"The ICAP 2016 Summer School",

July 18-22, 2016

Venue: ***1503 conference room, 고등과학원 KIAS***
85 Hoegiro (Cheongnyangni-dong 207-43) Dongdaemun-gu, Seoul 02455
Tel: +82-2-958-3711   Fax: +82-2-958-3770

Introduction

The ICAP 2016 Summer School will be held at the Korea Institute for Advanced Study (KIAS) in Seoul, Korea from July 18th to July 22nd the week preceding the ICAP 2016 conference. The summer school is designed for beginning graduate students and advanced level undergraduate students in atomic physics and related fields, and also for other researchers just moving into theses areas of research.

Lecturers

Wolfgang Ketterle (MIT, USA)
Peter Zoller (University of Innsbruck, Austria)
Paul Julienne (University of Maryland, USA)
Myungshik Kim (KIAS/Imperial College London, UK)
Yvan Castin (Laboratoire Kastler Brossel of ENS, France)
Jungsang Kim (Duke University, USA)

+ Short Course – Hanhee Paik (IBM, USA)
+ Plenary Session (Joint with Seoul Conference on Frontiers of Quantum Information Science)

Organizers

Jaewan Kim (KIAS)
Seung-Woo Lee (KIAS)
Contact: Deure Park (KIAS) - icap2016summerschool@gmail.com

Program Schedule

Time	Monday	Tuesday	Wednesday	Thursday	Friday
9:00-10:30	W. Ketterle I	P. Julienne II	M. Kim II	W. Ketterle III	Plenary Session I (joint with Seoul Conference on QIS)
10:30-10:45	Break	Break	Break	Break	Break
10:45-12:15	P. Julienne I	P. Zoller II	Y. Castin I	P. Julienne III	Plenary Session II (joint with Seoul Conference on QIS)
12:15-13:30	Lunch	Lunch	Lunch	Lunch	(Seoul Conference on Frontiers of Quantum Information Science)
13:30-15:00	P. Zoller I	M. Kim I	Excursion	Y. Castin II	
15:00-15:15	Break	Break		Break	
15:15-16:45	J. Kim I	W. Ketterle II		J. Kim II	
16:45-17:00	Break	Break		Social Hour	
17:00-17:40	Short Course I	Short Course II			
17:40-	Social Hour	Social Hour + Banquet			

Excursion: Changdeokgung, Bukchon, Insa-dong tour for international participants.

Wolfgang Ketterle (Nobel laureate 2001) - MIT, USA

TBA

Paul Julienne - University of Maryland, USA

Lecture 1: Cold Collision Basics

This lecture describes how to describe cold collisions quantum mechanically, focusing on the scattering and bound state properties near a collision threshold that are relevant to cold atom studies. The all-important concept of the scattering length will be illustrated, as well as the role of the long range potential between two interacting atoms.

Lecture 2: Feshbach Resonances

Magnetically tunable scattering resonances known as Feshbach resonances permit the control of the interactions of cold bosonic or fermionic atoms and have been essential to the multidisciplinary fruitfulness of cold atom studies. This lecture shows how to understand such resonances, using examples of magnetically tunable Feshbach resonances that have been successfully used in experimental work.

Lecture 3: Other Topics in Cold Collisions

The lecture series concludes by exploring some additional topics that are relevant to current research areas. These include the existence of universal scattering properties of reactive and inelastic collisions, the effect of reduced dimension, or tight quantum confinement on atomic and molecular collisions, and the chaotic dynamics of complex atoms or molecules.

Peter Zoller - University of Innsbruck, Austria

Quantum Simulation with Quantum Optical Systems

I will give two lectures introducing the topic of quantum simulation of quantum many-body systems with quantum optical systems from a theory perspective, and with emphasis of recent and modern developments.

In the first lecture I will discuss atoms in optical lattices as quantum simulation of (closed) Hamiltonian systems, and the corresponding atomic toolbox. As a special topic - motivated by ongoing experimental efforts - I will add a part on the quantum gas microscope and applications, and in particular discuss protocols for measuring entanglement entropy.

The second lecture will be devoted to open quantum system simulation, as a driven-dissipative quantum many body system far from equilibrium. I will introduce the concept of open quantum systems and master equations, and discuss quantum reservoir engineering. We will illustrate open quantum system simulation in the context of ‘chiral quantum optics’ - again motivated by ongoing experiments. Here atoms are coupled to photonic nanostructure with the generic feature that photon emission into the waveguide has a broken left-right symmetry due to spin-orbit coupling of light. This results in a rather unconventional many-body quantum system with ‘non-reciprocal’ (unidirectional) photon-mediated interactions between atoms. We will discuss the underlying theoretical concepts and techniques to describe, and point to new phenomena and applications of such ‘chiral’ quantum many-body systems, and as quantum networks, where nodes are connected by chiral quantum channels.

Myungshik Kim - KIAS and Imperial College London, UK

Bosonic Quantum State Engineering

Light fields have been closely connected to the test of paradoxical ideas in quantum mechanics. Building Schroedinger cat states and testing the principles of quantum mechanics have been realised in photonic systems. Recently there have been considerable interests in the generation and manipulation of the quantum-mechanical states of nano-mechanical oscillators which are massive objects by the quantum-mechanical standard. The two very different physical systems are described by the same mathematical tools as the both bear the bosonic statistics. In these lectures, we show some of the basic tools and methods to manipulate bosonic quantum systems.

Yvan Castin - Laboratoire Kastler Brossel of ENS, France

Strongly interacting Fermi gases

The system under consideration is a gas of spin-1/2 fermions with interactions of negligible range between opposite spin particles, characterised by the s-wave scattering length a. The intermediate regime between the Bose-Einstein-condensate-of-dimers limit (a tends to zero from above) and the Bardeen-Cooper-Schrieffer limit (a tends to zero from below) is currently under experimental and theoretical investigation. We shall first present basic theory tools for this system, the BCS theory (including its time dependent version) and the Random Phase Approximation of Anderson. We shall then present several applications of these tools to the study of fundamental questions, such as (i) the Landau critical velocity of an object moving in the zero-temperature gas of fermions, and (ii) the coherence time of the condensate of pairs in a gas initially prepared at nonzero temperature and isolated from the environment in its further evolution. In a second part, we shall concentrate on the unitary gas case (1/a=0), where the scaling symmetry opens the door for new physical phenomena such as the four-body Efimov effect, and helps theorists meet the challenge of calculating the recently measured fourth-order cluster (or virial) coefficient.

Jungsang Kim - Duke University, USA

Quantum Computing with Trapped Ions

Lecture 1: Trapped Ion Qubit Basics

This lecture will discuss the physical representation of qubits using trapped atomic ions, and their potential advantages and drawbacks. I will explain typical mechanisms used for the initialization, measurement, quantum logic gates and photonic interconnect protocols widely used in trapped ions. I will review several experimental efforts on cutting-edge implementation of quantum logic gate operations from various research groups around the world.

Lecture 2: Quantum Computing with Trapped Ions

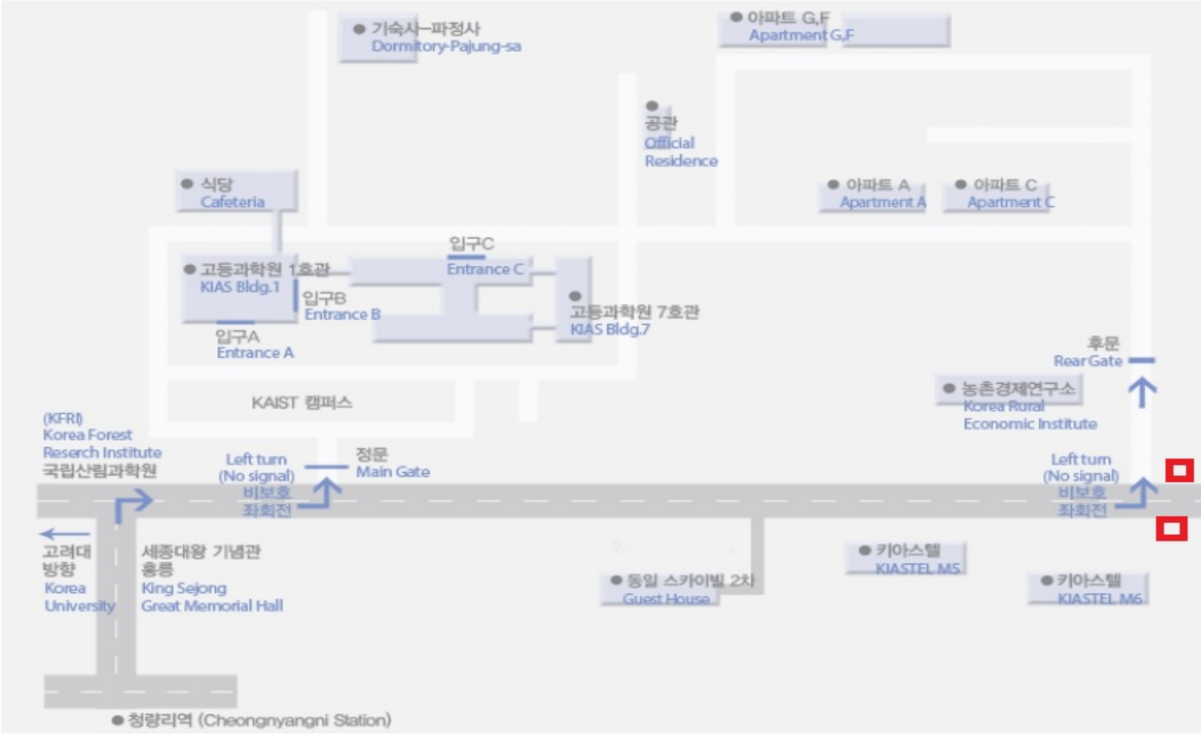
This lecture will discuss the advanced architectures for realizing quantum computers using trapped ions. Based on the basic protocols described in the first lecture, I will describe unique opportunities for realizing scalable quantum computers using this technology. The connectivity between the qubits available in the trapped ion system provides tremendous advantage in implementing complex quantum algorithms in this system. I will describe some examples of architecture-dependent performance of quantum algorithms in trapped ion quantum computation.

(Short Course) Hanhee Paik - IBM T J Watson Research Center, USA

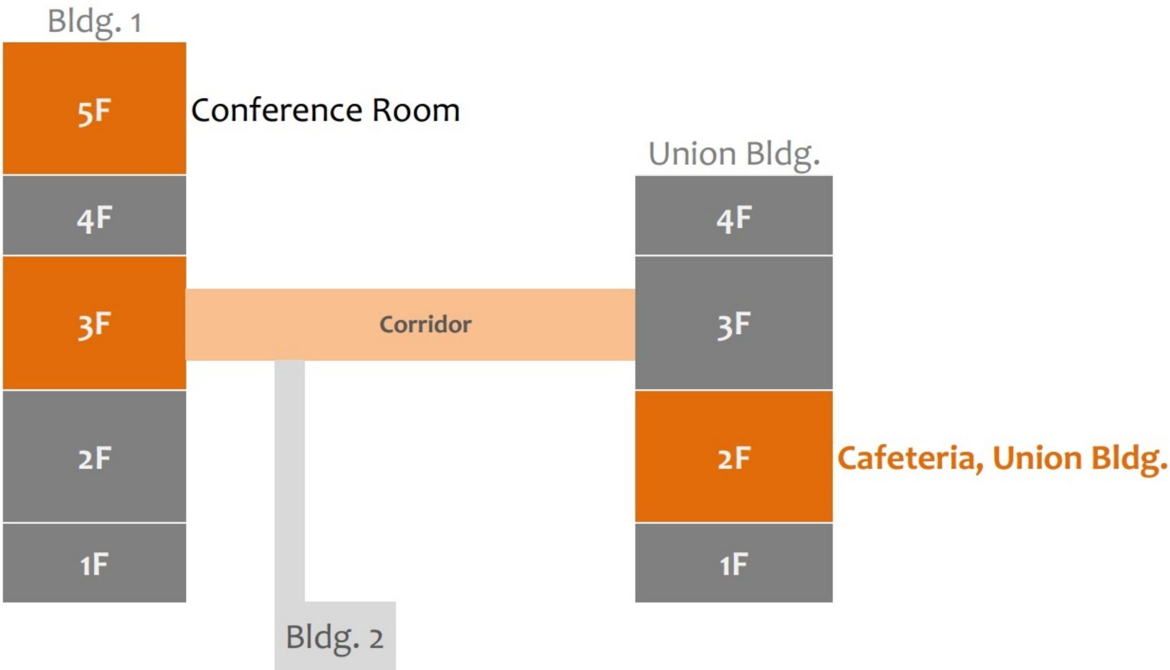
Introduction to superconducting qubits and Quantum Experience:
a 5-qubit quantum processor in the cloud.

In this 2-day session, I will overview the basics of superconducting qubits: Josephson junction, a circuit model, circuit QED, coherence, and a control and measurement. Then I will introduce Quantum Experience, a 5-qubit superconducting qubit in the cloud that IBM recently lunched for research and education purposes. Anyone can register from the webpage https://quantumexperience.ng.bluemix.net for an access. We will walk through the official tutorial in the Quantum Experience website together and play a few demo quantum codes during the session.

Campus Map



Way to Cafeteria, Lunch Place



Off-campus restaurants

LOCATION	NAME	FOOD TYPE	LOCATION	NAME	FOOD TYPE
1*	Song chon(송존)	Sushi $$$	13	Misssaigong(미스사이공)	Hanoi beef soup $
2	Saiya(사이야)	Japanese $$	14*	Mr. Pizza (미스터피자)	Pizza $$
3	Sol nang gu(솔낭구)	Galbi, Bulgogi $$$	15	Sulbing(설빙)	Dessert café $
4	Kyeong hee gung(경희궁)	Korean $$	16	Bareuda gimseonseng(바르다김선생)	Gimbap $
5*	Dadam gooksu(다담국수)	Korean noodles $	17	Bon Jook(본죽)	Gruel $
6*	Honghak(홍학)	Shabu Shabu $$	18	Dunkin donuts(던킨도너츠)	Donuts $
7	Komyong(고명)	Budae jjigae / Spicy Sausage Stew $	19	Paris baguette(파리바게트)	Bakery $
8	Mariche(마리채)	Pork belly $$$	20*	Shangrila(샹그리아)	Chinese $$
9*	Myeongseongkwan(명성관)	Galbi, Bugogi $$$	21	Youngyang dolsot(영양돌솥집)	Dolsotbap, Samgyetang $$
10	Pungcheonjangeo(풍천장어)	Broiled eels $$$	22*	New delhi(뉴델리)	Indian $$
11	Burger king(버거킹)	Hamburger $	23*	Nova Italiano(노바이탈리아노)	Pasta $$
12	Sushihaenaru(스시해나루)	Japanese $$	24	Yoogane(유가네)	Chicken galbi $$

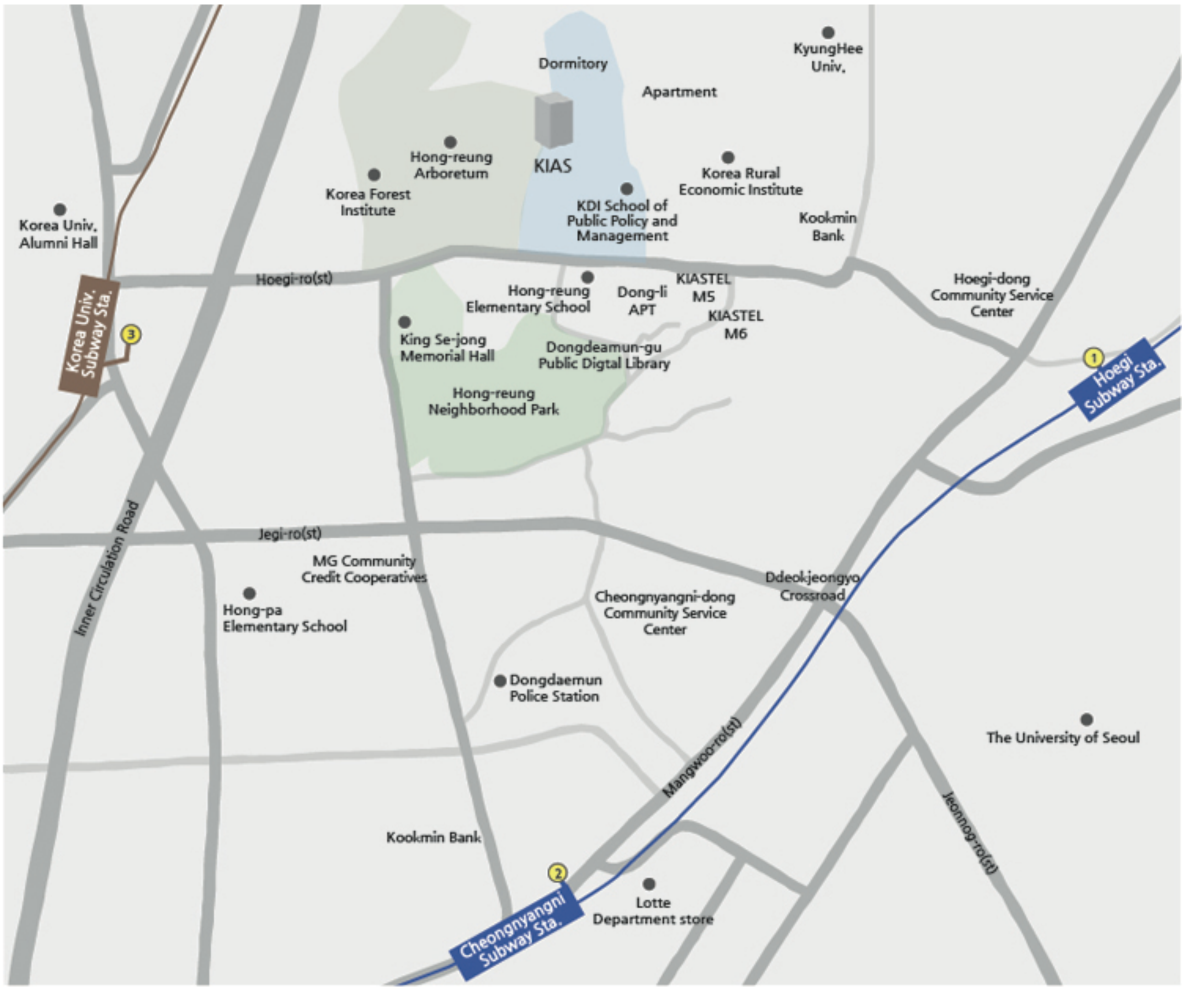
$<10,000KRW, $$<20,000KRW, $$$ ~30,000KRW

* : recommended

Maps and Directions

KIAS (고등과학원)

85 Hoegiro (Cheongnyangni-dong 207-43) Dongdaemun-gu Seoul 02455 Tel: +82-2-958-2640	서울시 동대문구 청량리동 207-43 고등과학원 (우:130:722) **(Show this to your taxi driver)**



From Incheon International Airport

There are several ways to get to KIAS from Incheon International Airport. You may purchase Limousine or Premium Bus tickets or obtain information at the Transportation Information Counter located near the exits 2, 4, 9 and 13 on the passenger terminal arrival floor.

Limousine Bus

Bus No. 6002

The convenient bus to KIAS is one bound for Cheongnyangni of which number is "6002" and the bus stop at the airport is No."5B" and "12A". The fare is 10,000 Korean Won and the bus departs every 15~20 minutes. The first bus at the airport departs at 05:30 and the last bus departs at 23:30. You can get off at 'Cheongnyangni Station' bus stop, which will take about one and a half hours.

Bus No. 6101

Take a Limousine Bus No.6101 'Dobong(Seongdong)' route at the bus stop 3B, 10A (Bus fare is 14,000 won). Get off at 'Korea Univ. Station' bus stop and then take a taxi. To KIAS, it will cost less than 3,000 Korean Won.

Then, take a taxi to KIAS. To KIAS. Either from Cheongnyangni or Korea Univ. Station, it will cost you less than 3,000 Korean Won. Please show 'Direction for Taxi Driver' to a taxi driver so that he/she can understand where you are headed. For more information, please visit Incheon International Airport website.

Airport Train

Airport train is available from the airport to Seoul Station. This service will cost you 3,700 Korean Won, and total estimated time to KIAS is about an hour. You should get off at the Seoul Station, which is the last stop. Then, from Seoul Station to KIAS, you can take a subway or you can use a taxi service, which will cost you about 10,000 Korean Won.

Taxi

If you have heavy luggage, we suggest that you take a taxi. There are two different types of taxis. One is regular taxi and the other is deluxe taxi (black-colored). In case of the former, it will cost about 75,000 Korean Won from the Incheon International Airport to KIAS including a toll (7,500 Korean Won). In case of deluxe taxi, it will cost 95,000 Korean Won including toll

(7,500 Korean Won). However, please keep in mind that it may cost more depending on traffic condition.

From Hoegi Station

Bus

Please go out through exit No. 1 and go straight until you arrive at an intersection. Cross the road to the right at first and then to the straight line. Cross the road and turn right. Walk straight until you see a bus stop. Take No.1215 or No.273 and get off at 'KAIST Campus/Hong-neung Elementary School' bus stop.

Taxi

Please go out through exit No.1 and take a taxi. Please show 'Direction for Taxi Driver' to a taxi driver so that he/she can understand where you are headed. It will cost about 2,400 Korean Won

From Cheongnyangni Station

Bus

Please go out through exit No. 2 and go straight, turn right at the corner and then go straight until you see a bus stop. Take No.1215 and get off at 'Hong-neung Elementary School' bus stop. Please cross the road to reach KIAS which is in the KAIST campus.

Taxi

Please go out through exit No.2 and a taxi. Please show 'Direction for Taxi Driver' to a taxi driver so that he/she can understand where you are headed. It will cost about 2,400 Korean Won.