

National Institute of Physics

Management Team

Terminal Report for the Structure and Dynamics Research Program

Period covered: 01 January 2015 to 31 December 2015

Prepared by:

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Program Coordinator

Structure and Dynamics Research Program

Submitted: 15 December 2015

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1 Executive Summary

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1.1.1 Organization

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PhD – 3		
MS – 3		
BS – 13		
Apprentices	11	3
Total	33	

1.1.2 Mentoring

Degree Program	Sem 2 AY 14–15 (p. 4)	Midyear 2015	Sem 1 AY 15–16 (p. 4)	Total
BS Physics	1	0	0	1
BS Applied Physics	1	0	2	3
MS Physics	2	0	1	3
PhD Physics	0	0	1	1
Total	4	0	4	8

1.2 Research Highlights

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2 Technical Report

2.1 Activities of the Research Program

The Structure and Dynamics (SanD) Research Program continues to grow. It has seen a sharp rise in research productivity in the calendar year 2015. The total number of students graduated has quadrupled (two to eight) and a total of four graduate students obtained advanced degrees (3 MS and 1 PhD). Two journal articles have been published in widely-circulated physics journals, and another one is currently in press. Total conference papers and presentations increased from 11 to 27. Two research projects funded by agencies outside NIP have been successfully terminated. In 2016 non-NIP support for SanD research will come from one ongoing research grant, with two more research proposals undergoing review.

2.1.1 Organization

Regular Members (3)

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

PhD Student Members (3)

- 1) Baldo, Carlos III – D7, University Research Associate
- 2) Ilano, Neris – D5
- 3) Santos-Putungan, Alexandra – D2

MS Student Members (3)

- 1) Cortez, April – M4
- 2) Villaruel, Aura Mae – M3
- 3) Itable, Gene – M2

BS Student Members (13)

- 1) Nicolas, Mark Lawrence – B9
- 2) Dizon, Joshua – B6
- 3) Robert Tacbad – B6
- 4) Sanchez, John Kevin – B6
- 5) Tabernilla, Ryan Carlos – B6
- 6) dela Rosa, Rafael – B5
- 7) Laurente Jr., Salvador – B5
- 8) Acosta, Geronimo Allan Jerome – B4
- 9) Colina, Nicholas Christopher – B4
- 10) Elegado, Christopher Patrick – B4
- 11) Esperanza, Robertson – B4
- 12) Fernandez, Zed Harold – B4
- 13) Peria, Lean Louiel – B4

Apprentices (11)

- 1) Mendoza, Jade – M3
- 2) Manceras, Amancio – M2

- 3) Mangada, Mykhal – M2
- 4) Sambo, Jan Philippe – M2
- 5) Ottong, Zheina – B5
- 6) Ayang-ang, Cleofe Dennielle – B4
- 7) Tan, Apolinario Miguel – B4
- 8) Ang, Paul Daniel – B3
- 9) Ferrer, Nica Jane – B3
- 10) Santos, Eduard Renzo – B3
- 11) Trinidad, Jhames Niño – B3

2.1.2 Mentoring

Graduated Sem 2 AY 2014–2015

BS Physics (1)

- 1) Seroje, King Karl R.

BS Thesis: Mode entanglement in bosonic systems: coherent states, squeezed states, displaced squeezed states, and squeezed coherent states

Adviser: Francis Paraan

BS Applied Physics (1)

- 1) Puspus, Xavier M.

BS Thesis: Quantum entanglement in a spin-partitioned BCS ground state

Adviser: Francis Paraan

MS Physics (2)

- 1) Barbarona, Rona F.

MS Thesis: Spin-orbit entanglement entropy in a two-dimensional electron system with Rashba interactions

Adviser: Francis Paraan

- 2) Bayocboc Jr., Francis A.

MS Thesis: Work fluctuation and irreversible entropy in a quenched XY Heisenberg magnet

Adviser: Francis Paraan

Graduated Sem 1 AY 2015–2016

BS Applied Physics (2)

- 1) Sanchez, John Kevin R.

BS Thesis: Parallel simulations of Wolff Monte Carlo algorithm in a 2D Ising model on a kagome lattice

Adviser: Francis Paraan

- 2) Tacbad, Robert C.

BS Thesis: Parallel calculation of the largest Lyapunov exponent from time series

Adviser: Francis Paraan

MS Physics (1)

- 1) Villaruel, Aura Mae B.

MS Thesis: *Polarization fluctuation as an entanglement measure for N-level systems*

Adviser: Francis Paraan

PhD Physics (1)

1) Baldo III, Carlos F.

Dissertation: Spin-polarized electron transport in a uniform perpendicular magnetic field along a curved nanowire with Rashba and Dresselhaus spin-orbit couplings

Adviser: Cristine Villagonzalo

2.2 Research Highlights**2.2.1 International peer-reviewed journal articles (2)**

- 1) Bayocboc Jr., F. A. and F. N. C. Paraan. 2015. “Exact work statistics of quantum quenches in the anisotropic XY model.” *Physical Review E* 92:032142.
- 2) Seroje, K. K. R., R. S. dela Rosa, and F. N. C. Paraan. 2015. “Effective thermodynamics of isolated entangled squeezed and coherent states.” *European Journal of Physics* 36:055051.

2.2.2 International conference papers (2)

- 1) Ilano, N., R. Banzon, and C. Villagonzalo. 2015. “A critically damped quantum search may not necessarily be optimal.” In *Proceedings of the Asian Quantum Information Science Conference 2015*, Seoul, South Korea, 25–28 August 2015, 147–148.
- 2) Villaruel, A. M. B. and F. N. C. Paraan. 2015. “Polarization fluctuation as an entanglement monotone for entangled two-level systems.” In *Proceedings of the Asian Quantum Information Science Conference 2015*, Seoul, South Korea, 25–28 August 2015, 271–272.

2.2.3 International conference presentations (5)

- 1) Baldo III, C. F. and C. Villagonzalo. 2015. “Optimal curvilinear transport of a spin-polarized electron with Rashba and Dresselhaus spin-orbit coupling in a uniform magnetic field.” Presented at the 9th International Conference on Computational Physics, Singapore, 07–11 January 2015.
- 2) Bayocboc Jr., F. A. and F. N. C. Paraan. 2015. “Work statistics in quantum quenches in the Heisenberg XY model.” Presented at the Quantum Many-Body Systems Far from Equilibrium Workshop: Quench dynamics, thermalisation, and cold-atom experiments, Stellenbosch, South Africa, 09–13 March 2015.
- 3) Ilano, N., C. Villagonzalo, and R. Banzon. 2015. “Effect of varying the position of the ancilla qubit and the coupling constants in the simulation of Grover’s quantum search algorithm.” Presented at the 9th International Conference on Computational Physics, Singapore, 07–11 January 2015.
- 4) Santos-Putungan, A. B. and F. N. C. Paraan. 2015. “Structural and magnetic properties of $\text{Zn}_{0.5}\text{Co}_{0.5}\text{O}$ alloy configurations via DFT.” Presented at the 8th Conference of Asian Consortium on Computational Materials Science, Taipei, Taiwan, 16–18 June 2015.
- 5) Villagonzalo, C. 2015. “Spin-orbit coupled effects on the transport of two-dimensional electron systems and nanowires.” Invited talk at the Collaborative Conference on 3D and Materials Research 2015, BEXCO, Busan, South Korea, 15–19 June 2015.

2.2.4 Local conference papers (13)

- 1) Ilano, N., R. Banzon, and C. Villagonzalo. 2015. “Simulation of Grover’s algorithm with position-variation of the ancilla qubit.” In *Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress*, Vigan City, 03–06 June 2015, SPP-2015-2B-06.

- 2) Baldo III, C. F. and C. Villagonzalo. 2015. “Electron spin polarization along a one-dimensional wire with periodic Rashba and uniform Dresselhaus spin-orbit couplings.” In Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress, Vigan City, 03–06 June 2015, SPP-2015-3B-05.
- 3) Barbarona, R. F. and F. N. C. Paraan. 2015. “Spin polarization and its fluctuation in a two-dimensional electron gas with Rashba spin-orbit interactions.” In Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress, Vigan City, 03–06 June 2015, SPP-2015-5C-07.
- 4) Bayocboc Jr., F. A. and F. N. C. Paraan. 2015. “Exact expression for the work fluctuation in a quenched transverse field Ising chain.” In Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress, Vigan City, 03–06 June 2015, SPP-2015-PA-48.
- 5) Cortez, A. and C. Villagonzalo. 2015. “Electric field and spin precession effects on spin injection to semiconductors in three-terminal ferromagnet-insulator-nonmagnetic junctions.” In Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress, Vigan City, 03–06 June 2015, SPP-2015-PA-44.
- 6) dela Rosa, R. S. and F. N. C. Paraan. 2015. “Entanglement entropy of the Silbey-Harris polaron ansatz for a spin-boson model.” In Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress, Vigan City, 03–06 June 2015, SPP-2015-PB-47.
- 7) Itable, G. M. M. and C. Villagonzalo. 2015. “Non-equilibrium collective transport in an Ising chain with Kawasaki dynamics.” In Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress, Vigan City, 03–06 June 2015, SPP-2015-5C-03.
- 8) Laurente Jr., S. T. and F. N. C. Paraan. 2015. “Exact calculation of the average work done in a quenched quantum Ising model.” In Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress, Vigan City, 03–06 June 2015, SPP-2015-PB-48.
- 9) Puspupus, X. M. and F. N. C. Paraan. 2015. “Rényi entanglement entropy of the spin-partitioned BCS ground state.” In Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress, Vigan City, 03–06 June 2015, SPP-2015-2B-03.
- 10) Salazar, H. T., A. B. Santos-Putungan, A. A. Salvador, R. V. Sarmago, M. F. Empizo, K. Yamanoi, R. Arita, T. Shimizu, and N. Sarukura. 2015. “Structural and optical properties of ZnO microrods as fast and efficient UV scintillator materials.” In Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress, Vigan City, 03–06 June 2015, SPP-2015-5B-07.
- 11) Santos-Putungan, A. B., J. G. A. Dizon, D. B. Putungan, and F. N. C. Paraan. 2015. “Enhanced ferromagnetism in $\text{Zn}_{0.5}(\text{Co})_{0.5}\text{O}$ alloy: DFT calculations.” In Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress, Vigan City, 03–06 June 2015, SPP-2015-PA-14.
- 12) Tacbad, R. C., Z. H. E. Fernandez, and F. N. C. Paraan. 2015. “Lateral motion of a spherical particle suspended in Couette flow.” In Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress, Vigan City, 03–06 June 2015, SPP-2015-5C-04.
- 13) Villaruel, A. M. B. and F. N. C. Paraan. 2015. “Polarization fluctuation can partially order entangled qubit states.” In Proceedings of the Samahang Pisika ng Pilipinas: 33rd Physics Congress, Vigan City, 03–06 June 2015, SPP-2015-3B-03.

2.2.5 Local conference presentations (7)

- 1) Villagonzalo, C. 2015. “Spectral and thermodynamic properties of two-dimensional electron systems in the quantum Hall regime.” Presented at the Workshop on theories in Quantum Phenomena and Condensed Matter Physics, University of the Philippines Los Baños, 22–23 April 2015.

- 2) Paraan, F. N. C. 2015. “Mode entanglement in BCS superconductivity, quantum optics, and quantum Hall physics.” Presented at the Workshop on theories in Quantum Phenomena and Condensed Matter Physics, University of the Philippines Los Baños, 22–23 April 2015.
- 3) Baldo III, C. F. 2015. “Spin switching in a spin-orbit coupled transport in a curved nanowire.” Presented at the Workshop on theories in Quantum Phenomena and Condensed Matter Physics, University of the Philippines Los Baños, 22–23 April 2015.
- 4) Cortez, A. 2015. “Electric field and spin precession effects on spin injection to semiconductors in three-terminal ferromagnet-insulator-nonmagnetic junctions.” Presented at the Workshop on theories in Quantum Phenomena and Condensed Matter Physics, University of the Philippines Los Baños, 22–23 April 2015.
- 5) Ilano, N. 2015. “Simulation of the quantum search algorithm in an Ising spin system.” Presented at the Workshop on theories in Quantum Phenomena and Condensed Matter Physics, University of the Philippines Los Baños, 22–23 April 2015.
- 6) Santos-Putungan, A. 2015. “Computational materials science via density functional theory: General introduction and success stories.” Presented at the Workshop on theories in Quantum Phenomena and Condensed Matter Physics, University of the Philippines Los Baños, 22–23 April 2015.
- 7) Villaruel, A. M. 2015. “Quantum fluctuation theorems in quenched systems.” Presented at the Workshop on theories in Quantum Phenomena and Condensed Matter Physics, University of the Philippines Los Baños, 22–23 April 2015.

2.2.6 NIP funded projects (3)

- 1) Project Leader: Banzon, Ronald S.
Project Title: Quantum computation simulation of an Ising nuclear spin chain computer of various sizes
Period: 01 January 2015–31 December 2015
- 2) Project Leader: Paraan, Francis Norman C.
Project Title: Parallelized calculation of electronic structure for materials simulation
Period: 01 January 2015–31 December 2015
- 3) Project Leader: Villagonzalo, Cristine DLR.
Project Title: Modelling of spin accumulation and extraction in ferromagnetic tunnel heterostructures
Period: 01 January 2015–31 December 2015

2.2.7 Non-NIP funded projects (4)

- 1) Project Leader: Baldo III, Carlos F.
Type: OVCRD Thesis and Dissertation Grant/Project No. 151501 DNSE
Project Title: Transport in nanowires with Rashba and Dresselhaus spin-orbit couplings
Period: 01 January 2015–31 December 2015
Amount: P60 000
- 2) Project Leader: Paraan, Francis Norman C.
Type: OVPAAL Balik PhD Grant/OVPAAL-BPhD-2012-05
Project Title: Quantum entanglement in low-dimensional systems: quantum spin chains and continuum systems
Period: 01 April 2013–31 July 2015

Amount: P1 914 000

- 3) Project Leader: Paraan, Francis Norman C.

Type: OVCRD PhD Incentive Award/PhDIA Project No. 141420

Project Title: Quenches in solvable spin-chain models

Period: 01 October 2014–30 September 2015

Amount: P300 000

- 4) Project Leader: Villagonzalo, Cristine DLR.

Type: OVPAAs Enhanced Creative Writing and Research Grant/ECWRG 2014-12

Project Title: Specific heat capacity studies in a two-dimensional electron system with Rashba spin-orbit coupling in tilted magnetic fields

Period: 02 February 2015–01 August 1 2016

Amount: P600,000.00 (subject to withholding tax)

2.2.8 Major equipment acquired or upgraded (2)

- 1) Two (2) Desktop computers with UPS and voltage regulators

Cost: P122 691.90

Mode of acquisition: OVPAAs-BPhD-2012-05

End-user: Paraan, Francis Norman C.

- 2) Computer accessories, parts, and peripherals

Cost: P21 700.00

Mode of acquisition: PhDIA Project No. 141420

End-user: Paraan, Francis Norman C.

2.2.9 Outbound travel abroad (9)

- 1) Name: Baldo III, Carlos F.

Purpose: Research dissemination

Place: Singapore

Dates: 07–11 January 2015

Mode of exchange: REPS Research Dissemination Grant

- 2) Name: Ilano, Neris F.

Purpose: Research dissemination

Place: Singapore

Dates: 07–11 January 2015

Mode of exchange: College of Science Grant

- 3) Name: Villagonzalo, Cristine DLR.

Purpose: Research dissemination

Place: Singapore

Dates: 07–11 January 2015

Mode of exchange: Personal

- 4) Name: Elegado, Christopher Patrick P.

Purpose: Student exchange program

Place: Japan

Dates: 02–15 March 2015

Mode of exchange: JICE/DOST Japan-East Asia Network of Exchange for Students and Youths Exchange Programme

- 5) Name: Bayocboc Jr., Francis A.
Purpose: Research dissemination
Place: Stellenbosch, South Africa
Dates: 09–13 March 2015
Mode of exchange: OVPAA-BPhD-2012-05
- 6) Name: Villagonzalo, Cristine DLR.
Purpose: Research dissemination
Place: Busan, South Korea
Dates: 15–19 June 2015
Mode of exchange: ECWRG 2014-12
- 7) Name: Santos-Putungan, Alexandra B.
Purpose: Research dissemination
Place: Taipei, Taiwan
Dates: 16–18 June 2015
Mode of exchange: OVPAA-BPhD-2012-05
- 8) Name: Ilano, Neris F.
Purpose: Research dissemination
Place: Seoul, Korea
Dates: 25–28 August 2015
Mode of exchange: ECWRG-2014-12
- 9) Name: Villaruel, Aura Mae B.
Purpose: Research dissemination
Place: Seoul, Korea
Dates: 25–28 August 2015
Mode of exchange: DOST-SEI ASTHRDP Student Research Support Fund

2.2.10 Inbound visiting researchers (1)

- 1) Visitor: Outram, Benjamin
Purpose: Research talk
Duration: 18 May 2015
NIP Contact: Paraan, Francis Norman C.
Mode of exchange: Personal

2.3 Extension Work Highlights

2.3.1 Extension Work Activities¹ (7)

- 1) Name: Ronald Banzon
Extension work: Subject consultant for physics curriculum
Organization: Philippine Science High School System
- 2) Name: Francis Paraan
Extension work: Referee
Organization: American Physical Society

¹From 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) Name: Francis Paraan
Extension work: Topical editor
Organization: Samahang Pisika ng Pilipinas
- 4) Name: Francis Paraan
Extension work: Moderator
Organization: Department of Science and Technology Science Education Institute
Event: National DOST-SEI ASTHRDP-NSC Scholars' Conference, 07–08 May 2015
- 5) Name: Francis Paraan
Extension work: Judge
Organization: Philippine Society of Youth Science Clubs
Event: 3rd Annual SEARCH for the Most Outstanding Science Club, 07 March 2015
- 6) Name: Cristine Villagonzalo
Extension work: Philippine Representative to the Asia Pacific Center for Theoretical Physics (APCTP), Pohang, South Korea
Organization: National Research Council of the Philippines
- 7) Name: All SanD members
Extension work: Volunteer fund-raising activity
Organization: Central Visayan Institute Foundation

2.3.2 Research Interns and Trainees (4)

- 1) Intern/Trainee: Andales, Hillary Diane
School: PSHS Eastern Visayas
NIP Contact: Paraan, Francis Norman C.
Remarks: NIP-PSHS Science Internship Program (MOU)
- 2) Intern/Trainee: Famador, John Althani
School: PSHS Central Visayas
NIP Contact: Paraan, Francis Norman C.
Remarks: NIP-PSHS Science Internship Program (MOU)
- 3) Intern/Trainee: Romero, Justin Che
School: PSHS Bicol Region
NIP Contact: Paraan, Francis Norman C.
Remarks: NIP-PSHS Science Internship Program (MOU)
- 4) Intern/Trainee: Rojas, Nathalie Liezel
School: University of Northern Philippines
NIP Contact: Paraan, Francis Norman C.
Remarks: DOST Summer Practical Training Program

2.4 Challenges Encountered

- 1) Graduate students that attended SPP 2015 were not supported by university funds.
Proposed solution: Other sources of funding must be obtained in 2016 for graduate students.

2.5 Awards, Accreditations, and Positions of Responsibilities Held

2.5.1 National awards and positions held (3)

- 1) Name: Puspus, Xavier M.
Award: National Finalist 2015 BPI-DOST Science Awards
Award-giving body: BPI, DOST
- 2) Name: Cristine Villagonzalo
Position: Second Vice President
Organization: Samahang Pisika ng Pilipinas
- 3) Name: Francis Paraan
Position: Councilor
Organization: Samahang Pisika ng Pilipinas

3 Appendices

3.1 Photographs



SanD members as of June 2015

3.2 Attached journal publications

- 3.2.1 Bayocboc Jr., F. A. and F. N. C. Paraan. 2015. “Exact work statistics of quantum quenches in the anisotropic XY model.” *Physical Review E* 92:032142.
- 3.2.2 Seroje, K. K. R., R. S. dela Rosa, and F. N. C. Paraan. 2015. “Effective thermodynamics of isolated entangled squeezed and coherent states.” *European Journal of Physics* 36:055051.