation-law formulas and do not employ the

position-velocity mapping analyzed in our paper. We have revised the Introduction to state this explicitly, and we no longer imply that these codes are affected.

#### **Manuscript changes:**

- **Introduction, paragraphs 3–5 (completely rewritten):** The revised text now reads: "In practice, different codes implement mass transfer in different ways. Analytic binary evolution and population synthesis codes such as BSE (9) and COSMIC (10) evolve orbital parameters directly using formulas derived from conservation laws; the issue we discuss here does not arise in these codes. Similarly, detailed stellar evolution codes such as MESA (8) resolve mass transfer through differential equations for orbital elements, and hydrodynamic codes (e.g., SPH) resolve the transfer stream directly, so that angular momentum transport emerges naturally from the equations of motion."
- **New Section 5.6 (Applicability):** This section explicitly states: "This work does not claim that existing analytic binary evolution or population synthesis codes exhibit the drift analyzed here... Codes such as BSE, COSMIC, and MESA evolve orbital elements directly using conservation-law formulas and do not employ the position-velocity mapping we analyze."
- **Abstract (final sentence):** Now specifies the closure is relevant to "numerical simulations that represent mass transfer through discrete position–velocity updates, such as interacting binaries embedded in dynamical N-body simulations."

#### **Comment 2**

*Reviewer Comment:* Hydrodynamic simulations such as SPH codes and grid-based stellar interaction codes simulate the actual gas flow between stars. The transfer stream carries angular momentum naturally, so conservation arises automatically from the equations of motion. Again, the issue mentioned in your manuscript does not arise.

**Response:** Agreed. We have added an explicit statement in the Introduction acknowledging that hydrodynamic codes resolve the transfer stream directly, so that angular momentum transport emerges naturally from the equations of motion.

**Manuscript change:** Introduction, paragraph 3 now includes: "...and hydrodynamic codes (e.g., SPH) resolve the transfer stream directly, so that angular momentum transport emerges naturally from the equations of motion." We also added "Comparison with resolved-stream simulations" as an explicit future research direction in Section 5.8.

#### **Comment 3**

*Reviewer Comment:* The only models where mass is manually moved instantaneously between bodies are hybrid N-body or toy dynamical models. Even in these models, many cluster codes do not teleport mass between stars the way the paper describes. Instead they usually adjust orbital elements directly, or apply analytic binary evolution prescriptions. So the exact operator analyzed in the manuscript may not be used in any major codes.

**Response:** We acknowledge this point. The revised manuscript no longer claims that the specific mapping is widely used. Instead, we frame the mapping as a clearly defined computational operator whose angular momentum properties we characterize analytically. We identify dynamical N-body simulations as the context where such position-velocity mappings may arise when analytic orbital-element updates cannot be applied (e.g., when the binary's orbit is simultaneously perturbed by external bodies).

**Manuscript changes:** Introduction, paragraphs 4–6 (rewritten to clarify scope). Section 3.2 now explicitly states this is "one specific computational idealization" and that "other instantaneous prescriptions exist." New Section 5.6 (Applicability) identifies dynamical N-body simulations as the primary application context.

#### **Comment 4**

*Reviewer Comment:* Therefore, your manuscript mainly seems to serve as a numerical cautionary example. You do not show that any existing astrophysical code actually uses that scheme. If you were to inspect the implementation of NBODY6, COSMIC, BSE, etc. and reproduce the drift inside one of those codes, then the result could become significant. Can you show this?

**Response:** We investigated the source code of BSE/COSMIC (evol2.f subroutine) and the NBODY6 framework. In all cases, mass transfer is handled through analytic updates to orbital elements, not through direct manipulation of particle positions and velocities. The drift we analyze therefore does not arise in these specific codes. Rather than misrepresenting the scope of our result, we have reframed the paper to acknowledge this honestly.

**Importantly, we have substantially strengthened the analytical contribution.** The new Section 3.4 derives  $L_f/L_0 = (1-f)(1+fq_0)$  in closed form and proves that the unclosed mapping freezes the orbit at  $a_f/a_0 = 1$ . This transforms the paper from a numerical cautionary example into an analytical characterization of the mapping's behavior, with all numerical results following as predictions of the closed-form formula.

**Manuscript changes:** Introduction (reframed). Section 3.4 (Cumulative Drift in the Continuous Limit), entirely new. Section 5.6 (Applicability). Section 6 (Conclusions), rewritten to emphasize analytical contributions.

#### **Comment 5**

**Reviewer Comment:** You state that as  $\delta t$  approaches zero, unclosed instantaneous mapping is not equal to continuous transfer — an operator splitting issue. The argument depends on holding the mapping fixed while shrinking  $\delta t$ . However, that mapping includes a strong assumption that the transferred mass instantly acquires the accretor's velocity. If the transferred mass were assigned the donor's velocity, or an intermediate stream velocity, then the angular momentum change per step would be different and may approach zero as  $\delta t \rightarrow 0$ . Hence, the non-convergence the paper highlights is not a universal property of instantaneous transfer, but a property of one specific mapping. Please make this clear.

**Response:** This is a correct and important observation. We have added explicit statements in three locations clarifying that the non-convergence is a property of this specific mapping, not a universal property of all instantaneous transfer schemes.

**Manuscript changes:**

- **Introduction, paragraph 5:** "This paper analyzes one such instantaneous relocation mapping... Other prescriptions are possible—for example, assigning the donor's velocity or an intermediate stream velocity—and would produce different angular momentum behavior."

- **Section 3.2, final paragraph:** "Other instantaneous prescriptions exist—for example, depositing mass with the donor's velocity or with an intermediate stream velocity—and would produce different angular momentum changes. The present analysis focuses on the accretor-comoving deposition rule because it provides a clear and analytically tractable example."

- **Section 5.4, final paragraph (new text):** "The non-convergence discussed here is not a universal property of all instantaneous transfer schemes. Different velocity assignments—such as depositing mass with the donor's velocity or with an intermediate stream velocity—would produce different per-step angular momentum changes and may exhibit different limiting behavior."

#### **Comment 6**

**Reviewer Comment:** Your 4–22% orbital drift looks large because of the way you have set up the experiment. You transfer a large total mass fraction (15%), error accumulates over 500 events and you have chosen mass ratios that maximize angular momentum difference. How does the drift scale with total transferred mass? What happens if only 1–2% mass transfer occurs?

**Response:** We have conducted additional simulations at mass-transfer fractions of 1%, 2%, 5%, 10%, and 15% for all three mass ratios. The results are presented in new Table 5 (Section 5.5). Crucially, the new analytical result in Section 3.4 now provides a complete explanation: because the unclosed mapping yields  $a_f/a_0 = 1$  exactly, the deviation relative to the conservative prediction is simply  $|1 - (a_f/a_0)_{\text{cons}}| / (a_f/a_0)_{\text{cons}}$ . This formula predicts every entry in Table 5 to within simulation precision.

#### **Key findings from Table 5:**

- At 1% mass transfer: deviations of 1.01% ( $q_0=0.5$ ), 0.02% ( $q_0=1.0$ ), 1.97% ( $q_0=2.0$ )
- At 2% mass transfer: deviations of 2.03% ( $q_0=0.5$ ), 0.08% ( $q_0=1.0$ ), 3.88% ( $q_0=2.0$ )

• The drift scales approximately linearly with  $f$  for small transferred fractions, as predicted by Equation 14:  $(L_f - L_0)/L_0 \approx f(q_0 - 1)$  when  $f \ll 1$ .

**Manuscript changes:** Section 3.4 (new analytical derivation with Equations 14–18). Section 5.5 (Scaling with Transferred Mass Fraction), rewritten with Table 5. Table 5 caption notes that numerical values match the analytical prediction to within simulation precision.

#### Comment 7

**Reviewer Comment:** The strongest practical use I see for this is when binaries are embedded in multi-body dynamical simulations, where analytic orbital evolution formulas cannot be applied. If you framed the work as a method for maintaining angular-momentum consistency during mass transfer in dynamical N-body simulations, then the contribution would be clearer. Demonstrating its behavior in 3–5 body systems would be an important validation step.

**Response:** We agree that this is the clearest framing. The revised manuscript now explicitly positions the closure condition as most relevant to dynamical N-body simulations.

**Regarding multi-body validation: We have now included proof-of-concept hierarchical three-body experiments (new Section 4.5, Figure 5, Table 4).** The inner binary uses the same  $q_0 = 2.0$  configuration, with a third body on a wider circular orbit. We test two configurations:

- Case D (Weak perturber):  $m_3 = 0.3 M_\odot$  at  $a_{\text{out}} = 8.0$  AU
- Case E (Stronger perturber):  $m_3 = 0.8 M_\odot$  at  $a_{\text{out}} = 5.0$  AU

#### Results from Table 4:

- Case D:  $(a_f/a_0)_{\text{closed}} = 0.8187$ ,  $(a_f/a_0)_{\text{unclosed}} = 0.9995$
- Case E:  $(a_f/a_0)_{\text{closed}} = 0.8157$ ,  $(a_f/a_0)_{\text{unclosed}} = 0.9970$
- Mean transfer-induced jump:  $\langle |\Delta L_{\text{pair}}/L_{\text{pair,pre}}| \rangle_{\text{closed}} \sim 10^{-16}$  vs.  $\langle |\Delta L_{\text{pair}}/L_{\text{pair,pre}}| \rangle_{\text{unclosed}} \sim 2 \times 10^{-4}$

The closure suppresses the artificial transfer-induced angular-momentum drift in the inner binary by a factor of  $\sim 10^{12}$ , demonstrating that it remains effective even when an external gravitational perturber is present. We note that these tests are proof-of-concept and do not constitute a general N-body validation; broader parameter-space exploration is mentioned as future work in Section 5.8. Our simulation code and corresponding GitHub have been appropriately updated.

**Manuscript changes:** Abstract (updated final sentence). Introduction, paragraph 4 (reframed). Section 4.5 (Three-Body Proof-of-Concept), entirely new. Figure 5 (new). Table 4 (new). Section 5.6 (Applicability), new. Section 5.8 (Suggested Research Directions), includes "Multi-body validation" paragraph. Section 6 (Conclusions), final paragraph updated.

#### Reviewer 2

##### Comment 1

**Reviewer Comment:** Please verify that all links to the references point to the correct source.

**Response:** We have verified all 16 reference links and corrected three entries:

- **Reference 3 (Ge et al. 2024):** Had an incorrect DOI. Corrected to: 10.3847/1538-4357/ad7ea6
- **Reference 5 (Tauris & van den Heuvel 2023):** Previously mixed book and arXiv citation styles. Now cited cleanly as a book from Princeton University Press.
- **Reference 12 (Hairer, Lubich & Wanner):** Had the wrong DOI and incomplete title. Corrected to: Geometric Numerical Integration: Structure-Preserving Algorithms for Ordinary Differential Equations (2nd ed.), Springer, 2006, DOI 10.1007/3-540-30666-8.

**Manuscript change:** References 3, 5, and 12 corrected. All other DOI links are correct.

##### Comment 2

**Reviewer Comment:** The authors must disclose and acknowledge any assistance received in the preparation of this manuscript, including but not limited to editorial, technical, analytical, or writing support.

**Response:** We have updated the Acknowledgments section to properly acknowledge all assistance received.

**Manuscript change:** The Acknowledgments section now reads: "The author thanks Dr. Alexander Mushtukov (University of Oxford) for mentorship and scientific discussions during the development of this work, conducted through the CCIR Academy Future Scholar program. This

work made use of NumPy (15) and Matplotlib (16). AI-assisted tools were used for language editing. All research, analysis, coding, and writing were performed solely by the author."

### Comment 3

**Reviewer Comment:** Include enough recent references along with foundational ones. Ensure references directly support your claims. Avoid padding. Use credible sources.

**Response:** All 16 references are from peer-reviewed journals or established academic publishers. The references include both foundational works and recent publications:

- **Foundational:** Paczyński (1971), Zahn (1977), Eggleton (1983)
- **Recent:** Ge et al. (2024), Tauris & van den Heuvel (2023), Breivik et al. (2020)

Each reference is cited where it directly supports a claim. No references have been added for padding.

**Manuscript change:** No change required; existing references meet the stated criteria.

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We believe these revisions address all reviewer concerns comprehensively. The manuscript has been substantially strengthened through the addition of new analytical content, three-body validation, and scaling analysis. We thank the reviewers for their constructive feedback, which has improved the clarity and rigor of this work.

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Thank you for addressing my comments. The paper is much improved. I am still trying to see if there may be a use for the 'closure' beyond numerical correction. To that effect, I asked chatgpt to evaluate my idea of the magnitude of closure or pattern of closure in binaries in a galaxy encode information about that galaxy's heterogeneity or complexity. Part of the chat is reproduced below. Please examine and propose a speculative, yet coherent and logical idea about how your 'closure' can be a useful diagnostic tool to probe the universe. Please include in a subsection called "perspective" or something similar.

(part of ) Chatgpt conversation follows:

you are not understanding my point of view. I am trying to predict physical properties - not trying to correlate with known physical properties

I understand your point better now. You are not trying to validate the closure against known physics. Instead, you're proposing to use the behavior of the closure itself as a probe to infer unknown physical properties. That is a different goal, and the reasoning is actually closer to how some discoveries in physics begin.

Let me restate your idea in clearer terms.

1. Your conceptual method

You are proposing something like this:

Use a fixed numerical framework with a known artifact (the closure).

Apply it to many systems (many binaries within galaxies).

Observe how the closure behaves:

magnitude

stability

collapse thresholds.

Use patterns in those behaviors to infer underlying physical structure.

In other words:

closure behavior

→

information about system dynamics

closure behavior → information about system dynamics

You are treating the closure almost like a measurement instrument.

2. This approach actually exists in science

Scientists sometimes use proxy signals to infer hidden properties.

Examples:

Turbulence

numerical viscosity behavior reveals turbulence scales.

Chaos detection

divergence of numerical trajectories reveals chaotic dynamics.

Spectroscopy

spectral lines reveal atomic structure.

In all these cases, scientists interpret patterns in a response function to infer structure.

So your approach is conceptually valid.

3. Why the closure could carry information

The closure magnitude depends on things like:

velocity differences in the binary

perturbations from nearby bodies

orbital geometry

mass ratios.

Those quantities are influenced by the local gravitational environment.

So if you sampled many binaries across a galaxy, closure statistics might reflect:

density of nearby stars

perturbation frequency

dynamical chaos in that region.

That could encode information about galactic dynamical structure.

4. What your method would actually measure

What the closure behavior would most likely reflect is something like:

strength of perturbations acting on binaries

frequency of strong encounters

degree of dynamical chaos in stellar environments.

Those are meaningful physical quantities.

5. The real challenge

The main difficulty is separating:

information coming from the physical system

information coming from the numerical method.

But if the algorithm is fixed and applied uniformly, patterns could still reveal relative differences between systems.

6. Your idea in plain language

You're essentially saying:

The way a numerical correction behaves might encode information about the underlying system it is correcting.

That is a legitimate scientific idea.

✓ Bottom line:

Yes — if the numerical framework is fixed and applied consistently, patterns in closure behavior across many binaries could potentially reveal information about the dynamical environment of galaxies, such as perturbation strength or interaction complexity. In that sense, the closure could act as a proxy signal for underlying physical structure.

If you'd like, I can also show you a historical case where a numerical artifact unexpectedly revealed real physics—it's actually quite similar to the line of thinking you're pursuing.

yes

There is a famous historical example where unexpected numerical behavior revealed real physics.

It's called the Fermi–Pasta–Ulam–Tsingou experiment, and it is very relevant to the kind of reasoning you're exploring.

1. The original goal of the experiment

In the early 1950s, physicists including Enrico Fermi, John Pasta, and Stanislaw Ulam used one of the first computers to simulate a chain of masses connected by slightly nonlinear springs.

They expected the system to behave like classical statistical physics predicted:

energy initially placed in one vibrational mode

should gradually spread to all modes eventually reaching thermal equilibrium.

2. What the simulation actually showed

Instead, something very strange happened.

Energy did not spread evenly.

Instead:

the energy moved into a few modes

then returned almost exactly to the initial configuration

this cycle repeated.

This became known as FPU recurrence.

The behavior was completely unexpected.

3. Why this mattered

At first, scientists thought the strange behavior might be:

a programming error

a numerical artifact

a limitation of early computers.

But when they investigated further, they discovered something deeper:

The system was revealing hidden mathematical structure in nonlinear dynamics.

4. What was eventually discovered

This work led to major breakthroughs:

the theory of solitons

the discovery of integrable nonlinear systems

major developments in chaos theory and nonlinear dynamics.

In other words, a strange numerical result turned out to expose new physics and mathematics.

5. Why this relates to your idea

Your line of thinking is similar:

Observe unusual behavior in a numerical correction (closure).

Ask whether patterns in that behavior might reflect deeper properties of the system.

Investigate those patterns systematically.

That's the same reasoning scientists used with the FPU experiment.

6. But there is an important difference

In the FPU case:

the anomaly appeared in a physically accurate model.

the equations themselves were correct.

In the closure case:

the anomaly arises from a numerical operator that is already known to be artificial.

So the odds of discovering new physics from it are lower—but the methodological thinking you're using is scientifically legitimate.

✓ Bottom line:

The Fermi–Pasta–Ulam–Tsingou experiment is a famous example where unexpected numerical behavior revealed real physics (solitons and nonlinear dynamics). Your reasoning—examining patterns in numerical corrections to infer underlying system structure—is conceptually similar to the approach that led to that discovery.

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### **Response to Reviewers (Second Review)**

*On the Conditions Under Which Instantaneous Mass-Transfer Mappings Reproduce Conservative Limits*

Jerry (Yuze) Li

We thank the editor and reviewer for their careful reading and constructive feedback. The sole reviewer comment requests a speculative but coherent discussion of whether the closure condition might serve as a useful diagnostic tool beyond its role as a numerical correction. We have incorporated a new subsection to address this idea and describe the change below.

**Reviewer Comment:** “Thank you for addressing my comments. The paper is much improved. I am still trying to see if there may be a use for the ‘closure’ beyond numerical correction. To that effect, I asked chatgpt to evaluate my idea of the magnitude of closure or pattern of closure in binaries in a galaxy encode information about that galaxy’s heterogeneity or complexity. Part of the chat is reproduced below. Please examine and propose a speculative, yet coherent and logical idea about how your ‘closure’ can be a useful diagnostic tool to probe the universe. Please include in a subsection called “perspective” or something similar.

(part of ) Chatgpt conversation follows:

you are not understanding my point of view. I am trying to predict physical properties - not trying to correlate with known physical properties

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The closure magnitude depends on things like:

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That could encode information about galactic dynamical structure.

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What the closure behavior would most likely reflect is something like:

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Your idea in plain language  
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The way a numerical correction behaves might encode information about the underlying system it is correcting.

That is a legitimate scientific idea.

✓ Bottom line:

Yes — if the numerical framework is fixed and applied consistently, patterns in closure behavior across many binaries could potentially reveal information about the dynamical environment of galaxies, such as perturbation strength or interaction complexity. In that sense, the closure could act as a proxy signal for underlying physical structure.

If you'd like, I can also show you a historical case where a numerical artifact unexpectedly revealed real physics—it's actually quite similar to the line of thinking you're pursuing.

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There is a famous historical example where unexpected numerical behavior revealed real physics. It's called the Fermi–Pasta–Ulam–Tsingou experiment, and it is very relevant to the kind of reasoning you're exploring.

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✓ Bottom line:

The Fermi–Pasta–Ulam–Tsingou experiment is a famous example where unexpected numerical behavior revealed real physics (solitons and nonlinear dynamics). Your reasoning—examining

patterns in numerical corrections to infer underlying system structure—is conceptually similar to the approach that led to that discovery.”

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**Response:** The reviewer's suggestion is genuinely stimulating, and we have engaged with it carefully, including the FPUT analogy and the distinction the reviewer's own source draws between that case and the closure setting. We have added a new subsection, Section 5.7, titled “Closure as a Diagnostic Quantity: A Perspective,” to the Discussion. The subsection develops the idea that closure magnitudes, if evaluated across large ensembles of binaries in different galactic environments, could in principle serve as a proxy signal for regional differences in stellar encounter rates, density structure, or dynamical heterogeneity. It also acknowledges the important disanalogy with the FPUT case, namely that the closure arises from a known artificial operator rather than a physically accurate model, so as not to overstate the prospects for new physical discovery via this route. A new reference (Ref. 17) has been added for the FPUT report. The insertion of Section 5.7 has shifted the subsequent section numbers accordingly: sections 5.7–5.8 in the prior submission are renumbered 5.8–5.9 respectively. No content in those sections has been changed.

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We believe these revisions address the concern comprehensively. The manuscript has been substantially strengthened through the addition of this subsection. We thank the reviewer for the constructive feedback, which has improved the clarity and rigor of this work.

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Thank you for addressing my comment.

Before I accept your manuscript, please provide a word document (or more preferably a Linux Ubuntu librewriter document) of your manuscript.

Please pay carefull attention to formatting since equations often behave erratically during conversion.

Please format the document per the Journal’s guidelines found here: <https://jhss.scholasticahq.com/for-authors>, quick guide for submission.

Please make sure the references are in APA format with live links in each reference.

Once you upload this document, I can accept and send for copyediting. Please respond ASAP since the Journal wants to publish this quarter (before March 31).

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Dear Editor,

Thank you for accepting this manuscript for publication. As requested, we have converted the manuscript from PDF to a Word document (.docx) and reformatted it to comply with the Journal's Quick Guide for Submission. No changes were made to the scientific content, results, or conclusions.

We appreciate the time and effort of the editorial board and reviewer and look forward to seeing the manuscript published.

Sincerely,

Jerry (Yuze) Li

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Marc Garneau Collegiate Institute

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accepted