淡江時報 第 1222 期

洪振湧引領陳俊諺 學術論文登上《Nano Letters》

學習新視界

【本報訊】物理系校友，中央大學博士生陳俊諺與其指導教授，本校物理系副教授洪振湧、中央大學物理系教授唐毓慧，以及西班牙馬德里自治大學凝態物理系教授Farkhad等研究團隊，日前共同發表最新研究成果，論文「Stochastic Nature of Voltage–Controlled Charge Dynamics in AlOx Magnetic Tunnel Junctions（磁穿隧接面中電壓驅動電荷動態行為的隨機特徵）」刊登於國際頂尖期刊《Nano Letters》，並獲選為該期封面文章。

《Nano Letters》是美國化學會創辦的重要期刊，專門發表奈米科技和材料的前沿研究，根據2025年期刊指標，期刊的近五年影響因子為9.9，引用分數為14.9，在凝態物理、材料與化學相關領域中深受學術界高度肯定。

洪振湧表示，這項研究聚焦於奈米級磁性隧道接面的電子傳輸行為，團隊透過電壓控制與低頻雜訊的量測技術，搭配理論模擬，成功掌握超薄AlOx元件中電荷的隨機變化，並觀察到「自旋電子憶阻器」不僅具備磁性與電性雙重操控能力，還能實現多重記憶狀態，對未來發展人工智慧、類神經元系統與機器學習技術，具有極高的應用潛力。特別的是，該元件能在室溫下展現「機率位元」的行為模式，突破過去量子位元必須在極低溫下操作的限制，為未來發展高效能、低能耗的智慧元件提供新方向。

洪振湧也肯定陳俊諺的優異表現，提到「他在大學時期曾於物理系的自旋電子學實驗室進行專題研究，並曾獲得國科會大專生研究計畫與年度研究創作獎，目前在中央大學攻讀博士，由我和唐毓慧共同指導，持續朝學術研究發展邁進。」


04.6
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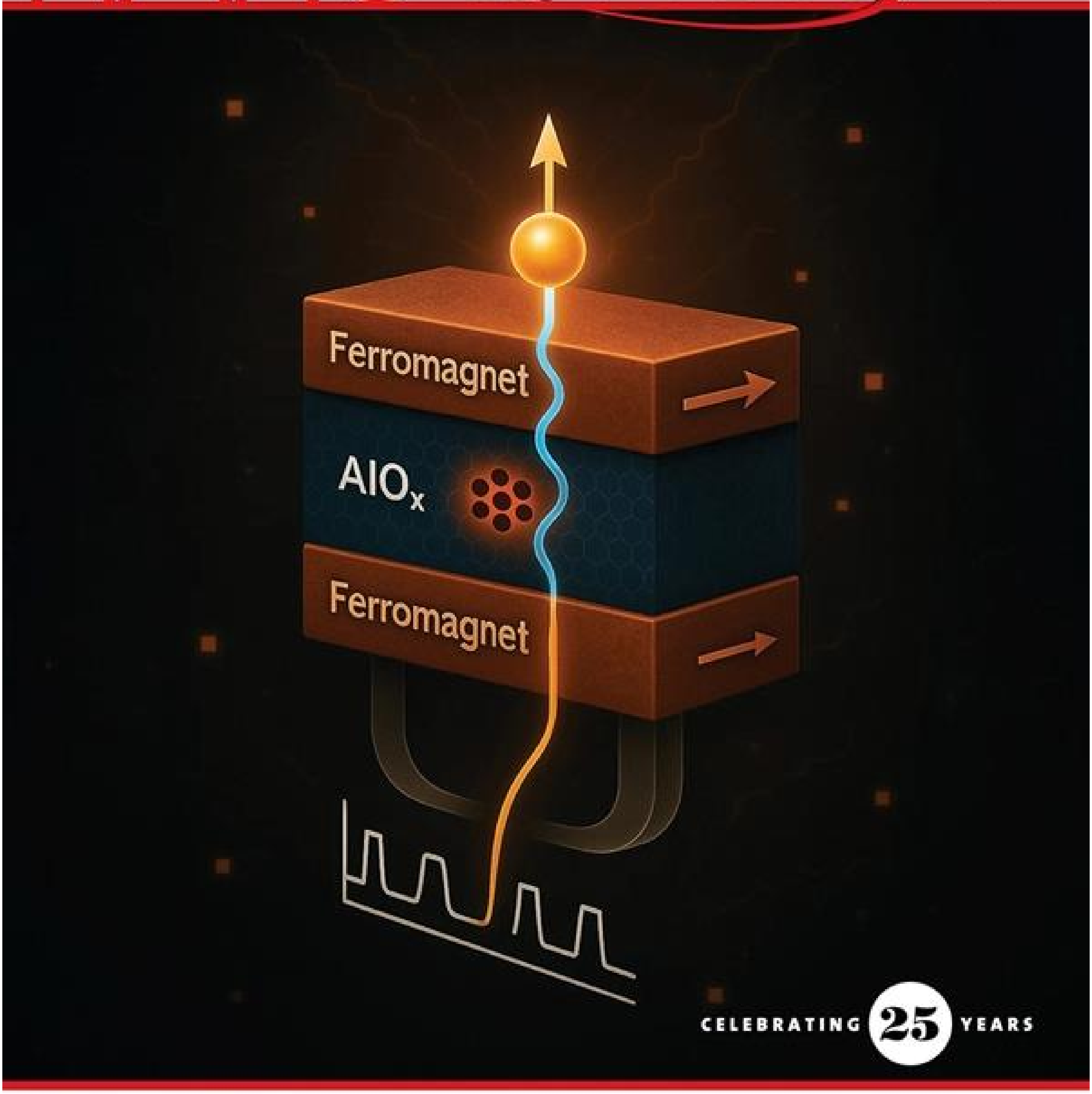

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Letter

Stochastic Nature of Voltage-Controlled Charge Dynamics in AlO_x Magnetic Tunnel Junctions

Chun-Yen Chen, Bao-Huei Huang, Yu-Hui Tang,* César Gonzalez-Ruano, Farkhad G. Aliev, Dah-Chin Ling, and Jhen-Yong Hong*

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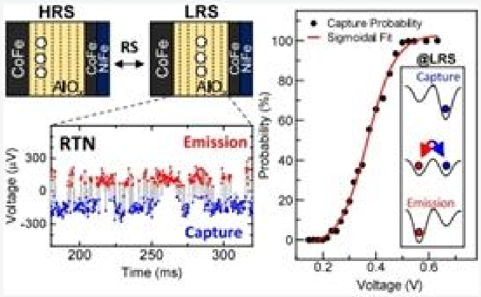

ABSTRACT: Spintronic memristors based on ferromagnetic metal/oxide heterostructures have recently enabled reversible manipulation of both magnetic properties and resistive switching (RS), offering promising prospects for multibit memory and neuromorphic computing. In this study, we investigate the stochastic nature and relaxation processes of charge dynamics induced by localized oxygen vacancy (V_O) in AlO_x-based magnetic tunnel junctions (MTJs). We observe that random telegraph noise (RTN) exhibits charge stochasticity at specific bias voltages in the low resistance state (LRS), reflecting the competition and transition between charge capture and emission states against the thermal energy. This behavior reveals that the thermally unstable charge stochasticity originates from localized traps in the AlO_x barrier. In contrast, the high resistance state (HRS) favors the RTN emission states, indicating the dominance of direct tunneling effects. Through numerical calculations based on the tight-binding (TB) model and experimental results, we demonstrate that voltage-driven shifts in the V_O position within the AlO_x barrier, associated with RS, govern the charge dynamics of the MTJs investigated. These findings provide valuable insights and practical implications for the development of next-generation devices leveraging charge stochasticity in AlO_x-based MTJs.

KEYWORDS: *magnetic tunnel junction, memristor, resistive switching, random telegraph noise, oxygen vacancy*