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Dengue Virus Nonstructural Protein 1: A Pathogenic Factor and Therapeutic Target

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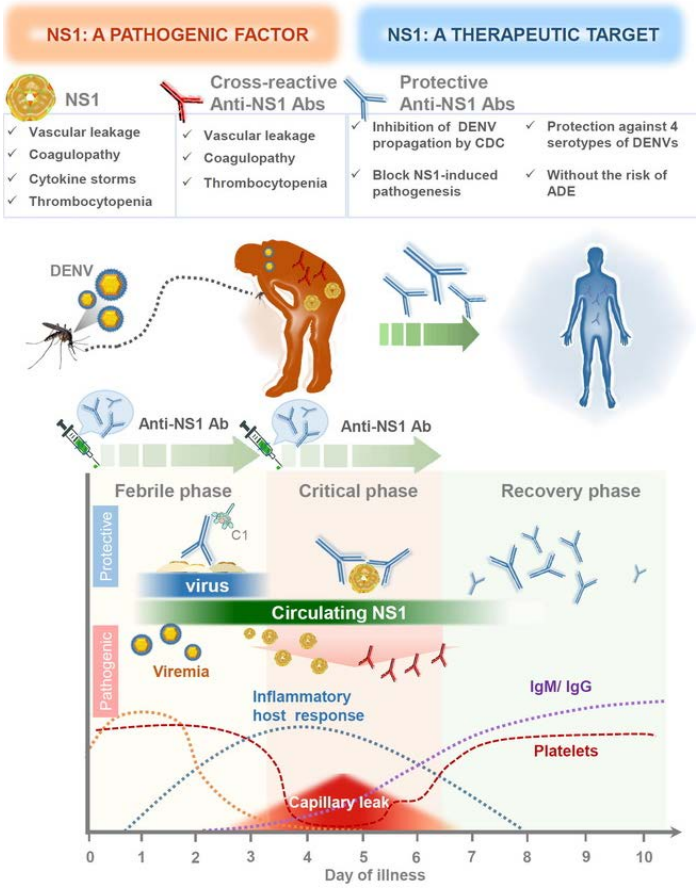
Dengue virus (DENV) infection is the most common mosquito-borne viral infection. Majority of DENV-infected subjects demonstrate asymptomatic profiles or mild dengue fever. Unfortunately, others may progress to severe dengue hemorrhagic fever (DHF) or dengue shock syndrome (DSS). Vascular leakage and hemorrhage are two characteristic pathogenic changes in DHF/DSS patients. However, the pathogenic mechanisms of vascular leakage and hemorrhage induced by DENV infection are still not fully understood. DENV nonstructural protein 1 (NS1), which can be secreted in patients' sera, has been used as an early diagnostic marker for dengue infection. However, the roles of NS1 in dengue pathogenesis are unclear. We are the first one to show that antibodies (Abs) against DENV NS1 can cross-react to human endothelial cells and platelets and disrupt their functions. In addition, we found NS1 can directly induce endothelial hyperpermeability and glycocalyx degradation through macrophage migration inhibitory factor-induced autophagy. Furthermore, DENV NS1 can bind to platelet and induce its activation and apoptosis, leading to thrombocytopenia. Therefore, NS1 is a pathogenic factor which can cause vascular leakage and hemorrhage by NS1 itself or NS1-induced cross-reactive Abs. To block the pathogenic effects of NS1, we have identified monoclonal Abs (mAbs) against NS1 which do not cross-react to human proteins but can protect mice from lethal challenge of all four serotypes of DENV infection. The pathogenic effects of NS1 and the advantage of therapeutic targeting at NS1 by its mAbs are summarized in the following figure.



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Thermal Performance of Two-Phase Thermosyphon Loop in Rotating Thin Pad

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Motor rotor cooling play crucial role for the technology advancement of an electric motor with high power density. The coolant flow in rotating passage is affected by Coriolis force and centrifugal buoyancy. The attendant influences on turbulent characteristics, flow structures and interfacial mechanics act simultaneously to alter the thermal performance form the stationary scenarios. It remains as a difficult task to measure the boiling flow structures and heat transfer rates with negative gauge pressures at rotating conditions. Fig. 1(a) depicts the boiling flow snapshots at stationary and rotating conditions. As the dimensionless rotation number (Ω) increases, the boiling structure yields from slug flow to nucleate boiling conditions with strings of coherent mini vapor bubbles. The corresponding thermal performances shown by Fig. 1(b) exhibits the decrease of total thermal resistance as Ω increases. The applicability of two-phase heat transfer device operated at negative gauge pressures is assumed for future developments of passive motor rotor cooling devices.

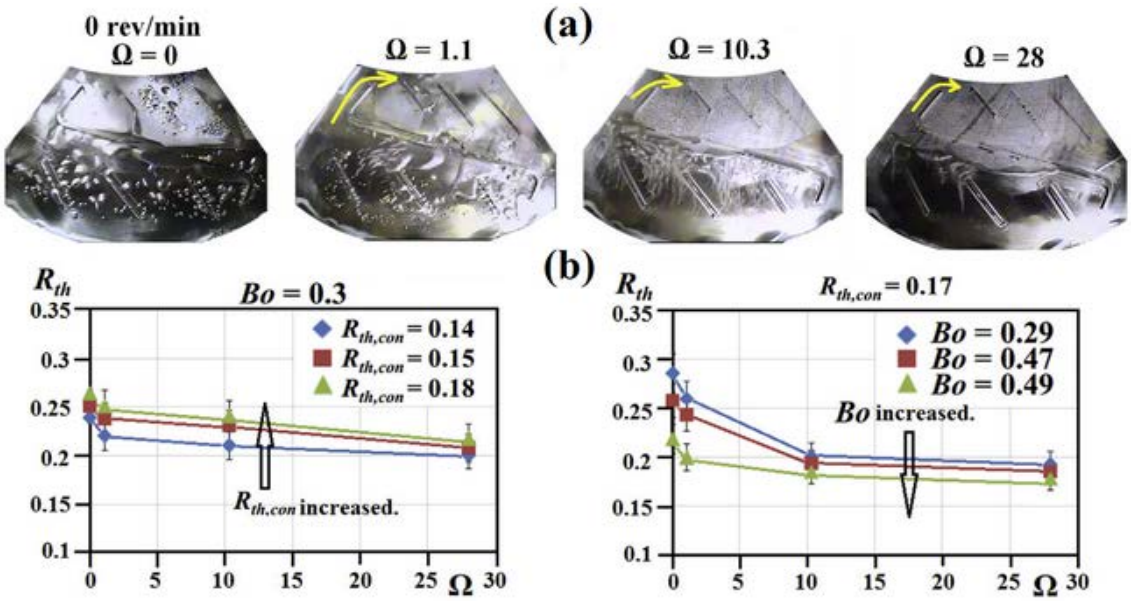

Fig. 1. (a) boiling flow snapshots at stationary and rotating conditions (b) variations of total thermal resistance of rotating thermosyphon pad against Ω.

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A Review of Semi-Analytical Numerical Methods for Laminated Composite and Multilayered Functionally Graded Elastic/Piezoelectric Plates and Shells

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This article was intended to present a comprehensive survey regarding the papers examining various three-dimensional (3D) structural behavior of laminated composite (LC) plates/shells and functionally graded (FG) plates/shells using a semi-analytical numerical method. This review article contains 198 references, of which 50 papers are contributed from the research group of the first author, Professor Chih-Ping Wu.

Due to the fact that the pure 3D analytical approaches, including the state space, the series expansion, the modified Pagano, and the perturbation methods, are mathematically complicated and that the solution processes of the pure 3D numerical methods, including the 3D differential quadrature (DQ), the 3D finite element (FE), and the 3D differential reproducing kernel (DRK) meshless methods, are very time consuming, a class of compromise approaches, so-called 3D semi-analytical numerical method, has thus been developed for the quasi-3D structural behavior analysis of these LC and FG plates/shells.

The first author's research group incorporated the state space and the perturbation methods with the DQ, the FE, and the DRK methods to develop some innovative computational methods for the above-mentioned structures, such as the state space DQ, the state space DRK, the asymptotic DQ, the asymptotic DRK, and the asymptotic FE methods, most of which were proposed for the first time in the literature.

The accuracy and the convergence rate of Wu's semi-analytical DQ, DRK, and FE methods were validated by comparing their solutions with the exact 3D solutions available in the literature. The results showed the solutions of these semi-analytical numerical methods are in excellent agreement with the exact 3D solutions and the convergence rate of these semi-analytical numerical methods is rapid. The detailed comparative study of the results obtained using different semi-analytical numerical methods can be found in the article (Composite Structures, vol. 147, pp. 1-15).

Table 1. Comparisons with regard to the meshes and configuration between the current finite cylindrical prism and traditional layerwise shell elements.

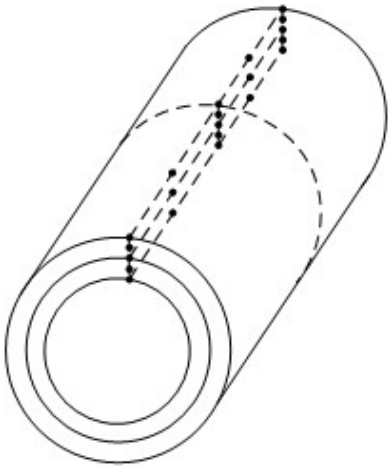
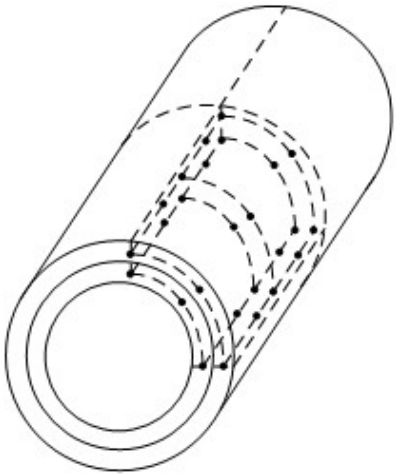
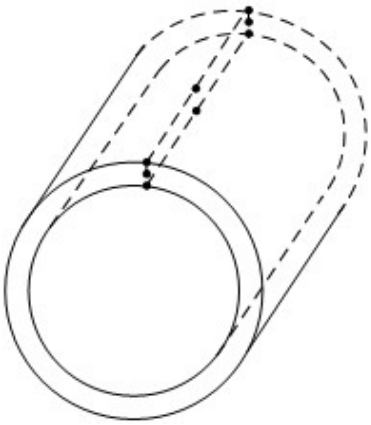
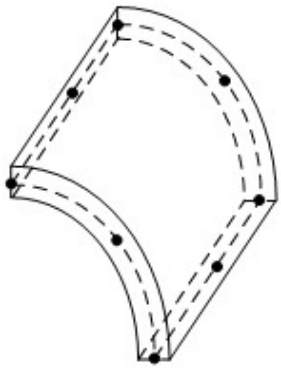
Elements	Finite cylindrical prism elements	Layer-wise shell elements
Meshes	 (the 2x1x2 mesh)	 (1/4 cylindrical model with a 2x1x2 mesh)
Configuration	 (a Q8 prism element)	 (a Q8 shell element)

Table 2. Comparative studies of the results obtained by using the current finite prism method and the exact 3D solutions for the stress and deformation analyses of a simply-supported, [90°/0°/90°] laminated composite cylinder under a sinusoidally distributed load(L/R=4 and R/h=4).

Theory	Related parameters	$\bar{\sigma}_x\left(\frac{L}{2},0,\frac{h}{2}\right)$	$\bar{\sigma}_\theta\left(\frac{L}{2},0,\frac{h}{2}\right)$	$\bar{\tau}_{x\theta}\left(0,\frac{\pi}{2},\frac{h}{2}\right)$	$\bar{u}_r\left(\frac{L}{2},0,0\right)$
RMVT-based Q8 FCPM	Mesh (36x6)	0.1238	6.5335	0.1080	4.0056
	Mesh (48x9)	0.1260	6.5415	0.1081	4.0088
	Mesh (48x12)	0.1262	6.5433	0.1081	4.0086
RMVT-based Q9 FCPM	Mesh (36x6)	0.1238	6.5333	0.1080	4.0056
	Mesh (48x9)	0.1256	6.5414	0.1081	4.0088
	Mesh (48x12)	0.1262	6.5432	0.1081	4.0086
Modified Pagano method		0.1269	6.5462	0.1082	4.0097
3D Elasticity Solutions		0.1270	6.5450	0.1081	4.0090

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Low Rank Approximation For Entangled Quantum Systems

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Introduction to Quantum Entanglement and Mathematical Models

Quantum entanglement is a marvelous phenomenon that plays an essential task in quantum informatics [1, 2, 3, 4, 5, 6]. The miracle demonstrates how pairs or groups of particles generate, interact, or share properties so that the variation of one particle will instantly transform the characteristics of another particle. In other words, we could imagine that there is a mysterious communication channel which forwards information even faster than the speed of light. To the study of entanglement, we suitably represent quantum states in terms of some properly selected basis over the complex field. Then, we express the rule of entanglement in quantum mechanics systems as Kronecker products between states of density matrices of the subsystems. Subsequently, we can investigate the property of entanglement as the following low rank approximation problem:

$$\min_{\substack{\theta_r \in R_+, x_r \in C^m,\ y_r \in C^n \\ \|x_r\|=1, \|y_r\|=1}} \left\| \rho - \sum_{r=1}^{k} \theta_r (x_r x_r^*) \otimes (y_r y_r^*) \right\|_F^2 \qquad ①$$

where * denotes the conjugate transpose, stands for the Kronecker product, and ρ $C^{mn \times mn}$ is a positive definite matrix.

Difficulties and Breakthrough

A low rank approximation to an entangled bipartite system represented in ① is fundamentally different from a conventional tensor approximation with several new challenges:

The twist caused by the Kronecker product destroys the multi-linearity. The famous alternating least squares techniques can hardly be applied.

To correctly characterize the quantum properties, it is necessary to involve complex variables. The approximation amounts to the optimization of real-valued functions over the complex spaces.

The approximation needs to deal with a proper low rank, which is not known a priori, and to maintain the probability distribution among the states.

Thus, we propose a dynamical system approach to tackle the problem ① with complex variables directly. This method, utilizing the projected gradient flow and the notion of Wirtinger calculus, is concise and can achieve convergence from any starting point. We ensure for no difficulty that the requirement of the combination coefficients θ_r's must be a probability distribution. When needed, we can even obtain the desired low-rank approximation by dynamically adjusting the predicted rank k.

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Analysis of Suitable Operating Models for Charging Facilities of Electric Vehicles in Taiwan

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Taiwan Power Company collaborative research project

With the Taiwan government's promotion policies related to electric vehicles (EV), the domestic electricity demand for EV charging facilities and the number of installations are expected to grow significantly. Due to the future needs for power supplying facilities and communication standards of EV charging system installation, the issues of power line deployment of EV charging facilities, energy management strategies of charging point operators (CPO), and international communication standards of EV charging facilities should be further investigated to cooperate with the relevant development policies of Taipower company (TPC). This work collects domestic and foreign related cases and establishes a demonstration system for researches and discussions, a system which is beneficial to maintain the power supply quality and meet the requirements of EV charging facilities deployment, energy management optimization, and information interoperability. Besides, this research integrates G2V and V2G operational models and develops the energy management strategies and related regulations for power industries. In addition, the communication protocols, such as OCPP, OSCP, and OpenADR are integrated and tested in the demonstration system. Based on the development and tests of related technologies in this research, the impact caused by a large number of charging facilities on the power grid can be effectively reduced. A win-win situation is achieved to enhance the stability of regional power systems and satisfy the power demand of electric vehicles, simultaneously.

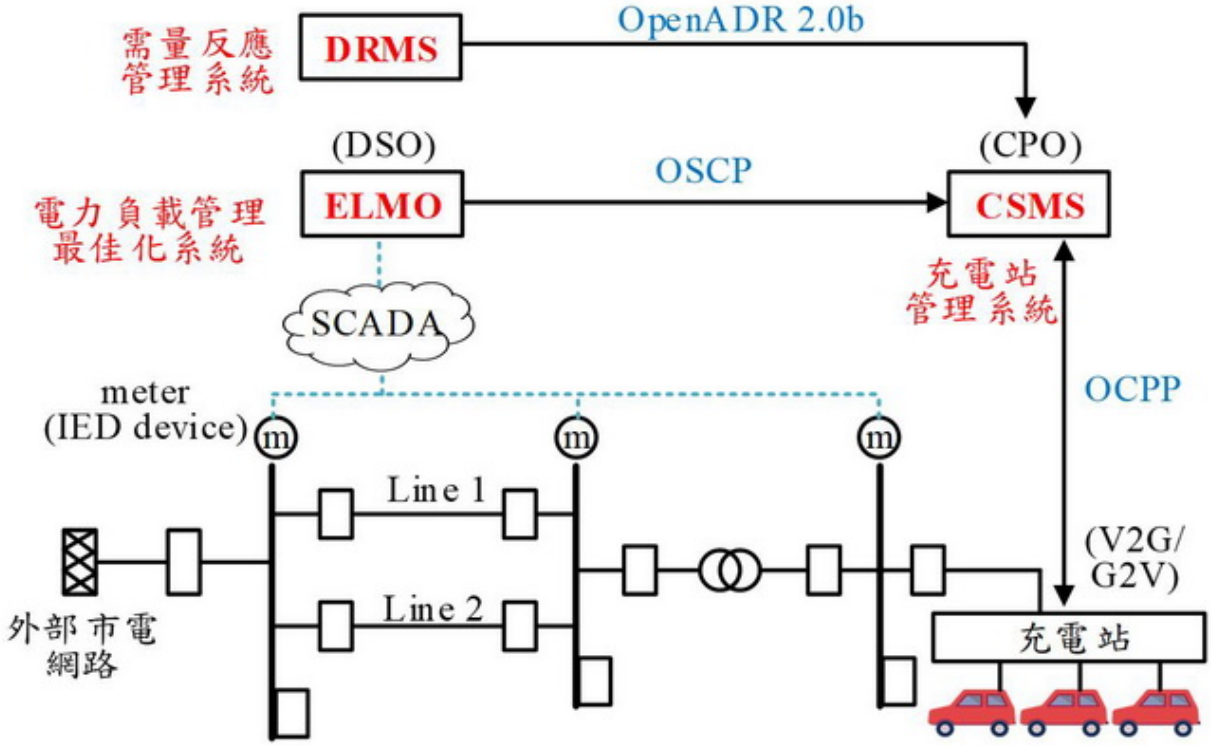

Figure 1. The schematic diagram of integrated structure for EV charging facilities.