

國立中央大學數學系

專題演講

主 講 人：李彥奇博士 (鴻海研究院)

演講題目：**Unveiling Molecular Communication: Channel Modeling and Capacity Analysis**

演講茶會：2024年03月14日(星期四) 3:30 p.m. ~ 4:00 p.m.

茶會地點：中央大學鴻經館M306

演講時間：2024年03月14日(星期四) 4:00 p.m. ~ 5:00 p.m.

演講地點：中央大學鴻經館M107

Abstract：

This talk is structured into two parts.

Part I: Introduction to Molecular Communication and Channel Modeling

To begin, I will give a brief overview of the emerging field of Molecular Communication (MC). Subsequently, we will delve into the mathematical modeling of communication channels used in MC systems. After developing a suitable mathematical model, we will explore the analysis of the Channel Impulse Response (CIR) within diffusive MC systems. In our recent research, we introduce a novel approach where the transmission position, rather than the transmission time, serves as an information carrier. This new channel is termed the First-Arrival-Position (FAP) channel, in which the information is recorded in the first hitting position on the receiver surface. By meticulously examining the relationship between the convection-diffusion equation (a PDE model) and the Itô diffusion process (an SDE model), we aim to find a closed-form FAP density formula for characterizing the channel response of such FAP systems. For this purpose, tools from stochastic analysis are employed, including the generator of a diffusion semigroup and Dynkin's formula.

Part II: Introduction to Information Theory and Channel Capacity Analysis

The second part begins with an introduction to basic concepts from information theory. A central concept is the "channel capacity", which encapsulates the fundamental information transmission rate of the channel under consideration. Our recent research tackles the problem of estimating the channel capacity of FAP channels from two perspectives. First, we focus on capacity estimation within a subclass of FAP channels termed VDFAP channels (where VD denotes vertical drift). Second, we explore scenarios under zero-drift assumption. Our results demonstrate that FAP channels exhibit behavior akin to heavy-tailed Cauchy distributions as the background drift velocity approaches zero. Because Cauchy-like distributions lack first and second moments, traditional constraints (e.g., the mean-square constraint) on input distributions are rendered ineffective. To address this challenge, we introduce a relative power measure, the α -power, into the field of MC. We explicitly depict the signal space required to characterize the zero-drift FAP channel capacity. Additionally, we derive the Shannon capacity of FAP channels in 2D and 3D spaces in closed form, under a newly proposed logarithmic constraint.

敬 請 公 告 ， 歡 迎 參 加