Theoretical Physics Group, National Institute of Physics, UP Diliman

Annual Report 2020
Theoretical Physics Group

Period covered: *1 January 2020 - 31 December 2020*

Prepared by: *Michael Francis Ian Vega II, Ph.D., Program Coordinator*

Submitted: *23 January 2021*

Contents

1 Executive Summary

1.1 Activities of the Research Group

1.1.1 Organization

	Number
PhD Faculty	6
Student Members	54
PhD = 20	
MS = 20	
BS = 14	
Apprentices	11
Total	**71**

1.1.2 Mentoring

Degree Program	Sem 2, AY 2019-2020	Midyear 2020	Sem 1, AY 2020-2021
PhD Physics	1	0	?
MS Physics	8	1	?
BS Physics	12	0	?
BS Applied Physics	1	0	?
Total	**22**	**1**	?

(This report was prepared before graduation numbers for the First Semester AY 2020-2021 became final. The COVID-19 installment of this Annual Report is out-of-synch with the academic year.)

1.2 Research Highlights

	Number
International (ISI and Scopus) publications	8
Local peer-reviewed publications	0
International conference presentations with full papers	2
Local peer-reviewed conference papers	20
Conference presentations (without full papers)	5
Other invited lectures/talks	1
NIP Funded Projects	4
Non-NIP Funded Projects	1
Outbound travel abroad	0
Inbound visiting researchers	0

1.3 Extension Work Highlights

	Number
Extension Work Activities	11
Research Interns and Trainees	0

1.4 Challenges Encountered

(1) COVID-19 pandemic; lack of interaction; mental health problems, (2) Lack of lab space, (3) All airconditioning broken, (4) Rodent infestation

1.5 Awards, Accreditations, and Positions of Responsibilities Held

	Number
National awards or accreditation received, positions of responsibility held	0
International awards or accreditations received, positions of responsibility held	2
Other accomplishments	1

2
Technical Report

2.1 Activities of the Research Group

1. The Theoretical Physics Group now has 71 research members, consisting of 6 PhD faculty, 54 students, and 11 apprentices.
2. Dr. Jayson Cosme joined the group as our newest tenure-track faculty. He comes to us with a PhD from Massey University (New Zealand) and postdoctoral experience from the Institute of Laser Physics, University of Hamburg (Germany). He is specialist in the theory of quantum fluids in cold atoms and superconductors.
3. The group helped graduate 1 PhD, 8 MS, and 13 BS students. Notably, our PhD graduate, Dr. Reginald Bernardo, became the first person to earn a PhD in gravitational physics from a Philippine institution. This has received a fair amount of national attention.
4. The group has published 8 ISI/Scopus-indexed papers.
5. The group continues to conduct research in a new "remote mode" brought about the COVID-19 pandemic. Research meetings and seminars are still regularly
6. The Gravity Group, as a subgroup of Theoretical Physics, organized its annual Gravity Workshop in August 2020. The remote mode gave us an opportunity to open the workshop to outside participants. Workshop consisted of morning lectures on Mathematica, cosmology, gravitational waves, black holes, stellar structure, etc., and afternoon problem-solving sessions. There were about 40 participants in total, a quarter of whom were students from outside the Institute.

2.1.1 Organization

Regular Members / PhD Faculty (6)

1. Esguerra, Jose Perico — Professor
2. Galapon, Eric — Professor
3. Vega, Michael Francis Ian — Professor
4. Cosme, Jayson — Associate Professor
5. Flores, Marvin — Assistant Professor (*on postdoctoral leave*)
6. Sombillo, Denny Lane — Assistant Professor (*on postdoctoral leave*)

PhD Student Members (21)
[Esguerra: 6; Galapon: 9; Vega: 5]

1. Blancas, Philip Jordan — D6+ (Galapon)
2. Cañeso, Diane — D6+ (Esguerra)

3. Aban, Christine — D5 (Esguerra)
4. Besagas, John Paul — D5 (Galapon)
5. Butanas, Bienvenido — D5 (Esguerra)
6. Ramoso, Angel Marco — D5 (Esguerra)
7. Nuñez, Kimver Louie — D4 (Esguerra)
8. Salig, James — D4 (Galapon)
9. Villanueva, John Adrian — D4 (Vega)
10. Dumigpe, Art Graeson — D3 (Galapon)
11. Fortuna, Sean — D3 (Vega)
12. Elmaguin, John Carlo — D2 (Vega)
13. Flores, Philip Caesar — D2 (Galapon)
14. Mecca, Jerome — D2 (Vega)
15. Pablico, Dean Alvin — D2 (Galapon)
16. Rojas, Nathalie Liezel — D2 (Galapon)
17. Tica, Christian — D2 (Galapon)
18. Garrido, Jeric — D1 (Esguerra)
19. Magadan, John Jaykel — D1 (Galapon)
20. Procurato, Jhon Delo — D1 (Vega)
21. Ugalino, Mark Ivan — D1 (Vega)

MS Student Members (20)
[Esguerra: 5; Galapon: 4; Vega: 11]

1. Caidic, Niel — M3++ (Esguerra)
2. Alvarez, Justin — M3++ (Esguerra)
3. Dajac, Carlo Vincienzo — M3++ (Esguerra)
4. Bagunu, Ramon Jose — M3+ (Galapon)
5. Dizon, Austin — M3+ (Galapon)
6. Andallo, Art Marcello – M3 (Galapon)
7. Bautista, Joshua Beethoven — M3 (Vega)
8. De Peralta, Rexcel — M3 (Galapon)
9. Wong, Jam Benneth — M3 (Galapon)
10. Alkuino, Gabriel Sedrick — M2 (Vega)
11. Aviñante, Aldon Christian — M2 (Esguerra)
12. Balagon, Val Anthony — M2 (Vega)
13. Baybay, John Adrian — M2 (Vega)
14. Celestial, John — M2 (Vega)
15. De Leon, Karlo — M2 (Vega)
16. Perez, Marc Christian — M2 (Vega)
17. Santos, Leonarc Michelle — M2 (Galapon)

18. Sese, Lemuel John — M2 (Galapon)
19. Sevilla, Christopher Gerard — M2 (Esguerra)
20. Villanueva, Lloyd – M2 (Galapon)
21. Alzate, Willard Roy — M1 (Vega)
22. Angeles, Janna May — M1 (Vega)
23. Saret, Lemuel Gavin — M1 (Vega)
24. Tan, Lizbeth Joy — M1 (Vega)

BS Physics Members (12)
[Esguerra: 5; Galapon: 3; Vega: 4]

1. Urzo, Clark Angelo — B7+ (Vega)
2. Alhambra, Gabrielle Melissa — B5 (Vega)
3. Josol, Guillermo Glenn — B5 (Galapon)
4. Monge, Daniel Anthony — B5 (Galapon)
5. Salazar, Jaythan Edrick — B5 (Vega)
6. Zeta, Allan Christopher — B5 (Galapon)
7. Mercado, Joaquin Nicholas — B4 (Vega)
8. Salvador, Adriana Marie — B4 (Esguerra)
9. Villanueva, Ignacio — B4 (Esguerra)
10. Dela Cruz, Sean — B3 (Esguerra)
11. Magnawa, Marc Cyrel — B3 (Esguerra)
12. Rodelas, Joseph — B3 (Esguerra)

BS Applied Physics Members (2)
[Esguerra: 1; Vega: 1]

1. Go, Stephanie Nicole — B5 (Esguerra)
2. Palpal-latoc, Carl Justin — B5 (Vega)

Apprentices (11)
[Cosme: 4, Vega: 7]

1. Perez, Abraham — B4 (Cosme)
2. Abdao, Robert Diel — B3 (Cosme)
3. Bait-it, Abigail — B3 (Vega)
4. Dy, Gedrich Jiann — B3 (Vega)
5. Gurrea, Luke Kenneth — B3 (Vega)
6. Oidem, John Rommel — B3 (Vega)
7. Oña, Cedric Adriane — B3 (Vega)
8. Panganiban, Ronald — B3 (Vega)
9. Tuquero, Richelle Jade — B3 (Cosme)
10. Reyes, John Matthew — B3 (Cosme)
11. Yulo, Jesus Miguel — B3 (Vega)

Organization Summary

	Number
Regular Members	6
Student Members	54
PhD = 20	
MS = 20	
BS = 14	
Apprentices	11
Total	**71**

2.1.2 Mentoring

Graduated 2nd Semester, AY 2019-2020
(PhD = 1, MS = 8, BS = 13)

1. *Reginald Christian Bernardo*, PhD Physics (2020)
   College of Science Most Outstanding PhD Graduate; Edgardo Gomez Award
   Thesis: Compact Objects, cosmologies, and gravitational perturbations in scalar-tensor theories of gravity (Adviser: Ian Vega)
2. *Joshua Carlo Casapao*, MS Physics (2020)
   Thesis: Locally decomposable entanglement witness with inherent partial ordering (Adviser: Eric Galapon)
3. *Ralph Adrian Farrales*, MS Physics (2020)
   Thesis: Conjugates to one particle Hamiltonians in 1-dimension in differential form (Adviser: Eric Galapon)
4. *Jeric Garrido*, MS Physics (2020)
   Thesis: Trajectory design, analysis, and optimization of a solar sail spacecraft (Adviser: Jose Perico Esguerra)
5. *John Jaykel Magadan*, MS Physics (2020)
   Thesis: Time of arrival operators for parity-time symmetric quantum mechanics" (Adviser: Eric Galapon)
6. *Juan Antonio Magalang*, MS Physics (2020)
   Thesis: Continuous-time random walks with stochastic resetting on graphs (Adviser: Jose Perico Esguerra)
7. *Jhon Delo Procurato*, MS Physics (2020)
   Thesis: Direct photon emission from a charged particle orbiting a spherically symmetric black hole (Adviser: Ian Vega)
8. *Kenneth Jhon Remo*, MS Physics (2020)
   Thesis: Representations of the finite part of a divergent integral and its applications (Adviser: Eric Galapon)
9. *Mark Ivan Ugalino*, MS Physics (2020)
   Thesis: Dynamical friction effects on circular orbits immersed in a finite gaseous background (Adviser: Ian Vega)
10. *Anika Maria Athena Acosta*, BS Physics (2020)
    Thesis: A shortcut to adiabaticity through double-impulse interruption

(Adviser: Eric Galapon)

11. *Xyd Agapito*, BS Physics (2020)
    Magna cum laude, Leticia Shahani Award for Best BS Physics Thesis
    Thesis: Environment-induced exact decoherence in a bit-by-bit measurement
    (Adviser: Eric Galapon)
12. *Willard Roy Alzate*, BS Physics (2020)
    Cum laude
    Thesis: General-relativistic dynamics of an extreme-mass-ratio binary in a time-dependent tidal field (Adviser: Ian Vega)
13. *Janna May Angeles*, BS Physics (2020)
    Cum laude
    Thesis: Cosmic evolution with interacting dark matter and dynamical dark energy
    (Adviser: Ian Vega)
14. *Lance Joseph Apolinario*, BS Physics (2020)
    Thesis: Rigid-body dynamics with viscous friction on a turntable
    (Adviser: Jose Perico Esguerra)
15. *Matthew Steven Dinglasan*, BS Physics (2020)
    Thesis: Demystifying the delayed-choice quantum eraser using the density matrix formulation of quantum mechanics (Adviser: Eric Galapon)
16. *John Bert Lazaro*, BS Physics (2020)
    Cum laude
    Thesis: Motion of a charged particle with anisotropic mass in uniform electric and magnetic fields (Adviser: Jose Perico Esguerra)
17. *Joshua Jethro Jedidah Malimata*, BS Applied Physics (2020)
    Thesis: Occupation site probability distribution of the non-uniform evanescent random walk
    (Adviser: Jose Perico Esguerra)
18. *Christine Joy Reloza*, BS Physics (2020)
    Thesis: Tripartite entanglement preservation in a common zero temperature Lorentzian reservoir via qubit addition (Adviser: Eric Galapon)
19. *Marco Immanuel Rivera*, BS Physics (2020)
    Magna cum laude
    Thesis: Approximate analytical expressions for bound orbits under the influence of pseudo-Newtonian potentials (Adviser: Jose Perico Esguerra)
20. *Lemuel Gavin Saret*, BS Physics (2020)
    Thesis: Photon scattering by an Alcubierre warp drive spacetime (Adviser: Ian Vega)
21. *Marc Arvie Talavera*, BS Physics (2020)
    Cum laude
    Thesis: Identification of conjugate quantization for linear systems and quantum oscillator
    (Adviser: Eric Galapon)
22. *Lizbeth Joy Tan*, BS Physics (2020)
    Cum laude
    Thesis: Approximate analytic light curves for tidal disruption events (Adviser: Ian Vega)

Graduated Midyear, AY 2019-2020
(MS = 1)

1. *Kimver Louie Nuñez*, MS Physics (2020) Non-thesis option
   (Adviser: Jose Perico Esguerra)

Mentoring Summary

Degree Program	Sem 2, AY 2019-2020	Midyear 2020	Sem 1, AY 2020-2021
PhD Physics	1	0	?
MS Physics	8	1	?
BS Physics	12	0	?
BS Applied Physics	1	0	?
Total	**22**	**1**	?

(This report was prepared before graduation numbers for the First Semester AY 2020-2021 became final. The COVID-19 installment of this Annual Report is out-of-synch with the academic year.)

2.2 *Research Highlights*

2.2.1 *International peer-reviewed articles (8)*

(Underlined authors are members of the Theoretical Physics Group.)

1. Abac, A. G., Esguerra, J. P. & Otadoy, R. E. S., *Modified structure equations and mass-radius relations of white dwarfs arising from the linear Generalized Uncertainty Principle*, **International Journal of Modern Physics D** (November 11, 2020) DOI: https://doi.org/10.1142/S021827182150005X
2. Bernardo, R. C., Celestial, J., & Vega, I. (2020). *Stealth black holes in shift symmetric kinetic gravity braiding*. **Physical Review D**, 101(2), 24036. https://doi.org/10.1103/PhysRevD.101.024036
3. Flores, M., Gross, C., Kim, J. S., Lebedev, O. & Mondal, S. (2020). *Multi-Higgs boson probes of the dark sector*. **Physical Review D**, 102, 015004. https://doi.org/10.1103/PhysRevD.102.015004
4. Flores, M., Kar, D., & Kim, J. S. (2020). *Constraining Stealth SUSY with illuminated fat jets at the LHC*. **Physics Letters B**, 801, 135151. https://doi.org/10.1016/j.physletb.2019.135151
5. Homann G., Cosme J. G., Mathey L. (2020). *Higgs time crystal in a high-T_c superconductor*. **Physical Review Research** 2, 043214. https://doi.org/10.1103/PhysRevResearch.2.043214
6. Pablico, D. A. L., & Galapon, E. A. (2020). *Quantum traversal time across a potential well*. **Physical Review A**, 101(2), 1-13. https://doi.org/10.1103/PhysRevA.101.022103
7. Ramoso, A. M., Magalang, J. A., Sanchez-Taltavull, D., Esguerra, J. P., and Roldan, E. (2020). *Stochastic resetting antiviral therapies prevent drug resistance development*. **Europhysics Letters**, 132 (2020) 50003. https://doi.org/10.1209/0295-5075/132/50003
8. Sombillo, D. L. B., Ikeda,Y. Sato, T. and Hosaka, A. (2020). *Classifying the pole of an amplitude using a deep neural network.* **Physical Review D**, 102, 016024. https://doi.org/10.1103/PhysRevD.102.016024

2.2.2 *Publication in local peer reviewed journals (0)*

2.2.3 *International conference presentations with full papers (2)*

(Underlined authors are members of the Theoretical Physics Group.)

1. Cometa, A. P. and Esguerra, J. P. H. (2020). *Anomalous diffusion in the one-dimensional linear chain driven internally by one-parameter Mittag-Leffler noise.* AIP Conference Proceedings 2286, 020004 (2020); https//doi.org/10.1063/5.030081 (9th International Jagna Workshop, Jagna, Bohol, Philippines)

2. Magalang, J. A. and Esguerra J. P., (2020), *Hitting, commute, and cover time distributions for resetting random walks on circular graphs*. AIP Conference Proceedings 2286, 040001 (2020); https://doi.org/10.1063/5.0029722 (9th International Jagna Workshop, Jagna, Bohol, Philippines)

2.2.4 International conference presentations without full papers (0)

2.2.5 Local peer-reviewed conference papers (20)

1. J Cosme, Semiclassical equations of motion for interacting bosons in a one-dimensional optical lattice inside a recoil-resolved cavity, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-5C-05 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-5C-05.
2. MI Rivera and JP Esguerra, Linear emulator approach for bound orbits under the influence of the Paczynski-Wiita potential, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-5A-04 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-5A-04.
3. KJM Remo and EA Galapon, Generalized contour integral representation of the finite part, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-1F-03 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-1F-03.
4. LL Villanueva and EA Galapon, Kampé de Fériet function reduction formula via finite-part integration, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-2G-03 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-2G-03.
5. RJC Bagunu and EA Galapon, Quantum time of arrival for the harmonic oscillator using the simplest symmetrization rule, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-2G-04 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-2G-04
6. NL Rojas and EA Galapon, An application of the exactified PoincarÃl' asymptotic expansion of the Hankel integral to thin film thermography, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-2G-10 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-2G-10.
7. LJ Tan and MFI Vega, Approximate analytic light curves for the tidal disruption of a polytropic star, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-1E-03 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-1E-03
8. MIG Ugalino and MFIG Vega, Steady-state density perturbations induced by a point mass in a finite cylinder, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-1E-04 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-1E-04.
9. RC Bernardo, JM Angeles, and MFI Vega, Cosmological dynamics in a self-tuning cubic Horndeski theory, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-1E-05 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-1E-05.
10. JAN Villanueva and MFIG Vega, Black hole inspirals in an expanding universe, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-1E-06 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-1E-06.
11. JCN Elmaguin and MFI Vega, Phase-plane analysis for a spinning particle orbiting a Schwarzschild black hole with second-order spin corrections, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-1F-01 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-1F-01.
12. JMZ Angeles and MFI Vega, Dynamics in an invariant manifold of an interacting dark matter and scalar field system, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-1F-02 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-1F-02
13. JDL Procurato and MFIG Vega, Energy shift maps for direct photon emission by a particle orbiting a Schwarzschild black hole, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-1F-04 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-1F-04.

14. JBP Bautista and MFIG Vega, Testing for the Wada property in a weakly magnetized black hole system, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-5A-02 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-5A-02.
15. JAB Baybay, RC Bernardo, and MFI Vega, Scattering of nonlinear bosonic fields: A case study in superradiance, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-5A-05 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-5A-05.
16. G Alkuino and MFIG Vega, Geometric horizon for distorted black holes, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-5A-08 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-5A-08.
17. LGG Saret and MFI Vega, Photon scattering by an Alcubierre warp drive, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-5A-09 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-5A-09.
18. CJB Palpal-latoc and MFIG Vega, Cosmic evolution with delay differential equations, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-2G-06 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-2G-06.
19. KN de Leon and MFIG Vega, Geodesics in the Ruppeiner geometry of an ideal gas, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-2G-08 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-2G-08.
20. J de L Celestial and MFIG Vega, First law of black hole mechanics for charged black holes in a class of Horndeski theories, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-2G-09 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-2G-09.

2.2.6 Conference presentations (without full papers) (5)

1. J. Cosme, Dynamical control of phases and time crystals in an atom-cavity system, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-INV-5C-01 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-INV-5C-01.
2. J. P. Esguerra, Discrete- and Continuous-time Evanescent Random Walks, Joint QLS-CMSP Virtual Summer Retreat on Heat, Water, Noise, and Life.
3. N. Caidic, Stochastic Behavior of Two Unequally Biased Brownian Particles with Internal Resetting, Joint QLS-CMSP Virtual Summer Retreat on Heat, Water, Noise, and Life.
4. A. Ramoso, First-passage Characteristics of Resetting Biased Diffusion with Mixed Absorbing and Reflecting Boundaries, Joint QLS-CMSP Virtual Summer Retreat on Heat, Water, Noise, and Life.
5. J. A. Magalang, Hitting and Cover Times of Resetting Random Walks on Finite Networks, Discrete- and Continuous-time Evanescent Random Walks, Joint QLS-CMSP Virtual Summer Retreat on Heat, Water, Noise, and Life.

2.2.7 Other invited lectures/talks (1)

1. I. Vega, *Career Paths and Opportunities in Theoretical Physics*. Physics Meet-Up, Department of Physics, Central Mindanao University, and Bukidnon Physics Society. 26 June 2020

2.2.8 NIP funded projects (4)

1. Project Leader: Jayson Cosme
   Project Title: Semiclassical approach to cold bosons with competing short- and long-range interactions in an optical lattice

Amount: PhP38,500
Duration: 1 August 2020 — 31 December 2020

2. Project Leader: Jose Perico Esguerra
Project Title: Biased diffusion with stochastic resetting on an interval with reactive boundaries
Amount: PhP105,600
Duration: 1 January 2020 — 31 December 2020

3. Project Leader: Eric Galapon
Project Title: Application of the exactified Poincare asymptotic expansion of the Hankel integral to thin film thermography
Amount: PhP105,600
Duration: 1 January 2020 — 31 December 2020

4. Project Leader: Michael Francis Ian Vega II
Project Title: Analytic modeling of light curves from tidal disruption events
Amount: PhP105,600
Duration: 1 January 2020 — 31 December 2020

2.2.9 Non-NIP funded projects (1)

1. Project Leader: Eric Galapon
Type: OVPAA Enhanced Creative Work and Research Grant
Project Title: Analytic integration: theory and application
Amount: PhP600,000
Duration: 2019 — 2021

2.2.10 Outbound travel abroad (0)

2.2.11 Inbound visiting researchers (0)

2.3 Extension Work Highlights

2.3.1 Extension Work Activities (14)

1. Jayson Cosme
Referee, Physical Review B
Referee, Samahang Pisika ng Pilipinas

2. Jose Perico Esguerra
Topical Editor, Theoretical and Mathematical Physics, Samahang Pisika ng Pilipinas
Referee, European Journal of Physics
Member, General Council of the Asia Pacific Center for Theoretical Physics
National Astronomy Education Coordinator (Philippines), IAU-Office of Astronomy Education

3. Marvin Flores
ATLAS Qualification Task
Referee, Samahang Pisika ng Pilipinas

4. Eric Galapon
Referee, Samahang Pisika ng Pilipinas

5. Denny Lane Sombillo
Referee, Samahang Pisika ng Pilipinas

6. Michael Francis Ian Vega II
   Topical Editor, Theoretical and Mathematical Physics, Samahang Pisika ng Pilipinas
   Referee, Physical Review D
   Referee, Journal of Cosmology and Astroparticle Physics
   Referee, European Physical Journal Plus

2.3.2 Research Interns and Trainees (0)

2.4 Challenges Encountered

The COVID-19 pandemic was the main challenge for any organization this year. Our research group is no exception. The quarantine and the closure of the Institute has significantly disrupted the activities we have come to expect every year. Although as theoretical physicists our need for physical lab equipment is less than that of our experimental colleagues, we have lost much in the countless informal interactions and conversations that were denied us this year. Each of our respective subgroups has taken advantage of videoconferencing platforms such as Zoom to continue formal research meetings and Journal Club seminars, but these only constitute a small fraction of the essential interaction that fuels research. The lack of face-to-face interactions has made it very difficult to maintain morale and enthusiasm for creative work.

There has been a notable uptick in reported mental health issues from within the group. Though these problems likely differed in their direct causes, there is no doubt that the confinement and isolation brought about by the extended quarantine contributed to them.

Prior to the onset of the COVID-19 pandemic, our group was already facing with a number of problems. Our 70-member population makes us one of the largest research groups in the Institute. But our current lab space is insufficient for our size. We are almost double the population of some groups, but do not nearly have double the lab space. This space problem is expected to worsen as Dr. Cosme's subgroup will steadily grow over the next few years. Also, none of our airconditioning units function. And finally, we have had a persistent rodent problem that remains unsolved.

2.5 Awards, Accreditations, Positions of Responsibility Held, and other Accomplishments

2.5.1 National awards or accreditations received, positions of responsibility (0)

2.5.2 International awards or accreditations received, positions of responsibility (2)

1. Jose Perico Esguerra
   Member, General Council of the Asia Pacific Center for Theoretical Physics
   National Astronomy Education Coordinator (Philippines), IAU-Office of Astronomy Education

2.5.3 Other accomplishments (1)

1. Xyd Agapito – *Leticia Shahani Award for Most Outstanding BS Physics Thesis*, College of Science, UP Diliman

3
Photos, ISI/SCI Publications and other appendices

3.1 PhD Faculty

Top row, left to right: Jose Perico Esguerra, Eric Galapon, Ian Vega, Jayson Cosme
Bottow row, left to right: Marvin Flores, Denny Lane Sombillo

3.2 *ISI/SCI, Scopus publications*

International Journal of Modern Physics D

MODIFIED STRUCTURE EQUATIONS AND MASS-RADIUS RELATIONS OF WHITE DWARFS ARISING FROM THE LINEAR GENERALIZED UNCERTAINTY PRINCIPLE

ADRIAN G. ABAC

Department of Physics, University of San Carlos, Nasipit, Talamban
Cebu City, Cebu 6000, Philippines
adrian.abac18@gmail.com

JOSE PERICO H. ESGUERRA

National Institute of Physics, University of the Philippines, Diliman
Quezon City, 1101, Philippines
jesguerra@nip.upd.edu.ph

ROLAND EMERITO S. OTADOY

Department of Physics, University of San Carlos, Nasipit, Talamban
Cebu City, Cebu 6000, Philippines
rsotadoy@usc.edu.ph

Received Day Month Year
Revised Day Month Year

The generalized uncertainty principle (GUP) is a common feature among several approaches related to quantum gravity. An approach to GUP was recently developed that contains both linear and quadratic terms of momenta, from which an infinitesimal phase space volume was derived up to the linear term of momenta. We studied the effects

PHYSICAL REVIEW D **101,** 024036 (2020)

Stealth black holes in shift symmetric kinetic gravity braiding

Reginald Christian Bernardo,* John Celestial,† and Ian Vega‡
National Institute of Physics, University of the Philippines, Diliman, Quezon City 1101, Philippines

(Received 20 November 2019; published 16 January 2020)

We derive all hairy stealth black holes in the most general second-order, shift symmetric, scalar-tensor theory with luminally propagating gravitational waves, often called kinetic gravity braiding. Our approach exploits a loophole in a recently obtained no-go statement which claims shift symmetry breaking to be necessary for stealth solutions to exist in kinetic gravity braiding. We highlight the essential role played by a covariantly constant kinetic density in obtaining these solutions. Lastly, we propose a parametrization of the theories based on the asymptotics of its stealth solutions and comment on the intriguing singular effective metric for scalar perturbations in stealth black holes.

DOI: 10.1103/PhysRevD.101.024036

I. INTRODUCTION

There is continuing effort to understand whether the black holes observed by astronomers are indeed the black holes predicted by general relativity. The detection of gravitational waves (GWs) from binary black hole mergers by the LIGO and Virgo collaborations [1] and the recent imaging of the M87 supermassive black hole by the Event Horizon Telescope [2] draw part of their huge significance from this desire to square new observations with theoretical expectations. They represent our first direct probes of the

by their mass, electric charge, and spin, according to the celebrated no-hair theorems [27–30]. The new degrees of freedom (d.o.f.) in alternative theories of gravity threaten to spoil this simplicity, by seemingly supporting black hole solutions that depend on other parameters and that are associated with long-range fields (i.e., "hair"). However, by some rather surprising twist of irony, various physical considerations often conspire to prevent this from happening [31–33]: the black holes of general relativity also tend to be solutions of alternative theories. In this context, they

PHYSICAL REVIEW D **102,** 015004 (2020)

Multi-Higgs boson probes of the dark sector

Marvin Flores,[1,2] Christian Gross,[3] Jong Soo Kim,[4] Oleg Lebedev,[5] and Subhadeep Mondal[5]

[1]*School of Physics, University of the Witwatersrand, 2050 Johannesburg, South Africa*
[2]*National Institute of Physics, University of the Philippines, Diliman, 1101 Quezon City, Philippines*
[3]*Dipartimento di Fisica dell'Università di Pisa and INFN, Sezione di Pisa, IT-56127 Pisa, Italy*
[4]*National Institute for Theoretical Physics and School of Physics, University of the Witwatersrand, 2050 Johannesburg, South Africa*
[5]*Department of Physics and Helsinki Institute of Physics, Gustaf Hällströmin katu 2a, FI-00014 Helsinki, Finland*

(Received 5 January 2020; accepted 21 June 2020; published 13 July 2020)

We consider dark sectors with spontaneously broken gauge symmetries, where cascade decays of the dark sector fields naturally produce multi-Higgs boson final states along with dark matter. Our study focuses on two and three Higgs boson final states with missing energy using a multivariate analysis with boosted decision trees. We find that the di-Higgs boson channel is quite promising for the $\bar{b}b + \gamma\gamma$ and $\bar{b}b + \bar{\ell}\ell$ decay modes. The tri-Higgs boson final state with missing energy, on the other hand, appears to be beyond the reach of the LHC in analogous channels. This may change when fully hadronic Higgs boson decays are considered.

DOI: 10.1103/PhysRevD.102.015004

I. INTRODUCTION

The scalar sector of the Standard Model (SM) remains relatively little explored compared to the gauge sector. In particular, no Higgs boson self-interaction has been measured. It is a well-motivated and experimentally viable possibility that the Higgs field plays the role of a portal

states this method is efficient, in the intermediate mass range (below 700 GeV or so) it is less reliable. In our work, we consider both two and three Higgs boson final states, which subsequently decay into $\bar{b}b$, $\gamma\gamma$, and WW. These have the advantage of being cleaner channels with a lower background. Instead of using a traditional cut-based analy-

Physics Letters B 801 (2020) 135151

Contents lists available at ScienceDirect

Physics Letters B

www.elsevier.com/locate/physletb

Constraining Stealth SUSY with illuminated fat jets at the LHC

Marvin Flores [a,c,*], Deepak Kar [a], Jong Soo Kim [b]

[a] School of Physics, University of the Witwatersrand, Johannesburg, South Africa
[b] National Institute for Theoretical Physics and School of Physics, University of the Witwatersrand, Johannesburg, South Africa
[c] National Institute of Physics, University of the Philippines Diliman, Quezon City, Philippines

ARTICLE INFO

Article history:
Received 28 May 2019
Received in revised form 14 November 2019
Accepted 9 December 2019
Available online 12 December 2019
Editor: A. Ringwald

Keywords:
Supersymmetry
Phenomenology

ABSTRACT

We investigate the discovery potential of a Stealth SUSY scenario involving squark decays by reconstructing the lightest neutralino decay products using a large-radius jet containing a high transverse momentum photon. Requirements on the event topology, such as photon and large-radius jet multiplicity result in less background than signal. We also estimated the sensitivity of our analysis and found that it has a better exclusion potential compared to the strongest existing search for the specific benchmark points considered here.

1. Introduction

Among the existing beyond-the-Standard-Model (BSM) scenarios, supersymmetry (SUSY) is the leading theoretical framework that explains unresolved questions in the Standard Model such as phase space for the true LSP to carry energy, thereby producing signatures of low $\not{E}_T$.

In this paper, we study the above scenario by considering a particular toy model with a specific decay chain given by

PHYSICAL REVIEW RESEARCH **2**, 043214 (2020)

Higgs time crystal in a high-T_c superconductor

Guido Homann[1,*] Jayson G. Cosme[1,2,3] and Ludwig Mathey[1,2]

[1]*Zentrum für Optische Quantentechnologien and Institut für Laserphysik, Universität Hamburg, 22761 Hamburg, Germany*

[2]*The Hamburg Centre for Ultrafast Imaging, Luruper Chaussee 149, 22761 Hamburg, Germany*

[3]*National Institute of Physics, University of the Philippines, Diliman, Quezon City 1101, Philippines*

(Received 12 May 2020; revised 14 October 2020; accepted 21 October 2020; published 10 November 2020)

We propose to induce a time-crystalline state in a high-T_c superconductor, by optically driving a sum resonance of the Higgs mode and a Josephson plasma mode. The generic cubic process that couples these fundamental excitations converts driving of the sum resonance into simultaneous resonant driving of both modes, resulting in an incommensurate subharmonic motion. We use a numerical implementation of a semiclassical driven-dissipative lattice gauge theory on a three-dimensional layered lattice, which models the geometry of cuprate superconductors, to demonstrate the robustness of this motion against thermal fluctuations. We demonstrate this light-induced time-crystalline phase for mono- and bilayer systems and show that this order can be detected for pulsed driving under realistic technological conditions.

DOI: 10.1103/PhysRevResearch.2.043214

I. INTRODUCTION

Optical driving of solids constitutes a new method of designing many-body states. Striking examples of this approach include light-induced superconductivity [1–3] as well as optical control of charge density wave phases [4]. For these states, the carefully tuned light field either renormalizes the phase boundary of the equilibrium phase, as is the case for light-induced superconductivity, or renormalizes a nearby

In this paper, we propose to create a light-induced time-crystalline state in a high-T_c superconductor. This advances light control of superconductors towards genuine nonequilibrium orders and furthers time crystals in the solid-state domain [16]. We characterize the observed nonequilibrium state as a time crystal based on the following criteria [12]: (i) A time crystal spontaneously breaks time-translation symmetry; that is, it exhibits a subharmonic response to the drive. (ii) The subharmonic response is robust against perturbations

PHYSICAL REVIEW A **101**, 022103 (2020)

Quantum traversal time across a potential well

Dean Alvin L. Pablico * and Eric A. Galapon †

Theoretical Physics Group, National Institute of Physics, University of the Philippines, Diliman, Quezon City 1101, Philippines

(Received 13 August 2019; accepted 21 January 2020; published 10 February 2020)

We consider the quantum traversal time of an incident wave packet across a potential well using the theory of quantum time of arrival (TOA) operators. This is done by constructing the corresponding TOA operator across a potential well via quantization. The expectation value of the potential-well TOA operator is compared to the free-particle case for the same incident wave packet. The comparison yields a closed-form expression of the quantum well traversal time which explicitly shows the classical contributions of the positive and negative momentum components of the incident wave packet and a purely quantum-mechanical contribution significantly dependent on the well depth. An incident Gaussian wave packet is then used as an example. It is shown that for shallow potential wells, the quantum well traversal time approaches the classical traversal time across the well region when the incident wave packet is spatially broad and approaches the expected quantum free-particle traversal time when the wave packet is localized. For deep potential wells, the quantum traversal time oscillates from positive to negative, implying that the wave packet can be advanced or delayed.

DOI: 10.1103/PhysRevA.101.022103

I. INTRODUCTION

One of the simplest and most studied potentials in quantum mechanics is the rectangular one-dimensional potential such as the potential barrier and well. This type of potential offers interesting quantum-mechanical phenomena such as the quantum tunneling through a potential barrier and quantum reflection and transmission through a potential well. Such phenomena are predicted by solving the time-independent

attoclock and momentum-space imaging [9]. Although there is still no consensus on whether or not quantum tunneling occurs instantaneously, the attosecond science community is more inclined toward instantaneous quantum tunneling time [6,10]. Such experimental results are also consistent with the independent theoretical predictions of Galapon [11] and Petersen and Pollak [12–14].

Now that the tunneling time for particles passing through

A LETTERS JOURNAL EXPLORING THE FRONTIERS OF PHYSICS

LETTER

Stochastic resetting antiviral therapies prevent drug resistance development

A. M. Ramoso[1], J. A. Magalang[1], D. Sánchez-Taltavull[2], J. P. Esguerra[1] and É. Roldán[3]

Published 30 December 2020 • Copyright © 2020 EPLA

EPL (Europhysics Letters), Volume 132, Number 5

Citation A. M. Ramoso *et al* 2020 *EPL* **132** 50003

– Hide article information

Author affiliations

[1] Theoretical Physics Group, National Institute of Physics, University of the Philippines - Diliman, Quezon City 1101, Philippines

[2] Visceral Surgery and Medicine, Inselspital, Bern University Hospital, Department for Biomedical Research, University of Bern - Murtenstrasse 35, 3008 Bern, Switzerland

[3] ICTP - The Abdus Salam International Centre for Theoretical Physics - Strada Costiera 11, 34151, Trieste, Italy

PHYSICAL REVIEW D **102,** 016024 (2020)

Classifying the pole of an amplitude using a deep neural network

Denny Lane B. Sombillo,[1,2,*] Yoichi Ikeda,[3] Toru Sato,[2] and Atsushi Hosaka[2]

[1]*National Institute of Physics, University of the Philippines Diliman, Quezon City 1101, Philippines*
[2]*Research Center for Nuclear Physics (RCNP), Osaka University, Osaka 567-0047, Japan*
[3]*Department of Physics, Kyushu University, Fukuoka 819-0395, Japan*

(Received 26 March 2020; accepted 9 July 2020; published 28 July 2020)

Most of the exotic resonances observed in the past decade appear as a peak structure near some threshold. These near-threshold phenomena can be interpreted as genuine resonant states or enhanced threshold cusps. Apparently, there is no straightforward way of distinguishing the two structures. In this work, we employ the strength of deep feed-forward neural network in classifying objects with almost similar features. We construct a neural network model with scattering amplitude as input and the nature of a pole causing the enhancement as output. The training data is generated by an S-matrix satisfying the unitarity and analyticity requirements. Using the separable potential model, we generate a validation data set to measure the network's predictive power. We find that our trained neural network model gives high accuracy when the cutoff parameter of the validation data is within 400–800 MeV. As a final test, we use the Nijmegen partial wave and potential models for nucleon-nucleon scattering and show that the network gives the correct nature of the pole.

DOI: 10.1103/PhysRevD.102.016024

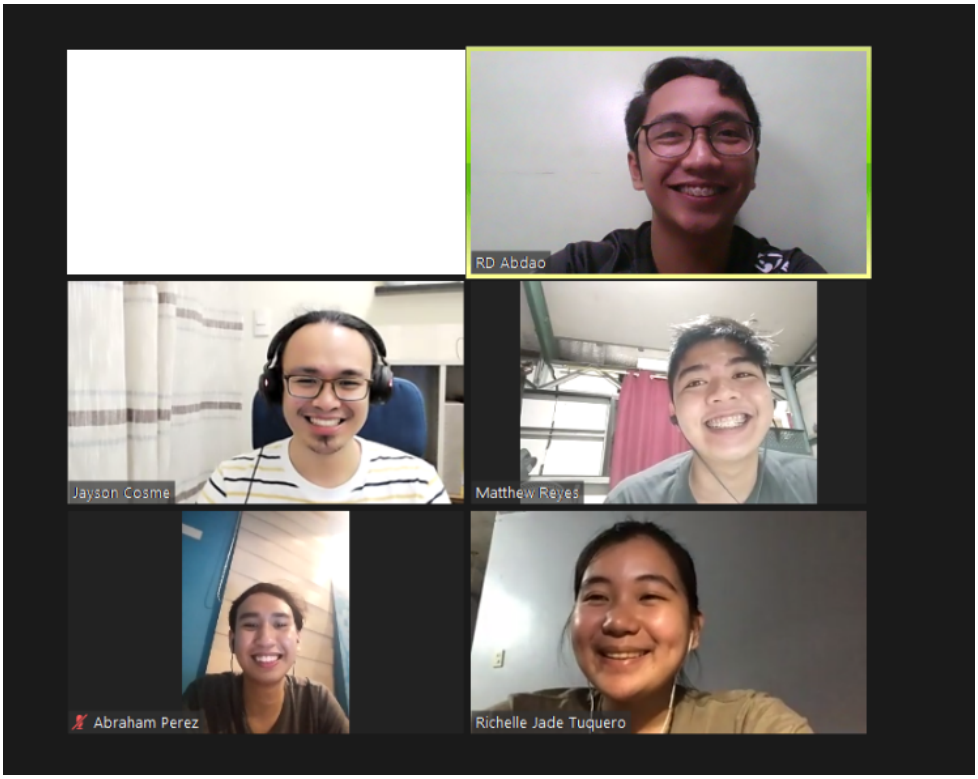
I. INTRODUCTION

Renewed interest in hadron spectroscopy started after the discovery of $X(3872)$ in 2003 [1]. Since then, several candidates of nonstandard exotic hadrons are proposed. One common feature of these phenomena is that they

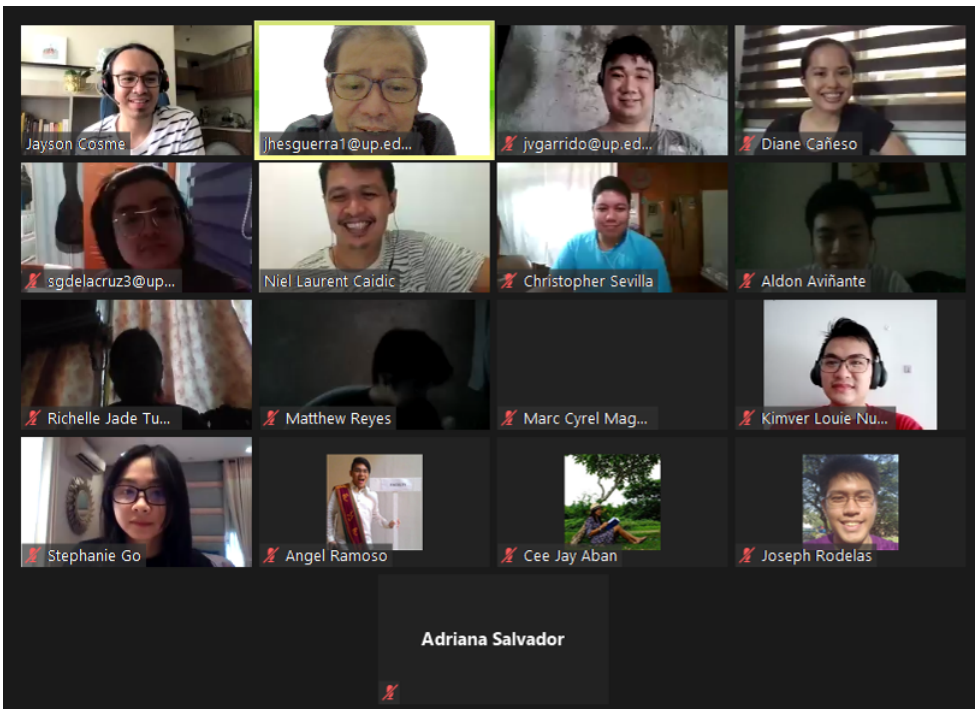
The purpose of this paper is to address the origin of the sharp peak observed around the threshold of two-body hadron scattering problems. We specifically focus on the case where a near-threshold pole causes the peak structure and attempt to identify its nature, i.e., whether it is a bound, resonance, or virtual state pole. Until now, there has not

3.3 Subgroup photos

Theory of Quantum Fluids Group



Esguerra Group



High Energy and Nuclear Physics Group

Gravity Group