

**PROCORE - FRANCE/HONG KONG JOINT RESEARCH SCHEME  
COMPLETION REPORT**

**Project Reference Number**

F\_HK02/10T

**Project Title**

Stochastic Chen's System: Stability and Applications  
隨機陳氏系統：穩定性及其應用

**Particulars**

	Hong Kong team				French team			
Name of Project Co-ordinator (with title)	English: Guanrong Chen Chinese: 陳關榮				Guoting Chen			
Name of Co-Investigator (if any)	English: K W Chung Chinese: 鐘國威							
Institution or Institutional affiliation	<input checked="" type="checkbox"/>	CityU	<input type="checkbox"/>	HKU	<input type="checkbox"/>	CEA	<input type="checkbox"/>	INRA
	<input type="checkbox"/>	CUHK	<input type="checkbox"/>	HKUST	<input type="checkbox"/>	CNRS No.	<input type="checkbox"/>	INRIA
	<input type="checkbox"/>	HKBU	<input type="checkbox"/>	LU	<input type="checkbox"/>	INFREMER	<input type="checkbox"/>	INSERM No.
	<input type="checkbox"/>	HKIED	<input type="checkbox"/>	PolyU	<input checked="" type="checkbox"/>	University of	Lille	
	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	Others:		
Other project team members (if any)					Volker Mayer			

**Funding Period**

	1 <sup>st</sup> year	2 <sup>nd</sup> year (if applicable)
Start Date	1 Jan 2011	1 Jan 2012
Completion Date	31 Dec 2011	31 Dec 2012

**Objective(s) as per original application**

1. Study dynamical properties of Chen's system with random perturbations;
2. Study the asymptotic stability;
3. Study the applications to control systems theory

[Please attach relevant document(s)]

**i) Outline of proposed research and results obtained**

(1) Integrability of plane differential systems (see the joint paper [1]). This problem has been studied by many authors and it has many applications. We have been concentrated on the integrability of the Lotka-Volterra type systems of degree 4 and with 1:-(3q-1) resonances. We have proved some sufficient conditions for the integrability of the systems and given some necessary conditions by studying the first two saddle values of the system. In the particular cases of 1:-2, 1:-5 and 1:-8 resonances, we derive necessary and sufficient conditions for the integrability of the systems (see [1]).

(2) We have obtained a simple yet complex one-parameter family of generalized Lorenz-like systems, which is closely related to the proposed topic of Chen's system: its applications (see [2]).

(3) We have begun to study stochastic differential systems. For example, in [3], SIRS (susceptible-infected-removed-susceptible) model influenced by random perturbations has been studied. We prove that the solutions are positive for positive initial conditions and are global, that is, there is no finite explosion time. We present necessary and sufficient conditions for the almost sure asymptotic stability of the steady state of the stochastic system.

**ii) Significance of research results**

All proposed research topics have been investigated, and the activities went slightly beyond the proposed scope. The results will be very useful for further extension and generalization of the Lorenz-Chen systems family.

**iii) Research output**

[1] C. Liu, G. T. Chen and G. R. Chen, Integrability of Lotka-Volterra type systems of degree 4. *J. Math. Anal. Appl.* 388 (2012), 1107–1116. [attached]

[2] X. Wang, J. Chen, J-A. Lu and G. R. Chen, A simple yet complex one-parameter family of generalized Lorenz-like systems, *International Journal of Bifurcation and Chaos*, 22 (2012): 1250116. [attached]

[3] G. T. Chen, T. Li and C. Liu, Lyapunov exponent of a stochastic SIRS model, *Comptes Rendus Mathematique, Acad. Sci. Paris, Ser. 351* (2013): 33-35.

**iv) Potential for or impact on further research collaboration**

In the near future, we can work together on stochastic generalized Lorenz system: stability and applications.