ABSTRACTS – WRITING AND GRADING ABSTRACTS[1]

by Kelly Sullivan and Physics Department

The abstract is a single, short paragraph that conveys the essential information regarding your research. In it, you should state what was addressed and what your results were. For experimental papers state your goals (e.g., what you measured and how or what problem was addressed), what your results were including values with uncertainty, if relevant, how your results/data compared to previous results and/or theoretical values or models, and what your results mean - all as concisely as possible! Consequently, the abstract is best written after you have written the rest of the report.

Scientists typically read the title and abstract first to determine if the article is worth reading. As such, these are very important, and must clearly describe the salient results and their implications.

Because they are concise summaries of the work, abstracts are available for free from journals while the rest of the article may be behind a paywall. Therefore, the abstract should stand alone. Unlike the main text, abstracts do *not* have footnoted citations.

A sample abstract from the University of Maryland:
"The A-technique was employed to measure the B-parameter in System C. Under conditions D, we find values for the B-parameter of XXX±YY m/s. These values imply Z."

This is about as short as you could make it. For our experiments in Physics 290, we will have a 200-word limit.

Another suggestion for Phys 290-like papers online (http://www.ncsu.edu/labwrite/lc/lc-improvinglaprep.htm) is to prepare your abstract by stringing together summary statements from each of the major sections of the lab report:

Introduction: main objective(s) of lab; hypothesis
Experiment: a quick description of how you made your measurement
Results: statement of the findings, including any numerical result with uncertainty
Discussion: judgment about hypothesis; explanation for judgment
Conclusion: what you learned about the scientific concept

Below is a grading rubric for grading experimental abstracts.

Rubric for Abstract

Category	**Excellent**	**Good**	**Fair**	**Poor**
1. Experiment goals including reference to relevant theory	3	2	1	0
2. Description of how measurement was made	3	2	1	0
3. Results, including values w/ uncertainties	6	4	2	0
4. Compare data/results to model/theoretical value	6	4	2	0
5. Meaning of Results	6	4	2	0
6. Organization and Clarity	3	2	1	0
7. Concise, fits within length limits of journal or conference	3	2	1	0

Total Score: / 30

[1] Adapted from documents by Kelley Sullivan, Associate Professor of Physics at Ithaca College. https://faculty.ithaca.edu/kdsullivan/teaching/phys360/tutorials/

Of course, this is not a hard and fast rule for all abstracts and different journals have different goals. But this is generally a good format for data-related papers. We include below a different rubric for abstracts of theory papers.

1. This is a famous article from 2016
   Title: Observation of Gravitational Waves from a Binary Black Hole Merger.
   (https://doi.org/10.1103/PhysRevLett.116.061102)

   Abstract:

   On September 14, 2015 at 09:50:45 UTC the two detectors of the Laser Interferometer Gravitational-Wave Observatory simultaneously observed a transient gravitational-wave signal. The signal sweeps upwards in frequency from 35 to 250 Hz with a peak gravitational-wave strain of 1.0×10^{-21}. It matches the waveform predicted by general relativity for the inspiral and merger of a pair of black holes and the ringdown of the resulting single black hole. The signal was observed with a matched-filter signal-to-noise ratio of 24 and a false alarm rate estimated to be less than 1 event per 203000 years, equivalent to a significance greater than 5.1σ. The source lies at a luminosity distance of 410^{+160}_{-180} Mpc corresponding to a redshift $z = 0.09^{+0.03}_{-0.04}$. In the source frame, the initial black hole masses are $36^{+5}_{-4}M_{\odot}$ and $29^{+4}_{-4}M_{\odot}$, and the final black hole mass is $62^{+4}_{-4}M_{\odot}$, with $3.0^{+0.5}_{-0.5}M_{\odot}c^2$ radiated in gravitational waves. All uncertainties define 90% credible intervals. These observations demonstrate the existence of binary stellar-mass black hole systems. This is the first direct detection of gravitational waves and the first observation of a binary black hole merger.

Category	**Excellent**	**Good**	**Fair**	**Poor**
1. Experiment Goals	3	2	1	0
2. Description of how measurement was made	3	2	1	0
3. Results, including values w/ uncertainties	6	4	2	0
4. Compare data/results to model/theoretical value	6	4	2	0
5. Meaning of Results	6	4	2	0
6. Organization and Clarity	3	2	1	0
7. Concise, fits within length limits of journal or conference	3	2	1	0

Total Score: / 30

Remember to ANNOTATE the abstract!

2. Recent article analyzing gravitational wave results

PHYSICAL REVIEW LETTERS **135,** 111403 (2025)

Editors' Suggestion Featured in Physics

GW250114: Testing Hawking's Area Law and the Kerr Nature of Black Holes

A. G. Abac *et al.*[*]
(LIGO Scientific, Virgo, and KAGRA Collaborations)

(Received 13 August 2025; revised 25 August 2025; accepted 26 August 2025; published 10 September 2025)

The gravitational-wave signal GW250114 was observed by the two LIGO detectors with a network matched-filter signal-to-noise ratio of 80. The signal was emitted by the coalescence of two black holes with near-equal masses $m_1 = 33.6^{+1.2}_{-0.8} M_\odot$ and $m_2 = 32.2^{+0.8}_{-1.3} M_\odot$, and small spins $\chi_{1,2} \leq 0.26$ (90% credibility) and negligible eccentricity $e \leq 0.03$. Postmerger data excluding the peak region are consistent with the dominant quadrupolar ($\ell = |m| = 2$) mode of a Kerr black hole and its first overtone. We constrain the modes' frequencies to $\pm 30\%$ of the Kerr spectrum, providing a test of the remnant's Kerr nature. We also examine Hawking's area law, also known as the second law of black hole mechanics, which states that the total area of the black hole event horizons cannot decrease with time. A range of analyses that exclude up to five of the strongest merger cycles confirm that the remnant area is larger than the sum of the initial areas to high credibility.

DOI: 10.1103/kw5g-d732

Category	Excellent	Good	Fair	Poor
1. Experiment Goals	3	2	1	0
2. Description of how measurement was made	3	2	1	0
3. Results, including values w/ uncertainties	6	4	2	0
4. Compare data/results to model/theoretical value	6	4	2	0
5. Meaning of Results	6	4	2	0
6. Organization and Clarity	3	2	1	0
7. Concise, fits within length limits of journal or conference	3	2	1	0

Total Score: / 30

Remember to ANNOTATE the abstract!

3. Abstract for article from Prof. Viva Horowitz

NANO LETTERS Letter

Cite This: *Nano Lett.* 2019, 19, 2121–2127 pubs.acs.org/NanoLett

Deterministic Quantum Emitter Formation in Hexagonal Boron Nitride via Controlled Edge Creation

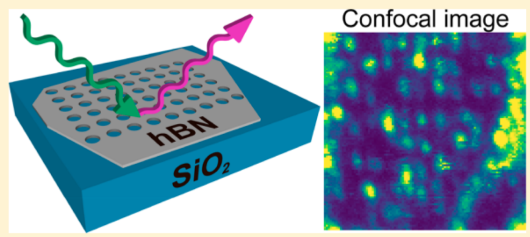
Joshua Ziegler,[†] Rachael Klaiss,[†] Andrew Blaikie,[†] David Miller,[†] Viva R. Horowitz,[§] and Benjamín J. Alemán*[,†]

[†]Department of Physics; Material Science Institute; Center for Optical, Molecular, and Quantum Science, University of Oregon, Eugene, Oregon 97403, United States

[§]Department of Physics, Hamilton College, Clinton, New York 13323, United States

Supporting Information

ABSTRACT: Quantum emitters (QEs) in 2D hexagonal boron nitride (hBN) are extremely bright and are stable at high temperature and under harsh chemical conditions. Because they reside within an atomically thin 2D material, these QEs have a unique potential to couple strongly to hybrid optoelectromechanical and quantum devices. However, this potential for coupling has been underexplored because of challenges in nanofabrication and patterning of hBN QEs. Motivated by recent studies showing that QEs in hBN tend to form at edges, we use a focused ion beam (FIB) to mill an array of patterned holes into hBN. Using optical confocal microscopy, we find arrays of bright, localized photoluminescence that match the geometry of the patterned holes. Furthermore, second-order photon correlation measurements on these bright spots reveal that they contain single and multiple QEs. By optimizing the FIB parameters, we create patterned single QEs with a yield of 31%, a value close to Poissonian limit. Using atomic force microscopy to study the morphology near emission sites, we find that single QE yield is highest with smoothly milled holes on unwrinkled hBN. This technique dramatically broadens the utility and convenience of hBN QEs and achieves a vital step toward the facile integration of the QEs into large-scale photonic, plasmonic, nanomechanical, or optoelectronic devices.



KEYWORDS: *Quantum emitter, 2D material, hexagonal boron nitride, focused ion beam*

Category	Excellent	Good	Fair	Poor
1. Experiment Goals	3	2	1	0
2. Description of how measurement was made	3	2	1	0
3. Results, including values w/ uncertainties	6	4	2	0
4. Compare data/results to model/theoretical value	6	4	2	0
5. Meaning of Results	6	4	2	0
6. Organization and Clarity	3	2	1	0
7. Concise, fits within length limits of journal or conference	3	2	1	0

Total Score: / 30

Remember to ANNOTATE the abstract!

4. Abstract for article from Prof. Viva Horowitz

Spatial mapping and analysis of graphene nanomechanical resonator networks

Brittany Carter[1,2,3], Viva R. Horowitz[4], Uriel Hernandez[1,2,3], David J. Miller[1,2,3], Andrew Blaikie[1,2,3], and Benjamín J. Alemán[1,2,3,5,]*

[1]Department of Physics, University of Oregon, Eugene, Oregon, 97403, United States
[2]Materials Science Institute, University of Oregon, Eugene, Oregon, 97403, United States
[3]Center for Optical, Molecular, and Quantum Science, University of Oregon, Eugene, Oregon, 97403, United States
[4]Physics Department, Hamilton College, Clinton, New York, 13323, United States
[5]Phil and Penny Knight Campus for Accelerating Scientific Impact, University of Oregon, Eugene, Oregon, 97403, United States

*Corresponding Author: Benjamín J. Alemán, baleman@uoregon.edu

Nanoelectromechanical (NEMS) resonator networks have drawn increasing interest due to their potential applications in emergent behavior, sensing, phononics, and mechanical information processing. A challenge toward realizing these large-scale networks is the ability to controllably tune and reconfigure the collective, macroscopic properties of the network, which relies directly on the development of methods to characterize the constituent NEMS resonator building blocks and their coupling. In this work, we demonstrate a scalable optical technique to spatially map graphene NEMS networks and read out the fixed-frequency collective response as a single vector. Using the response vectors, we introduce an efficient algebraic approach to quantify the site-specific elasticity, mass, damping, and coupling parameters of network clusters. We apply this technique to accurately characterize single uncoupled resonators and coupled resonator pairs by sampling them at just two frequencies, and without the use of curve fitting or the associated *a priori* parameter estimates. Our technique may be applied to a range of classical and quantum resonator systems and fills in a vital gap for programming NEMS networks.

Unpublished preprint available: https://arxiv.org/abs/2302.03680

Category	Excellent	Good	Fair	Poor
1. Experiment Goals	3	2	1	0
2. Description of how measurement was made	3	2	1	0
3. Results, including values w/ uncertainties	6	4	2	0
4. Compare data/results to model/theoretical value	6	4	2	0
5. Meaning of Results	6	4	2	0
6. Organization and Clarity	3	2	1	0
7. Concise, fits within length limits of journal or conference	3	2	1	0

Total Score: / 30

Remember to ANNOTATE the abstract!

5. Abstract for article from Charles Collett

PHYSICAL REVIEW RESEARCH **2**, 032037(R) (2020)

Rapid Communications

Constructing clock-transition-based two-qubit gates from dimers of molecular nanomagnets

Charles A. Collett,[1,2,3] Paolo Santini,[4] Stefano Carretta,[4] and Jonathan R. Friedman[1,*]

[1]*Department of Physics and Astronomy, Amherst College, Amherst, Massachusetts 01002, USA*

[2]*Department of Physics, Hamilton College, Clinton, New York 13323, USA*

[3]*Department of Physics, Muhlenberg College, Allentown, Pennsylvania 18104, USA*

[4]*Dipartimento di Fisica e Scienze della Terra, Università di Parma, Parma 43123, Italy*

(Received 6 April 2020; accepted 29 July 2020; published 13 August 2020)

A good qubit must have a coherence time long enough for gate operations to be performed. Avoided level crossings allow for clock transitions in which coherence is enhanced by the insensitivity of the transition to fluctuations in external fields. Because of this insensitivity, it is not obvious how to effectively couple qubits together while retaining clock-transition behavior. Here we present a scheme for using a heterodimer of two coupled molecular nanomagnets, each with a clock transition at zero magnetic field, in which all of the gate operations needed to implement one- and two-qubit gates can be implemented with pulsed radio-frequency radiation. We show that given realistic coupling strengths between the nanomagnets in the dimer, good gate fidelities (~99.4%) can be achieved. We identify the primary sources of error in implementing gates and discuss how these may be mitigated, and investigate the range of coherence times necessary for such a system to be a viable platform for implementing quantum computing protocols.

DOI: 10.1103/PhysRevResearch.2.032037

Category	**Excellent**	**Good**	**Fair**	**Poor**
1. Experiment Goals	3	2	1	0
2. Description of how measurement was made	3	2	1	0
3. Results, including values w/ uncertainties	6	4	2	0
4. Compare data/results to model/theoretical value	6	4	2	0
5. Meaning of Results	6	4	2	0
6. Organization and Clarity	3	2	1	0
7. Concise, fits within length limits of journal or conference	3	2	1	0

Total Score: / 30

Remember to ANNOTATE the abstract!

6. Abstract for article from Profs. Gordon Jones and Brian Collett

PRL **119,** 042502 (2017) PHYSICAL REVIEW LETTERS week ending 28 JULY 2017

Measurement of the Electron-Antineutrino Angular Correlation in Neutron β Decay

G. Darius, W. A. Byron, C. R. DeAngelis, M. T. Hassan, and F. E. Wietfeldt
Tulane University, New Orleans, Louisiana 70118, USA

B. Collett and G. L. Jones
Hamilton College, Clinton, New York 13323, USA

M. S. Dewey, M. P. Mendenhall, J. S. Nico, and H. Park[*]
National Institute of Standards and Technology, Gaithersburg, Maryland 20899, USA

A. Komives
DePauw University, Greencastle, Indiana 46135, USA

E. J. Stephenson
Indiana University, Bloomington, Indiana 47408, USA
(Received 15 March 2017; published 25 July 2017)

We report the first result for the electron-antineutrino angular correlation (a coefficient) in free neutron β decay from the aCORN experiment. aCORN uses a novel method in which the a coefficient is proportional to an asymmetry in proton time of flight for events where the β electron and recoil proton are detected in delayed coincidence. Data are presented from a 15 month run at the NIST Center for Neutron Research. We obtained $a = -0.1090 \pm 0.0030(\text{stat}) \pm 0.0028(\text{sys})$, the most precise measurement of the neutron a coefficient reported to date.

DOI: 10.1103/PhysRevLett.119.042502

Category	**Excellent**	**Good**	**Fair**	**Poor**
1. Experiment Goals	3	2	1	0
2. Description of how measurement was made	3	2	1	0
3. Results, including values w/ uncertainties	6	4	2	0
4. Compare data/results to model/theoretical value	6	4	2	0
5. Meaning of Results	6	4	2	0
6. Organization and Clarity	3	2	1	0
7. Concise, fits within length limits of journal or conference	3	2	1	0

Total Score: / 30

Remember to ANNOTATE the abstract!

7. Abstract for article from Profs. Gordon Jones and Brian Collett

PHYSICAL REVIEW C **110**, 015502 (2024)

Recoil-order and radiative corrections to the aCORN experiment

F. E. Wietfeldt,[1] W. A. Byron,[1,*] B. Collett,[2] M. S. Dewey,[3] T. R. Gentile,[3] F. Glück,[4] M. T. Hassan,[1] G. L. Jones,[2] A. Komives,[5] J. S. Nico,[3] and E. J. Stephenson[6]

[1]*Department of Physics and Engineering Physics, Tulane University, New Orleans, Louisiana 70118, USA*
[2]*Physics Department, Hamilton College, Clinton, New York 13323, USA*
[3]*National Institute of Standards and Technology, Gaithersburg, Maryland 20899, USA*
[4]*Karlsruhe Institute of Technology, IAP, POB 3640, 76021 Karlsruhe, Germany*
[5]*Department of Physics and Astronomy, DePauw University, Greencastle, Indiana 46135, USA*
[6]*CEEM, Indiana University, Bloomington, Indiana 47408, USA*

(Received 5 March 2024; accepted 14 June 2024; published 8 July 2024)

The aCORN experiment measures the electron-antineutrino correlation a coefficient in free neutron decay. We update the previous aCORN results [G. Darius *et al.*, Phys. Rev. Lett. **119**, 042502 (2017) and M. T. Hassan *et al.*, Phys. Rev. C **103**, 045502 (2021)] to include radiative and recoil corrections to first order, and discuss a key issue in the comparison of results from different a-coefficient experimental methods when these effects are considered. The corrected combined result is $\overline{a} = -0.10779 \pm 0.00125\,(\text{stat}) \pm 0.00134\,(\text{sys})$, averaged over the full Fermi neutron beta spectrum. The corresponding corrected result for the ratio of weak coupling constants $\lambda = G_A/G_V$ is $\lambda = -1.2712 \pm 0.0061$, and the corresponding value of a_0, useful for comparing to proton recoil measurements, is $a_0 = -0.1053 \pm 0.0018$. This improves agreement with previous a-coefficient experiments, in particular the 2020 aSPECT result [M. Beck *et al.*, Phys. Rev. C **101**, 055506 (2020)].

DOI: 10.1103/PhysRevC.110.015502

Category	Excellent	Good	Fair	Poor
1. Experiment Goals	3	2	1	0
2. Description of how measurement was made	3	2	1	0
3. Results, including values w/ uncertainties	6	4	2	0
4. Compare data/results to model/theoretical value	6	4	2	0
5. Meaning of Results	6	4	2	0
6. Organization and Clarity	3	2	1	0
7. Concise, fits within length limits of journal or conference	3	2	1	0

Total Score: / 30

Remember to ANNOTATE the abstract!

1. Abstract for article from Prof. Adam Lark:

The Astronomical Journal, 170:146 (15pp), 2025 September https://doi.org/10.3847/1538-3881/ade67b

Updated Masses for the Gas Giants in the Eight-planet Kepler-90 System Via Transit-timing Variation and Radial Velocity Observations

David E. Shaw[1], Lauren M. Weiss[1], Eric Agol[2], Karen A. Collins[3], Khalid Barkaoui[4,5,6], Cristilyn N. Watkins[3], Richard P. Schwarz[3], Howard M. Relles[3], Chris Stockdale[7], John F. Kielkopf[8], Fabian Rodriguez Frustaglia[9], Allyson Bieryla[3], Joao Gregorio[10], Owen Mitchem[11], Katherine Linnenkohl[11], Adam Popowicz[12], Norio Narita[13,14,15], Akihiko Fukui[13,15], Michaël Gillon[4], Ramotholo Sefako[16], Avi Shporer[17], Adam Lark[18], Amelie Heying[18], Isa Khan[18], Beibei Chen[18], Kylee Carden[19], Donald M. Terndrup[19], Robert Taylor[19], Dasha Crocker[19], Sarah Ballard[20], and Daniel C. Fabrycky[21]

Abstract

The eight-planet Kepler-90 system exhibits the greatest multiplicity of planets found to date. All eight planets are transiting and were discovered in photometry from the NASA Kepler primary mission. The two outermost planets, g ($P_g = 211$ days) and h ($P_h = 332$ days), exhibit significant transit-timing variations (TTVs), but were only observed six and three times, respectively, by Kepler. These TTVs allow for the determination of planetary masses through dynamical modeling of the pair's gravitational interactions, but the paucity of transits allows a broad range of solutions for the masses and orbital ephemerides. To determine accurate masses and orbital parameters for planets g and h, we combined 34 radial velocities (RVs) of Kepler-90, collected over a decade, with the Kepler transit data. We jointly modeled the transit times of the outer two planets and the RV time series, then used our two-planet model to predict their future times of transit. These predictions led us to recover a transit of Kepler-90 g with ground-based observatories in 2024 May. We then combined the 2024 transit and several previously unpublished transit times of planets g and h with the Kepler photometry and RV data to update the masses and linear ephemerides of the planets, finding masses for g and h of $15.0 \pm 1.3\,M_\oplus$ and $203 \pm 16\,M_\oplus$, respectively, from a Markov Chain Monte Carlo analysis. These results enable further insights into the architecturally rich Kepler-90 system and pave the way for atmospheric characterization with space-based facilities.

Category	Excellent	Good	Fair	Poor
1. Experiment Goals	3	2	1	0
2. Description of how measurement was made	3	2	1	0
3. Results, including values w/ uncertainties	6	4	2	0
4. Compare data/results to model/theoretical value	6	4	2	0
5. Meaning of Results	6	4	2	0
6. Organization and Clarity	3	2	1	0
7. Concise, fits within length limits of journal or conference	3	2	1	0

Total Score: / 30

Remember to ANNOTATE the abstract!

8. Abstract for article from Prof. Megan Marshall Smith (theorist)

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY

MNRAS **478,** 1837–1843 (2018) doi:10.1093/mnras/sty1184
Advance Access publication 2018 May 7

Angular momentum transport in thin magnetically arrested discs

Megan D. Marshall,[1★] Mark J. Avara[2,3,4] and Jonathan C. McKinney[1,3,5]

[1] *Department of Physics, University of Maryland, College Park, MD 20742, USA*
[2] *Center for Computational Relativity and Gravitation, Rochester Institute of Technology, Rochester, NY 14623, USA*
[3] *Department of Astronomy, University of Maryland, College Park, MD 20742*
[4] *Frontiers in Graviational Wave Astrophysics Postdoctoral Fellow, Rochester Institute of Technology, Rochester, NY 14623, USA*
[5] *Joint Space-Science Institute, University of Maryland, College Park, MD 27042, USA*

Accepted 2018 May 3. Received 2018 April 26; in original form 2017 October 4

ABSTRACT

In accretion discs with large-scale ordered magnetic fields, the magnetorotational instability (MRI) is marginally suppressed, so other processes may drive angular momentum transport leading to accretion. Accretion could then be driven by large-scale magnetic fields via magnetic braking, and large-scale magnetic flux can build-up on to the black hole and within the disc leading to a magnetically arrested disc (MAD). Such an MAD state is unstable to the magnetic Rayleigh–Taylor (RT) instability, which itself leads to vigorous turbulence and the emergence of low-density highly magnetized bubbles. This instability was studied in a thin (ratio of half-height H to radius R, $H/R \approx 0.1$) MAD simulation, where it has a more dramatic effect on the dynamics of the disc than for thicker discs. Large amounts of flux are pushed off the black hole into the disc, leading to temporary decreases in stress, then this flux is reprocessed as the stress increases again. Throughout this process, we find that the dominant component of the stress is due to turbulent magnetic fields, despite the suppression of the axisymmetric MRI and the dominant presence of large-scale magnetic fields. This suggests that the magnetic RT instability plays a significant role in driving angular momentum transport in MADs.

Key words: accretion, accretion discs – black hole physics – gravitation; magnetic fields; MHD; methods: numerical.

The rubric is a little different for a theoretical (not experimental) work.

Category	Excellent	Good	Fair	Poor
1. Scientific Goals	3	2	1	0
2. Description of how science was conducted	3	2	1	0
3. Results (findings)	6	4	2	0
4. Compare to previous work and expectations	6	4	2	0
5. Meaning of Results	6	4	2	0
6. Organization and Clarity	3	2	1	0
7. Concise, fits within length limits of journal or conference	3	2	1	0

Total Score: / 30

Remember to ANNOTATE the abstract!

9. Abstract for article from Prof. Seth Major (theorist)

PHYSICAL REVIEW D **105,** 104050 (2022)

Energy for accelerating observers in black hole spacetimes

Seth A. Major

Department of Physics, Hamilton College, Clinton, New York 13323, USA

(Received 11 March 2022; revised 20 April 2022; accepted 2 May 2022; published 24 May 2022)

Energies for constantly accelerating observers in Bañados, Teitelboim, and Zanelli; Schwarzschild; and Schwarzschild–de Sitter spacetimes are derived. The expressions are in terms of acceleration, cosmological constant, and area, quantities measurable by the observers. Based on results from quantum fields in curved spacetime for the redshifted Hawking temperature, quasilocal entropy and thermodynamic-like laws are briefly explored in the three spacetimes.

DOI: 10.1103/PhysRevD.105.104050

The rubric is a little different for a theoretical (not experimental) work.

Category	**Excellent**	**Good**	**Fair**	**Poor**
1. Scientific Goals	3	2	1	0
2. Description of how science was conducted	3	2	1	0
3. Results (findings)	6	4	2	0
4. Compare to previous work and expectations	6	4	2	0
5. Meaning of Results	6	4	2	0
6. Organization and Clarity	3	2	1	0
7. Concise, fits within length limits of journal or conference	3	2	1	0

Total Score: / 30

Remember to ANNOTATE the abstract!

10. Abstract for article from Prof. Kate Brown (theorist)

The Astronomical Journal, 166:168 (21pp), 2023 October https://doi.org/10.3847/1538-3881/acef1e

Modified Newtonian Dynamics as an Alternative to the Planet Nine Hypothesis

Katherine Brown[1] and Harsh Mathur[2]
[1] Physics Department, Hamilton College, 198 College Hill Road, Clinton, NY 13323, USA
[2] Physics Department, Case Western Reserve University, 10900 Euclid Avenue, Cleveland, OH 44106, USA
Received 2022 August 4; revised 2023 July 26; accepted 2023 August 9; published 2023 September 22

Abstract

A new class of Kuiper Belt objects (KBOs) that lie beyond Neptune with semimajor axes greater than 250 astronomical units show orbital anomalies that have been interpreted as evidence for an undiscovered ninth planet. We show that a modified gravity theory known as modified Newtonian dynamics (MOND) provides an alternative explanation for the anomalies using the well-established secular approximation. We predict that the major axes of the orbits will be aligned with the direction toward the Galactic center and that the orbits cluster in phase space, in agreement with observations of KBOs from the new class. Thus, MOND, which can explain galactic rotation without invoking dark matter, might also be observable in the outer solar system.

Unified Astronomy Thesaurus concepts: Modified Newtonian dynamics (1069); Kuiper belt (893)

The rubric is a little different for a theoretical (not experimental) work.

Category	Excellent	Good	Fair	Poor
1. Scientific Goals	3	2	1	0
2. Description of how science was conducted	3	2	1	0
3. Results (findings)	6	4	2	0
4. Compare to previous work and expectations	6	4	2	0
5. Meaning of Results	6	4	2	0
6. Organization and Clarity	3	2	1	0
7. Concise, fits within length limits of journal or conference	3	2	1	0

Total Score: / 30

Remember to ANNOTATE the abstract!