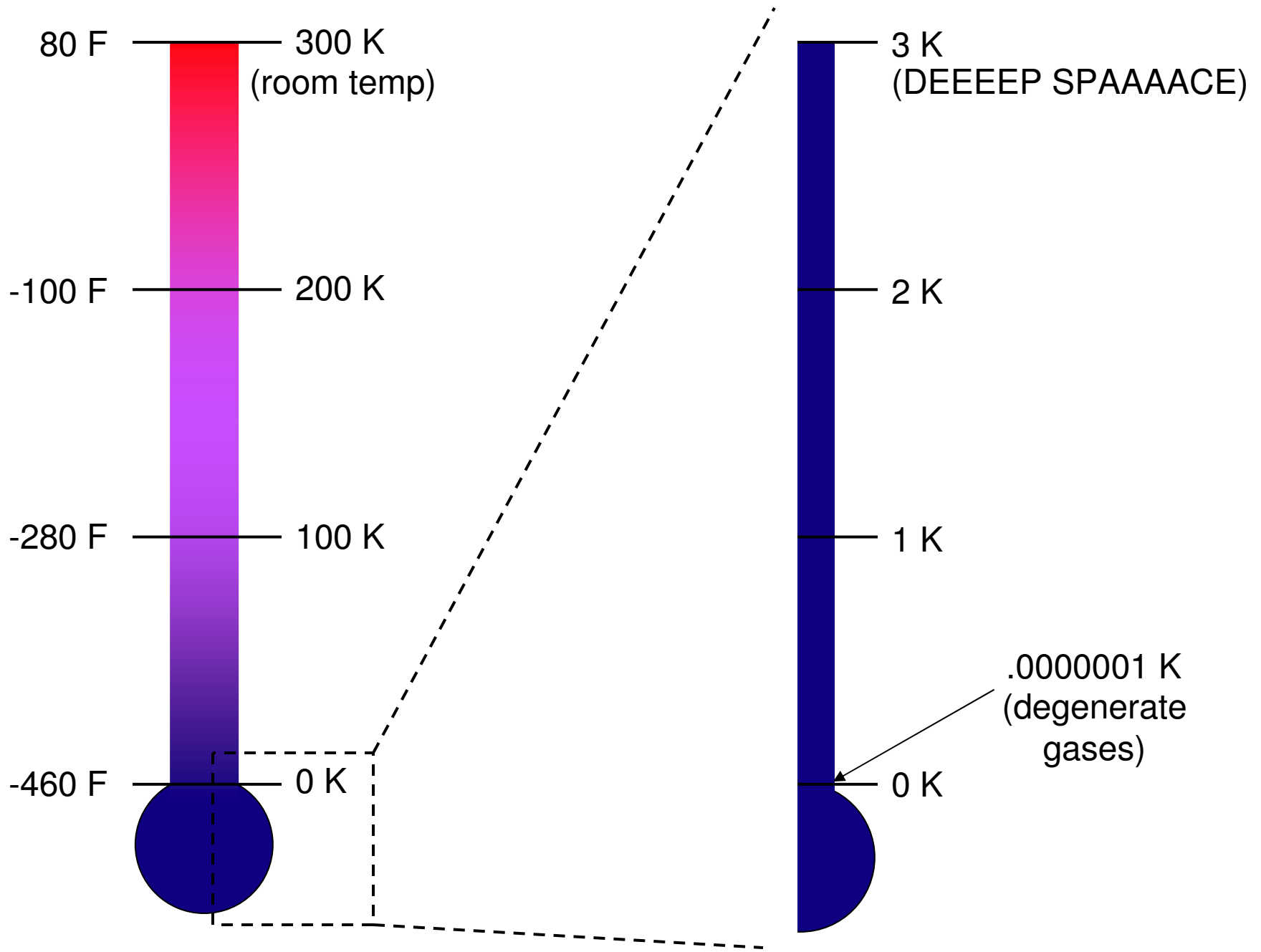


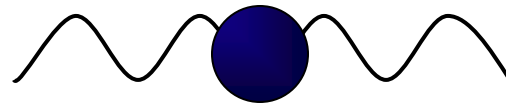
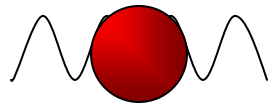
Bose-Einstein Condensates, Fermi Superfluid Gases, and Other Weird States of Matter

Stephen Granade



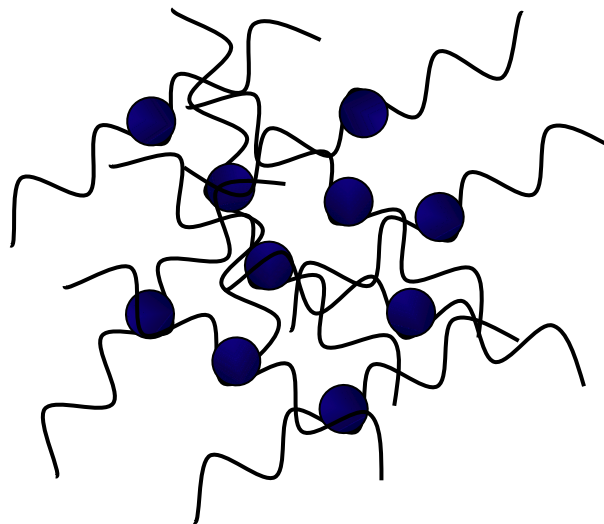
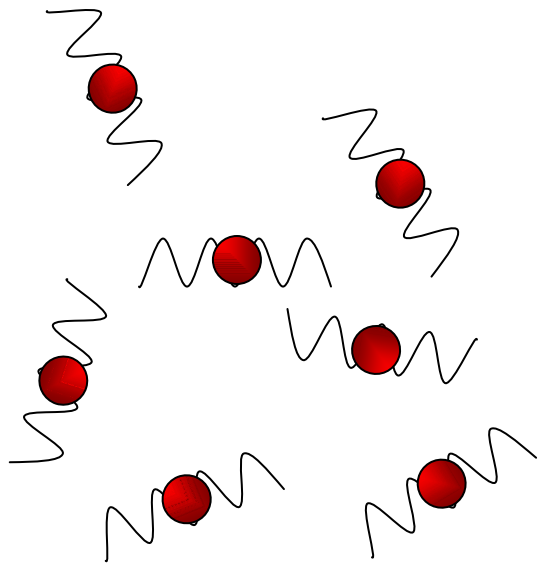
De Broglie Wavelength

$$\lambda = \frac{h}{mv}$$

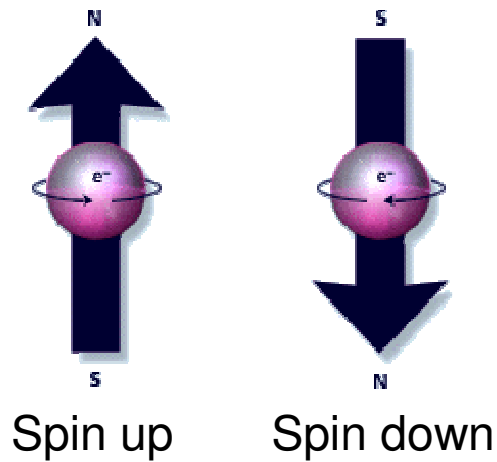


Lower temperatures and less motion mean larger wavelength

Phase Space Density



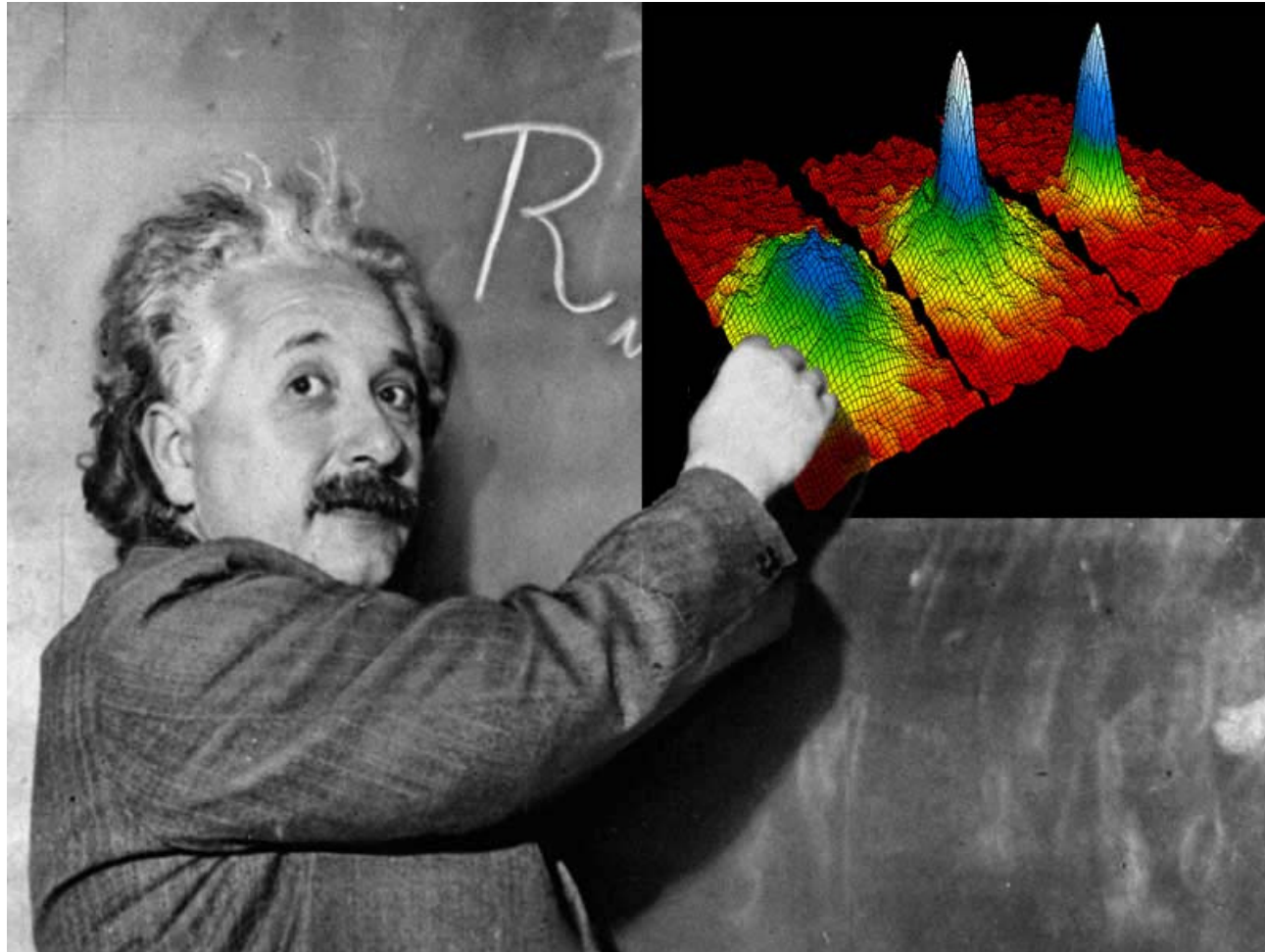
Spin



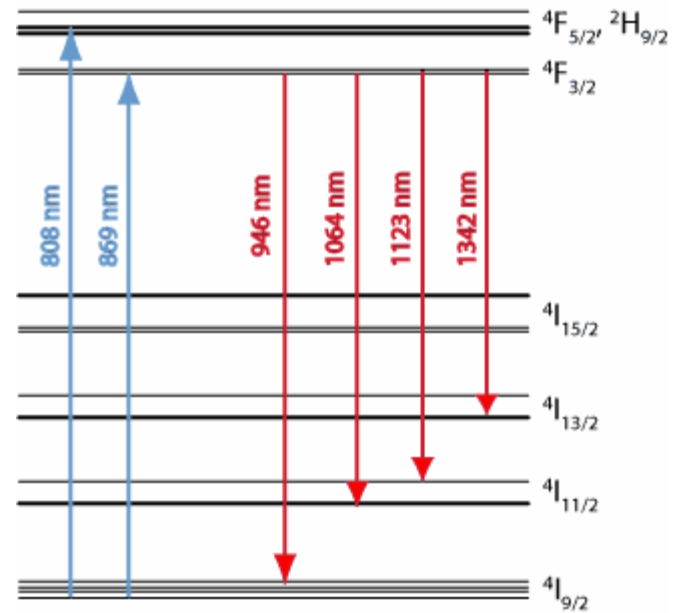
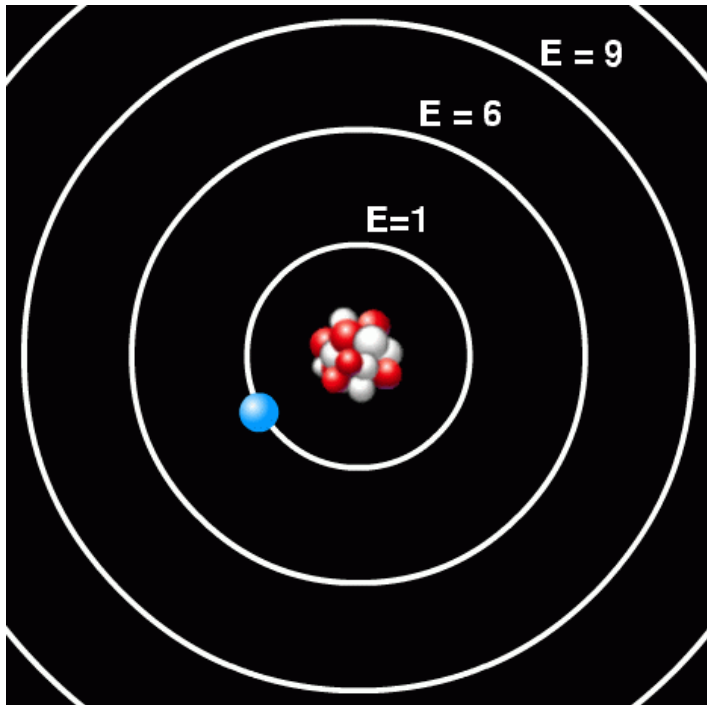
$$S = \hbar \sqrt{s(s+1)}$$

Quantized	Fermions	Bosons
$s = 0$	0	0
$1/2$	1/2	1/2
1	1	1
$3/2$	3/2	3/2
2	2	2
$5/2$	5/2	5/2
3	3	3
$7/2$	7/2	7/2
4	4	4
...

Bose Einstein Condensation

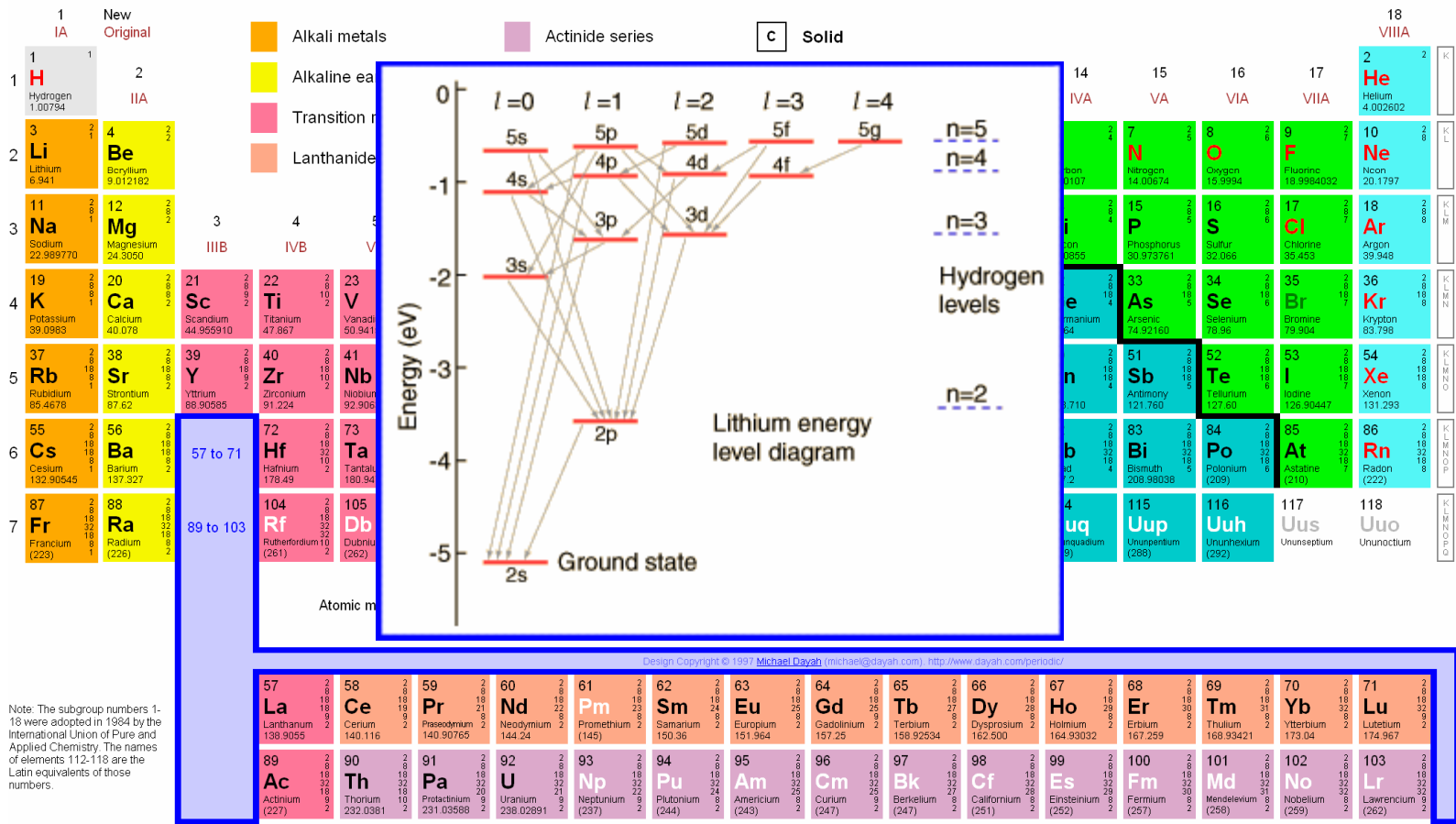


Atomic Energy Levels

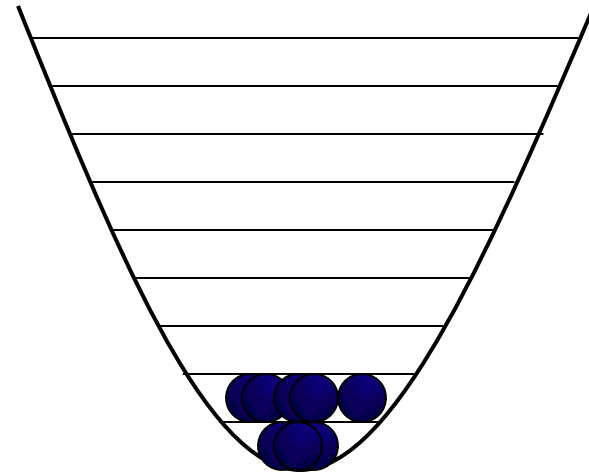
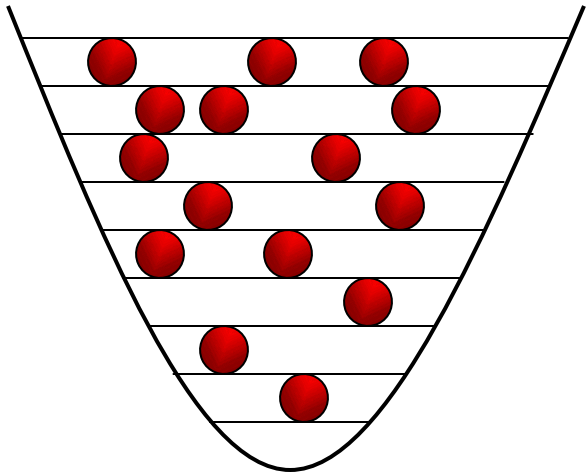


Alkali Atoms Are Bestest

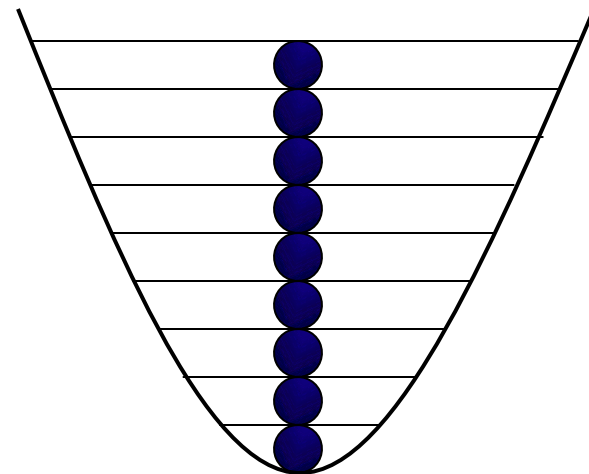
Periodic Table of the Elements



Atoms in a Box

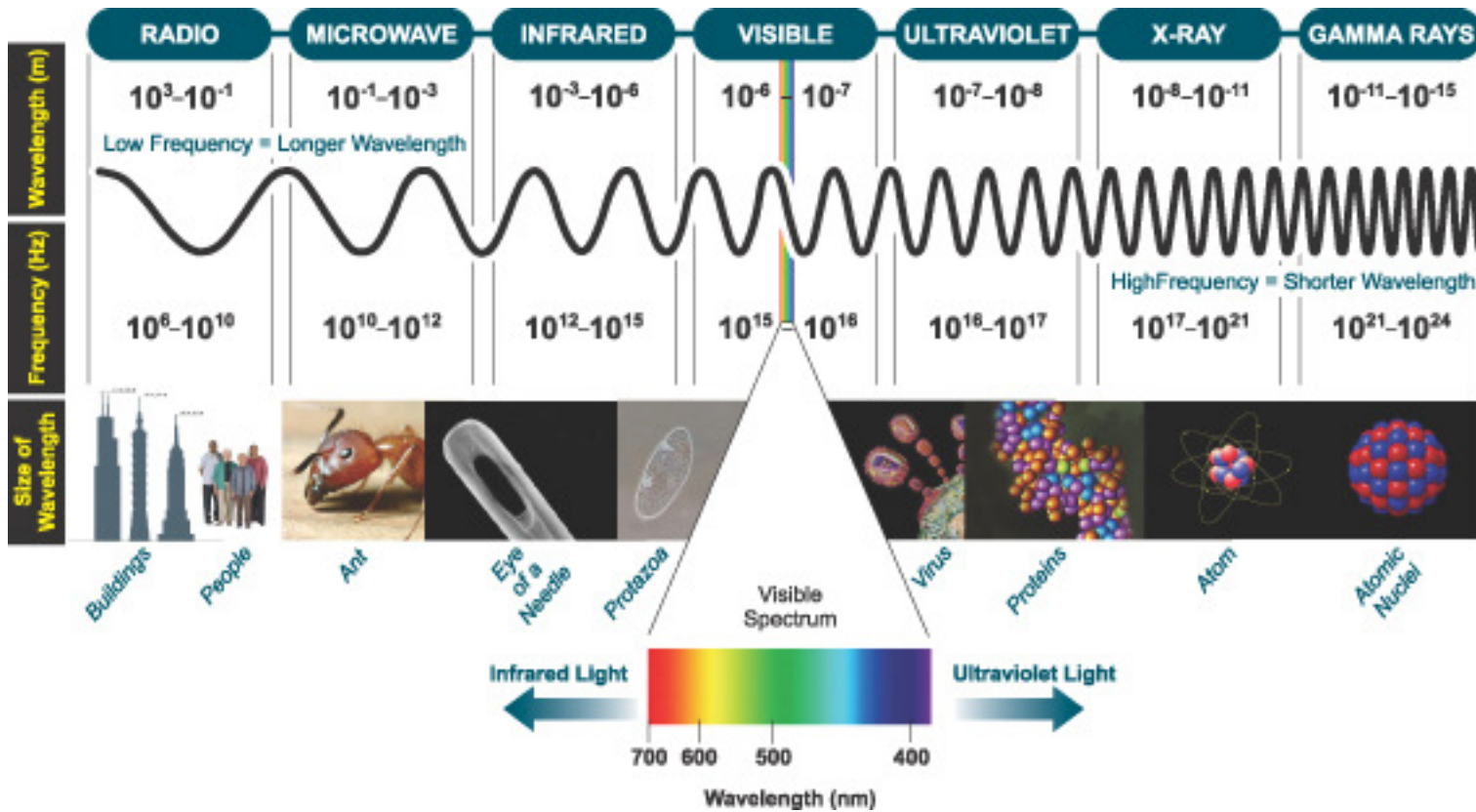


Bosons

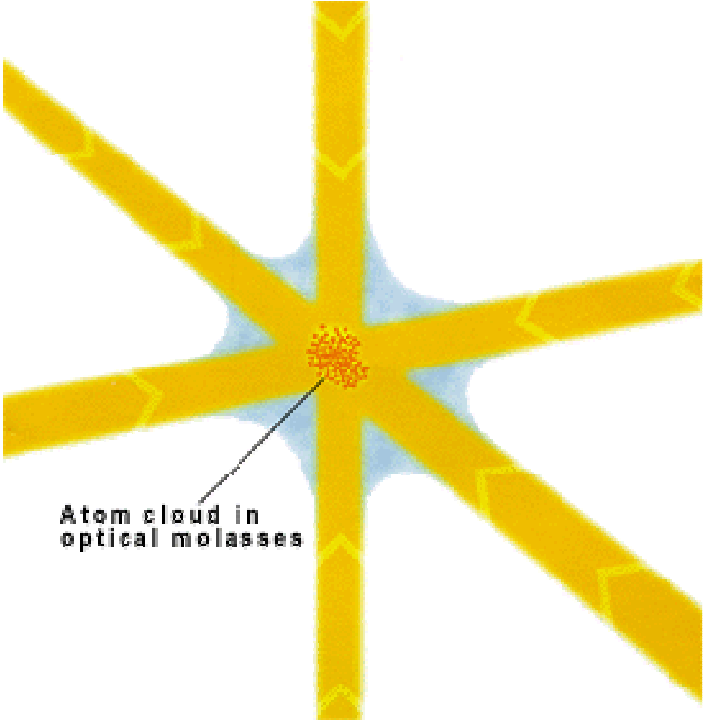


Fermions

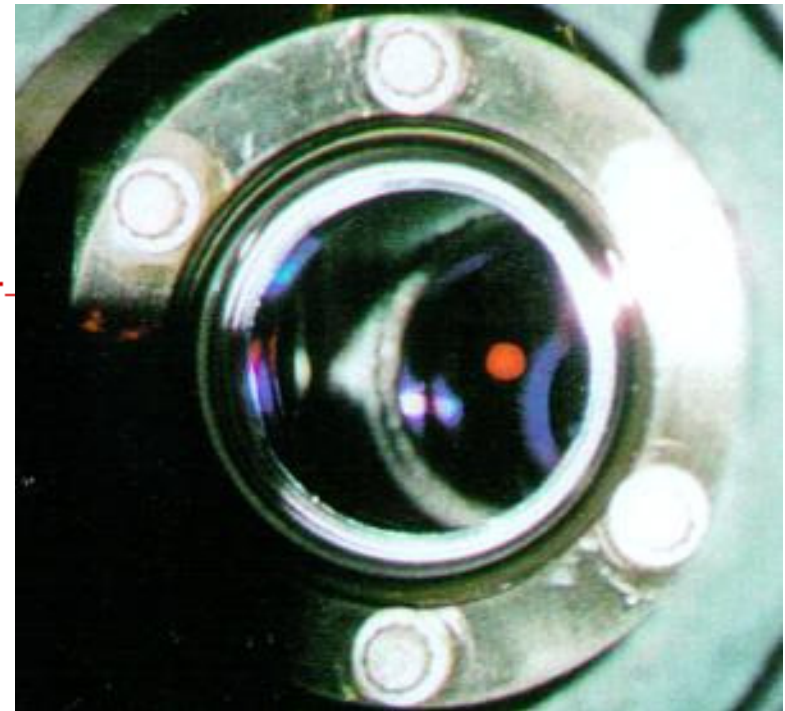
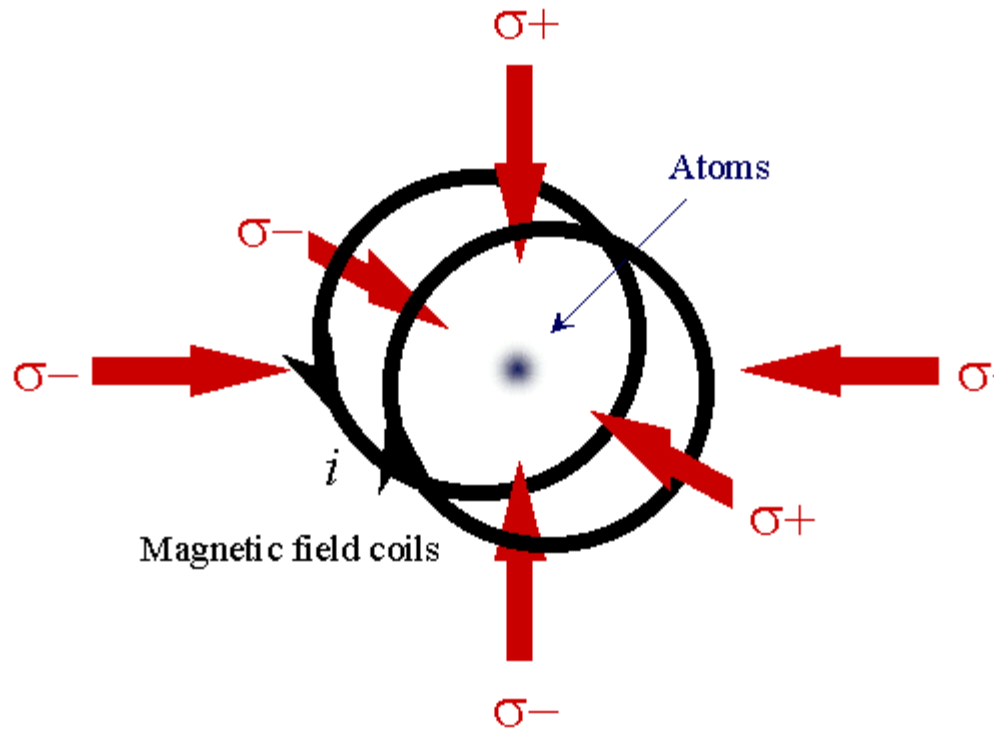
Light and Energy



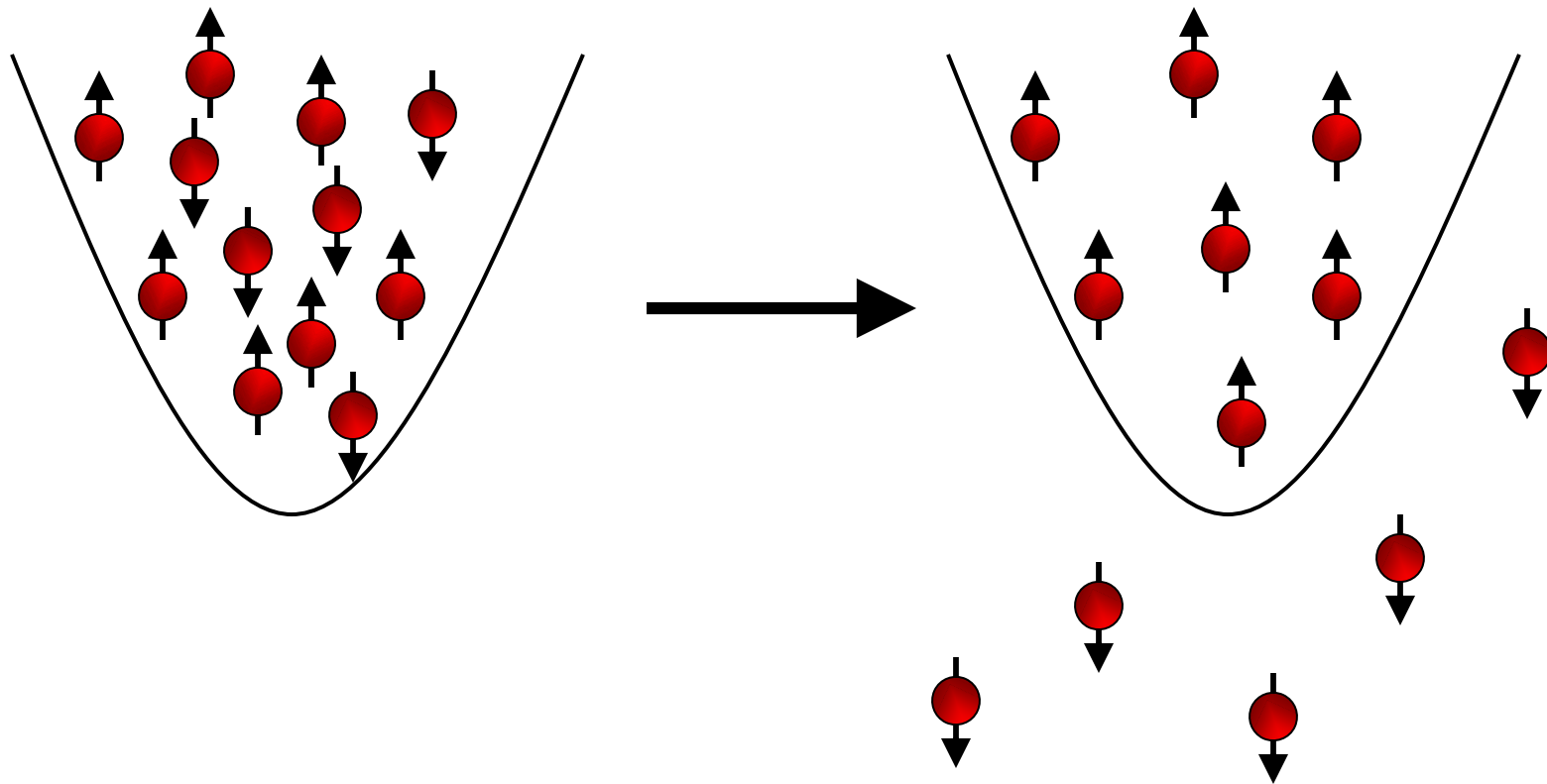
Optical Molasses



Magneto-Optical Trap

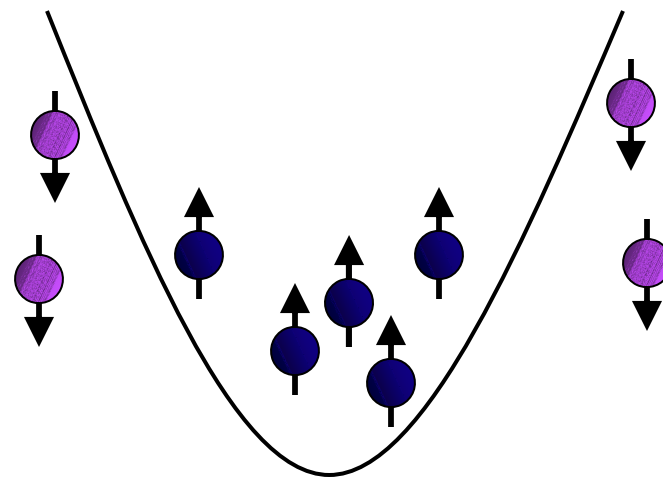
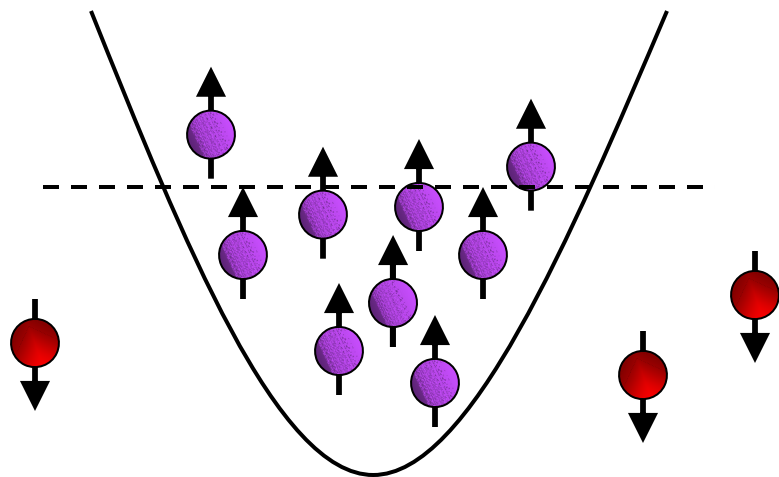
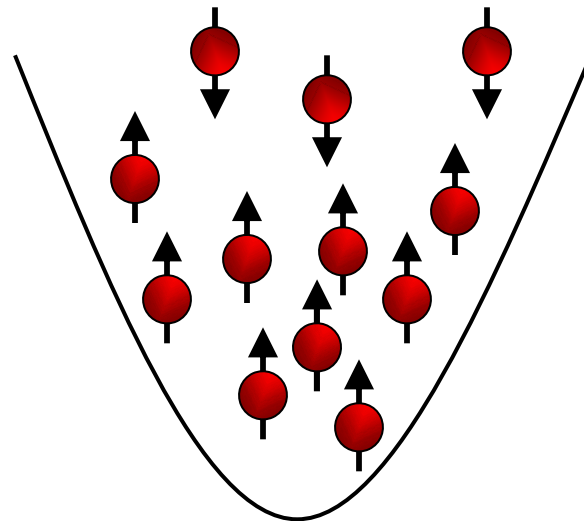
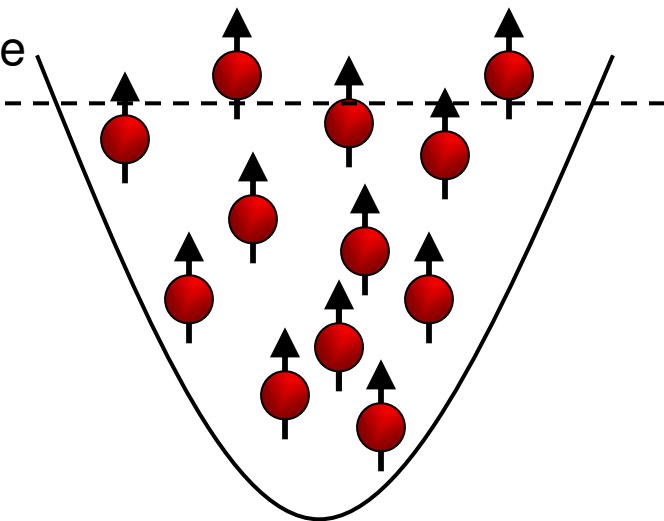


Magnetic Trap



Evaporative Cooling

RF
knife



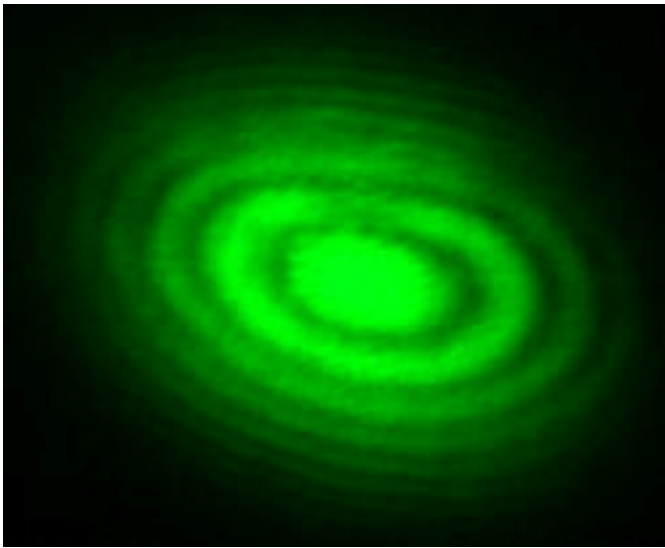
Making a BEC

(psst, Stephen, switch to the movie)

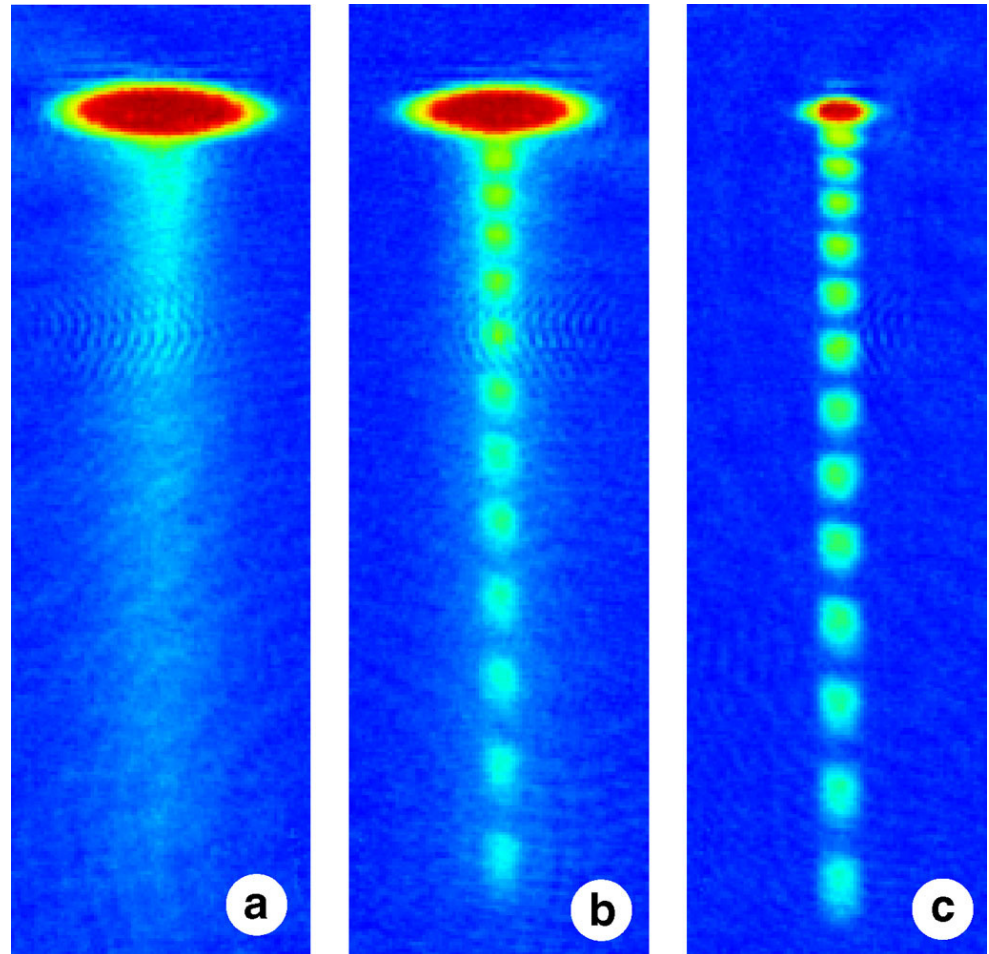
Nobel Prize!



Atom Laser and Interference

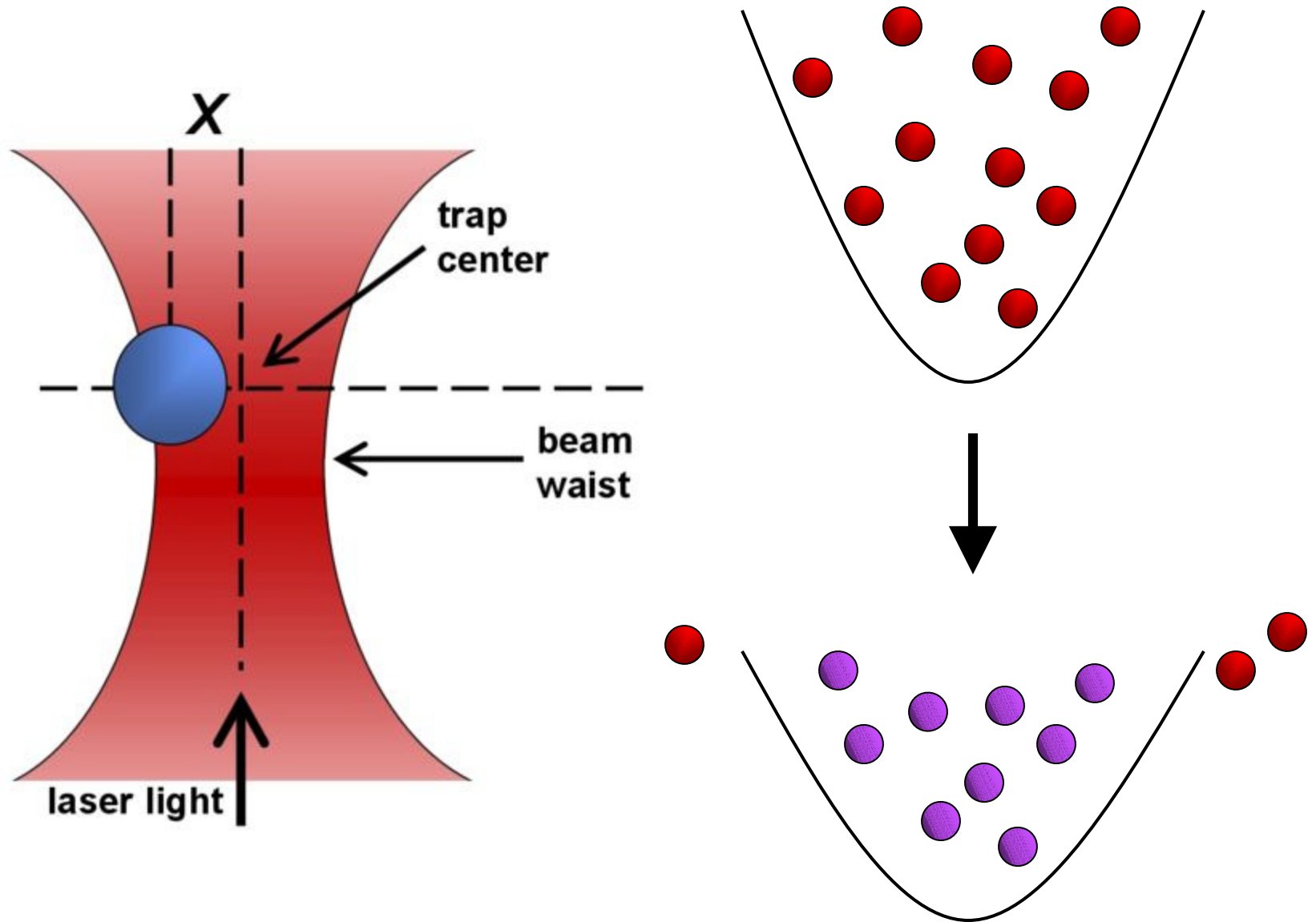


Light interference from visible laser



Interference from atom laser

Optical Trap



Vortices in Fermionic Superfluid

