

National Institute of Physics

Management Team

**Terminal Report for the Structure and Dynamics Research Program**

Period covered: 01 January 2022 to 31 December 2022

Prepared by:

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Structure and Dynamics Research Program

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## 1 Executive Summary

### 1.1 Activities of the Research Program

#### 1.1.1 Organization

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Student Members	20	p. 3
PhD – 3		
MS – 3		
BS – 14		
Apprentices	8	p. 3
Total	<b>31</b>	

#### 1.1.2 Mentoring

Degree Program	Sem 2 AY 2021–2022 (p. 4)	Midyear 2022(p. 4)	Sem 1 AY 21–22 (p. 4)	Total
BS Physics	1	0	0	1
BS Applied Physics	2	1	1	4
MS Physics	1	0	0	1
PhD Physics	1	0	0	1
Total	5	1	1	7

### 1.2 Research Highlights

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### 1.3 Extension Work Highlights

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### 1.5 Awards, Accreditations, and Positions of Responsibilities Held

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## 2 Technical Report

### 2.1 Activities of the Research Program

2021-2022 saw five undergraduate students graduated and completed their theses. One MS student defended their thesis. While the single PhD student did successfully defend his dissertation. Current regular membership in SanD (faculty and students) is now 31. There were two an international peer-reviewed article and 5 local conference peer-reviewed papers plus one local invited speaker.

The COVID-19 pandemic is a challenge that continues to question the means by which we are able to deliver educational targets.

#### 2.1.1 Organization

##### Regular Members (3)

- 1) Villagonzalo, Cristine – Professor
- 2) Banzon, Ronald – Associate Professor
- 3) Paraan, Francis – Professor

##### PhD Student Members (3)

- 1) Acosta, Geronimo Allan Jerome – D6
- 2) dela Rosa, Rafael – D7, University Research Associate 1 (URA 1)
- 3) Itable, Gene Moses- D7

##### MS Student Members (3)

- 1) Bongon, Alyssia – M2
- 2) Masbate, Julius – M7
- 3) Urbano, Kryss – M3

##### BS Student Members (14)

- 1) Brongcano, Mark – B4
- 2) Carig, Jami Joyce – B4
- 3) Daquioag, Alyana – B5
- 4) Estrada, John Benedick – B7
- 5) Gamboa, Jose Antonio – B4
- 6) Glorioso, Mico – B4
- 7) Hizon, Zachary – B4
- 8) Legara, Allen – B4
- 9) Malalad , Joshua – B4
- 10) Rances, Joseph Garrett – B4
- 11) Ricaña, Mary June – B4
- 12) Sacres, Kobe Brian – B5
- 13) Sorupia, Sven – B4
- 14) Suico, Samuel – B4

##### Apprentices (8)

- 1) Acda, Ron Michael – B3
- 2) Billiones, Ella May – B3

- 3) Camit, Ma. Ezthelia Kaye – B3
- 4) Danganan, Mark Gabriel – B3
- 5) Hernandez, Hans Emmanuel – B3
- 6) Lagrimas, Ajay – B3
- 7) Vertudes, Genesis – B3
- 8) Viray, Micah Louie – B3

### 2.1.2 Mentoring

#### Graduated Sem 1 AY 2021–2022

BS Applied Physics (Instrumentation) (1)

- 1) De Guzman, Tristan S.,  
BS Thesis: "Classifying Physics Articles by their Abstracts with Recurrent Neural Networks"  
Adviser: Francis Paraan

MS Physics (0)

#### Graduated Sem 2 AY 2021–2022

BS Physics (1)

- 1) Herman, Gene Michael P.  
Cum Laude BS Thesis: "Quantum Carnot Heat Engine With An Effective External Electric field Perturbation" Adviser: Dr. Cristine Villagonzalo

BS Applied Physics (Instrumentation) (2)

- 1) Dela Cruz, Leon Sergio C.  
Magna cum laude BS Thesis: "Particle Separation in Brownian Transport Through a confined Periodic Spherical Channel Via Perpendicular Forcing" Adviser: Ronald S. Banzon
- 2) Rangel, Jerico Miguel T.  
Magna cum Laude BS Thesis: "Qiskit implementation of the 5-body Ising model for alternating coupling constant chains" Adviser: Dr. Cristine Villagonzalo

BS Applied Physics (Materials Physics) (0)

MS Physics (1)

- 1) Feri, Klarence Anne M.  
MS Thesis: "Anisotropic specific heat of finite Lipkin-Meshkov-Glick spin system" Adviser: Dr. Cristine Villagonzalo

PhD Physics (0PhDsem2)

- 1) Villegas, Vladimir Paat PhD Dissertation: "Refrigeration and Spin Transport in a One-Dimensional Fermi-Hubbard Optical Lattice Exposed to External Electromagnetic Fields and a Fermi Gas Bath" Adviser: Dr. Cristine Villagonzalo

#### Graduated MY AY 2022

MS Physics (0)

BS Applied Physics (1)

- 1) Espalmado, Faye D.  
Cum Laude BS Thesis: "Protein Structure Prediction In 2D HP Lattice Model Using Particle Swarm Optimization" Adviser: Ronald Banzon

## 2.2 Research Highlights

### 2.2.1 International peer-reviewed articles (2)

- 1) Villegas, V. P., Villagonzalo, C. D. (2022). "Refrigeration using magnetocaloric and electrocaloric effects in a Fermi-Hubbard optical dimer exposed to a heat bath." *Physica A: Statistical Mechanics and Its Applications*, 600, 127540. <https://doi.org/10.1016/j.physa.2022.127540>
- 2) Villegas, V. P., Villagonzalo, C. D. (2022). "Caloric effects in an open Fermi-Hubbard optical dimer due to onsite and heat bath-induced two-particle interactions." *Journal of Magnetism and Magnetic Materials*, 564, 170094. (*J. Magn. Magn. Mat.*) <https://doi.org/10.1016/j.jmmm.2022.170094>

### 2.2.2 International conference presentations (1)

- 1) Vladimir P. Villegas, Cristine D. Villagonzalo, "Spin transport in a Fermi-Hubbard optical lattice interacting with Fermi gas bath", 29th International Conference on Low Temperature Physics, Sapporo, Japan, 23 August 2022 (online poster presentation)

### 2.2.3 Local peer-reviewed conference papers (5)

- 1) FNC Paraan, ST Sorupia and GMM Itable, "Effective Hamiltonian for a non-unitary quantum walk" in Proceedings of the 40th Samahang Pisika ng Pilipinas, SPP-2022-PB-10 (Philippines 2022)
- 2) AEM Ordonio, KAM Feri and CD Villagonzalo, "Crossing and anti-crossing of the Lipkin-MeshkovGlick Model for  $N = 4$  spin system" in Proceedings of the 40th Samahang Pisika ng Pilipinas, SPP-2022-2G-06 (Philippines, 2022)
- 3) GMP Herman and CD Villagonzalo, "Quantum Carnot heat engine with an effective external electric field perturbation" in Proceedings of the 40th Samahang Pisika ng Pilipinas, SPP-2022-1D-03 (Philippines, 2022)
- 4) VP Villegas and CD Villagonzalo, "Chemical potential-induced effects on caloric properties of a Fermi-Hubbard dimer" in Proceedings of the 40th Samahang Pisika ng Pilipinas, SPP-2022-1G-04 (Philippines, 2022)
- 5) KC Urbano and RS Banzon, "Fractal dimension in a modified 2D Ising system with regions without spin" in Proceedings of the 40th Samahang Pisika ng Pilipinas, SPP-2022- PB-9 (Philippines, 2022)

### 2.2.4 Local conference presentations (0)

#### 2.2.5 NIP funded projects (3)

- (a) Project Leader: Banzon, Ronald S.  
Project Title: Effects of regions without spin in a 2D Ising system  
Period: 01 January 2022–31 December 2022
- (b) Project Leader: Paraan, Francis Norman C.  
Project Title: Entanglement in Quantum Walks and Spin Dimers  
Period: 01 January 2022–31 December 2022
- (c) Project Leader: Villagonzalo, Cristine DLR.  
Project Title: Heat Capacity of a Fermi-Hubbard Dimer with an Exchange Interaction with a Thermal Bath  
Period: 01 January 2022–31 December 2022

**2.2.6 Non-NIP funded projects (0)**

**2.2.7 Other invited lectures/talks (0)**

- 1) Cristine Villagonzalo, "Exploring quantum phenomena of various fermionic quantum models through their thermodynamic properties" in Proceedings of the 40th Samahang Pisika ng Pilipinas, SPP-2022-INV-1A-01 (Philippines, 2022)
- 2) Cristine D. Villagonzalo, "The National Research Council of the Philippines (NRCP): Bridging the Gap Between Researchers and its Stakeholders", 58th Philippine Association of Medical Technologists Annual Convention, PICC, Pasay City, 3 December 2022

**2.2.8 Outbound travel abroad (0)**

**2.2.9 Inbound visiting researchers (0)**

## 2.3 Extension Work Highlights

### 2.3.1 Extension Work Activities<sup>1</sup> (5)

- (a) Name: Francis Paraan  
Extension work: Samahang Pisika ng Pilipinas Councilor, Proceedings of the SPP Editor-in-Chief, SPP Webmaster 2022  
Organization: Samahang Pisika ng Pilipinas
- (b) Name: Francis Paraan  
Extension work: Referee  
Organization: American Physical Society Physical Review Journals
- (c) Name: Cristine Villagonzalo  
Position: President  
Organization: National Research Council of the Philippines
- (d) Name: Cristine Villagonzalo  
Position: Physics Division (Division IX) Chair and Vice President of the Governing Board  
Organization: National Research Council of the Philippines
- (e) Name: Cristine Villagonzalo  
Position: Referee  
Organization: Elsevier, Springer & World Scientific Publishing

### 2.3.2 Research Interns and Trainees (0)

## 2.4 Challenges Encountered

- (a) Current health protocols prevented face-to-face classes. The continuing health crisis modified the implementation of classes that continued to execute in asynchronous mode.

## 2.5 Awards, Accreditations, and Positions of Responsibilities Held

### 2.5.1 National awards and positions held (2)

- (a) Name: Cristine Villagonzalo  
Position: President  
Organization: National Research Council of the Philippines
- (b) Name: Cristine Villagonzalo  
Position: Deputy Director for Academic Affairs  
Organization: National Institute of Physics

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<sup>1</sup>From the 2003 UP Diliman Faculty Manual 2003 Section 4.3.4: Extension includes services utilizing expertise and talent related to one's discipline, outside instruction and research, such as nondegree training, seminars, workshops, conferences, review classes [except UP College Admission Test (UPCAT)], advisory/technical/information services, exhibits, performances, consultancies (without professional fee), networking, advocacy, and volunteer/community work.

### 3 Appendices

#### 3.1 Photographs



SanD @ SPP2022 photo: Cristine Villagonzalo

#### 3.2 Photographs





SanD Christmas Party (2022.12.21)



SanD Christmas Party (2022.12.21)