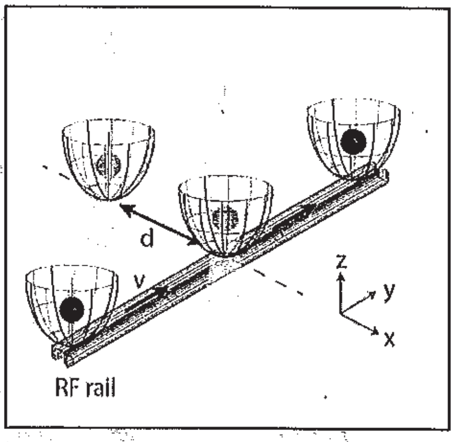
## 附件四、技術說明表

# 靜置陷俘離子與移動中離子的量子糾纏

**提案人：** 林俊達 教授
**單　位：** 國立臺灣大學　物理學系/研究所
**簡　歷：**(可列出相關連結，例如系所、研究室網頁)
2010 密西根大學物理博士
康乃迪克大學博士後研究 (2010-2012)
哈佛大學物理系與史密松天文中心 原子分子光學理論研究所博士後研究 (2012-2013)
台灣大學物理系與量子科學工程中心 (2014-)
https://www.phys.ntu.edu.tw/guindar1.html




**市場及需求:**

近幾年量子技術已經帶動新一波科技浪潮，更成為世界各國的戰略目標。目前全球量子計算市場預估約五億美元，年均增長率約為 30%，美國、歐洲、中國、印度等國皆競相投入大量資金發展量子科技，通用量子電腦則為其中最具代表性的目標。而離子阱系統為其中進展最快且效能最高的平台。本專利技術作為離子阱可擴展性的關鍵步驟，未來將可使用於量子電腦核心處理器、相關量子位元儲存周邊介面、量子網路等。

**技術摘要(含成果):**

我們提出了能使靜置陷俘離子與移動中離子直接形成量子糾纏的邏輯門，得以讓搬運中離子持續位於等速移動的電位能阱中，在經過陷俘離子時，照射雷射並透過調製脈衝操控振動模態與離子的量子位元態的耦合，可實現高精確度的量子糾纏邏輯門。其運算時間可快至微秒甚至次微秒等級，失真度可控制在 $10^{-4}$ 以下。

**優勢:**

本技術可大量減少離子搬運操控複雜度，提升速度效能，減少溫度上升，並提升遠距糾纏量子態的製備效率，降低時間與能量成本，進一步可衍生新穎的硬體擴展性架構，可使製程簡化而更具可行性與競爭性。

**競爭產品:**

US5793091A, US20190378033A1, US7875876B1, Honeywell H1 quantum computer, etc.

**專利現況:**

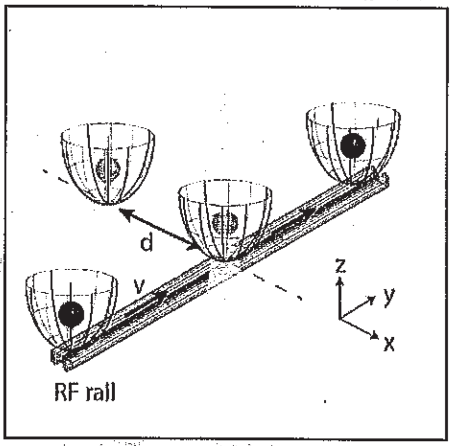
(1)專利申請中。
(2)本研究團隊具有五年以上研究經驗，為國內研究離子阱量子計算領域主力。

**聯絡方式(請不用填):**

臺大產學合作總中心
Tel: 02-3366-9945,　E-mail: ordiac@ntu.edu.tw

## Non-stop quantum entangling gate between a stationary ion qubit and a mobile one

**PI：** Prof. Guin-Dar Lin
Department of Physics, National Taiwan U.




**Experience:**

- University of Michigan (USA), PhD (2010)
- University of Connecticut (USA), Postdoctoral Research (2010-2012)
- Harvard-Physics and Smithsonian Center for Astrophysics, Institute for Theoretical Atomic, Molecular, and Optical Physics (ITAMP), Postdoctoral Research (2012-2013)
- National Taiwan University and Center for Quantum Science and Technology (2014-)
- https://www.phys.ntu.edu.tw/guindarl.html

**Market Needs:** Quantum technology is expected to revolutionize modern industries and business, and therefore become national strategies worldwide. It is estimated that the global market in 2021 for quantum technology is about 500 million USD with an averaged growth rate about 30% per year. Trapped ion systems have been one of the most promising platforms for universal quantum computer. Our technology provides a key element for arbitrary scalability, and can be applied to devices and products such as quantum computer core processors, quantum memory units, and quantum network.

**Our Technology:** Our technology enables us to perform a direct quantum entangling gate between a stationary ion qubit and another one in uniform motion. We direct a moving ion qubit passing by the stationary one, and apply lasers to mediate their interaction. By engineering the laser pulses, we are able to realize a high-fidelity quantum entangling gate whose gate time is around the order of magnitude of microseconds and sub-microseconds with infidelity about $10^{-4}$.

**Strength:** Our scheme does not require the shuttled ion to be fully stopped. We can therefore accomplish more efficient and economic quantum gates compared to the ordinary ion shuttling scheme. Meanwhile, it avoids generation of extra heating, and hence saves the needed resources to cool down the system. With our scheme, we are able to revolutionize the scalable architecture based on the quantum charge coupled device (QCCD), and turn to a layout that can be more easily fabricated.

**Competing Products:** US5793091A, US20190378033A1, US7875876B1, Honeywell H1 quantum computer, etc.

**Intellectual Properties:**

(1) Patent application under review.
(2) Our research group has more than 5-year experiences and are the main power of the research in trapped ion quantum computing in Taiwan.

**Contact (do not need to fill out):**

Center for Industry-Academia Collaboration, NTU
Tel: 02-3366-9945, E-mail: ordiac@ntu.edu.tw