

*The Structure and Dynamics Group 2011 Annual Report*

National Institute of Physics  
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**Structure and Dynamics Research Program Annual Report**

Period Covered : **January – December 2011**

Program Coordinator : Dr. Cristine Villagonzalo

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### A.1 Past year activities and current list of research members

*Regular Activities.* The Structure and Dynamics Group have regular seminars every Monday afternoon this first semester, A.Y. 2011 – 2012. This second semester the seminars will be conducted every Wednesday afternoon. The research meetings per student vary according to the schedule of their thesis supervisors.

*Conferences Attended.* The following 2011 conferences have been attended by some members of the Structure and Dynamics group.

1. 8<sup>th</sup> World Scientific and Engineering Academy and Society (WSEAS) International Conference on Mathematical Biology and Ecology  
January 29 – 31, 2011, Puerto Morelos, Mexico  
(a.) Oral presentation by C.M. Piñol of the paper “The effect of limiting resources in aging populations” by C.M. Piñol and R. Banzon.
2. 26<sup>th</sup> International Conference on Low Temperature Physics  
August 10 – 17, 2011, Beijing, China  
(a.) Poster presentation by C. Baldo of the paper “Low-lying spin excitations due to next-nearest neighbour interactions in ferromagnetic lattices ” by C. Baldo III & C. Villagonzalo.  
(b.) Poster presentation by R. Gammag of the paper “The interplay of Rashba spin-orbit interaction and Landau level broadening on a two-dimensional electron gas under a tilted magnetic field” by R. Gammag and C. Villagonzalo.
3. 24<sup>th</sup> National Physics Congress  
October 24 – 26, 2011, National Institute of Physics, University of the Philippines Diliman  
(a.) Oral presentation by N. Ilano of the paper “Optimizing the damped quantum search algorithm” by N. Ilano, R. Banzon and C. Villagonzalo.  
(b.) Oral presentation by M. Capili of the paper “Determination of the critical exponent  $\beta$  in site percolation using average occupation” by M. Capili, C. Villagonzalo and R. Banzon.  
(c.) Poster presentation by C. Villagonzalo and R. Banzon of the paper “Persistence in the zero temperature dynamics of the 1D Ising model with long range interactions” by H. Lazo, R. Banzon and C. Villagonzalo.

*SanD Active Members.* The Structure and Dynamics Group consist of two Ph.D. faculty members, several graduate students and one undergraduate student. They are as follows:

Ph.D. Faculty Members	Dr. Ronald Banzon Dr. Cristine Villagonzalo Program Coordinator
Ph.D. Students	Chryslie Margus Piñol (up to May 2011) Carlos Baldo III Rayda Gammag (up to December 2011) Neris Ilano
M.S. Student	Micielle Capili
Undergraduate Student	Hilton Lazo

The SanD group has been waiting since January 2011 for the authority to fill of the vacated University Research Associate 1 position. Without this authority to fill, SanD is unable to hire one graduate student to do research in the group.

One M.S. student, Gina Rose Tongco, has been on a Leave – Of – Absence.

## A.2 List of graduate students who completed their thesis / dissertations in 2011

1. Ph.D. in Physics  
**Rayda P. Gammag** (NIP- CHED Scholar through the NIP as a Center of Excellence Program of the Commission on Higher Education)  
 Dissertation: *Tilted Magnetic Fields and Spin Interactions on a Two-Dimensional Electron Gas at Low Temperatures*  
 Defended on: October 2011  
 Adviser: Dr. C. Villagonzalo
  
2. Ph.D. in Physics  
**Chryslie Margus N. Piñol** (DOST-ASTHRD Scholar through the DOST's Accelerated Science and Technology Human Resource Development Program)  
 Dissertation: *A Verhulst-free Approach to Population Modeling*  
 Defended on: March 2011  
 Adviser: Dr. R. Banzon
  
3. M.S. in Physics  
**Kristine Eia S. Antonio**  
 Thesis: *A 2D Square Ising-like Susceptible-Infected Model for Malware Spread*  
 Defended on: March 2011  
 Adviser: Dr. R. Banzon

## A.3 Update on the mentorship record (2003 – 2011) of the SanD group

As of 2011, the SanD Ph.D. faculty members have mentored 2 Ph.D., 13 M.S. and 24 B.S. students.

**Table 1. Summary of the Mentorship Record of the Structure and Dynamics Group**

Year	Undergraduate			Graduate	
	B.S. Applied Physics	B.S. Physics	Total	M.S. in Physics	Ph.D. in Physics
2011	0	0	0	1	2
2010	1	0	1	1	0
2009	1	1	2	2	0
2008	1	0	1	3	0
2007	3	3	6	2	0
2006	4	0	4	2	0
2005	1	4	5	0	0
2004	1	4	5	2	0
2003	0	0	0	0	0
<b>total</b>	<b>12</b>	<b>12</b>	<b>24</b>	<b>13</b>	<b>2</b>

## **B.1 Amount and funding agency of funded projects**

### Project 1

Project title: Stability in a population model without random deaths by the Verhulst factor  
Proponent: Dr. Ronald Banzon  
Funding Agency: National Institute of Physics  
Duration: January – December 2011  
Amount: Php 42,000.00

#### Brief Description:

The concept of a carrying capacity is difficult to account for practically and is in some cases unessential in the description of the dynamics of a population. The resulting population model is significant in the sense that it will be the only one that does not use explicitly and/or implicitly a carrying capacity. The objective of the project is to find a population model that has non-vanishing steady states and that does not utilize the concept of a carrying capacity.

### Project 2

Project title: Long-range disorder effect on the heat capacity of two-dimensional electron systems  
Proponent: Dr. Cristine Villagonzalo  
Funding Agency: National Institute of Physics  
Duration: January – December 2011  
Amount: Php 42,000.00

#### Brief Description:

The goal of this project is to derive an analytic expression for the specific heat capacity of a two-dimensional electron system (2DES) when long range disorder is taken into account. The long range disorder will enter in the model via a Lorentzian shape of the density of states of the 2DES. Studying the thermodynamic properties of the 2DES are of interest since they are the active layer of semiconductor heterostructures which, in turn, are the basic components of computer chips.

### Project 3

Project title: Spin – orbit interaction in two-dimensional electron systems under tilted magnetic fields  
Proponent: Dr. Cristine Villagonzalo  
Funding Agency: Commission on Higher Education (CHED)  
This is through the “NIP as Center of Excellence Program” of CHED and in support of the NIP – CHED scholarship for Ms. Rayda Gammag for her Ph.D. dissertation.  
Duration: November 2010 – December 2011  
Amount: Php 100,000.00

#### Brief Description:

This work aims to analytically solve the Hamiltonian of a 2DES when the external magnetic field is tilted. After solving for the wave function analytically measurable properties like the specific heat and magnetization can be derived. The novel contribution of this work will help shed light on the anisotropy observed on magnetization, for example.

## **B.2 ISI Publications**

1. R. Gammag and C. Villagonzalo, Persistent spin splitting of a two-dimensional electron gas in tilted magnetic fields, accepted for publication in the *European Physical Journal B* (2011)

The articles below have been reported previously. But here lies the complete 2011 bibliographic citation:

2. C.M.N. Piñol and R.S. Banzon, Stability in a population model without random deaths by the Verhulst factor, *Physica A* **390** (2011) pp. 1295 – 1299  
[doi:10.1016/j.physa.2010.11.046]
3. C.M.N. Piñol and R.S. Banzon, Catastrophic senescence and semelparity in the Penna aging model, *Theory in Biosciences* **130** (2011) pp. 101 – 106  
[doi:10.1007/s12064-010-0115-7]
4. C. Villagonzalo and R. Gammag, The intrinsic features of the specific heat at half-filled Landau levels of two-dimensional electron systems, *Journal of Low Temperature Physics* **163** (2011) pp. 43 – 52  
[doi: 10.1007/s10909-010-0259-3]

### **B.3 Book Section / International Proceedings**

1. C.M.N. Piñol and R.S. Banzon, “The effect of limiting resources in aging populations” in Recent Advances in Fluid Mechanics, Heat and Mass Transfer and Biology, eds. Alexander Zemliak & Nikos Mastorakis (WSEAS Press, 2011), pp. 100 – 104  
[ISBN: 978-960-474-268-4]

### **B.4 Other Publications**

The following papers appears in the refereed **Proceedings of the 24<sup>th</sup> National Physics Congress**, held at the National Institute of Physics, University of the Philippines Diliman last 24 – 26 of October, 2011:

1. N. Ilano, R. Banzon and C. Villagonzalo, “Optimizing the damped quantum search algorithm” (manuscript # spp-2011-037)
2. M. Capili, C. Villagonzalo and R. Banzon, “Determination of the critical exponent  $\beta$  in site percolation using average occupation” (manuscript # spp-2011-048)
3. H. Lazo, R. Banzon and C. Villagonzalo, “Persistence in the zero temperature dynamics of the 1D Ising Model With Long Range Interactions ” (manuscript # spp-2011-182)

### **C. On-going Research Projects**

#### **C.1 Research on Spin Systems on Ferromagnetic Lattices**

Project: Low-lying Spin Excitations in Ferromagnetic Lattices  
Faculty involved: Dr. Cristine Villagonzalo  
Student involved: Carlos Baldo III (Ph.D. in Physics)

**Brief Description:**

With the emergence of new materials such as magnetic multilayers and compound high- $T_C$  superconductors, as well as, the current advances in probing magnetic excitations, the study of spin waves has gone beyond the interplay between nearest neighboring spins. In this project, spin excitations near the ground state in cubic ferromagnetic lattices are derived analytically using a semi-classical approach that incorporates next-nearest neighboring spin interactions.

## **C.2 Research on Computational Physics in Percolation**

**Project:** Determination of critical exponents and related properties in site percolation in a square lattice  
**Faculty involved:** Dr. Ronald Banzon and Dr. Cristine Villagonzalo  
**Student involved:** Micielle Capili (M.S. in Physics)  
**Brief description:**

According to the scaling theory of percolation, the clusters formed in a square lattice in site percolation explain the emergence of the bulk properties. The dynamics of the cluster size lead to the manifestation of different cluster features. Therefore, the aim of this work is to study the critical exponents of site percolation and their related properties when a cluster spans the lattice. This is important for the description of the behavior of systems near the phase transition.

## **C.3 Research on Numerical Modelling of Magnetic Systems**

**Project:** Zero-temperature Dynamics of the Ising Model with Long Range Interactions  
**Faculty involved:** Dr. Ronald Banzon and Dr. Cristine Villagonzalo  
**Student involved:** Hilton Lazo (B.S. in Physics)  
**Brief description:**

The one dimensional Ising model is the simplest model of magnetic spin systems and has been extensively studied using nearest neighbor interactions. Significant alterations in magnetic properties of a one dimensional spin system is expected when long range interactions are incorporated. The goal of this work is to investigate the spin dynamics as a result of the addition of long range interactions. An example is the persistence problem which is the tendency of the spins to stay in their initial configuration as the system undergoes temporal evolution. A numerical simulation will be conducted to observe the persistence nature and other properties at equilibrium.

## **C.4 Research on Quantum Computing**

**Project:** Dissipation-enhanced quantum search as applied to Ising spin systems  
**Faculty involved:** Dr. Ronald Banzon and Dr. Cristine Villagonzalo  
**Student involved:** Neris Ilano (Ph.D. in Physics)  
**Brief description:**

One aspect of this project is to seek on 8- and 12-spin Ising systems for at least one of their eigenstates of a certain eigenvalue by applying the damped quantum search. For comparison, we also show the classical result and the quantum search result assuming ignorance of the degeneracy of energy states. This is an example of searching in a quantum database. The ultimate goal is optimize the quantum search algorithm through a damping process.