

# AMO Physics at UBC

Open House, March 21 2014

The logo for CRUCS features the letters 'C', 'R', 'U', and 'S' in a large, bold, sans-serif font. Each letter is filled with a blue-to-white gradient and has a glowing, 3D effect with a bright white highlight on the left side of each letter.

Canadian Centre  
for Research on  
Ultra-Cold Systems

**AMPEL (AMO + Condensed matter)**  
(Advanced Materials and Process Engineering Lab)



# CRUCS

Canadian Centre  
for Research on  
Ultra-Cold Systems

## Ultra-fast optics and coherent control

**Valery Milner (E):** femtosecond control of atoms and molecules

**David Jones (E):** femto-second frequency combs and EUV generation

## Quantum gases

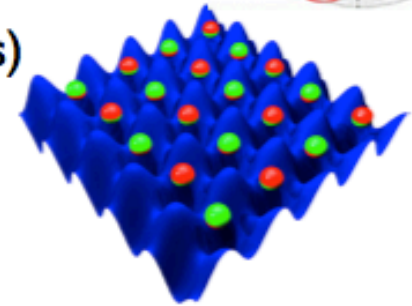
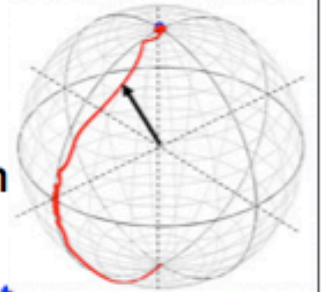
**Kirk W. Madison (E):** quantum gases (atoms & molecules)

**Fei Zhou (T):** many-body quantum mechanics with atoms

**Roman Krems (T / Chem):** ultra-cold chemistry

**Takamasa Momose (E):** cold molecules

**Edward Grant (E / Chem):** ultra-cold plasmas

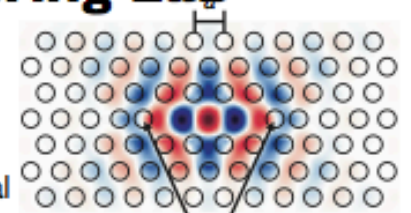


## AMPEL : Advanced Materials and Process Engineering Lab

### Photonics of micro and nano-structures

**Jeff Young (E):** photonic band-gap materials and quantum dots

photonic band-gap material



## TRIUMF : Canada's national lab for particle and nuclear physics

### Trapping of radioactive species

**John A. Behr (E):** laser cooling of neutral atoms

**Jens Dilling (E):** ion traps for radioactive isotopes



beta-decay

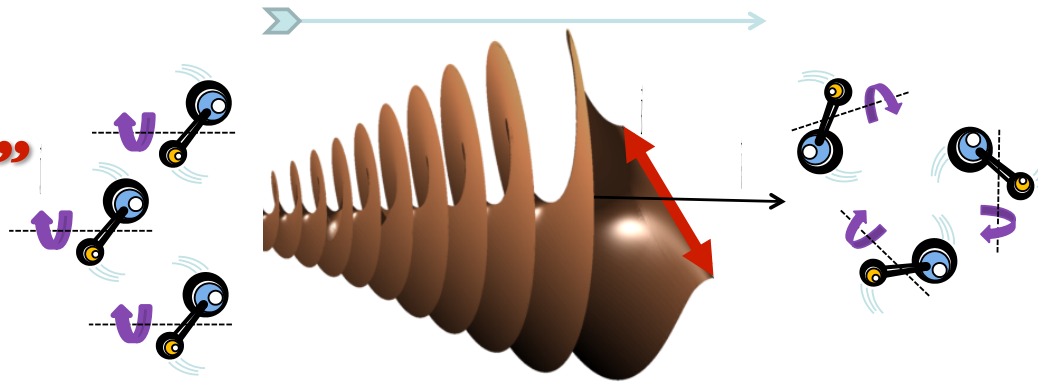


# Milner Research Group

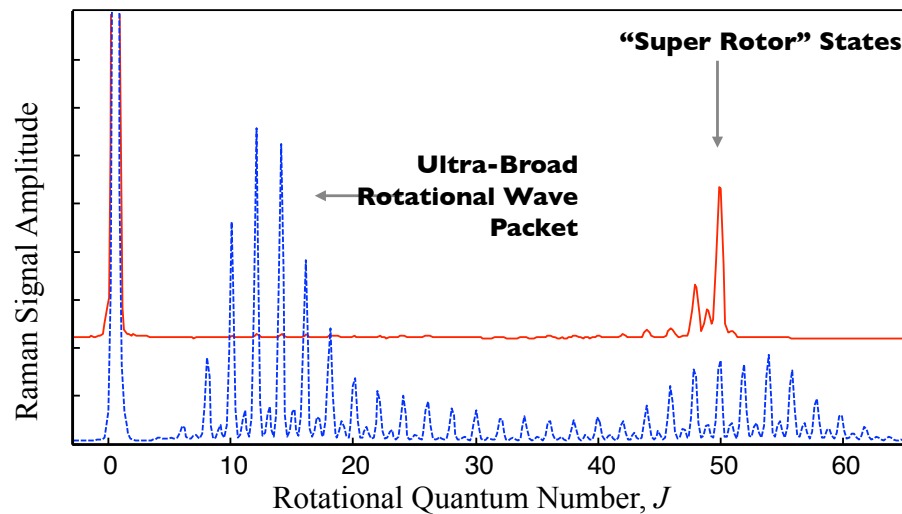
*Control and Study of Molecular Dynamics with Shaped Laser Pulses*

## Optical Centrifuge

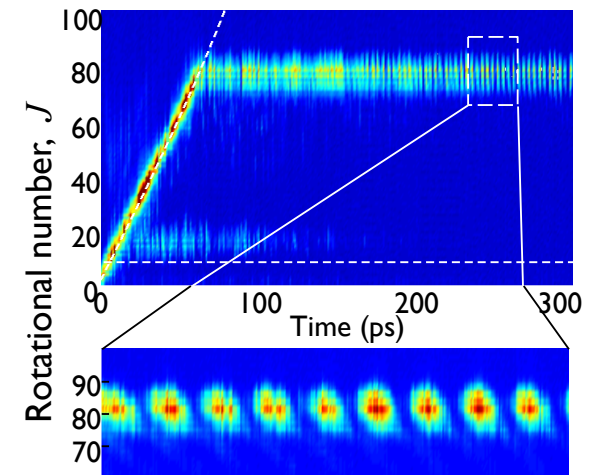
**Molecular  
"Super Rotors"**



## Extreme Rotational States



## Super-Fast Rotation

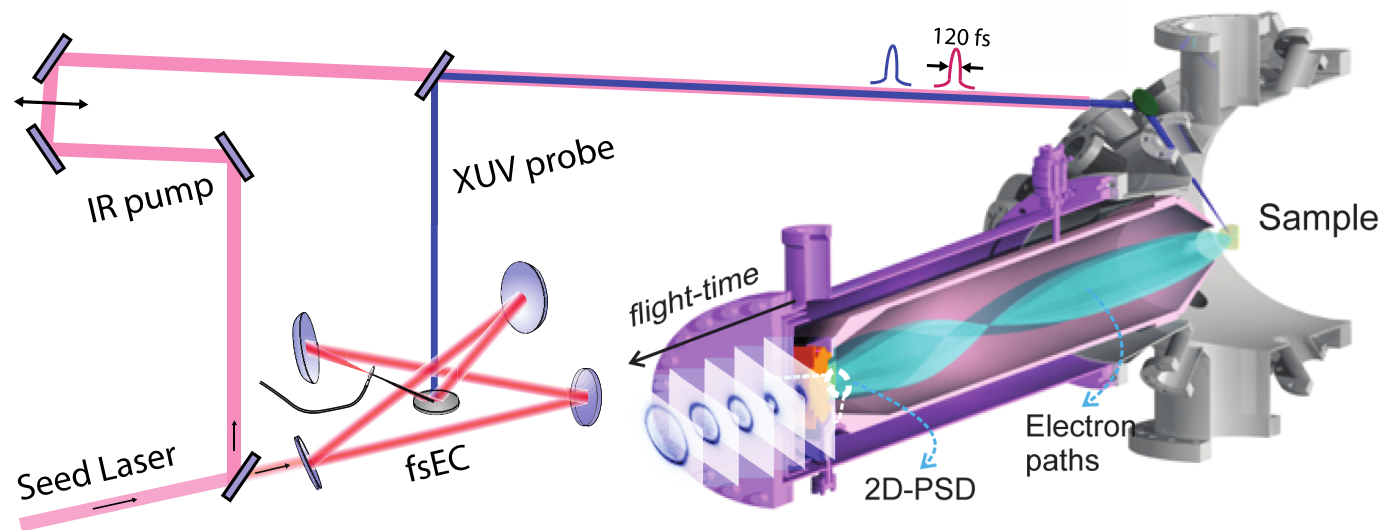


# Jones Group (AMO + Condensed Matter)

XUV femtosecond, time-resolved studies of correlated electron systems using Angle Resolved Photo-Emission Spectroscopy (APRES) with A. Damascelli and S. Burke

We have developed a world-unique femtosecond XUV source at UBC enabling a study of electron/phonon dynamics across an unprecedented range of quantum materials and electron momentum for truly *complete* studies of:

- Topological insulators (Jones/Damascelli)
- High  $T_c$  superconductors (Jones/Damascelli)
- Metal ligand dyes for next generation solar cells (Jones/Burke/Schiffrin)

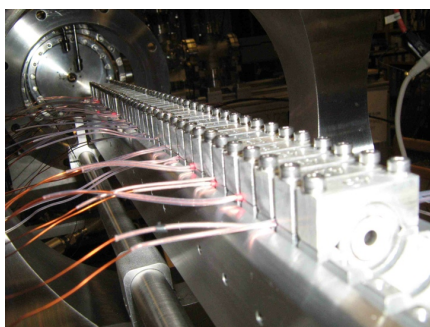


Opportunities:

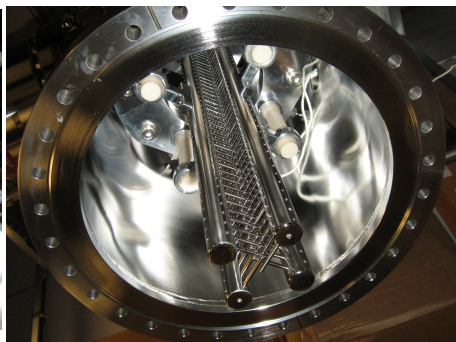
- Further laser development (MSc thesis projects)
- Ultrafast spectroscopy studies of materials (MSc and PhD thesis projects)

# Momose Research Group

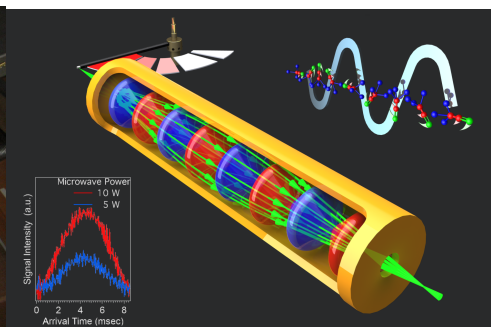
Development of various molecular decelerators and traps towards the first production of quantum gases of molecules and the study of ultracold chemistry (interstellar chemistry)



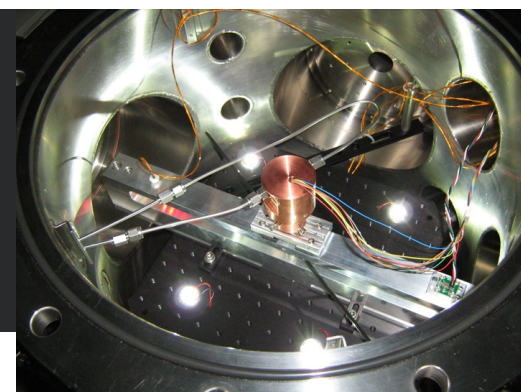
Zeeman decelerator



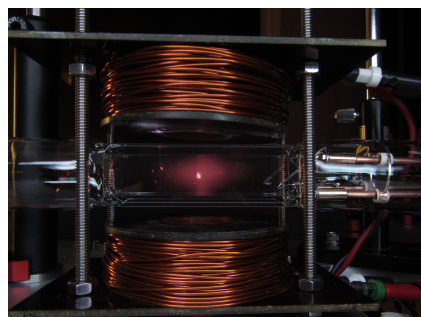
Stark decelerator



Superconducting cavity MW decelerator

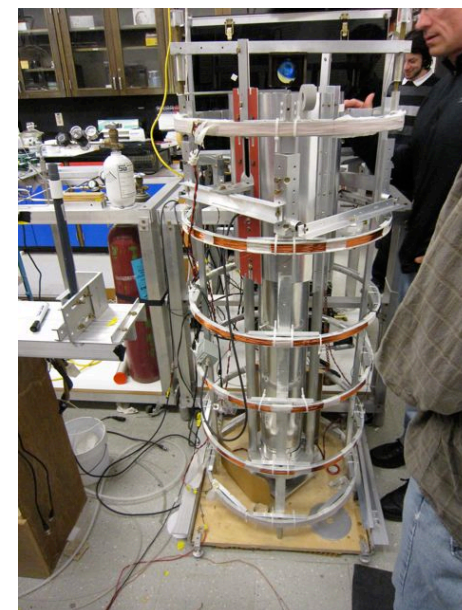
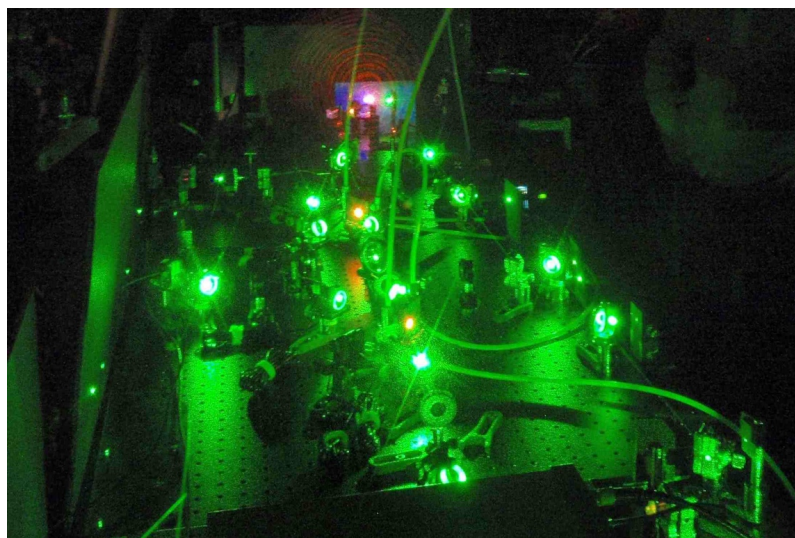


Counter rotating nozzle



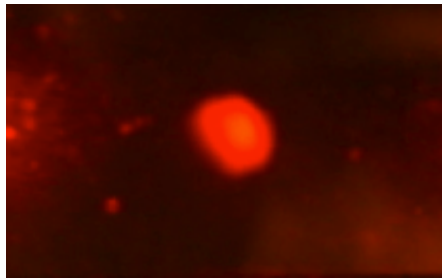
Photoassociation

Development of a new laser and optical detection system for ALPHA@CERN and UCN@TRIUMF

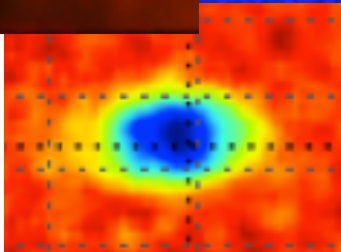


# Madison Research Group

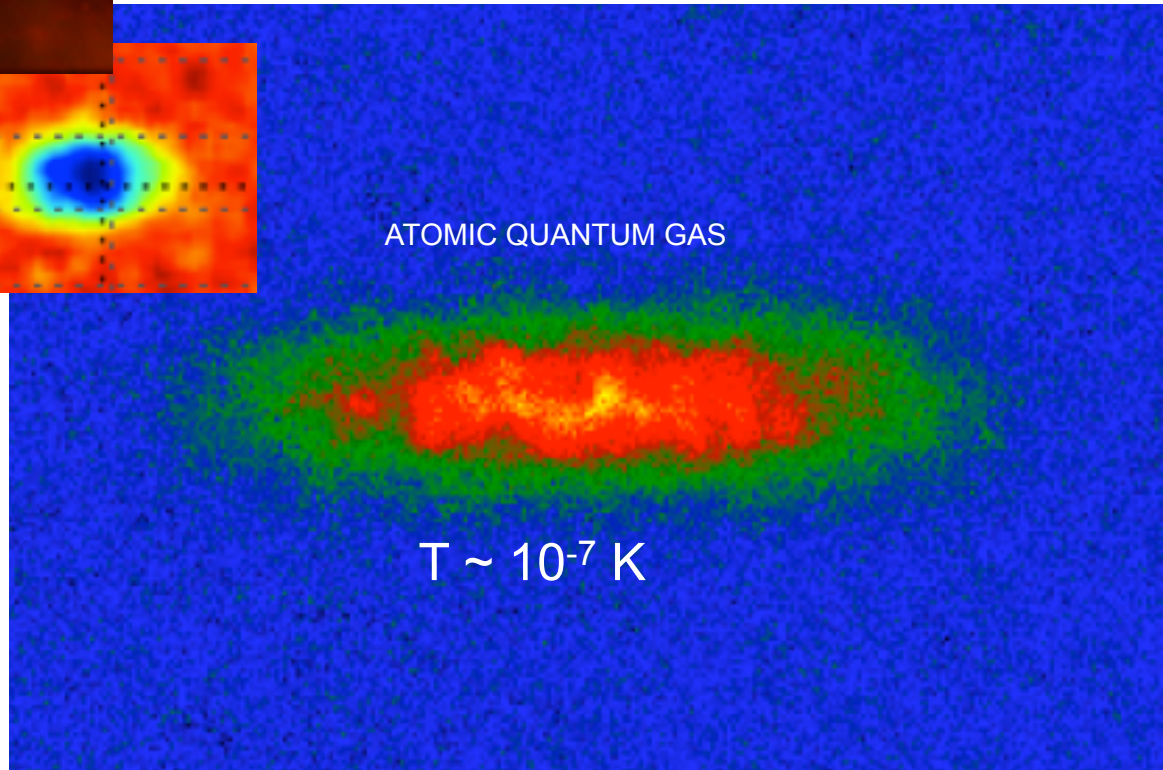
*Quantum gases and quantum sensors with cold atoms and molecules*



LASER COOLED GAS

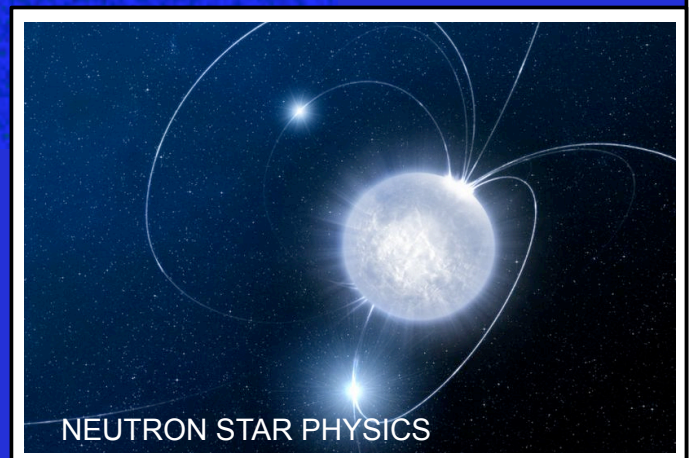
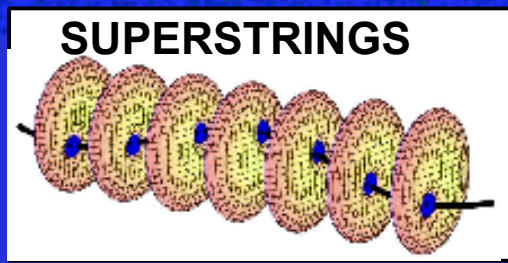
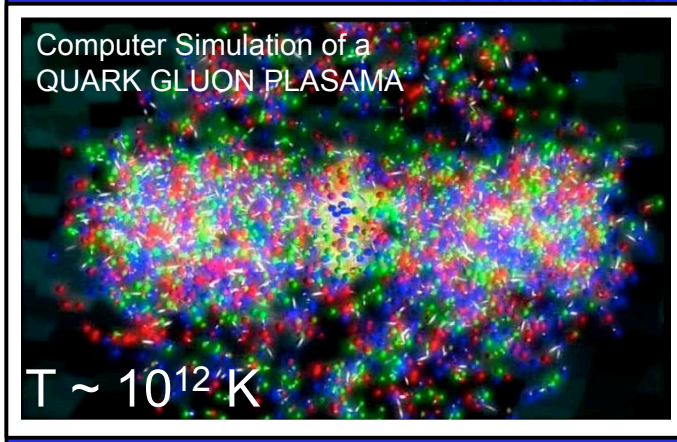
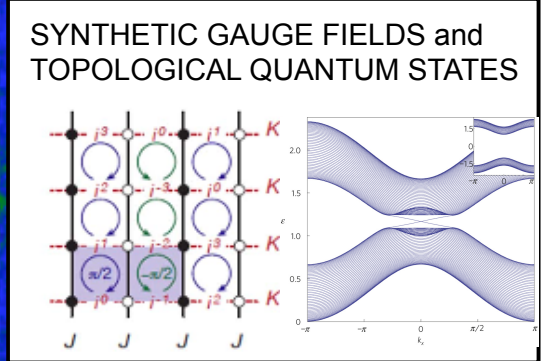
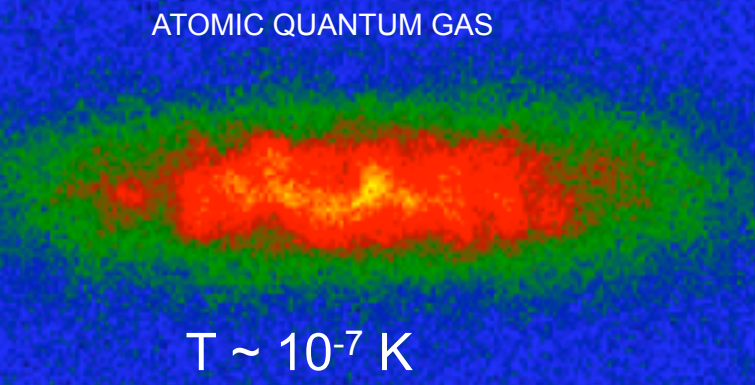
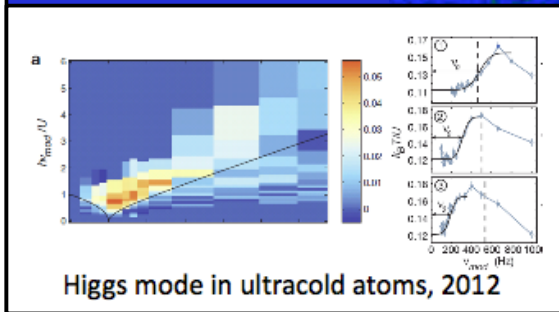
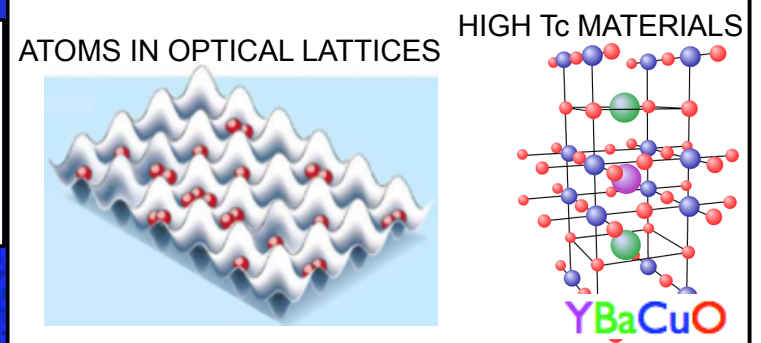
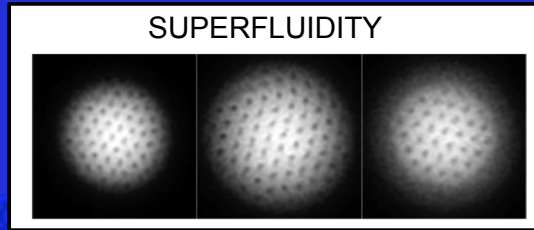
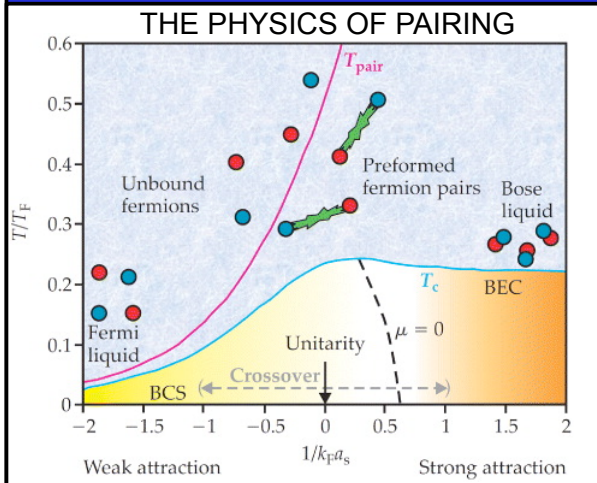


ATOMIC QUANTUM GAS



$T \sim 10^{-7} \text{ K}$

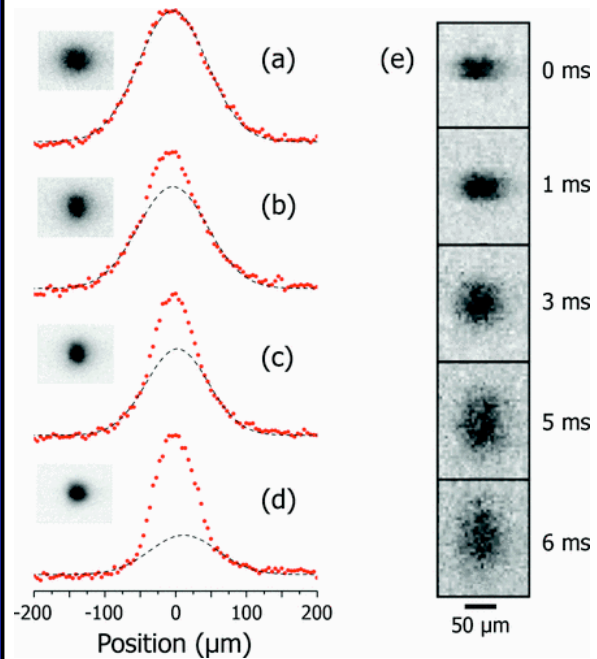
# Impact and applications of quantum gases



# Madison Research Group

Quantum gases and quantum sensors with cold atoms and molecules

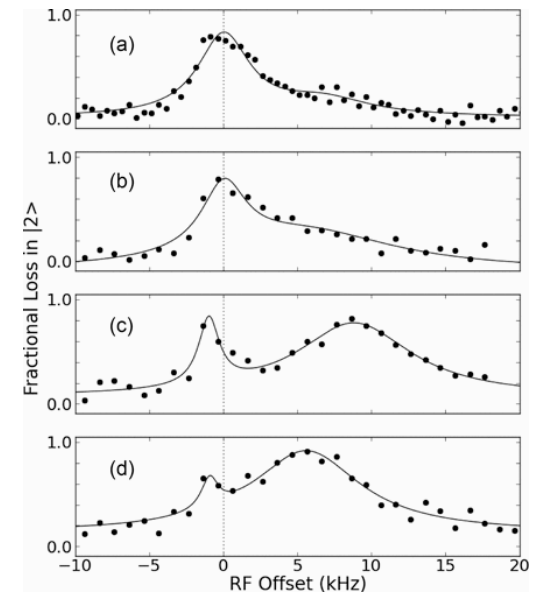
## Pictures of a molecular BEC



ATOMIC QUANTUM GAS

$T \sim 10^{-7}$  K

## RF spectroscopy of strongly interacting fermi atom pairs



Computer Simulation of a  
QUARK GLUON PLASAMA

$T \sim 10^{12}$  K

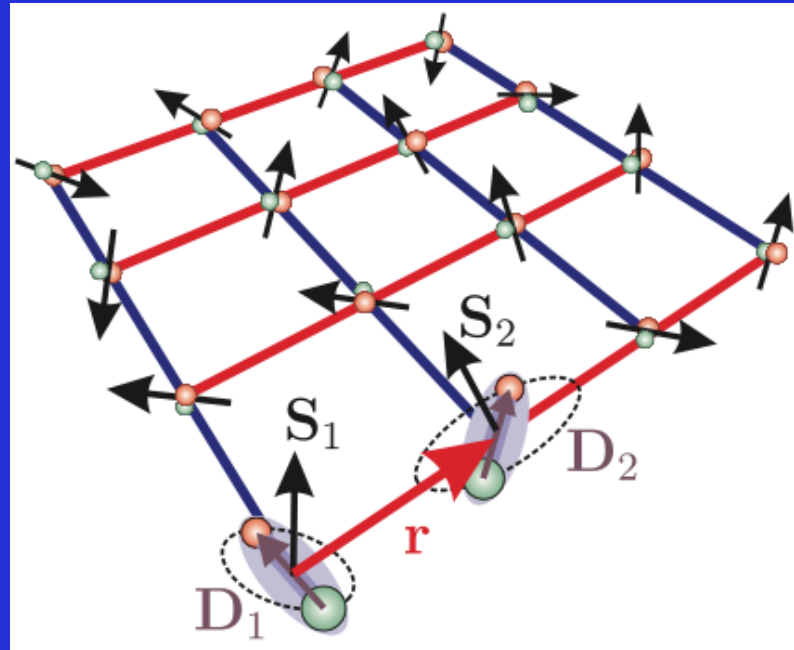
NEUTRON STAR PHYSICS



# Madison Research Group

*Quantum gases and quantum sensors with cold atoms and molecules*

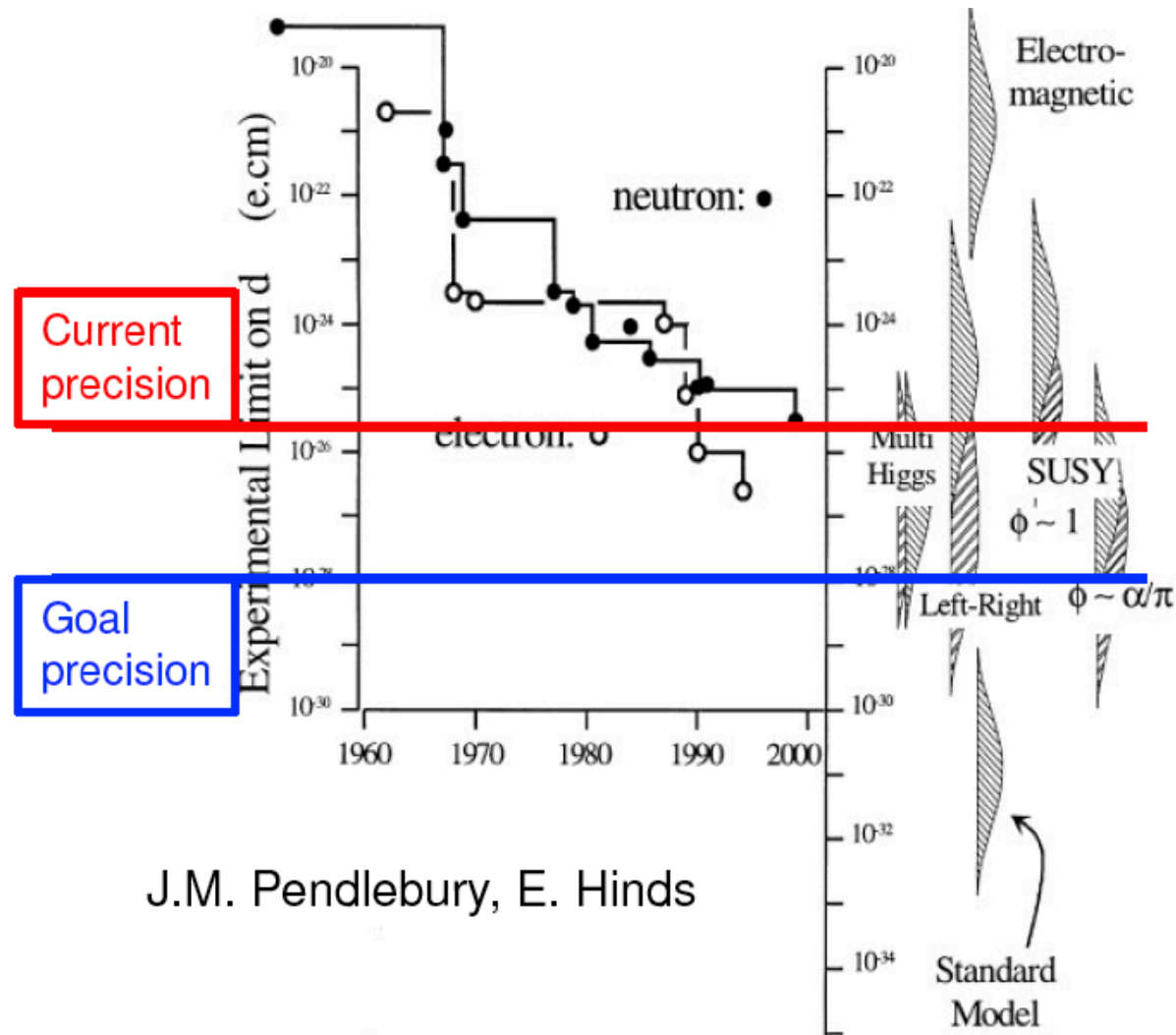
MOLECULAR QUANTUM GAS



# Jones/Madison/Momose (AMO for CPT tests)

Participation in International **Ultra-Cold Neutron Collaboration** (Japan, Canada, USA)

Goal is to measure the (hopefully zero) electric dipole moment of neutrons



J.M. Pendlebury, E. Hinds

# Jones/Madison/Momose (AMO for CPT tests)

Optical pump spin-polarized Xe and measure Larmor precession frequency

