

Quantum Physics

2018 spring

Quantum Physics

國立中興大學教學大綱

[維護教學大綱](#)[使用手冊](#)[列印](#)[English](#)[回上頁](#)

課程名稱	(中) 量子物理(二)(3352)				
	(Eng.) Quantum Physics(II)				
開課單位	物理系				
課程類別	選修	學分	3	授課教師	郭華丞
選課單位	物理系 / 學士班	授課語言	中文	開課學期	1062
課程簡述	大學部量子物理簡介。延續量子物理(一)：介紹3維空間物質波，角動量與自旋，量子光學。數學上介紹變分與微擾方法。學習程式進行數值計算。				
先修課程名稱					

課程與核心能力關聯配比(%)			課程目標之教學方法與評量方法	
課程目標	核心能力	配比(%)	教學方法	評量方法
建立學生量子物理觀念：包括角動量與自旋，量子光學等。了解物理問題中的對稱性。可以運用於原子物理與固態物理。能使用python語言進行物理問題數值計算。	2.(光電組)專業知能 3.問題分析與邏輯推理 4.自我充實的能力與溝通技巧	50 30 20	講授 討論 習作 專題探討/製作	實作 作業 口頭報告 出席狀況 書面報告

Quantum physics I (2017)

Quantum theory: reviews on modern physics	3hr
Wavepacket and Uncertainty relations	6hr
Schrodinger equations	6hr
Eigenfunctions and eigenvalues	9hr
Discussion	3hr
One-dimensional potentials	9hr
Hydrogen atom	9hr
Discussion	3hr

Quantum physics II

Angular momentum	6hr
Spin	6hr
Manyparticle system	6hr
Discussion	3hr
Perturbation method	6hr
Variational method	6hr
Solids	6hr
Quantum optics	6hr
Discussion	3hr

- **Textbook**

Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles 2nd Edition,

Robert Eisberg (Author), Robert Resnick, John Wiley & Sons (1986)

ISBN: 978-0471873730

- **Reference**

Quantum Physics, 3rd Edition,

Stephen Gasiorowicz, John Wiley & Sons (2003) ISBN:

978-0-471-05700-0

Introduction to Quantum Mechanics, 2nd Edition

by David J. Griffiths, Pearson Education ISBN: 978-0131118928

● Grading policy

1. Project
2. Homework
3. Participation/presentation
4. Final exam

● TA: 張譽瀚/鄭偉文

Rm 313 Tel 22840427 ext 313

● Office hours

Wed 12:30~13:30

Thu 12:30~13:30

網路資源

- 課程FB (搜尋並加入中興量物集中營)
- 即時公告，快訊分享，灌水543



網路資源

- ilearning (登入興大帳號)
- 講義下載，作業與報告上傳，重要訊息
- 可參考去年課程內容

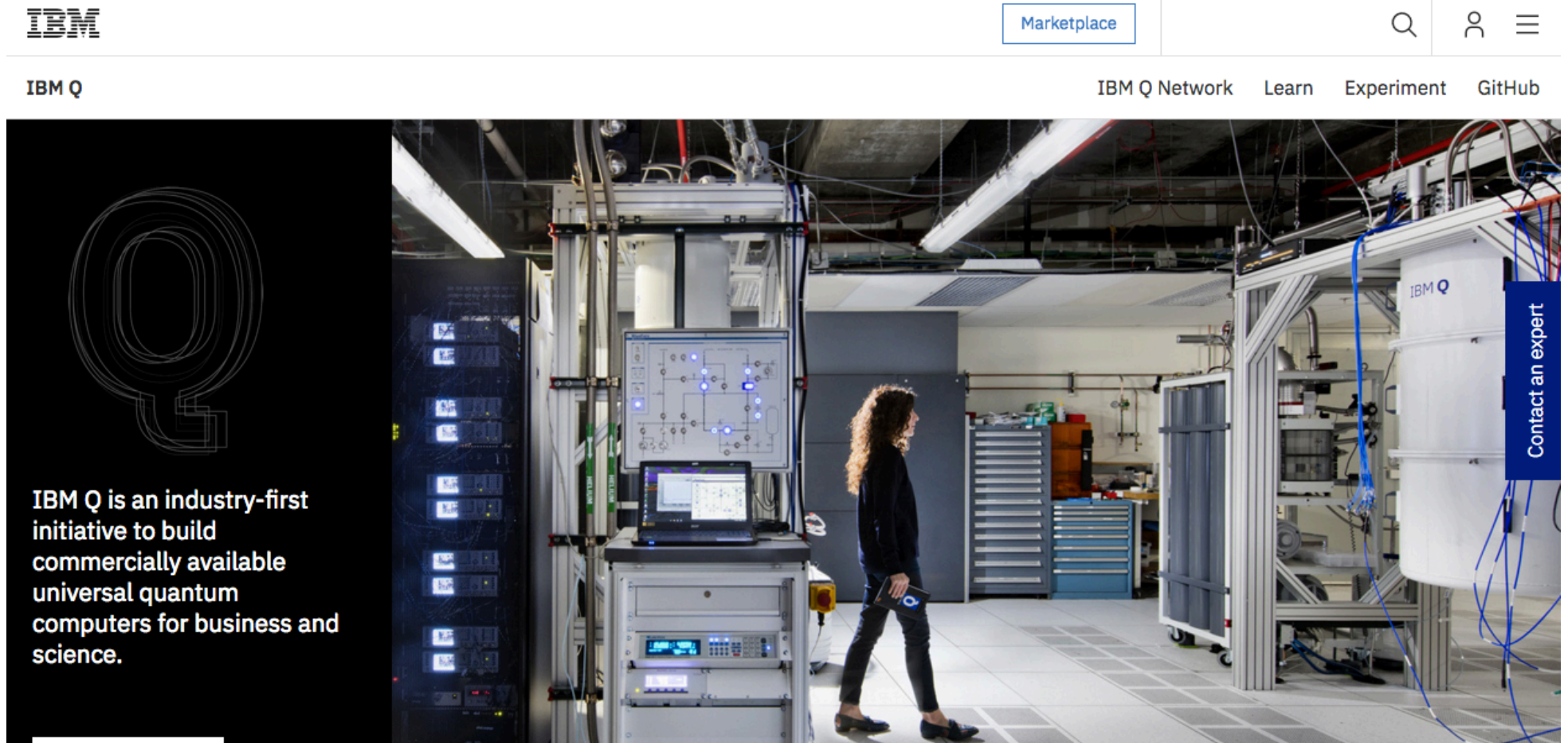


Python 專題

- 組隊：最多三人一隊，3/13之前分組完成
- 自己挑選題目4/10前決定完成。
- 每組題目不能雷同，由老師審核。先決定先贏。
- 4/10 和5/15進度報告。
- 6/29期末書面報告
- 期末發表大會：時間6/29。

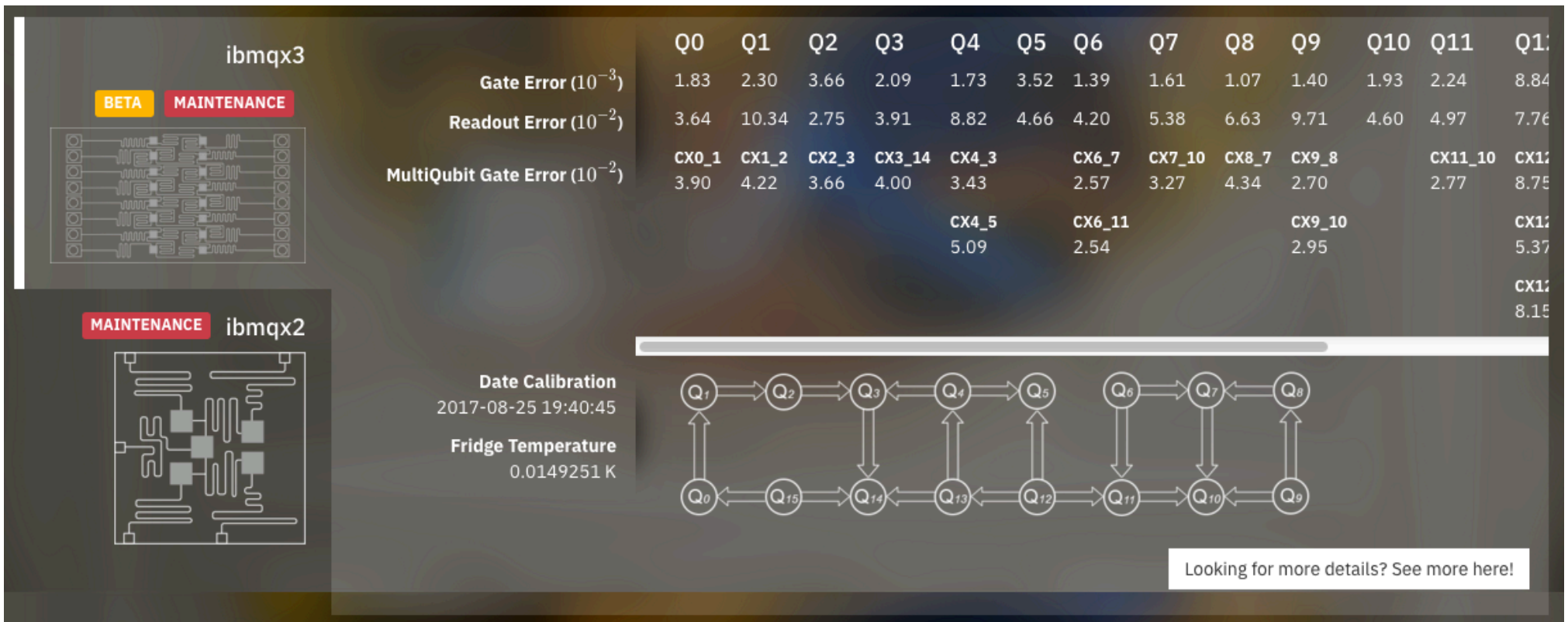
加分習題

- 除了正規的課堂習題，你可以嘗試新鮮的：



The image is a screenshot of the IBM Q website. At the top left is the IBM logo. To its right is a 'Marketplace' button, a search icon, a user profile icon, and a menu icon. Below the navigation bar, the text 'IBM Q' is on the left, and 'IBM Q Network Learn Experiment GitHub' is on the right. The main content area features a large photograph of a quantum computing laboratory. On the left side of the photo, there is a large white 'Q' logo and the text: 'IBM Q is an industry-first initiative to build commercially available universal quantum computers for business and science.' In the center of the photo, a woman with long dark hair is walking through the lab, carrying a folder. The lab is filled with various pieces of equipment, including server racks, control panels, and large white cryogenic containers. On the right side of the photo, there is a vertical blue button that says 'Contact an expert'.

IBM quantum processors



上學期說說而已，這學期...

The screenshot displays the IBM Q Experience Composer interface. At the top, there are navigation links for 'Learn', 'Experiment' (which is highlighted), 'GitHub', and 'Login'. Below this, there are tabs for 'Composer', 'Library', and 'Community'. A 'Back to the User Guide' button is visible in the top left of the composer area.

The main workspace shows a quantum circuit named '5Q Complete Superposition Circuit'. The circuit has five qubits, labeled q[0] through q[4], each starting in the $|0\rangle$ state. Each qubit line begins with a blue 'H' gate. The circuit is controlled by a classical register 'c' of size 5. The control line has a '5' and a slash, and is connected to five control points labeled 0, 1, 2, 3, and 4. Each control point has a vertical arrow pointing to a pink square gate on the corresponding qubit line. The gates are arranged in a staircase pattern: the first gate is on q[0] at control point 0, the second on q[1] at control point 1, the third on q[2] at control point 2, the fourth on q[3] at control point 3, and the fifth on q[4] at control point 4. A horizontal slider is located below the control line.

On the right side, there is a control panel with buttons for 'Run' and 'Simulate'. Below these are tabs for 'Gates', 'Properties', 'QASM', and 'My Units'. The 'Gates' tab is active, showing a grid of gate icons: 'id' (orange), 'X' (green), 'Y' (green), 'Z' (green), 'H' (blue), 'S' (blue), 'S†' (blue), a plus sign (blue circle), 'T' (red), and 'T†' (red). Below the gates are sections for 'BARRIER' (a vertical dashed line icon) and 'OPERATIONS' (a pink square icon with a white arc).











At the bottom left, there is a link '</> Switch to Qasm Editor'. At the bottom right, there is a button 'Add a description'.

<https://quantumexperience.ng.bluemix.net/qx/editor>

使用IBM量子電腦計算

- 先進行下面練習：
- 了解量子計算閘(gate)
- 使用IBM量子程式編輯後計算
- 使用紙筆或寫程式推導理想結果
- 作業內容：將自行編寫的程式上傳IBM進行雲端計算並與理想狀況比較

Summary of quantum gates

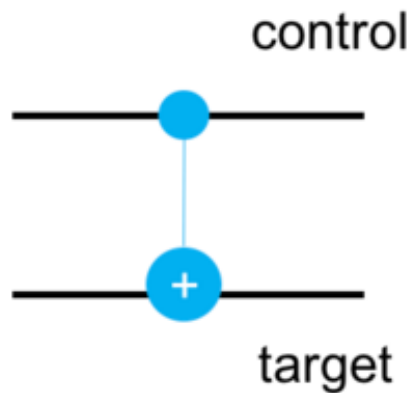
Table of Quantum Gates and what they do				
State	Gate sequence to prepare the state	Transformation on Bloch sphere	Gates to measure in the respective basis	Name of measurement basis
$ 0\rangle$	(none, ground state)	None		Z, "standard"
$ 1\rangle$		π rotation around X		Z, "standard"
$ +\rangle$		π rotation around X + Z	 	X
$ -\rangle$	 	π rotation around X + π rotation around X + Z	 	X

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Gate	Transformation on Bloch sphere (defined for single qubit)
X	π -rotation around the X axis, $Z \rightarrow -Z$. Also referred to as a bit-flip.
Z	π -rotation around the Z axis, $X \rightarrow -X$. Also referred to as a phase-flip.
H	maps $X \rightarrow Z$, and $Z \rightarrow X$. This gate is required to make superpositions.
S	maps $X \rightarrow Y$. This gate extends H to make complex superpositions. ($\pi/2$ rotation around Z axis).
S^\dagger	inverse of S. maps $X \rightarrow -Y$. ($-\pi/2$ rotation around Z axis).
T	$\pi/4$ rotation around Z axis.
T^\dagger	$-\pi/4$ rotation around Z axis.

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2-bit gate



Starting state

Ending State

$|00\rangle$

→

$|00\rangle$

$|10\rangle$

→

$|10\rangle$

$|01\rangle$

→

$|11\rangle$

$|11\rangle$

→

$|01\rangle$

ibm q: beginner's guide

- 這跟我要學的量子物理有關嗎？

- 非常有關！如果你想把自旋學好，這是最好的線上練習。