CMS-Studc Student Research Session
Session de recherche étudiante - SMC-comÉtud
(Org: **Kyle MacDonald** (McMaster University) and/et **Yingjie Qian** (McGill University))

LONGBIN CHEN, York University

ALEXANDER CHERNYAVSKY, McMaster University
Long-Time Stability of Standing Waves in Hamiltonian $\mathcal{PT}$-symmetric Chains of Coupled Pendula

I consider the Hamiltonian version of a $\mathcal{PT}$-symmetric lattice that describes dynamics of coupled pendula perturbed by a periodic resonant movement of their bases. Newton's equations of motion are reduced asymptotically to the $\mathcal{PT}$-symmetric discrete nonlinear Schrödinger equation. In the limit of weak coupling between the pendula, existence of periodic synchronized oscillations supported near one pair of coupled pendula follows by standard bifurcation analysis. If the gain-damping parameter that corresponds to the periodic resonance force is sufficiently small, spectral stability of such synchronized oscillations can be proved within the same limit. As the main contribution, I prove the nonlinear long-time stability of the synchronized oscillations by using the Lyapunov method. The periodic movement of coupled pendula is a saddle point of a constrained Hamiltonian function, which exists between the continuous bands of positive and negative energy. Nevertheless, I construct the approximate Lyapunov function and use it for the proof of nonlinear long-time stability of the synchronized oscillations of the coupled pendula.

MATTHEW JORDAN, McMaster University
The Eerie Oneness of Mathematics and Physics

Mathematics is freakishly good at describing the universe. For instance, it is possible to derive the fundamental laws of quantum mechanics from mathematical first principles, without even knowing what a hydrogen atom is. This talk will investigate this eerie oneness of mathematics and physics via the *Heisenberg group*, an easily-defined structure with far-reaching and deep applications. I will begin by deriving the Heisenberg group from elementary matrices, then explain how a simple matrix group can give us insights into Fourier analysis and quantum mechanics. In particular, I will demonstrate the relationship between the Heisenberg group and the celebrated but widely misunderstood Uncertainty Principle. Finally, I'll discuss some novel attempts to prove variations of the Uncertainty Principle. These topics were investigated by myself, Kirk Hendricks (University of Arizona), and Recep Çelibi (Lafayette College) as part of the Fields Undergraduate Summer Research Program 2015, under the supervision of Dr. Hadi Salmasian (University of Ottawa).

HOMAYUN KARIMI, McMaster University

TYLER MEADOWS, McMaster University

YURIJ SALMANIW, McMaster University

J.C. SAUNDERS, University of Waterloo

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Harmonic analysis on p-adic symmetric spaces, the discrete spectrum

Let F be a p-adic field and $G = \mathbf{G}(F)$ the F-points of a connected reductive group defined over F. Given an involution θ of G we define H to be the subgroup of θ-fixed points. The quotient $H\backslash G$ is a p-adic symmetric space. In this talk we will discuss harmonic analysis on $H\backslash G$ and the notion of distinguished representations. In particular, we will consider the problem of constructing the irreducible G-representations that occur as subrepresentations of the space of square-integrable functions on $H\backslash G$, the so called relative discrete series (RDS). We will give a construction of RDS representations for two symmetric quotients of p-adic general linear groups.

LIANG WANG, McMaster University

YIYUAN WANG, York University